

Hautakangas Wind Oy

## Rahkola- Hautakankaan tuulivoimahanke

Melu- ja varjostusmallinnusraportti

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# Rahkola- Hautakankaan tuulivoimahanke

## 1 MELU- JA VARJOSTUSMALLINNUKSEN TAVOITTEET

Hautakangas Wind Oy suunnittelee Rahkola-Hautakangas -nimistä tuulivoimapuistoa Oulaisten ja Haapaveden kaupunkien alueelle. Tuulivoimahankkeen aiheuttamia melu- ja varjostusvaikutuksia on arvioitu laatimalla mallinnukset tuulivoimaloiden aiheuttamista äänenpainetasoista ja varjostuksista. Mallinnusten tavoitteena on osoittaa, kuinka laajalle alueelle kyseiset vaikutukset ulottuvat ja arvioida vaikutukset lähiseudun ympärivuotiselle ja vapaa-ajan asutukselle.

Tuulivoimaloiden aiheuttamia meluvaikutuksia on arvioitu WindPRO-ohjelman DECIBEL-moduulilla. Tuulivoimaloiden aiheuttamat varjostusvaikutukset on mallinnettu WindPro-ohjelman SHADOW-moduulilla YVA-menettelyvaiheen kolmen hankevaihtoehdon voimaloiden sijoitussuunnitelmien perusteella. Melu- ja varjostusmallinnukset on laatinut Miikka Saranpää. Laaduntarkastuksen on tehnyt Johanna Harju FCG Finnish Consulting Group Oy:stä.

## 2 LÄHTÖTIEDOT JA MENETELMÄT

### 2.1 Melu

#### 2.1.1 Melumallinnus ISO 9613-2

Tuulivoimaloiden aiheuttamat äänenpainetasot on mallinnettu WindPRO-laskentaohjelman Decibel-moduulilla ISO 9613-2 standardin mukaisesti. Ympäristöhallinnon tuulivoimaloiden melun mallintamista koskevan ohjeen 2/2014 mukaisesti tuulen nopeutena käytettiin 10 m korkeudella mitattuna 8 m/s, ilman lämpötilana 15 °C, ilmanpaineena 101,325 kPa, ilman suhteellisenä kosteutena 70 % ja maanpinnan kovuutena arvoa 0,4. Laskenta on tehty 4,0 m maan pinnan tasosta.

Hankevaihtoehdoissa 1 ja 3 voimalamäärä on 40 kpl, joista 27 kpl sijoittuu Oulaisten alueelle ja 13 kpl Haapaveden alueelle. Hankevaihtoehdossa 2 voimalamäärä on pienempi, koostuen yhteensä 25 tuulivoimalaitoksesta. Hankevaihtoehdossa 2 Oulaisten alueelle sijoittuu 14 voimalaitosta ja Haapaveden alueelle 11 voimalaitosta. Tuulivoimaloiden äänenpainetasot on mallinnettu kaikissa kolmessa hankevaihtoehdoissa käyttäen GE 158-6,1 MW voimalaitosta (Taulukko 1). Hankevaihtoehdoissa 1 ja 2 Oulaisten puolelle sijoittuvien voimalaitosten napakorkeutena on käytetty 171 metriä, jolloin voimalaitosten kokonaiskorkeudeksi muodostuu 250 metriä. Haapaveden alueelle sijoittuvien voimalaitosten napakorkeutena on käytetty 221 metriä, jolloin voimalaitosten kokonaiskorkeudeksi muodostuu 300 metriä. Hankevaihtoehdossa 3 on kaikissa voimalaitoksissa napakorkeutena käytetty 221 metriä, jolloin voimalaitosten kokonaiskorkeudeksi muodostuu 300 metriä. GE 158-6,1 MW voimalaitoksen valmistajan ilmoittama tuulivoimalan tuottama äänitehotaso on 107,0 dB(A). Valmistajan ilmoittamiin melupäästöarvoihin on lisätty 2 dB varmuusarvo ympäristöministeriön antaman ohjeistuksen mukaisesti.

Yhteismelun mallinnoissa on huomioitu Rahkola-Hautakankaan suunniteltujen tuulivoimaloiden lisäksi Puutionsaaren tuulivoimahankkeen suunnitellut (49 kpl) tuulivoimalat. Puutionsaaren tuulivoimalat on mallinnettu napakorkeuksiltaan 200 m korkeilla GE 158 voimaloita, joiden roottorin halkaisija on 158 metriä. Voimalaitoksen äänitehotasona (LWA) on käytetty 108 dB(A) (Taulukko 2).

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

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Taulukko 1. Rahkola-Hautakangas tuulivoimahankkeen mallinnusohjelma ja tuulivoimaloiden äänitehotasot voimalaitoksella GE 158-6,1 MW sekä melun erityispiirteet.

MALLINNUSOHJELMAN TIEDOT							
Mallinnusohjelma ja versio: WindPRO version 3.4.388				Mallinnusmenetelmä: ISO 9613-2			
TUULIVOIMALOIDEN TIEDOT							
Tuulivoimalan valmistaja: GE Renewable Energy			Tyyppi: GE 158 – 6,1 MW			Sarjanumero/t:-	
Nimellisteho: 6,1 MW		Napakorkeus: 171 m / 221 m		Roottorin halkaisija: 158 m		Tornin tyyppi: teräs/hybridi	
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	Kyllä
Ei			Ei			Noise mode, lähtömelutaso	107 dB (+ 2 dB)
AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT							
<i>Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01</i>							
Valmistajan ilmoittamaan tuulivoimalan tuottamaan äänitehotasoon on lisätty epävarmuus 2 dB(A) jotta on saatu äänitehotaso vastaamaan takuuarvoa.							
Oktaaveittain [Hz],dB(A)		1/3-oktaaveittain [Hz] LWA dB					
		12,5	54,5	125	90,5	1250	100,2
63	90,2	16	60,9	160	91,9	1600	98,9
125	95,4	20	66,1	200	93,5	2000	97,5
250	99,9	25	70,8	250	95	2500	95,5
500	102,4	31,5	75,2	315	96,3	3150	92,9
1000	104,4	40	79,1	400	96,9	4000	88,9
2000	102,3	50	82,4	500	97,7	5000	84,8
4000	94,8	63	85,2	630	98,3	6300	78,3
8000	78,8	80	87,4	800	99	8000	68,7
<b>109,0 dB(A)</b>		100	89	1000	99,6	10000	56,1
Melun erityispiirteiden mittaust ja havainnot:							
Kapeakaistaisuus / Tonaalisuus		Impulssimaisuus		Merkityksellinen sykintä (amplitudi- modulaatio)		Muu, Mikä:	
kyllä	ei	kyllä	ei	kyllä	ei	kyllä	ei



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Taulukko 2. Puutionsaaren tuulivoimaloiden GE158-5.3MW HH200 tyyppitiedot ja äänitehotasot sekä melun erityispiirteet.

TUULIVOIMALOIDEN TIEDOT							
Tuulivoimalan valmistaja: General Electric				Tyyppi: GE158		Sarjanumero/t:-	
Nimellisteho: 5,3 MW		Napakorkeus: 200 m		Roottorin halkaisija: 158 m		Tornin tyyppi: teräs	
Mahdollisuudet vaikuttaa tuulivoimalan melupäästöön käytön aikana ja sen vaikutus meluun							
Lapakulman säätö		Pyörimisnopeus		Muu, mikä			
Kyllä	-	dB	Kyllä	-	dB	Noise mode säätö:	Mode 0 STE – Level
Ei			Ei			Noise mode, lähtömelutaso	106,0 dB(A)
AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT							
Melupäästötiedot perustuvat dokumenttiin: Noise_Emission-NO_5.3-158-50Hz_IEC_EN_r01.pdf							
Valmistajan ilmoittama tuulivoimalan tuottama äänitehotaso vastaa keskiäänitasoa, jolloin voimalan lähtöarvoihin on lisätty +2 dB vastaamaan ylempää luottamusväliä 95%.							
Oktaaveittain [Hz], dB(A)		1/3-oktaaveittain [Hz], dB(A)					
31,5	-	20	65,1	200	92,8	2000	96,3
63	89,2	25	69,8	250	94,3	2500	94,3
125	94,6	31,5	74,2	315	95,6	3150	91,7
250	99,2	40	78,1	400	96,1	4000	87,9
500	101,6	50	81,4	500	96,9	5000	83,8
1000	103,3	63	84,2	630	97,5	6300	77,5
2000	101,1	80	86,4	800	98	8000	67,9
4000	93,7	100	88,1	1000	98,5	10000	55,3
8000	78	125	89,7	1250	99		
<b>108,0 dB(A)</b>		160	91,2	1600	97,7		
Melun erityispiirteiden mittausta ja havainnot:							
Kapeakaistaisuus / Tonaalisuus		Impulssimaisuus		Merkityksellinen sykintä (amplitudimodulaatio)		Muu, Mikä:	
Kyllä	Ei	Kyllä	ei	Kyllä	ei	Kyllä	ei

### 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, Haka-

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la ja Hongisto, 2018) julkistamien Anojanssi projektin tulosten mukaisten ääneneristävyyssarvoin ja tuloksia verrattiin toimenpiderajoihin.

Anojanssi projektissa mitattiin ilmaääneneristävyys standardin ISO 16283-3:2016 mukaan. Projektissa valittiin 13 pientaloa ja 26 julkisivurakennetta niin, että edustettuina oli kevyitä, raskaita, uusia ja vanhoja julkisivurakenteita. Tuloksista johdettiin 84 % persentiili, joka kertoo arvon, joka ylittyi 84 % mitatuista suomalaisista pientaloista.

*Taulukko 3. Suomalaisen pientalon julkisivun äänitasoeron alalikiarvo Anojanssi projektin tulosten mukaisesti.*

f [Hz]	20	25	31.5	40	50	63	80	100	125	160	200
DL <sub>σ</sub> [dB]	7.6	8.3	9.2	10.3	11.5	13.0	14.8	16.8	18.8	21.1	22.8

Matalataajuisten melun laskelmassa huomioitiin maanpinnan muodon vaikutus ohjeen 4/2014 mukaisesti. Tulokset on esitetty taajuuskohtaisena taulukkona hankealuetta ympäröiville asuin- ja lomarakennuksille.

*Taulukko 4. Käytetyt mallinnusparametrit ISO 9613-2 laskelmissa*

AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT			
Laskenta korkeus		Laskentaruudun koko [m·m]	
ISO 9613-2: 4,0 m		25x25 m	
Suhteellinen kosteus		Lämpötila	
70 %	Muu, mikä ja miksi:	ISO 9613-2: 15 C°	
Maastomallin lähde ja tarkkuus			
Maastomallin lähde: MML maastotietokanta		Vaakaresoluutio:1,0	Pystyresoluutio:0,5
Maan- ja vedenpinnan absorptio ja heijastuksen huomioiminen, käytetyt kertoimet			
ISO 9613-2	0,4 / vesialueilla 0		HUOM
Ilmakehän stabiilius laskennassa/meteorologinen korjaus			
Neutraali, (0): Neutraali		Muu, mikä ja miksi:	
Sääolosuhteiden huomiointi; laskennassa käytetty tuulen suunnat ja nopeus			
Tuulen suunta: 0-360°		Tuulen nopeus: 10 metrin korkeudella mitattuna 8 m/s	
Voimalan äänen suuntaavuus ja vaimentuminen			
Vapaa avaruus: kyllä		Muu, mikä, miksi:	

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## 2.2 Varjostusmallinnus

Tuulivoimaloiden varjostusvaikutukset on mallinnettu kaikissa hankevaihtoehdoissa käyttäen roottorinhalkaisijaltaan 200 metristä voimalaitosta. Hankevaihtoehdoissa 1 ja 2 napakorkeudet ovat Oulaisten puolella 150 metriä ja Haapaveden puolella 200 metriä, kokonaiskorkeudeltaan voimala ovat tällöin 250 ja 300 metriä. Hankevaihtoehdossa 3 on käytetty kaikissa tuulivoimalassa 200 metrin napakorkeutta, eli 300 metrin kokonaiskorkeutta.

Varjostuksen yhteismallinnuksissa on huomioitu Rahkola-Hautakankaan suunniteltujen tuulivoimaloiden lisäksi suunnitellut Puutionsaaren (49 kpl) tuulivoimalat. Puutionsaaren tuulivoimalat on mallinnettu napakorkeuksiltaan 200 m korkeilla voimaloilla, joiden roottorin halkaisija on 200 metriä.

*Taulukko 5. Rahkola-Hautakanggs tuulivoimahankkeen mallinnusohjelma ja tuulivoimaloiden koko varjostusmallinnuksissa.*

MALLINNUSOHJELMAN TIEDOT			
Mallinnusohjelma ja versio: WindPRO versiot 3.4.388, 3.5.584		Mallinnusmenetelmä: ISO 9613-2	
TUULIVOIMALAN (TUULIVOIMALOIDEN TIEDOT)			
Tuulivoimalan valmistaja: Generic		Tyyppi: RD200	Sarjanumero/t:-
Nimellisteho:	Napakorkeus: 150/200 m	Roottorin halkaisija: 200 m	Tornin tyyppi: teräs/hybridi

Varjostusvaikutuksia mallinnettiin WindPRO-ohjelman Shadow-moduulilla. Laskennassa varjot huomioidaan, kun aurinko on yli 3 astetta horisontin yläpuolella. Varjoksi lasketaan tilanne, jossa siipi peittää vähintään 20 % auringosta.

Varjostusmallin laskennassa on huomioitu hankealueen korkeustiedot, tuulivoimaloiden sijainnit, tuulivoimalan napakorkeudet ja roottorin halkaisija sekä hankealueen aikavyöhyke. Mallinnuksessa otettiin huomioon auringon asema horisontissa eri kellon- ja vuodenaikoina, pilvisuus 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 voimaloi- ta kohti ns. ”greenhouse mode”.

Auringon keskimääräiset paistetunnit perustuvat Oulun Oulunsalon sääaseman mitattuihin säätietoihin 1981 - 2010. Laskentojen tuulen suunta ja nopeusjakamana 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 erikseen laskettu vaikutus tuulivoimahankealueen ympäristössä oleviin herkkiin kohteisiin.

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## 2.3 Raja- ja ohjearvot

### 2.3.1 Melu

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

*Taulukko 6. Valtioneuvoston asetuksen mukaiset tuulivoimaloiden melutason toimenpiderajat (Valtioneuvoston asetus 27.8.2015).*

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 keskiäänitasoina tersseittäin. Toimenpiderajat koskevat yöaikaa ja päivällä sallitaan 5 dB suuremmat arvot.

*Taulukko 7. Matalataajuisen sisämelun tunnin keskiäänitason toimenpiderajat nukkumiseen tarkoitetuissa tiloissa.*

Terssikaista Hz	20	25	31,5	40	50	63	80	100	125	160	200
Keskiäänitaso L <sub>Zeq</sub> ,1h, dB	74	64	56	49	44	42	40	38	36	34	32
Edellisestä laskettu keskiäänitaso A-painotettuna L <sub>Aeq</sub> ,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<sub>Aeq</sub>,1h mitattuna niissä tiloissa, jotka on tarkoitettu nukkumiseen.

### 2.3.2 Varjostus

Suomessa ei ole viranomaisten antamia yleisiä määräyksiä tuulivoimaloiden muodostaman varjostuksen enimmäiskestoista eikä varjonmuodostuksen arviointiperusteista. Ympäristöministeriön tuu-

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livoimarakentamisen suunnitteluohjeistuksessa 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.

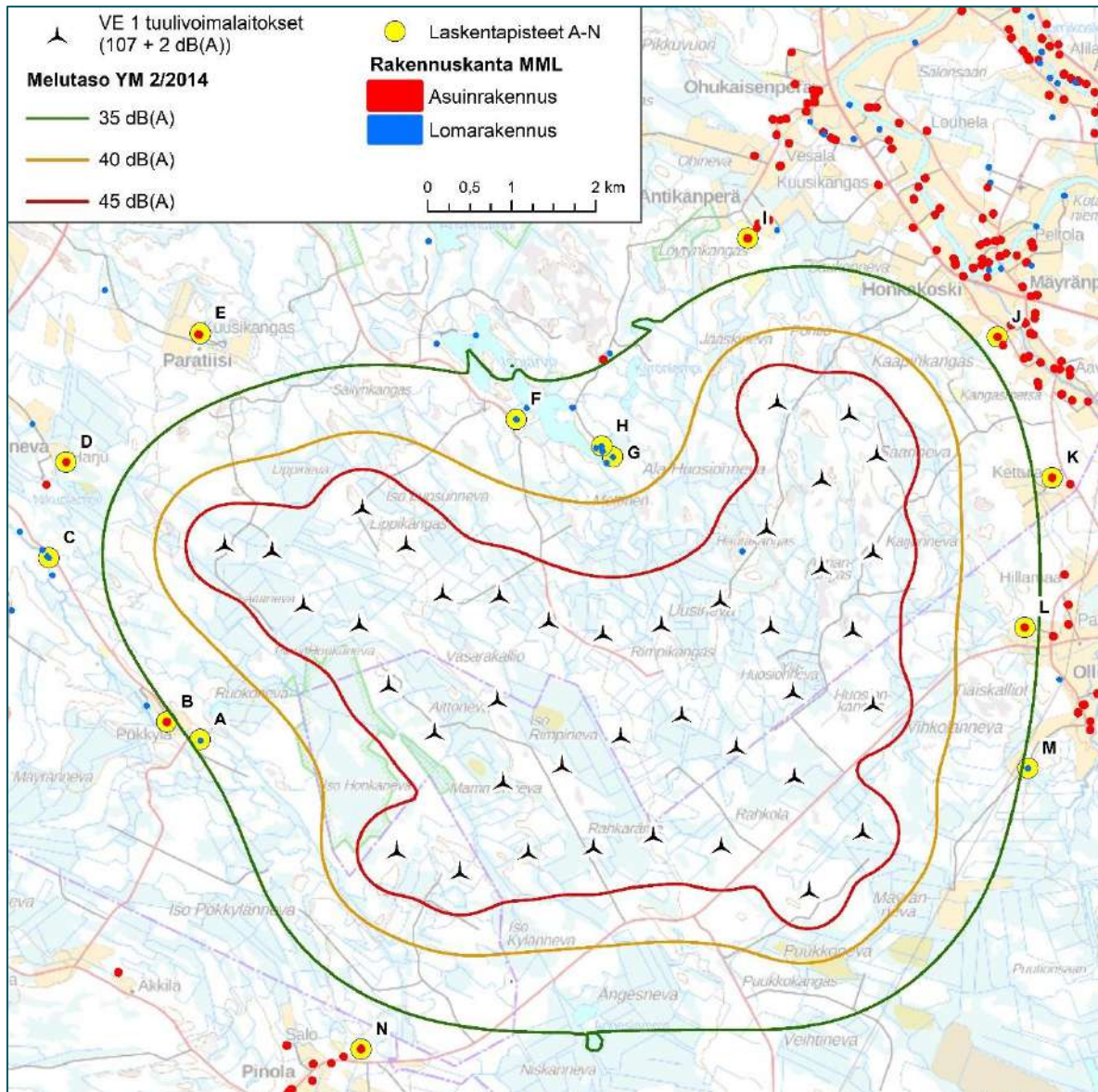
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### 3 MELU- JA VARJOSTUSMALLINNUSTEN TULOKSET

#### 3.1 Melu

##### 3.1.1 VE1: Melun laskentatulokset (ISO 9613-2)

Hankevaihtoehdon (VE1) melumallinnuksen mukaan melutaso 40 dB(A) ei ylitä lähimmillä asuin- ja lomarakennuksilla. Katso tarkemmat laskentatulokset liitteestä 1.



Kuva 1. Melumallinnuksen tulos hankevaihtoehdossa 1

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*Taulukko 8. Laskennalliset melutasot Rahkola-Hautakankaan tuulivoimahankkeen ympäristössä hankevaihtoehdossa 1*

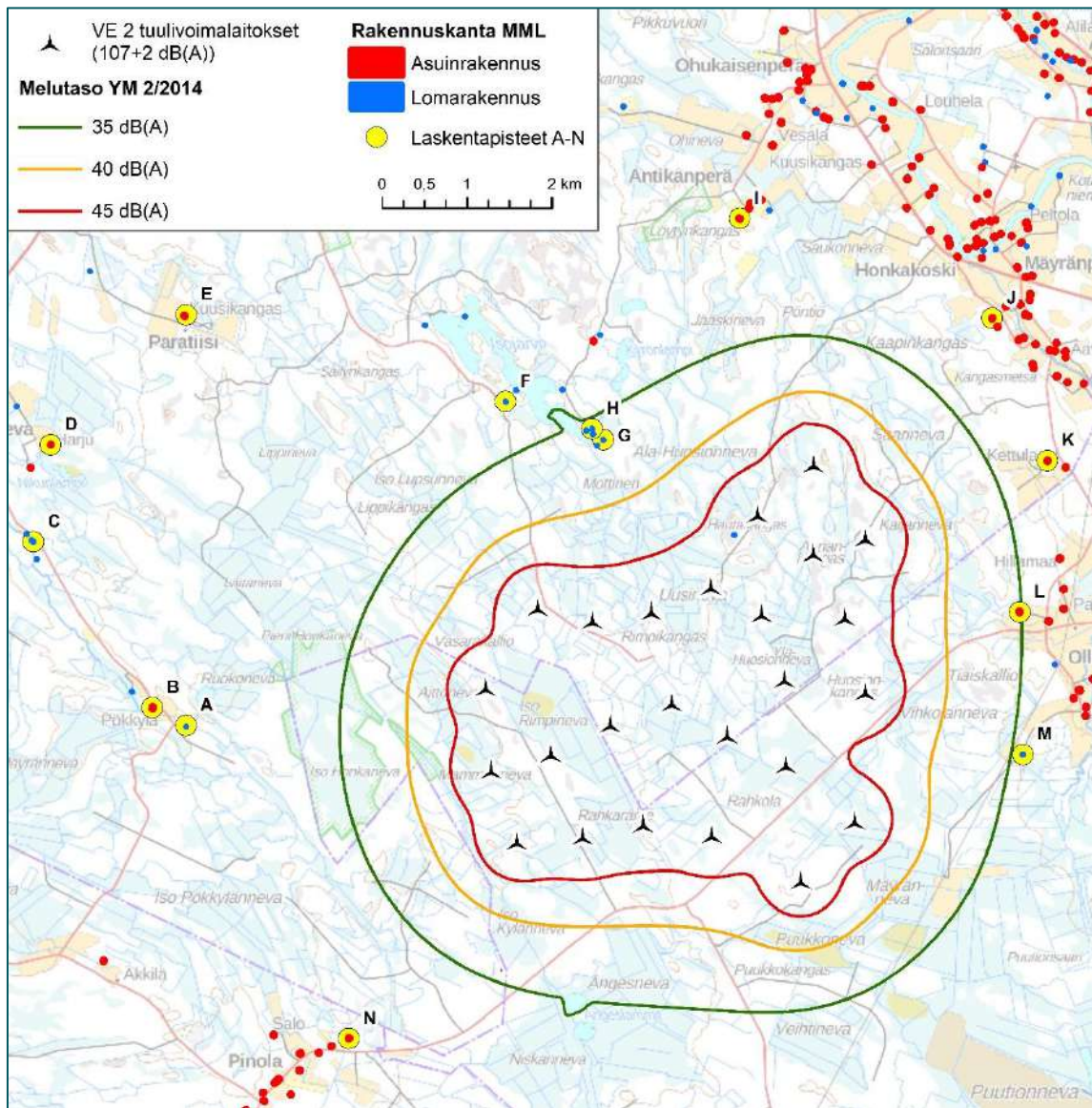
Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Lomarakennus A (Pökkylä)	394971	7114786	80	4,0	35,4
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	4,0	34,6
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	4,0	31,7
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	4,0	31,4
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	4,0	31,4
Lomarakennus F (Isojärventie)	398737	7118604	90	4,0	36,6
Lomarakennus G (Antikantie)	399889	7118156	90,8	4,0	38,2
Lomarakennus H (Antikantie)	399756	7118284	92,5	4,0	37,8
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	4,0	33
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	4,0	33,8
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	4,0	34
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	4,0	35,7
Lomarakennus M (Siliäkuru)	404833	7114443	100	4,0	34,7
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	4,0	32,4

### 3.1.2 VE2: Melun laskentatulokset ISO 9613-2)

Hankevaihtoehdon 2 (VE2) melumallinnuksen mukaan melutaso 40 dB(A) ei ylitä lähimmillä asuin- ja lomarakennuksilla. Katso tarkemmat laskentatulokset liitteestä 2.



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Kuva 2. Melumallinnuksen tulos hankevaihtoehdossa 2



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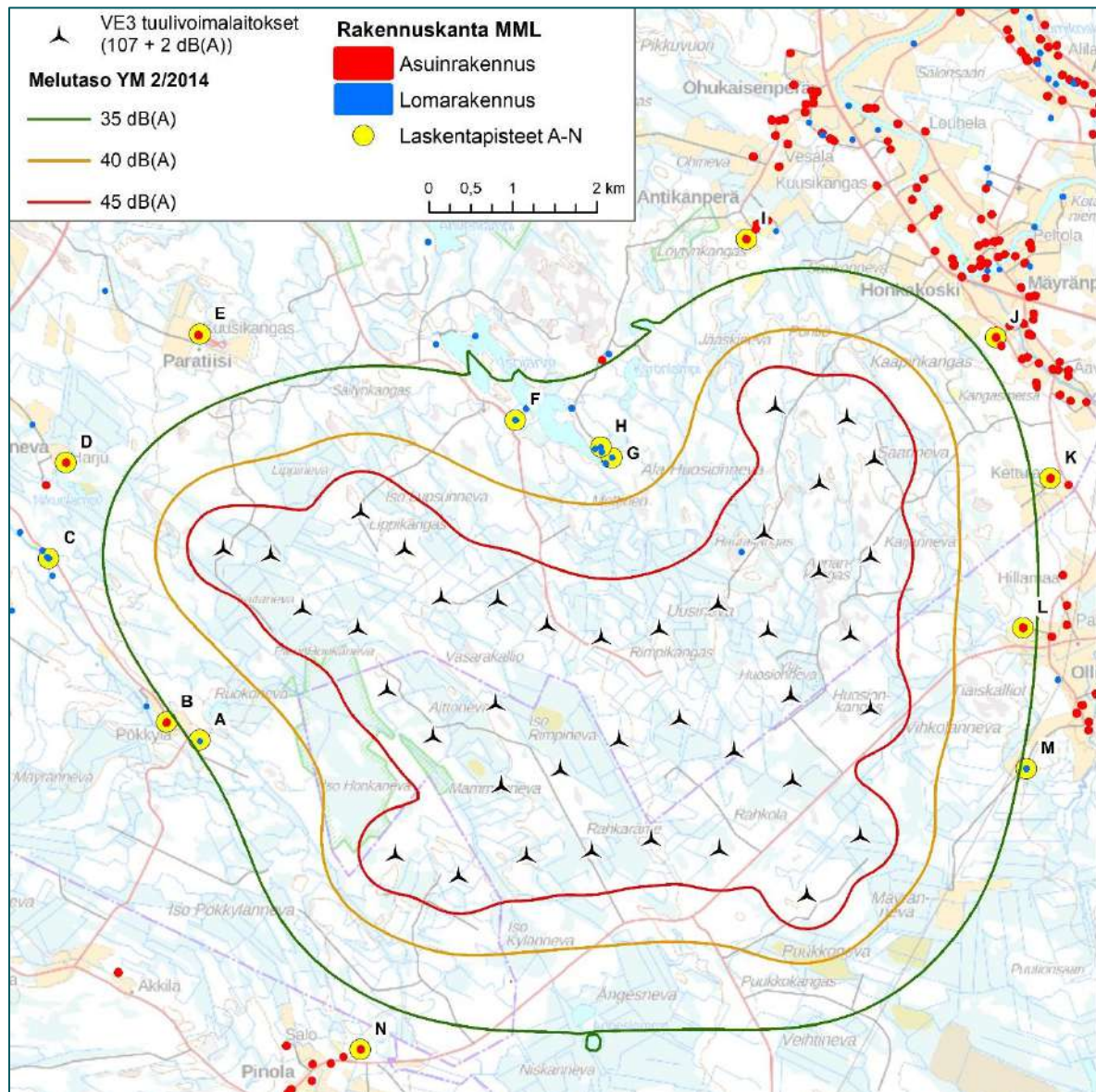
Taulukko 9. Laskennalliset melutasot Rahkola-Hautakankaan tuulivoimahankkeen ympäristössä hankevaihtoehdossa 2

Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Lomarakennus A (Pökkylä)	394971	7114786	80	4,0	28
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	4,0	27
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	4,0	23,4
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	4,0	23,1
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	4,0	24
Lomarakennus F (Isojärventie)	398737	7118604	90	4,0	32,5
Lomarakennus G (Antikantie)	399889	7118156	90,8	4,0	36,3
Lomarakennus H (Antikantie)	399756	7118284	92,5	4,0	35,6
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	4,0	29
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	4,0	30,1
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	4,0	32
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	4,0	35,1
Lomarakennus M (Siliäkuru)	404833	7114443	100	4,0	34,4
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	4,0	28,9

### 3.1.3 VE3: Melun laskentatulokset (ISO 9613-2)

Hankevaihtoehdon 3 (VE3) melumallinnuksen mukaan melutaso 40 dB(A) ei ylitä lähimmillä asuin- ja lomarakennuksilla. Katso tarkemmat laskentatulokset liitteestä 3.

3.2.2023



Kuva 3. Melumallinnuksen tulos hankevaihtoehdossa 3

3.2.2023

Taulukko 10. Laskennalliset melutasot Rahkola-Hautakankaan tuulivoimahankkeen ympäristössä hankevaihtoehdossa 3

Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Lomarakennus A (Pökkylä)	394971	7114786	80	4,0	35,4
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	4,0	34,6
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	4,0	31,7
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	4,0	31,4
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	4,0	31,3
Lomarakennus F (Isojärventie)	398737	7118604	90	4,0	36,5
Lomarakennus G (Antikantie)	399889	7118156	90,8	4,0	38,2
Lomarakennus H (Antikantie)	399756	7118284	92,5	4,0	37,8
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	4,0	32,9
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	4,0	33,7
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	4,0	34
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	4,0	35,7
Lomarakennus M (Siliäkuru)	404833	7114443	100	4,0	34,7
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	4,0	32,3

#### 3.1.4 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.

Rahkola-Hautakankaan tuulivoimahankkeen aiheuttama matalataajuinen melu ei yhdessäkään kolmesta hankevaihtoehdosta ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteen sisätiloissa.

Hankevaihtoehdon 1 tulokset laskentapisteittäin on esitetty taulukossa 11, hankevaihtoehdon 2 taulukossa 12 ja hankevaihtoehdon 3 taulukossa 13. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo).

3.2.2023

Taulukko 11. Matalataajuisen melun laskentatulokset VE1

Laskentapiste	Äänitaso ulkona		Äänitaso sisällä	
	L <sub>eq,1h</sub> – Asumis-terveys ohje sisällä	Hz	L <sub>eq,1h</sub> – Asumis-terveys ohje sisällä	Hz
Lomarakennus A (Pöykkylä)	6,3	63	-5,5	50
Asuinrakennus B (Pöykkyläntie 418)	5,7	63	-6,1	50
Lomarakennus C (~Pöykkyläntie 178)	3,5	63	-8,2	50
Asuinrakennus D (Luminevantie 162)	3,2	63	-8,5	50
Asuinrakennus E (Paratiisintie 231)	3,5	63	-8,2	50
Lomarakennus F (Isojärventie)	7,4	63	-4,4	50
Lomarakennus G (Antikantie)	8,5	63	-3,2	50
Lomarakennus H (Antikantie)	8,2	63	-3,6	50
Asuinrakennus I (Kalliokangas)	4,6	63	-7,1	50
Asuinrakennus J (Ojantakasentie 88)	4,9	63	-6,9	50
Asuinrakennus K (Ollilantie 218)	5,3	63	-6,5	50
Asuinrakennus L (Uusi-Kaikola)	6,5	63	-5,2	50
Lomarakennus M (Siliäkuru)	5,9	63	-5,9	50
Asuinrakennus N (Pinolantie 406)	4,4	63	-7,4	50

3.2.2023

Taulukko 12. Matalataajuisen melun laskentatulokset VE2

Laskentapiste	Äänitaso ulkona		Äänitaso sisällä	
	L eq,1h – Asumis-terveys ohje sisällä	Hz	L eq,1h – Asumis-terveys ohje sisällä	Hz
Lomarakennus A (Pökkylä)	1,2	63	-10,5	50
Asuinrakennus B (Pökkyläntie 418)	0,5	63	-11,2	50
Lomarakennus C (~Pökkyläntie 178)	-2,0	63	-13,6	50
Asuinrakennus D (Luminevantie 162)	-2,2	63	-13,8	50
Asuinrakennus E (Paratiisintie 231)	-1,5	63	-13,1	50
Lomarakennus F (Isojärventie)	4,2	63	-7,5	50
Lomarakennus G (Antikantie)	6,6	63	-5,2	50
Lomarakennus H (Antikantie)	6,1	63	-5,7	50
Asuinrakennus I (Kalliokangas)	1,8	63	-9,9	50
Asuinrakennus J (Ojantakasentie 88)	2,3	63	-9,4	50
Asuinrakennus K (Ollilantie 218)	3,6	63	-8,1	50
Asuinrakennus L (Uusi-Kaikola)	5,7	63	-6,1	50
Lomarakennus M (Siliäkuru)	5,2	63	-6,5	50
Asuinrakennus N (Pinolantie 406)	1,7	63	-10,0	50

3.2.2023

Taulukko 13. Matalataajuisen melun laskentatulokset VE3

Laskentapiste	Äänitaso ulkona		Äänitaso sisällä	
	L eq,1h – Asumis-terveys ohje sisällä	Hz	L eq,1h – Asumis-terveys ohje sisällä	Hz
Lomarakennus A (Pökkylä)	6,3	63	-5,5	50
Asuinrakennus B (Pökkyläntie 418)	5,7	63	-6,1	50
Lomarakennus C (~Pökkyläntie 178)	3,5	63	-8,2	50
Asuinrakennus D (Luminevantie 162)	3,2	63	-8,5	50
Asuinrakennus E (Paratiisintie 231)	3,5	63	-8,2	50
Lomarakennus F (Isojärventie)	7,4	63	-4,4	50
Lomarakennus G (Antikantie)	8,5	63	-3,3	50
Lomarakennus H (Antikantie)	8,2	63	-3,6	50
Asuinrakennus I (Kalliokangas)	4,6	63	-7,1	50
Asuinrakennus J (Ojantakasentie 88)	4,9	63	-6,9	50
Asuinrakennus K (Ollilantie 218)	5,3	63	-6,5	50
Asuinrakennus L (Uusi-Kaikola)	6,5	63	-5,2	50
Lomarakennus M (Siliäkuru)	5,9	63	-5,9	50
Asuinrakennus N (Pinolantie 406)	4,4	63	-7,4	50

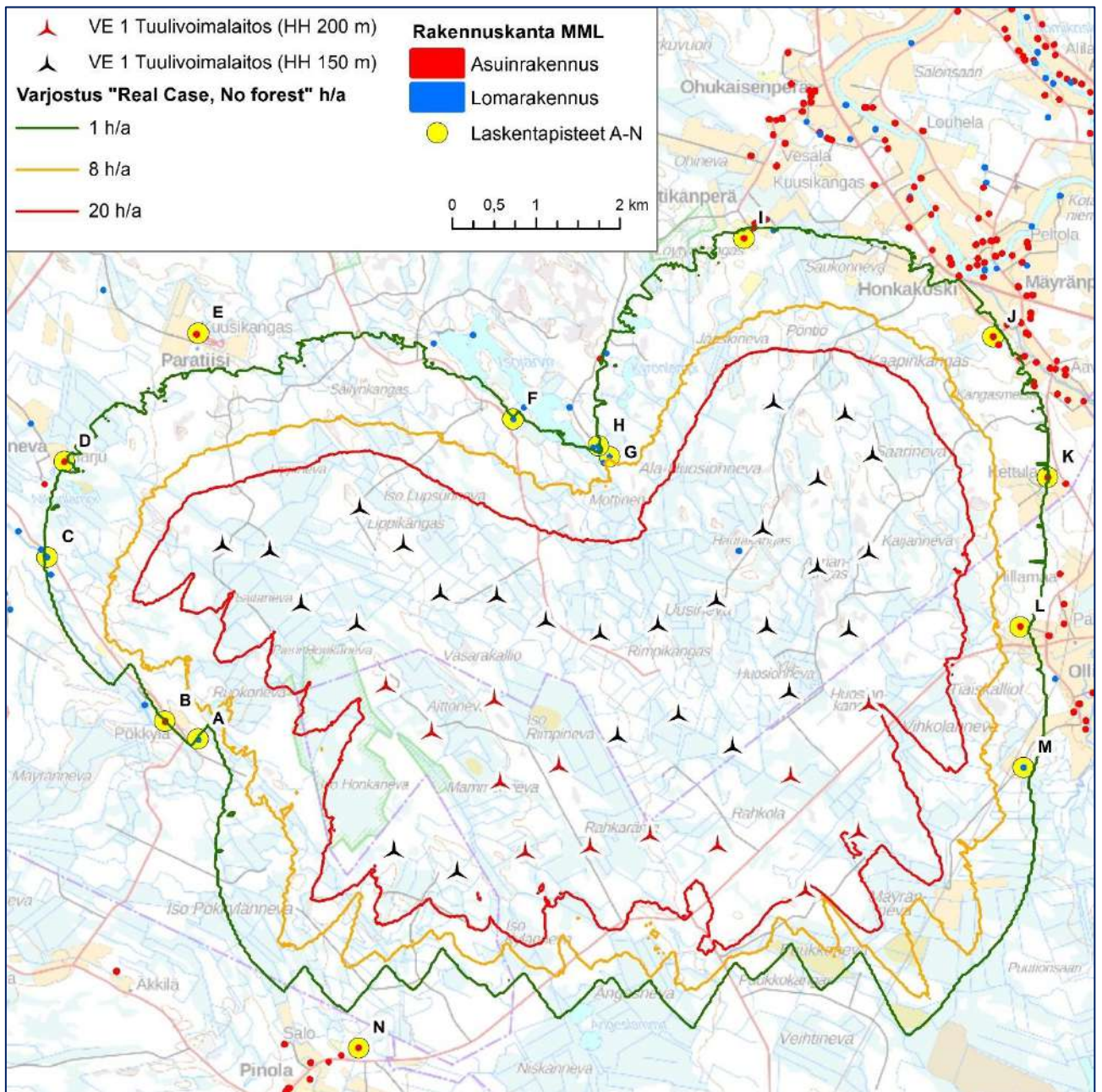
## 3.2 Varjostus

### 3.2.1 Hankevaihtoehto VE1

Hankevaihtoehdossa 1 ei > 8 h/a varjostusvaikutusalueelle sijoitu asuin- tai loma-ajanrakennuksia. Mallinnustulosten mukaan vaikutus on suurimmillaan 5 h 34 min hankealueen itäpuolella sijaitsevan asuinrakennuksen (laskentapiste L) alueella. Tarkemmat laskentatulokset on esitetty liitteessä 7.



3.2.2023



Kuva 4. Varjostusmallinnuksen tulos hankevaihtoehdossa 1 (puuston suojaavaa vaikutusta ei ole huomioitu)

## 3.2.2023

Taulukko 14. Varjostusmallinnuksen tulos VE1, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

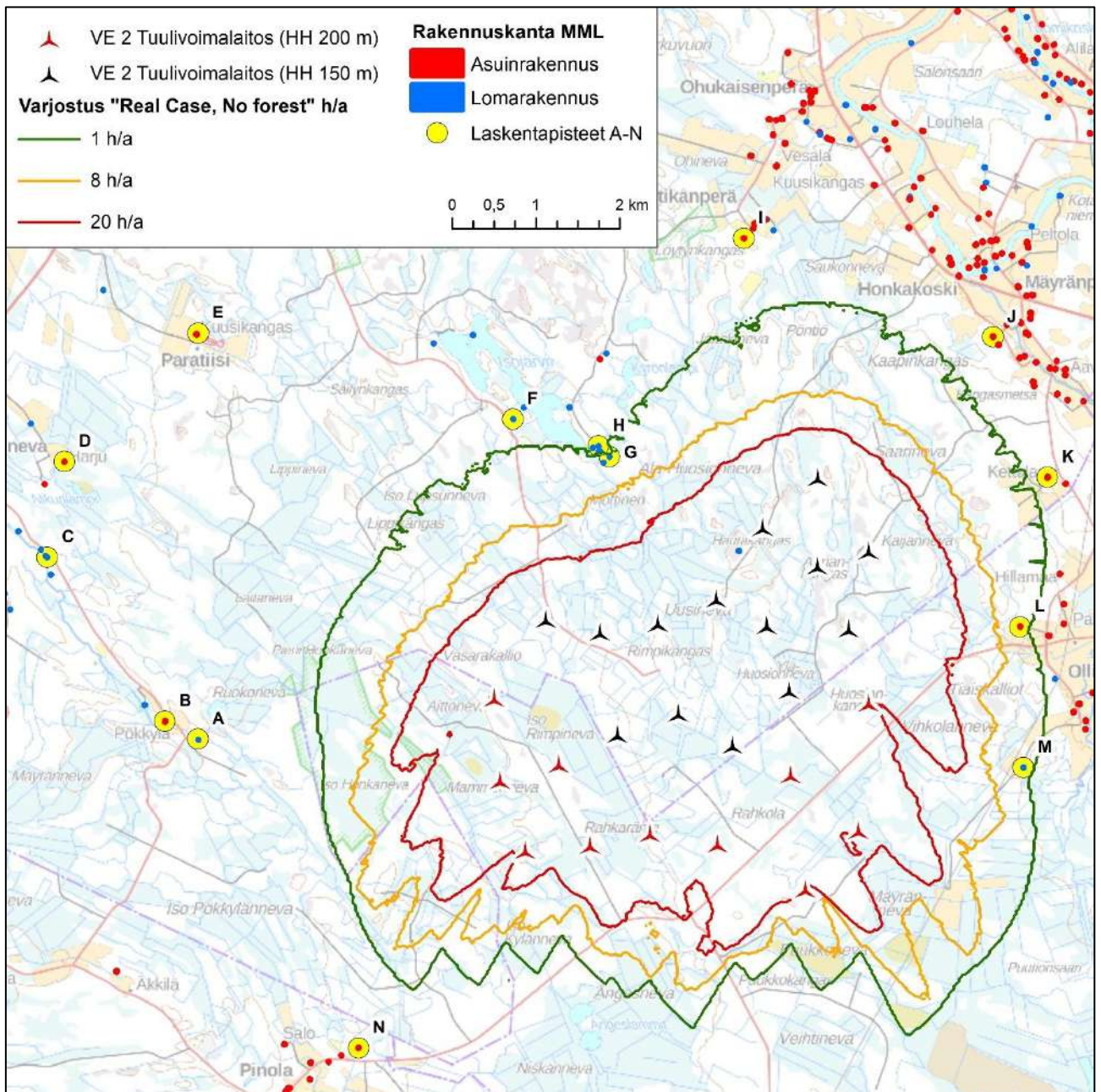
Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:46
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	1:40
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	1:10
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	5:31
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	1:17
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	2:30
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	1:26
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	5:34
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	3:04
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	0:00

## 3.2.2 Hankevaihtoehdo VE2

Hankevaihtoehdossa 2 ei > 8 h/a varjostusvaikutusalueelle sijoitu asuin- tai loma-ajanrakennuksia. Mallinnustulosten mukaan vaikutus on suurimmillaan 5 h 35 min hankealueen pohjoispuolella sijaitsevan lomarakennuksen (laskentapiste G) alueella. Tarkemmat laskentatulokset on esitetty liitteessä 8.



3.2.2023



Kuva 5. Varjostusmallinnuksen tulos hankevaihtoehdossa 2 (puuston suojaavaa vaikutusta ei ole huomioitu)

## 3.2.2023

Taulukko 15. Varjostusmallinnuksen tulos VE2, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

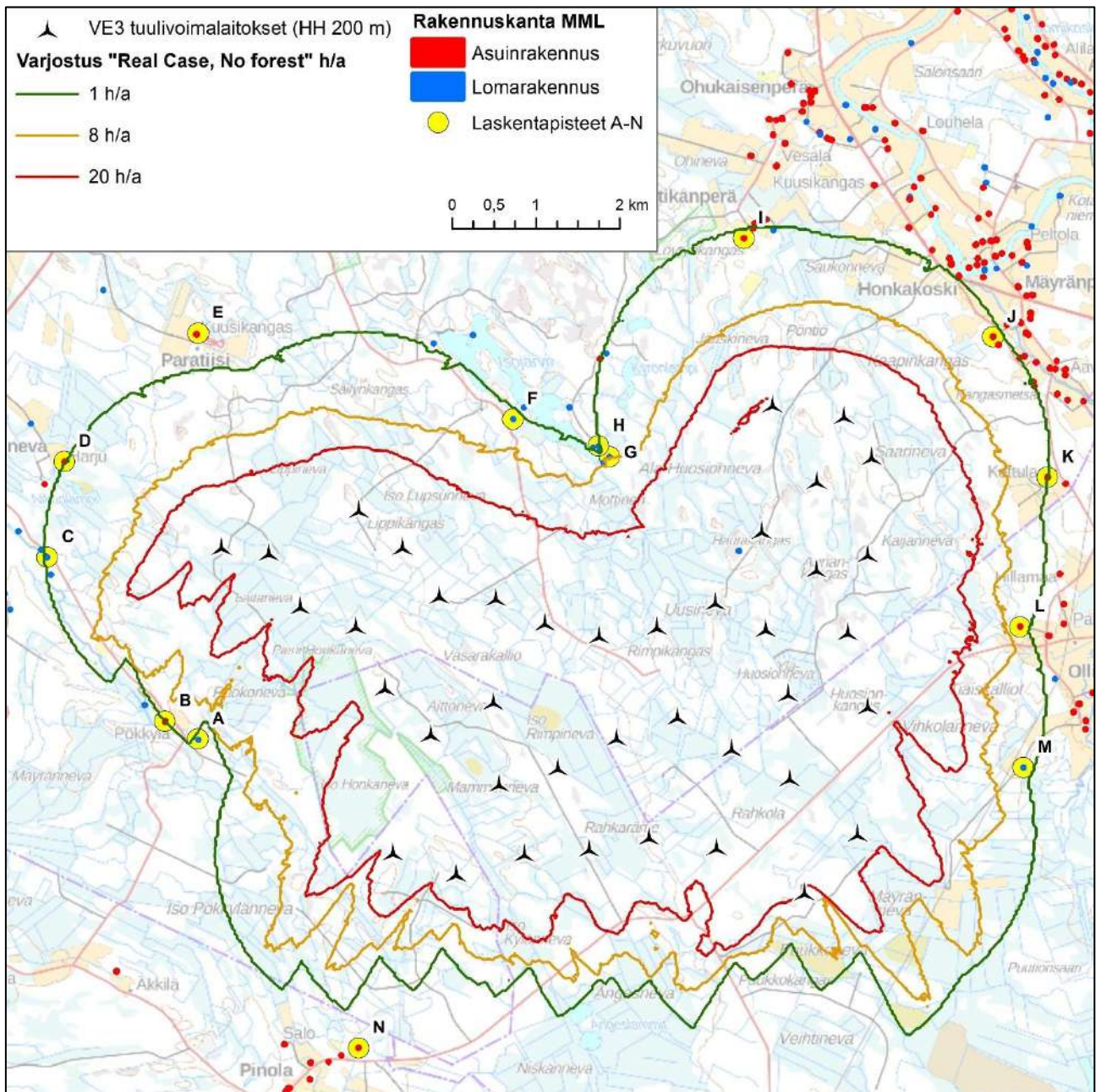
Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:00
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	0:00
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	0:00
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	3:25
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	0:00
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	0:00
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	0:00
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	5:35
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	3:04
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	0:00

## 3.2.3 Hankevaihtoehto VE3

Hankevaihtoehdossa 3 ei > 8 h/a varjostusvaikutusalueelle sijoitu asuin- tai loma-ajanrakennuksia. Mallinnustulosten mukaan vaikutus on suurimmillaan 7 h 20 min hankealueen pohjoispuolella sijaitsevan lomarakennuksen (laskentapiste G) alueella. Tarkemmat laskentatulokset on esitetty liitteessä 9.



3.2.2023



Kuva 6. Varjostusmallinnuksen tulos hankevaihtoehdossa 3 (puuston suojaavaa vaikutusta ei ole huomioitu)

3.2.2023

Taulukko 16. Varjostusmallinnuksen tulos VE3, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:10
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	2:13
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	1:35
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	7:20
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	1:33
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	3:10
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	2:02
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	6:56
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	3:07
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	0:00

## 4 MELUN JA VARJOSTUKSEN YHTEISMALLINNUSTEN TULOKSET

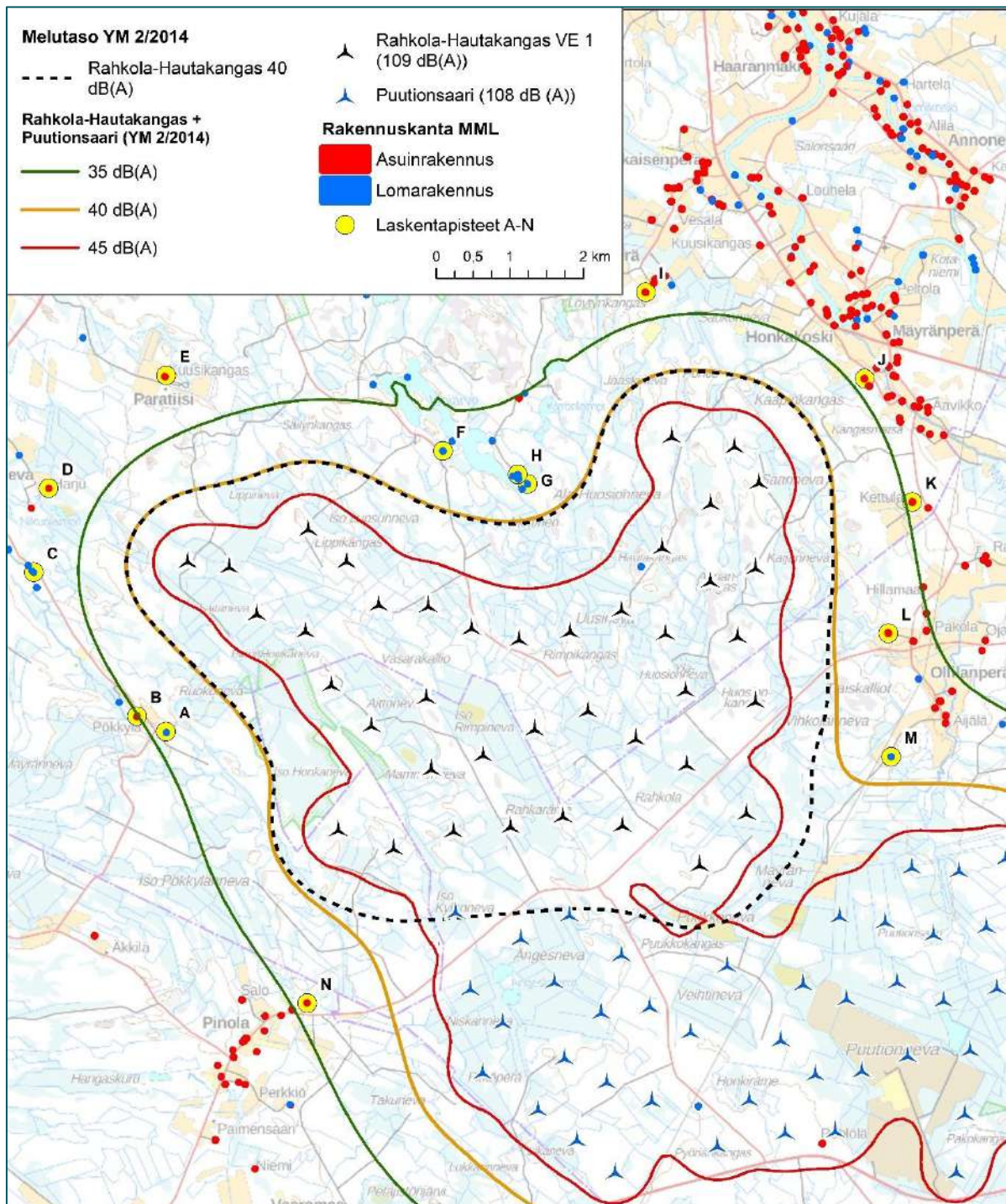
### 4.1 Melu

#### 4.1.1 VE1: Yhteismelun laskentatulokset (ISO 9613-2)

Hankevaihtoehdon 1 (VE1) yhteismelumallinnuksen mukaan melutaso 40 dB(A) ei ylitä Rahkola-Hautakankaan tuulivoimapuiston lähimmillä asuin- ja lomarakennuksilla. Katso tarkemmat laskentatulokset liitteestä 10.



3.2.2023



Kuva 8. Melun yhteisvaikutuksen mallinnuksen tulos hankevaihtoehdossa VE1. Kuvassa on esitetty mustalla katkoviivalla pelkän Rahkola-Hautakankaan melumallinnuksen tulos hankevaihtoehdossa 1.

3.2.2023

Taulukko 18. Laskennalliset yhteismelun tasot Rahkola-Hautakankaan tuulivoimahankkeen ympäristössä hankevaihtoehdossa 1

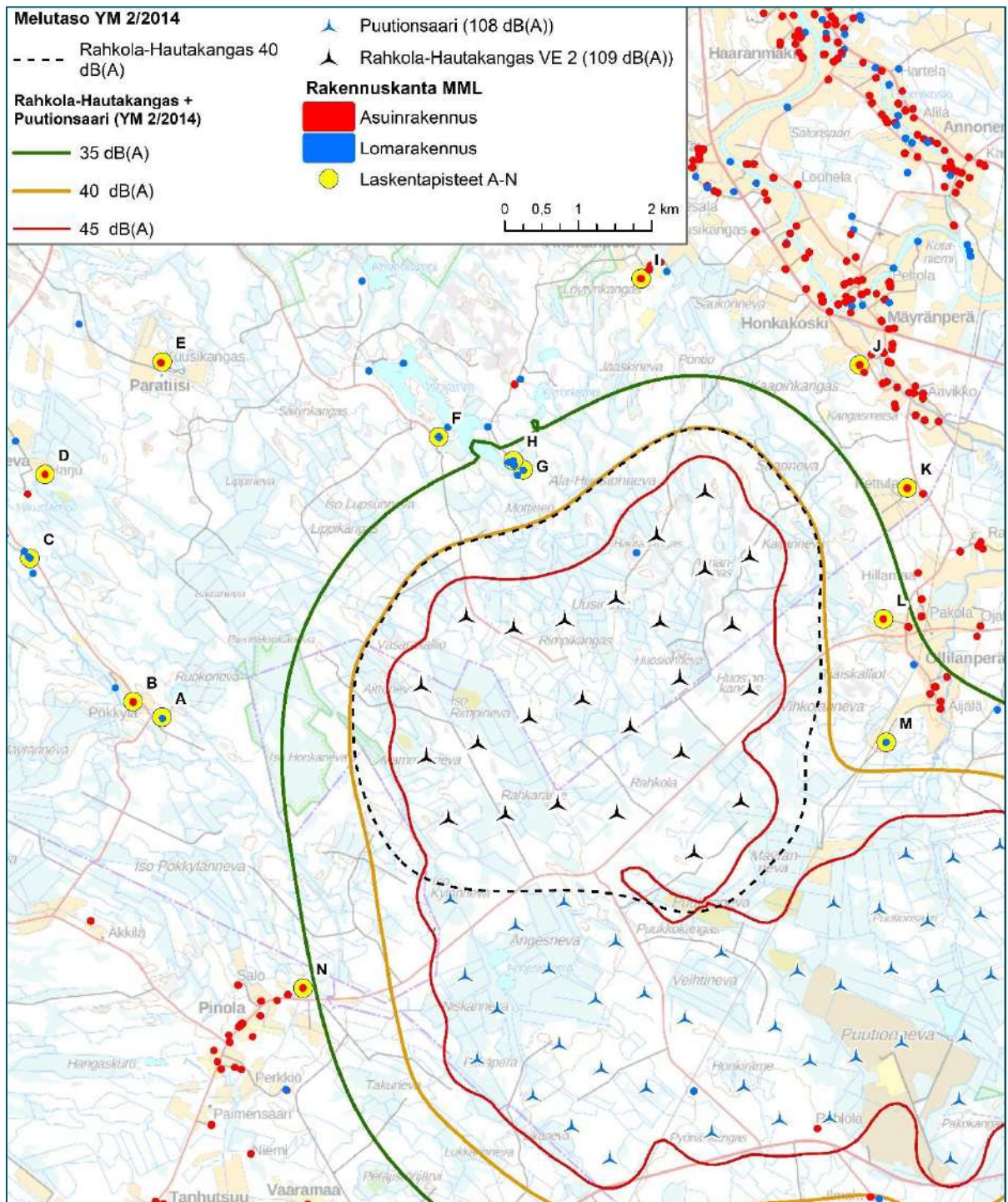
Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Lomarakennus A (Pökkylä)	394971	7114786	80	4,0	35,8
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	4,0	34,9
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	4,0	32,1
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	4,0	31,7
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	4,0	31,7
Lomarakennus F (Isojärventie)	398737	7118604	90	4,0	36,8
Lomarakennus G (Antikantie)	399889	7118156	90,8	4,0	38,4
Lomarakennus H (Antikantie)	399756	7118284	92,5	4,0	38,0
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	4,0	33,3
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	4,0	34,2
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	4,0	34,7
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	4,0	36,8
Lomarakennus M (Siliäkuru)	404833	7114443	100	4,0	38,7
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	4,0	35,7

#### 4.1.2 VE2: Yhteismelun laskentatulokset (ISO 9613-2)

Hankevaihtoehdon 2 (VE2) yhteismelun mallinnuksen mukaan melutaso 40 dB(A) ei ylitä Rahkola-Hautakankaan tuulivoimapuiston lähimmillä asuin- ja lomarakennuksilla. Katso tarkemmat laskentatulokset liitteestä 11.



3.2.2023



Kuva 9. Melumallinnuksen tulos vaihtoehdossa VE 2. Kuvassa on esitetty mustalla katkoviivalla pelkän Rahkola-Hautakankaan melumallinnuksen tulos hankevaihtoehdossa 2

3.2.2023

*Taulukko 19. Laskennalliset yhteismelun tasot Rahkola-Hautakankaan tuulivoimahankkeen ympäristössä hankevaihtoehdossa 2*

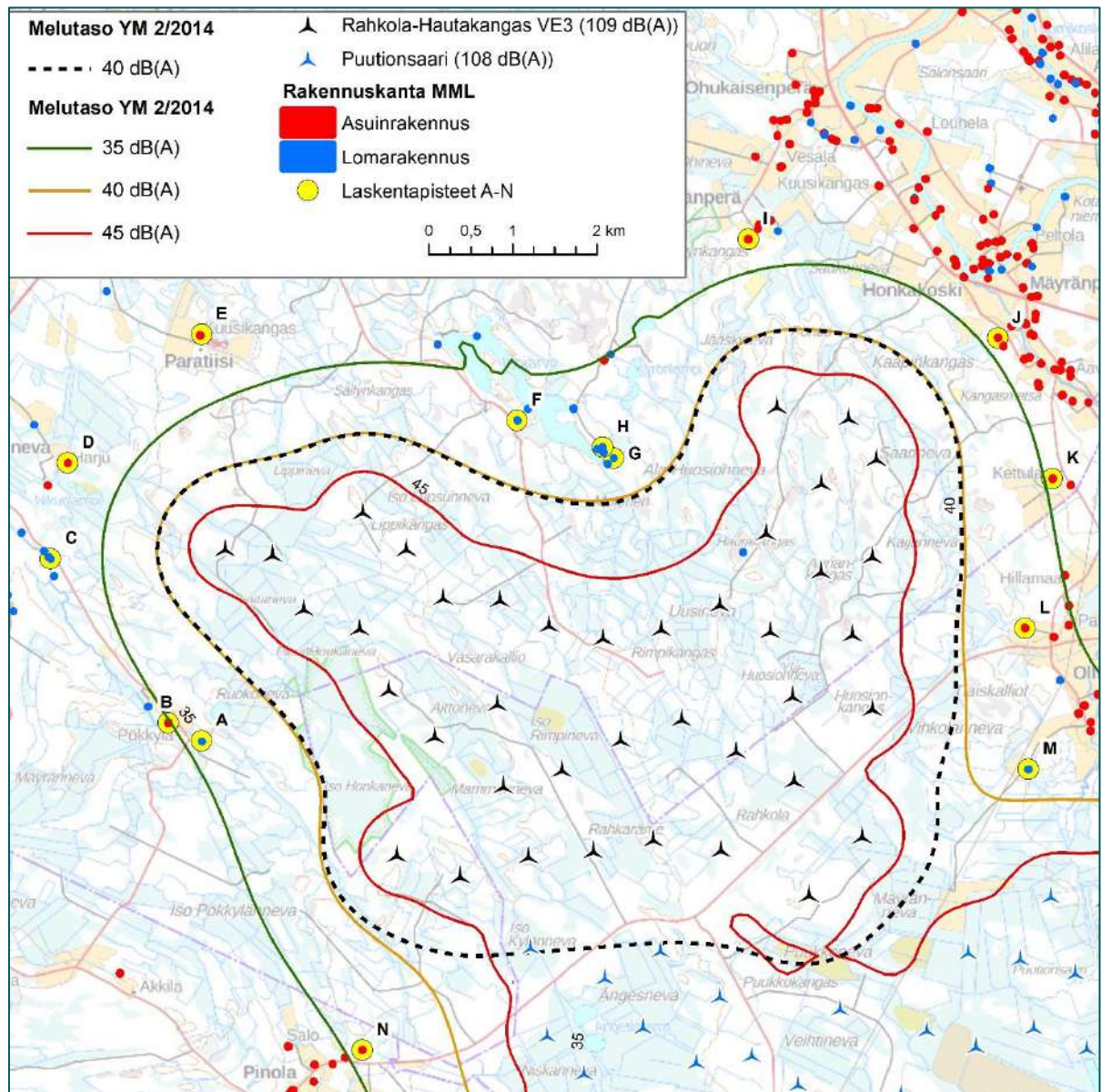
Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Lomarakennus A (Pökkylä)	394971	7114786	80	4,0	29,6
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	4,0	28,7
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	4,0	25,2
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	4,0	24,8
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	4,0	25,5
Lomarakennus F (Isojärventie)	398737	7118604	90	4,0	33
Lomarakennus G (Antikantie)	399889	7118156	90,8	4,0	36,6
Lomarakennus H (Antikantie)	399756	7118284	92,5	4,0	36
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	4,0	29,8
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	4,0	30,9
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	4,0	33
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	4,0	36,3
Lomarakennus M (Siliäkuru)	404833	7114443	100	4,0	38,6
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	4,0	34,4

#### 4.1.3 VE3: Yhteismelun laskentatulokset (ISO 9613-2)

Hankevaihtoehdon 3 (VE3) yhteismelun mallinnuksen mukaan melutaso 40 dB(A) ei ylitä Rahkola-Hautakankaan tuulivoimapuiston lähimmillä asuin- ja lomarakennuksilla. Katso tarkemmat laskentatulokset liitteestä 12.



3.2.2023



Kuva 9. Melumallinnuksen tulos vaihtoehdossa VE 3. Kuvassa on esitetty mustalla katkoviivalla pelkän Rahkola-Hautakankaan melumallinnuksen tulos hankevaihtoehdossa 3

3.2.2023

Taulukko 20. Laskennalliset yhteismelun tasot Rahkola-Hautakankaan tuulivoimahankkeen ympäristössä hankevaihtoehdossa 3

Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Lomarakennus A (Pökkylä)	394971	7114786	80	4,0	35,8
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	4,0	34,9
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	4,0	32
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	4,0	31,7
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	4,0	31,6
Lomarakennus F (Isojärventie)	398737	7118604	90	4,0	36,8
Lomarakennus G (Antikantie)	399889	7118156	90,8	4,0	38,3
Lomarakennus H (Antikantie)	399756	7118284	92,5	4,0	38
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	4,0	33,3
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	4,0	34,1
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	4,0	34,6
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	4,0	36,8
Lomarakennus M (Siliäkuru)	404833	7114443	100	4,0	38,7
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	4,0	35,6

#### 4.1.4 Matalataajuiset melutasot

Rahkola-Hautakankaan ja Puutionsaaren tuulivoimahankkeiden aiheuttama matalataajuinen melu ei Rahkola-Hautakankaan missään hankevaihtoehdossa ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteiden sisätiloissa.

Rahkola-Hautakankaan hankevaihtoehdon 1 tulokset laskentapisteittäin on esitetty taulukossa 21, hankevaihtoehdon 2 taulukossa 22 ja hankevaihtoehdon 3 taulukossa 23. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo).

3.2.2023

Taulukko 21. Matalataajuisen yhteismelun laskentatulokset VE1

Laskentapiste	Äänitaso ulkona		Äänitaso sisällä	
	L eq,1h – Asumis-terveys ohje sisällä	Hz	L eq,1h – Asumis-terveys ohje sisällä	Hz
Lomarakennus A (Pöykkylä)	7,0	63	-4,7	50
Asuinrakennus B (Pöykkyläntie 418)	6,4	63	-5,3	50
Lomarakennus C (~Pöykkyläntie 178)	4,2	63	-7,5	50
Asuinrakennus D (Luminevantie 162)	3,9	63	-7,7	50
Asuinrakennus E (Paratiisintie 231)	4,2	63	-7,5	50
Lomarakennus F (Isojärventie)	7,9	63	-3,8	50
Lomarakennus G (Antikantie)	9,0	63	-2,7	50
Lomarakennus H (Antikantie)	8,7	63	-3,0	50
Asuinrakennus I (Kalliokangas)	5,3	63	-6,4	50
Asuinrakennus J (Ojantakasentie 88)	5,8	63	-5,9	50
Asuinrakennus K (Ollilantie 218)	6,5	63	-5,2	50
Asuinrakennus L (Uusi-Kaikola)	8,1	63	-3,6	50
Lomarakennus M (Siliäkuru)	9,4	63	-2,4	50
Asuinrakennus N (Pinolantie 406)	7,3	63	-4,4	50

3.2.2023

Taulukko 22. Matalataajuisen yhteismelun laskentatulokset VE2

Laskentapiste	Äänitaso ulkona		Äänitaso sisällä	
	L eq,1h – Asumis-terveys ohje sisällä	Hz	L eq,1h – Asumis-terveys ohje sisällä	Hz
Lomarakennus A (Pökkylä)	3,2	63	-8,4	50
Asuinrakennus B (Pökkyläntie 418)	2,6	63	-9,0	50
Lomarakennus C (~Pökkyläntie 178)	0,2	63	-11,4	50
Asuinrakennus D (Luminevantie 162)	-0,1	63	-11,7	50
Asuinrakennus E (Paratiisintie 231)	0,3	63	-11,2	50
Lomarakennus F (Isojärventie)	5,2	63	-6,5	50
Lomarakennus G (Antikantie)	7,3	63	-4,4	50
Lomarakennus H (Antikantie)	6,9	63	-4,8	50
Asuinrakennus I (Kalliokangas)	3,1	63	-8,6	50
Asuinrakennus J (Ojantakasentie 88)	3,8	63	-7,8	50
Asuinrakennus K (Ollilantie 218)	5,3	63	-6,4	50
Asuinrakennus L (Uusi-Kaikola)	7,6	63	-4,2	50
Lomarakennus M (Siliäkuru)	9,1	63	-2,7	50
Asuinrakennus N (Pinolantie 406)	6,1	63	-5,6	50

3.2.2023

Taulukko 23. Matalataajuisen yhteismelun laskentatulokset VE3

Laskentapiste	Äänitaso ulkona		Äänitaso sisällä	
	L <sub>eq,1h</sub> – Asumis-terveys ohje sisällä	Hz	L <sub>eq,1h</sub> – Asumis-terveys ohje sisällä	Hz
Lomarakennus A (Pökkylä)	7,0	63	-4,7	50
Asuinrakennus B (Pökkyläntie 418)	6,4	63	-5,3	50
Lomarakennus C (~Pökkyläntie 178)	4,2	63	-7,5	50
Asuinrakennus D (Luminevantie 162)	3,9	63	-7,7	50
Asuinrakennus E (Paratiisintie 231)	4,2	63	-7,5	50
Lomarakennus F (Isojärventie)	7,9	63	-3,8	50
Lomarakennus G (Antikantie)	9,0	63	-2,7	50
Lomarakennus H (Antikantie)	8,7	63	-3,0	50
Asuinrakennus I (Kalliokangas)	5,3	63	-6,4	50
Asuinrakennus J (Ojantakasentie 88)	5,8	63	-5,9	50
Asuinrakennus K (Ollilantie 218)	6,5	63	-5,2	50
Asuinrakennus L (Uusi-Kaikola)	8,1	63	-3,6	50
Lomarakennus M (Siliäkuru)	9,4	63	-2,4	50
Asuinrakennus N (Pinolantie 406)	7,3	63	-4,4	50

## 4.2 Varjostus

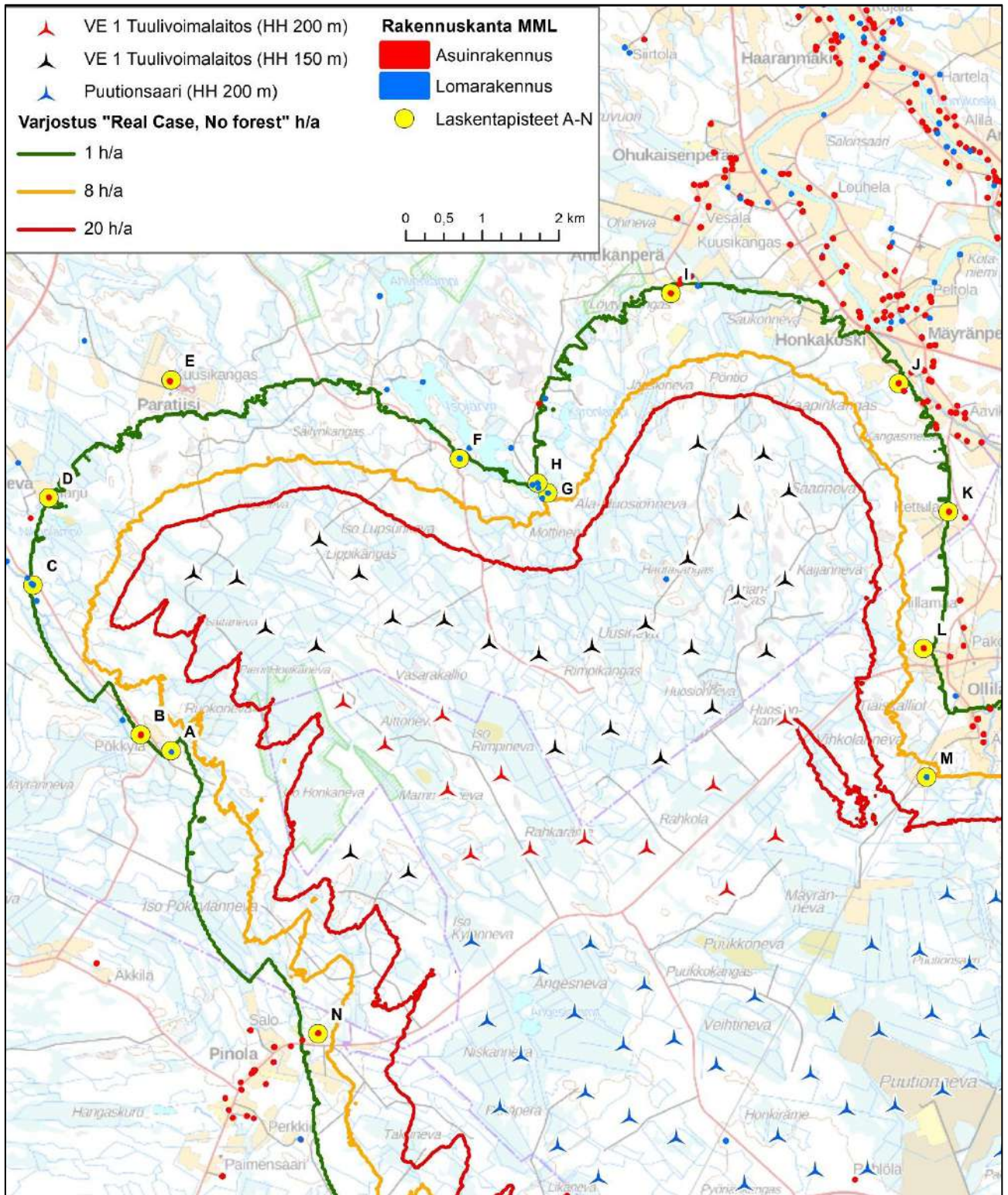
### 4.2.1 VE 1: Varjostuksen yhteisvaikutus

Hankevaihtoehdon 1 yhteisvaikutusten mallinnusten mukaan > 8 h/a varjostusvaikutusalueelle sijoittuu Rahkola-Hautakankaan läheisyydessä 1 loma-ajanrakennus. Vuosittainen varjostus on lomarakennuksen alueella 11 tuntia 49 minuuttia. Kyseessä on rakennus, jonka alueella varjostusvaikutus ylittyy jo ainoastaan Puutionsaaren hankkeen voimaloiden vaikutuksesta, ollen tällöin 12 tuntia ja 50 minuuttia vuodessa. (Lähde: Puutionsaaren tuulivoimahankkeen melu- ja varjostusvaikutukset, FCG 2020).

Tarkemmat varjostuksen yhteisvaikutuksen laskentatulokset on esitetty liitteessä 16.



3.2.2023



Kuva 11. Varjostuksen yhteismallinnuksen tulos hankevaihtoehdossa 1 (puuston suojaavaa vaikutusta ei ole huomioitu)

## 3.2.2023

Taulukko 24. Varjostuksen yhteismallinnuksen tulos VE1, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

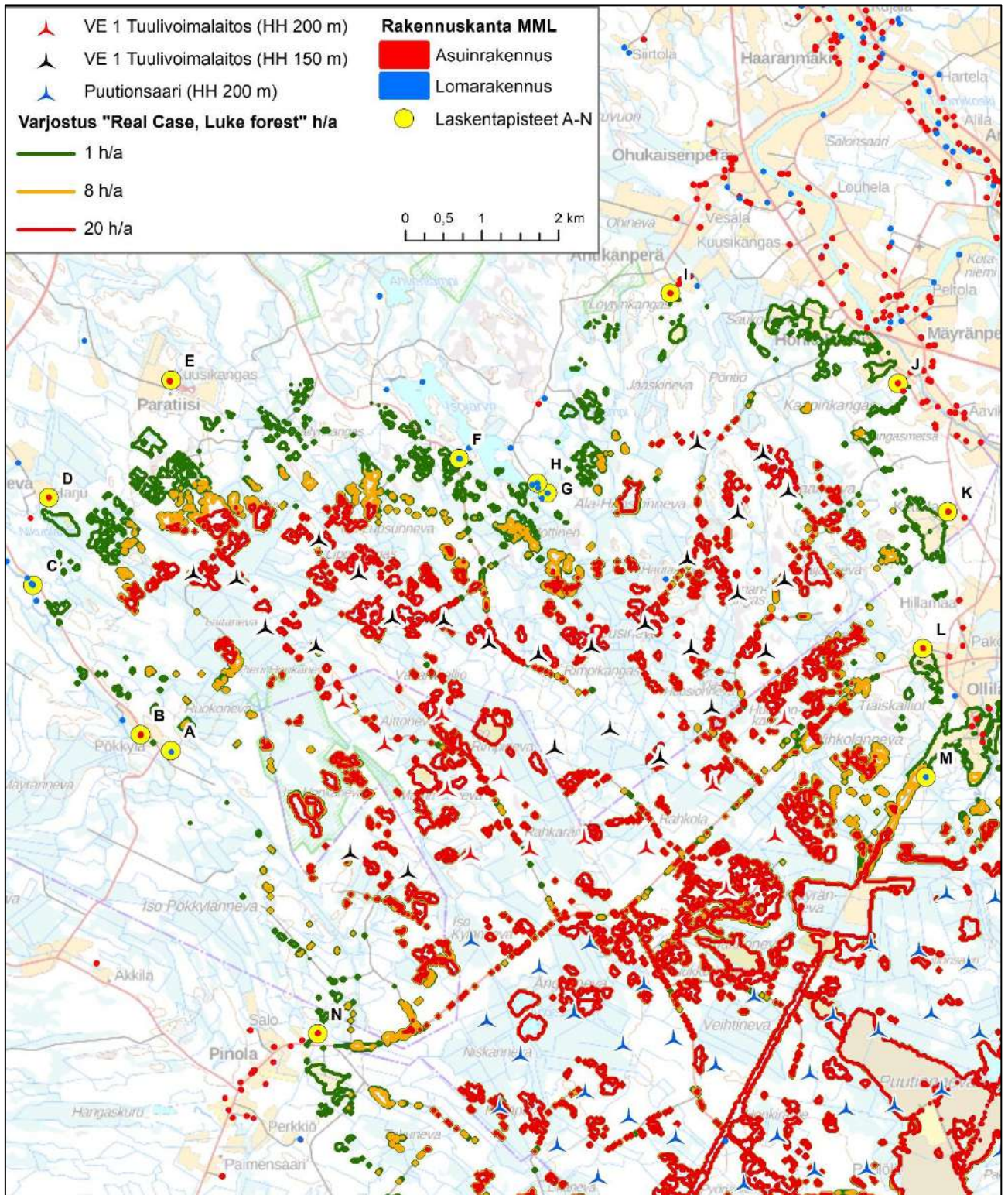
Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:46
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	1:41
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	1:11
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	5:35
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	1:18
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	2:32
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	1:27
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	5:38
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	11:49
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	4:50

Huomioitaessa puuston suojaava vaikutus, ei hankevaihtoehdossa 1 sijoitu > 8 h/a varjostusvaikutusalueelle asuin- tai loma-ajanrakennuksia. Mallinnustulosten mukaan vaikutus on suurimmillaan 3 h 6 min (laskentapiste M).

Tarkemmat varjostuksen yhteisvaikutuksen laskentatulokset on esitetty liitteessä 17.



3.2.2023



Kuva 12. Varjostuksen yhteismallinnuksen tulos hankevaihtoehdossa 1 (puuston suojaava vaikutus on huomioitu)



## 3.2.2023

Taulukko 25. Varjostuksen yhteismallinnuksen tulos VE3, kun puuston suojaava vaikutus on huomioitu ”real case, Luke forest”.

Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:00
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	0:00
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	0:00
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	2:05
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	1:18
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	0:00
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	0:00
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	3:05
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	3:06
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	0:00

#### 4.2.2 VE 2: Varjostuksen yhteisvaikutus

Hankevaihtoehdon 2 yhteisvaikutusten mallinnusten mukaan > 8 h/a varjostusvaikutusalueelle sijoittuu Rahkola-Hautakankaan läheisyydessä 1 loma-ajanrakennus. Vuosittainen varjostus on lomarakennuksen alueella 11 tuntia 52 minuuttia.

Kuten hankevaihtoehdon 2 osalta on mainittu, kyseessä on rakennus, jonka alueella varjostusvaikutus ylittyy jo ainoastaan Puutionsaaren hankkeen voimaloiden vaikutuksesta, ollen tällöin 12 tuntia ja 50 minuuttia vuodessa. (Lähde: Puutionsaaren tuulivoimahankkeen melu- ja varjostusvaikutukset, FCG 2020)

Tarkemmat varjostuksen yhteisvaikutuksen laskentatulokset on esitetty liitteessä 18.



3.2.2023

Taulukko 26. Varjostuksen yhteismallinnuksen tulos VE2, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

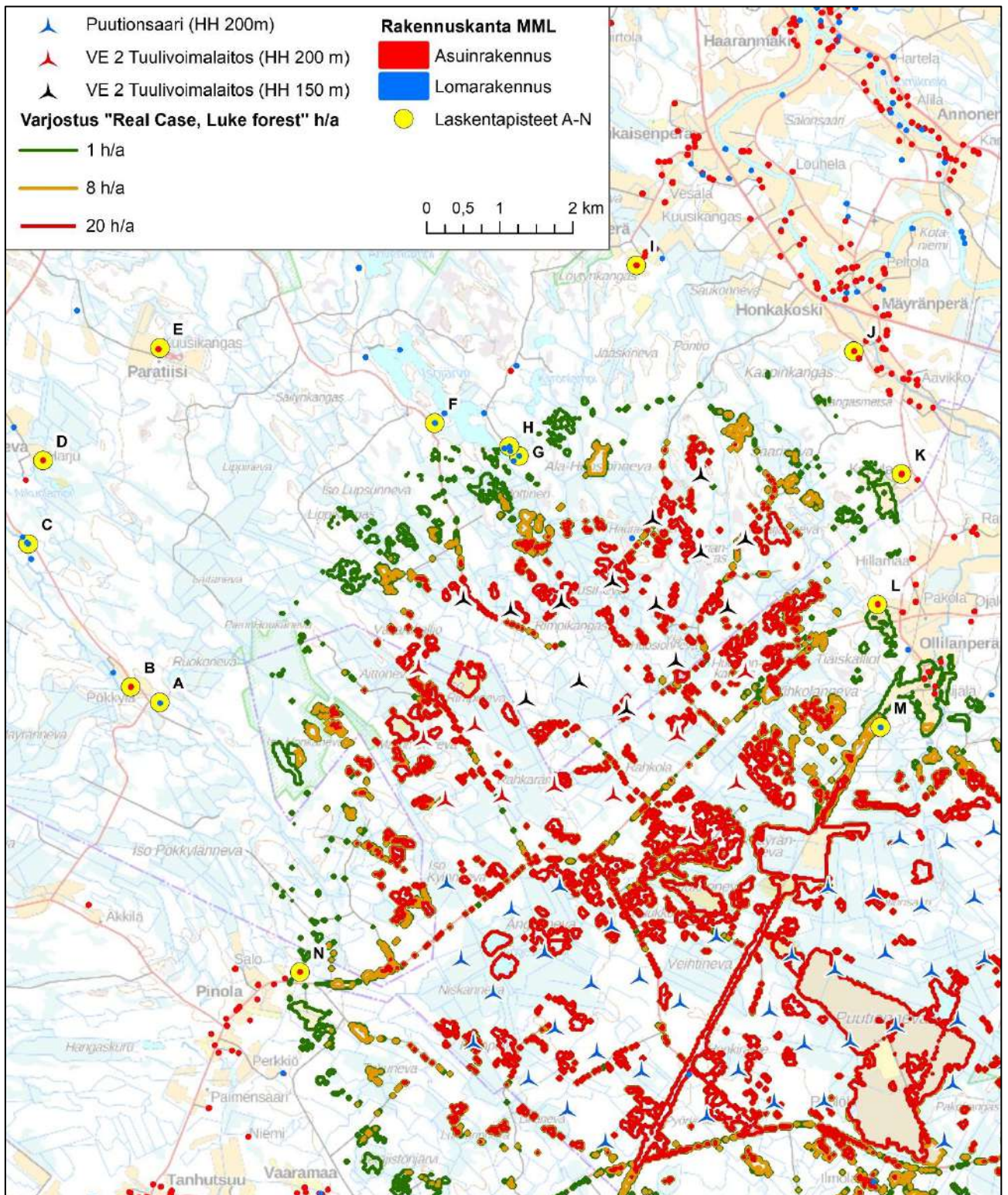
Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:00
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	0:00
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	0:00
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	3:27
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	0:00
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	0:00
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	0:00
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	5:39
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	11:52
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	4:51

Huomioitaessa puuston suojaava vaikutus, ei hankevaihtoehdossa 2 sijoitu > 8 h/a varjostusvaikutusalueelle asuin- tai loma-ajanrakennuksia. Mallinnustulosten mukaan vaikutus on suurimmillaan 3 h 6 min (laskentapisteet L ja M).

Tarkemmat hankevaihtoehdon 2 varjostuksen yhteisvaikutuksen laskentatulokset on esitetty liitteessä 19.



3.2.2023



Kuva 14. Varjostuksen yhteismallinnuksen tulos hankevaihtoehdossa 2 (puuston suojaava vaikutus on huomioitu)

## 3.2.2023

Taulukko 27. Varjostuksen yhteismallinnuksen tulos VE2, kun puuston suojaava vaikutus on huomioitu ”real case, Luke forest”.

Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:00
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	0:00
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	0:00
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	2:05
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	0:00
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	0:00
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	0:00
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	3:06
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	3:06
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	0:00

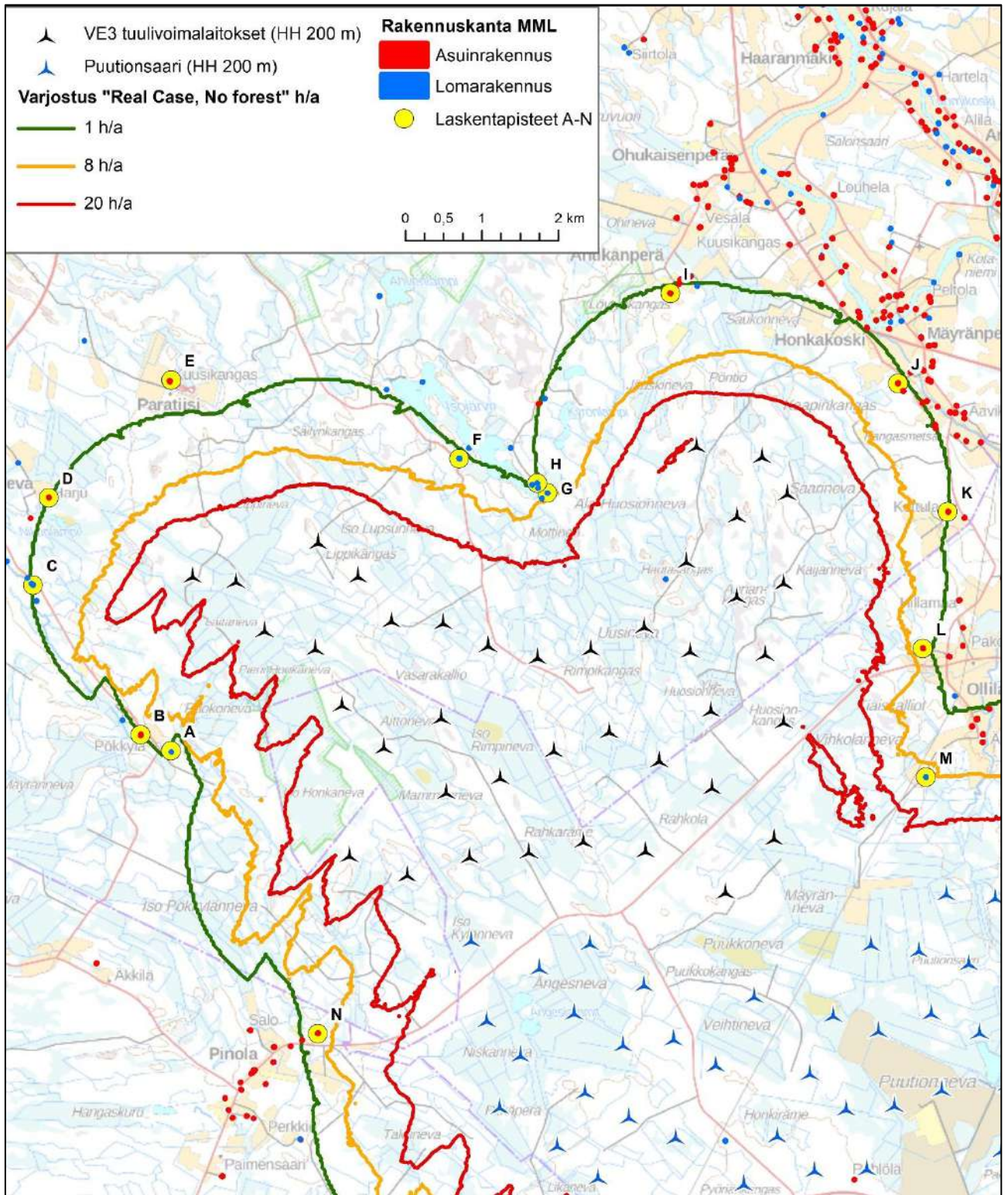
## 4.2.3 VE 3: Varjostuksen yhteisvaikutus

Hankevaihtoehdon 3 yhteisvaikutusten mallinnusten mukaan > 8 h/a varjostusvaikutusalueelle sijoittuu Rahkola-Hautakankaan läheisyydessä 1 loma-ajanrakennus. Vuosittainen varjostus on lomarakennuksen M alueella 11 tuntia 56 minuuttia. Kyseessä on rakennus, jonka alueella varjostusvaikutus ylittyy jo ainoastaan Puutionsaaren hankkeen voimaloiden vaikutuksesta, ollen tällöin 12 tuntia ja 50 minuuttia vuodessa. (Lähde: Puutionsaaren tuulivoimahankkeen melu- ja varjostusvaikutukset, FCG 2020).

Tarkemmat hankevaihtoehdon 3 varjostuksen yhteisvaikutuksen laskentatulokset on esitetty liitteessä 20.



3.2.2023



Kuva 15. Varjostuksen yhteismallinnuksen tulos hankevaihtoehdossa 3 (puuston suojaavaa vaikutusta ei ole huomioitu)



## 3.2.2023

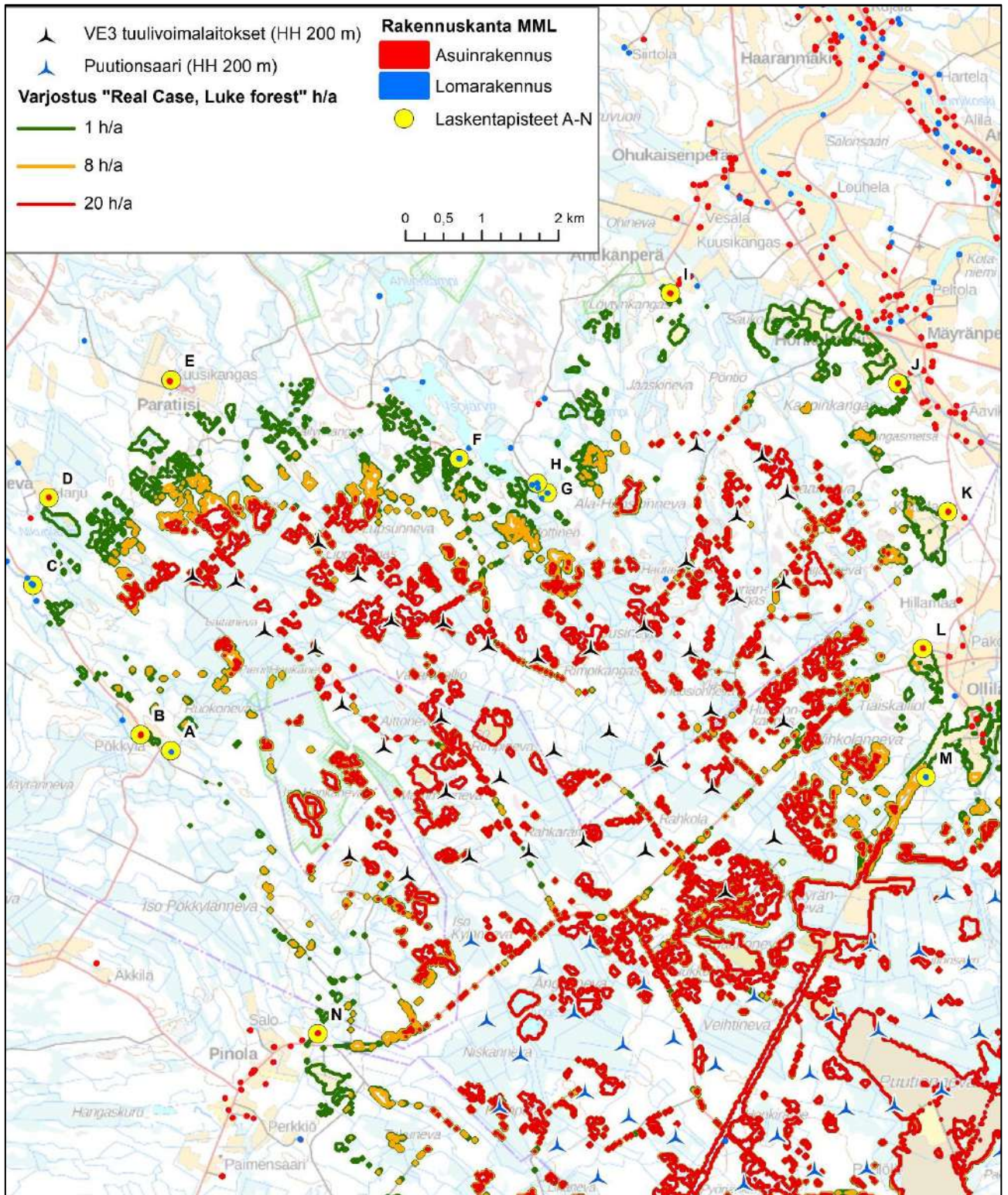
Taulukko 28. Varjostuksen yhteismallinnuksen tulos VE3, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:10
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	2:13
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	1:35
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	7:20
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	1:33
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	3:10
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	2:02
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	6:56
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	11:56
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	4:53

Huomioitaessa puuston suojaava vaikutus, ei hankevaihtoehdossa 3 sijoitu > 8 h/a varjostusvaikutusalueelle asuin- tai loma-ajanrakennuksia. Mallinnustulosten mukaan vaikutus on suurimmillaan 3 h 31 min (laskentapiste G).

Tarkemmat hankevaihtoehdon 3 varjostuksen yhteisvaikutuksen laskentatulokset on esitetty liitteessä 21.

3.2.2023



Kuva 16. Varjostuksen yhteismallinnuksen tulos hankevaihtoehdossa 3 (puuston suojaava vaikutus on huomioitu)

3.2.2023

Taulukko 29. Varjostuksen yhteismallinnuksen tulos VE3, kun puuston suojaava vaikutus on huomioitu ”real case, Luke forest”.

Rakennus	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskettaikkuna (m)	Varjostus (h/a)
Lomarakennus A (Pökkylä)	394971	7114786	80	5,0 x 5,0	0:00
Asuinrakennus B (Pökkyläntie 418)	394575	7114996	77,8	5,0 x 5,0	0:00
Lomarakennus C (~Pökkyläntie 178)	393172	7116951	75,2	5,0 x 5,0	0:00
Asuinrakennus D (Luminevantie 162)	393376	7118095	75,4	5,0 x 5,0	0:00
Asuinrakennus E (Paratiisintie 231)	394975	7119629	79,1	5,0 x 5,0	0:00
Lomarakennus F (Isojärventie)	398737	7118604	90	5,0 x 5,0	0:00
Lomarakennus G (Antikantie)	399889	7118156	90,8	5,0 x 5,0	2:40
Lomarakennus H (Antikantie)	399756	7118284	92,5	5,0 x 5,0	0:00
Asuinrakennus I (Kalliokangas)	401495	7120763	87,7	5,0 x 5,0	1:33
Asuinrakennus J (Ojantakasentie 88)	404469	7119588	83,3	5,0 x 5,0	0:00
Asuinrakennus K (Ollilantie 218)	405119	7117909	94,9	5,0 x 5,0	0:00
Asuinrakennus L (Uusi-Kaikola)	404793	7116122	94,4	5,0 x 5,0	3:31
Lomarakennus M (Siliäkuru)	404833	7114443	100	5,0 x 5,0	3:07
Asuinrakennus N (Pinolantie 406)	396890	7111092	87,9	5,0 x 5,0	0:00

**FCG Finnish Consulting Group Oy**

Miikka Saranpää, ins. AMK

Laatija

Johanna Harju, ins. AMK

Tarkastaja

3.2.2023

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**Liite 1. Melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 - Hankevaihtoehto 1**

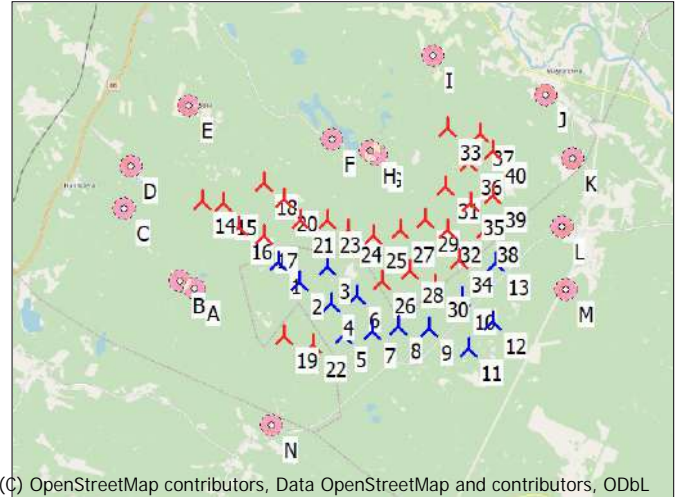


## DECIBEL - Main Result

Calculation: GE 158-6100\_107 dB+2dB\_reordered

Calculation is done according to Finnish guideline " Ympäristöhallinnon ohjeita 2 | 2014" from the Ministry of the Environment of Finland

All coordinates are in  
 Finish TM ETRS-TM35FIN-ETRS89



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL  
 Scale 1:200 000  
 🚰 New WTG      🏠 Noise sensitive area

## WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.					Creator	Name		
				[m]										
1	397 208	7 115 412	87,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
2	397 754	7 114 856	87,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
3	398 503	7 115 243	95,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
4	398 570	7 114 265	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
5	398 871	7 113 427	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
6	399 272	7 114 459	97,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
7	399 647	7 113 488	95,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
8	400 360	7 113 628	101,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
9	401 168	7 113 504	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
10	402 041	7 114 329	106,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
11	402 216	7 112 963	108,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
12	402 852	7 113 666	105,8	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
13	402 975	7 115 189	106,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
14	395 254	7 117 093	87,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
15	395 819	7 117 022	82,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
16	396 195	7 116 379	82,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
17	396 858	7 116 145	84,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
18	396 894	7 117 531	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
19	397 303	7 113 442	87,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
20	397 417	7 117 093	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
21	397 854	7 116 507	90,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
22	398 058	7 113 189	91,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
23	398 529	7 116 484	94,1	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
24	399 116	7 116 184	97,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
25	399 762	7 116 032	97,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
26	399 974	7 114 812	98,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
27	400 456	7 116 139	99,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
28	400 698	7 115 062	103,2	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
29	401 155	7 116 430	99,6	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
30	401 348	7 114 680	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
31	401 706	7 117 283	100,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
32	401 754	7 116 113	102,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
33	401 837	7 118 791	95,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
34	402 023	7 115 337	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
35	402 362	7 116 825	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
36	402 365	7 117 878	100,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
37	402 692	7 118 655	96,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
38	402 733	7 116 070	109,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
39	402 975	7 117 005	104,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
40	403 021	7 118 167	96,4	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0

## Calculation Results

## DECIBEL - Main Result

Calculation: GE 158-6100\_107 dB+2dB\_reordered

### Sound level

Noise sensitive area					Demands		Sound level		Demands fulfilled ?		
No.	Name	East	North	Z	Immission height	Noise	From WTGs	Distance to noise demand	Noise	2 dB penalty applied for one or more WTGs	
					[m]	[m]	[dB(A)]	[dB(A)]	[m]		
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	4,0	40,0	35,4	903	Yes	No	
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,8	4,0	40,0	34,6	1 033	Yes	No	
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,2	4,0	40,0	31,7	1 263	Yes	No	
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	4,0	40,0	31,4	1 309	Yes	No	
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,1	4,0	40,0	31,4	1 605	Yes	No	
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	4,0	40,0	36,6	769	Yes	No	
G	Lomarakennus G (Antikantie)	399 889	7 118 156	90,8	4,0	40,0	38,2	511	Yes	No	
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	4,0	40,0	37,8	667	Yes	No	
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	4,0	40,0	33,0	1 133	Yes	No	
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,3	4,0	40,0	33,8	979	Yes	No	
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	4,0	40,0	34,0	1 090	Yes	No	
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,4	4,0	40,0	35,7	810	Yes	No	
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	4,0	40,0	34,7	1 009	Yes	No	
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	87,9	4,0	40,0	32,4	1 386	Yes	No	

### Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	2323	2666	4319	4678	4772	3539	3836	3839	6856	8376	8296	7618	7686	4332
2	2784	3182	5038	5446	5523	3875	3930	3970	6992	8215	7973	7152	7091	3862
3	3561	3936	5598	5867	5629	3369	3226	3289	6279	7381	7133	6351	6380	4453
4	3637	4061	6029	6453	6457	4342	4108	4190	7126	7946	7495	6494	6266	3590
5	4130	4574	6701	7210	7324	5179	4837	4937	7791	8324	7689	6506	6048	3062
6	4313	4728	6589	6927	6723	4179	3748	3856	6684	7302	6789	5766	5561	4124
7	4853	5291	7343	7781	7716	5196	4674	4797	7506	7776	7035	5781	5273	3653
8	5512	5945	7919	8290	8063	5234	4552	4695	7225	7239	6401	5086	4547	4298
9	6328	6760	8707	9044	8710	5650	4825	4984	7266	6922	5917	4472	3783	4911
10	7085	7496	9248	9448	8833	5403	4391	4568	6457	5792	4721	3285	2794	6084
11	7471	7907	9884	10222	9842	6628	5691	5862	7833	6998	5735	4077	3007	5645
12	7960	8383	10222	10460	9879	6428	5380	5560	7226	6139	4811	3130	2128	6494
13	8014	8402	9960	10029	9150	5443	4281	4466	5767	4646	3463	2043	2002	7336
14	2324	2204	2087	2129	2551	3797	4755	4657	7240	9547	9899	9588	9939	6220
15	2391	2377	2648	2668	2740	3319	4225	4134	6798	9023	9342	9019	9376	6026
16	2009	2130	3077	3300	3471	3378	4099	4039	6878	8875	9054	8602	8852	5332
17	2325	2556	3773	3991	3960	3095	3637	3602	6544	8354	8447	7935	8155	5053
18	3352	3436	3767	3563	2843	2133	3060	2959	5623	7849	8234	8024	8518	6439
19	2692	3140	5420	6089	6610	5357	5377	5428	8436	9441	9002	7955	7596	2386
20	3362	3532	4247	4163	3521	2006	2691	2625	5486	7480	7745	7440	7875	6024
21	3358	3610	4703	4751	4247	2275	2619	2603	5601	7297	7399	6950	7278	5500
22	3476	3924	6166	6782	7140	5457	5294	5370	8317	9058	8493	7346	6890	2400
23	3942	4225	5377	5399	4746	2130	2155	2178	5206	6702	6742	6274	6626	5636
24	4374	4694	5993	6050	5387	2449	2118	2195	5160	6344	6246	5677	5976	5557
25	4950	5289	6654	6711	5988	2769	2128	2252	5038	5899	5676	5032	5314	5714
26	5003	5402	7130	7370	6942	3989	3345	3479	6142	6559	6005	4994	4873	4832
27	5649	5991	7329	7345	6498	3005	2095	2256	4739	5291	4988	4337	4694	6180
28	5734	6123	7759	7925	7322	4049	3198	3357	5756	5891	5258	4230	4181	5501
29	6399	6734	8000	7955	6959	3252	2141	2323	4346	4578	4231	3651	4180	6833
30	6378	6780	8486	8673	8069	4713	3770	3940	6085	5816	4965	3735	3493	5723
31	7183	7489	8540	8369	7128	3250	2016	2192	3486	3598	3470	3298	4224	7844
32	6912	7265	8623	8609	7637	3912	2766	2950	4657	4410	3814	3039	3503	6991
33	7949	8194	8858	8490	6913	3106	2049	2142	2001	2750	3398	3983	5280	9151
34	7073	7456	8997	9076	8252	4634	3536	3718	5452	4904	4025	2879	2949	6661
35	7667	7999	9191	9075	7901	4038	2808	2987	4032	3475	2962	2531	3432	7925
36	8014	8306	9240	8992	7595	3700	2492	2640	3013	2711	2754	2996	4230	8719
37	8636	8904	9671	9333	7778	3955	2847	2959	2424	2007	2539	3291	4725	9532
38	7867	8228	9602	9574	8535	4732	3527	3710	4854	3923	3012	2061	2657	7676
39	8306	8637	9803	9661	8419	4530	3294	3464	4039	2984	2327	2021	3165	8485
40	8731	9022	9924	9645	8178	4306	3132	3267	3011	2029	2114	2706	4141	9362



Project:

Rahkola\_Hautakangas

Licensed user:

FCG Finnish Consulting Group Oy  
Osmontie 34, PO Box 950  
FI-00601 Helsinki  
+358104095666  
Johanna Harju / johanna.harju@fcg.fi  
Calculated:  
20.1.2022 10.00/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: GE 158-6100\_107 dB+2dB\_reordered

Noise calculation model:

ISO 9613-2 Finland

Wind speed (in 10 m height):

8,0 m/s

Ground attenuation:

General, terrain specific

Ground factor for porous ground: 0,4

Area object with hard ground: Area object (Roughness, Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_Rahkola\_Hautakangas\_0.w2r (1

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

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:

Pure tones penalty is added to total noise impact at receptors

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]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[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: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH221

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 14.20
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63 [dB]	125 [dB]	250 [dB]	500 [dB]	1000 [dB]	2000 [dB]	4000 [dB]	8000 [dB]
From Windcat	221,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8

WTG: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH171

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 13.57
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63 [dB]	125 [dB]	250 [dB]	500 [dB]	1000 [dB]	2000 [dB]	4000 [dB]	8000 [dB]
From Windcat	171,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8

Noise sensitive area: A Lomarakennus A (Pökkylä)

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

Pure tone penalty: 0 dB

## DECIBEL - Assumptions for noise calculation

Calculation: GE 158-6100\_107 dB+2dB\_reordered

Noise sensitive area: B Asuinrakennus B (Pökkyläntie 418)

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

Pure tone penalty: 0 dB

Noise sensitive area: C Lomarakennus C (~Pökkyläntie 178)

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

Pure tone penalty: 0 dB

Noise sensitive area: D Asuinrakennus D (Luminevantie 162)

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

Pure tone penalty: 0 dB

Noise sensitive area: E Asuinrakennus E (Paratiisintie 231)

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

Pure tone penalty: 0 dB

Noise sensitive area: F Lomarakennus F (Isojärventie)

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

Pure tone penalty: 0 dB

Noise sensitive area: G Lomarakennus G (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: H Lomarakennus H (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: I Asuinrakennus I (Kalliokangas)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

## DECIBEL - Assumptions for noise calculation

Calculation: GE 158-6100\_107 dB+2dB\_reordered

Noise demand: 40,0 dB(A)

No distance demand

Pure tone penalty: 0 dB

Noise sensitive area: J Asuinrakennus J (Ojantakasentie 88)

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

Pure tone penalty: 0 dB

Noise sensitive area: K Asuinrakennus K (Ollilantie 218)

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

Pure tone penalty: 0 dB

Noise sensitive area: L Asuinrakennus L (Uusi-Kaikola)

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

Pure tone penalty: 0 dB

Noise sensitive area: M Lomarakennus M (Siliäkuru)

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

Pure tone penalty: 0 dB

Noise sensitive area: N Asuinrakennus N (Pinolantie 406)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

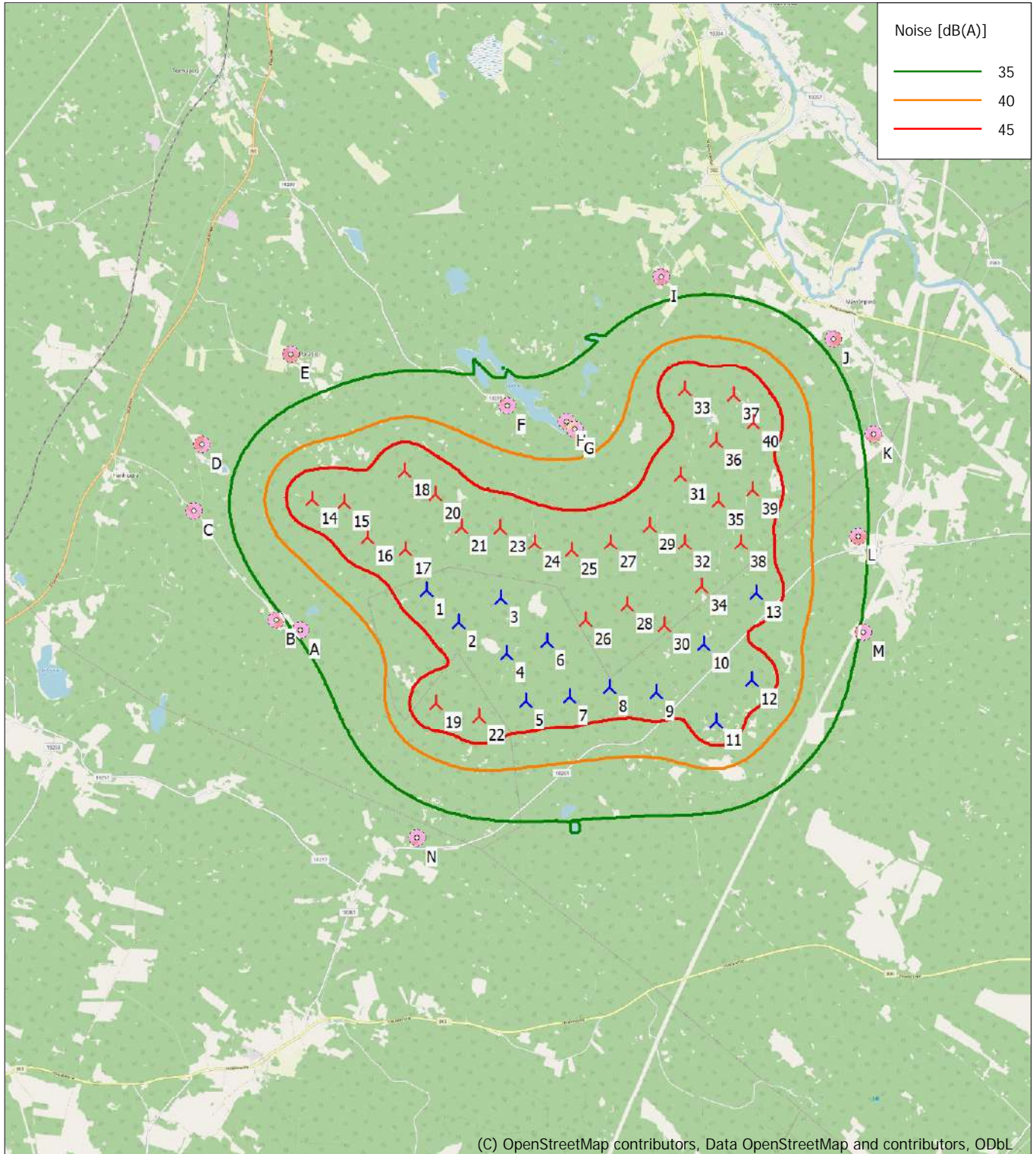
Noise demand: 40,0 dB(A)

No distance demand

Pure tone penalty: 0 dB

## DECIBEL - Map 8,0 m/s

Calculation: GE 158-6100\_107 dB+2dB\_reordered



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL



Map: EMD OpenStreetMap, Print scale 1:100 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 137 North: 7 115 877

New WTG

Noise sensitive area

Noise calculation model: ISO 9613-2 Finland. Wind speed: 8,0 m/s  
Height above sea level from active line object



3.2.2023

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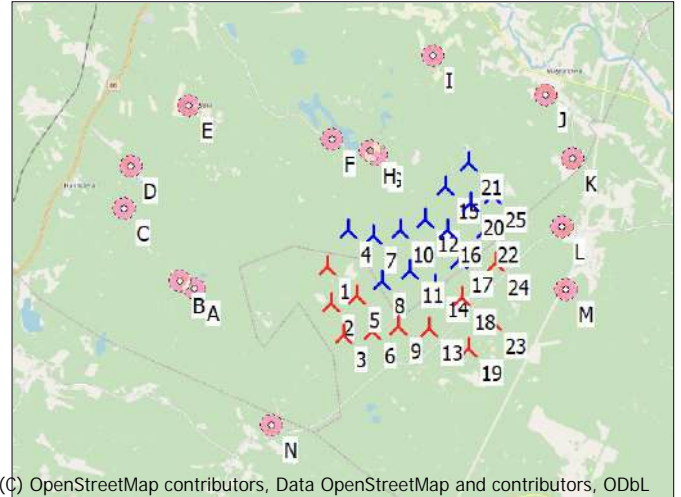
**Liite 2. Melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 - Hankevaihtoehto 2**

## DECIBEL - Main Result

Calculation: GE 158-6100\_107 dB+2dB\_reordered\_VE2

Calculation is done according to Finnish guideline " Ympäristöhallinnon ohjeita 2 | 2014" from the Ministry of the Environment of Finland

All coordinates are in  
 Finish TM ETRS-TM35FIN-ETRS89



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL  
 Scale 1:200 000  
 New WTG Noise sensitive area

### WTGs

East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
				Valid	Manufact.					Creator	Name		
1	398 503	7 115 243	95,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
2	398 570	7 114 265	90,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
3	398 871	7 113 427	90,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
4	399 116	7 116 184	97,3 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
5	399 272	7 114 459	97,5 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
6	399 647	7 113 488	95,9 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
7	399 762	7 116 032	97,5 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
8	399 974	7 114 812	98,7 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
9	400 360	7 113 628	101,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
10	400 456	7 116 139	99,7 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
11	400 698	7 115 062	103,2 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
12	401 155	7 116 430	99,6 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
13	401 168	7 113 504	105,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
14	401 348	7 114 680	105,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
15	401 706	7 117 283	100,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
16	401 754	7 116 113	102,5 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
17	402 023	7 115 337	105,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
18	402 041	7 114 329	106,3 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
19	402 216	7 112 963	108,3 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
20	402 362	7 116 825	105,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
21	402 365	7 117 878	100,5 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
22	402 733	7 116 070	109,7 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
23	402 852	7 113 666	105,8 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
24	402 975	7 115 189	106,7 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
25	402 975	7 117 005	104,3 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0

### Calculation Results

#### Sound level

Noise sensitive area	No.	Name	East	North	Z	Immission height	Demands Noise	Sound level From WTGs	Distance to noise demand	Demands fulfilled ?	
										Noise	2 dB penalty applied for one or more WTGs
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	4,0	40,0	28,0	2 603	Yes	No	
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,8	4,0	40,0	27,0	2 999	Yes	No	
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,2	4,0	40,0	23,4	4 705	Yes	No	
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	4,0	40,0	23,1	4 963	Yes	No	
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,1	4,0	40,0	24,0	4 474	Yes	No	
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	4,0	40,0	32,5	1 479	Yes	No	
G	Lomarakennus G (Antikantie)	399 889	7 118 156	90,8	4,0	40,0	36,3	748	Yes	No	
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	4,0	40,0	35,6	919	Yes	No	
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	4,0	40,0	29,0	2 153	Yes	No	
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,3	4,0	40,0	30,1	1 822	Yes	No	
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	4,0	40,0	32,0	1 397	Yes	No	

To be continued on next page...

## DECIBEL - Main Result

Calculation: GE 158-6100\_107 dB+2dB\_reordered\_VE2

...continued from previous page

Noise sensitive area					Immission height	Demands Noise	Sound level From WTGs	Distance to noise demand	Demands fulfilled ?	
No.	Name	East	North	Z	[m]	[dB(A)]	[dB(A)]	[m]	Noise	2 dB penalty applied for one or more WTGs
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,4	4,0	40,0	35,1	869	Yes	No
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	4,0	40,0	34,4	1 031	Yes	No
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	87,9	4,0	40,0	28,9	2 181	Yes	No

### Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	3561	3936	5598	5867	5629	3369	3226	3289	6279	7381	7133	6351	6380	4453
2	3637	4061	6029	6453	6457	4342	4108	4190	7126	7946	7495	6494	6266	3590
3	4130	4574	6701	7210	7324	5179	4837	4937	7791	8324	7689	6506	6048	3062
4	4374	4694	5993	6050	5387	2449	2118	2195	5160	6344	6246	5677	5976	5557
5	4313	4728	6589	6927	6723	4179	3748	3856	6684	7302	6789	5766	5561	4124
6	4853	5291	7343	7781	7716	5196	4674	4797	7506	7776	7035	5781	5273	3653
7	4950	5289	6654	6711	5988	2769	2128	2252	5038	5899	5676	5032	5314	5714
8	5003	5402	7130	7370	6942	3989	3345	3479	6142	6559	6005	4994	4873	4832
9	5512	5945	7919	8290	8063	5234	4552	4695	7225	7239	6401	5086	4547	4298
10	5649	5991	7329	7345	6498	3005	2095	2256	4739	5291	4988	4337	4694	6180
11	5734	6123	7759	7925	7322	4049	3198	3357	5756	5891	5258	4230	4181	5501
12	6399	6734	8000	7955	6959	3252	2141	2323	4346	4578	4231	3651	4180	6833
13	6328	6760	8707	9044	8710	5650	4825	4984	7266	6922	5917	4472	3783	4911
14	6378	6780	8486	8673	8069	4713	3770	3940	6085	5816	4965	3735	3493	5723
15	7183	7489	8540	8369	7128	3250	2016	2192	3486	3598	3470	3298	4224	7844
16	6912	7265	8623	8609	7637	3912	2766	2950	4657	4410	3814	3039	3503	6991
17	7073	7456	8997	9076	8252	4634	3536	3718	5452	4904	4025	2879	2949	6661
18	7085	7496	9248	9448	8833	5403	4391	4568	6457	5792	4721	3285	2794	6084
19	7471	7907	9884	10222	9842	6628	5691	5862	7833	6998	5735	4077	3007	5645
20	7667	7999	9191	9075	7901	4038	2808	2987	4032	3475	2962	2531	3432	7925
21	8014	8306	9240	8992	7595	3700	2492	2640	3013	2711	2754	2996	4230	8719
22	7867	8228	9602	9574	8535	4732	3527	3710	4854	3923	3012	2061	2657	7676
23	7960	8383	10222	10460	9879	6428	5380	5560	7226	6139	4811	3130	2128	6494
24	8014	8402	9960	10029	9150	5443	4281	4466	5767	4646	3463	2043	2002	7336
25	8306	8637	9803	9661	8419	4530	3294	3464	4039	2984	2327	2021	3165	8485

Project:  
Rahkola\_Hautakangas

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Osmontie 34, PO Box 950  
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+358104095666  
Johanna Harju / johanna.harju@fcg.fi  
Calculated:  
20.1.2022 13.46/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: GE 158-6100\_107 dB+2dB\_reordered\_VE2

Noise calculation model:

ISO 9613-2 Finland

Wind speed (in 10 m height):

8,0 m/s

Ground attenuation:

General, terrain specific

Ground factor for porous ground: 0,4

Area object with hard ground: Area object (Roughness, Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_Rahkola\_Hautakangas\_0.w2r (1

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

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:

Pure tones penalty is added to total noise impact at receptors

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]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[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: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH221

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 14.20
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data								
					63	125	250	500	1000	2000	4000	8000	
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	221,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8	

WTG: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH171

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 13.57
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data								
					63	125	250	500	1000	2000	4000	8000	
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	171,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8	

Noise sensitive area: A Lomarakennus A (Pökkylä)

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

Pure tone penalty: 0 dB



## DECIBEL - Assumptions for noise calculation

Calculation: GE 158-6100\_107 dB+2dB\_reordered\_VE2

Noise sensitive area: B Asuinrakennus B (Pökkyläntie 418)

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

Pure tone penalty: 0 dB

Noise sensitive area: C Lomarakennus C (~Pökkyläntie 178)

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

Pure tone penalty: 0 dB

Noise sensitive area: D Asuinrakennus D (Luminevantie 162)

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

Pure tone penalty: 0 dB

Noise sensitive area: E Asuinrakennus E (Paratiisintie 231)

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

Pure tone penalty: 0 dB

Noise sensitive area: F Lomarakennus F (Isojärventie)

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

Pure tone penalty: 0 dB

Noise sensitive area: G Lomarakennus G (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: H Lomarakennus H (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: I Asuinrakennus I (Kalliokangas)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Project:

Rahkola\_Hautakangas

Licensed user:

FCG Finnish Consulting Group Oy  
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Johanna Harju / johanna.harju@fcg.fi  
Calculated:  
20.1.2022 13.46/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: GE 158-6100\_107 dB+2dB\_reordered\_VE2

Noise demand: 40,0 dB(A)

No distance demand

Pure tone penalty: 0 dB

Noise sensitive area: J Asuinrakennus J (Ojantakasentie 88)

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

Pure tone penalty: 0 dB

Noise sensitive area: K Asuinrakennus K (Ollilantie 218)

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

Pure tone penalty: 0 dB

Noise sensitive area: L Asuinrakennus L (Uusi-Kaikola)

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

Pure tone penalty: 0 dB

Noise sensitive area: M Lomarakennus M (Siliäkuru)

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

Pure tone penalty: 0 dB

Noise sensitive area: N Asuinrakennus N (Pinolantie 406)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

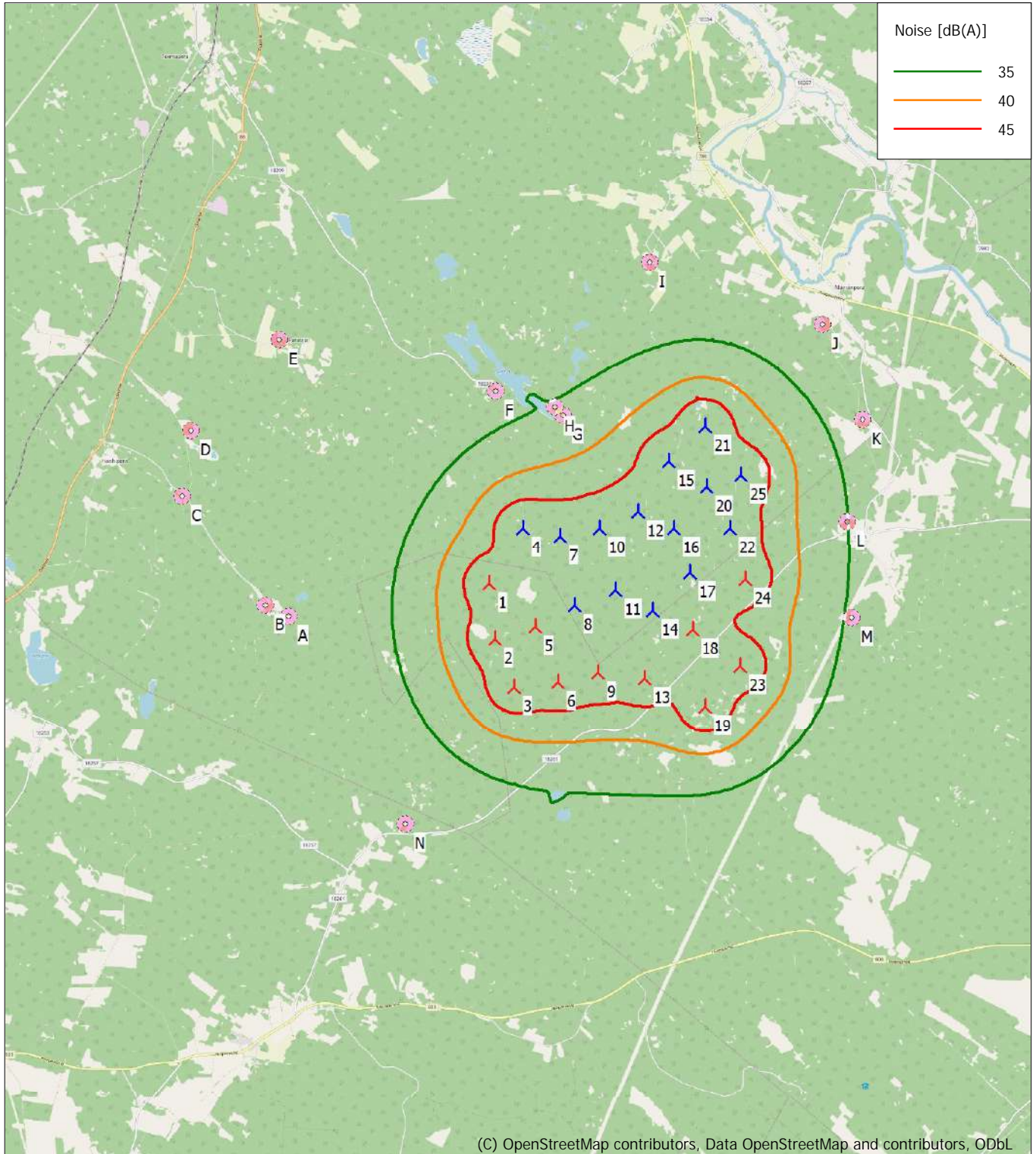
Noise demand: 40,0 dB(A)

No distance demand

Pure tone penalty: 0 dB

### DECIBEL - Map 8,0 m/s

Calculation: GE 158-6100\_107 dB+2dB\_reordered\_VE2



(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL



Map: EMD OpenStreetMap, Print scale 1:100 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 324 North: 7 115 613

New WTG

Noise sensitive area

Noise calculation model: ISO 9613-2 Finland. Wind speed: 8,0 m/s  
Height above sea level from active line object

3.2.2023

---

**Liite 3. Melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 - Hankevaihtoehto 3**



Project:

Rahkola\_Hautakangas

Licensed user:

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Calculated:

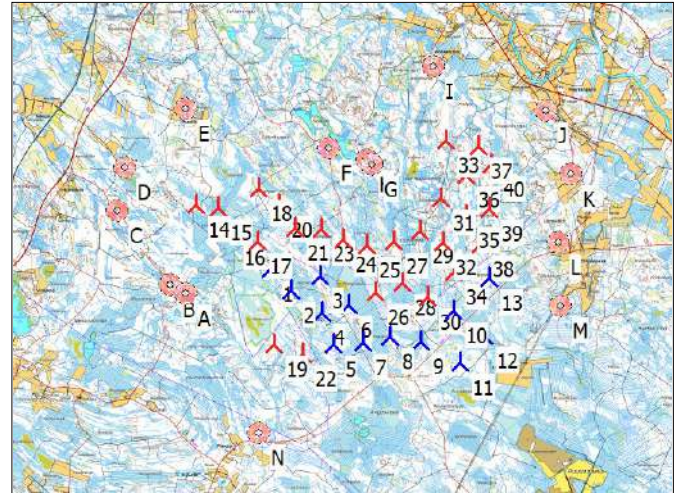
11.1.2023 10.48/3.5.584

## DECIBEL - Main Result

Calculation: VE3\_GE 158-6100\_107 dB+2dB

Calculation is done according to Finnish guideline " Ympäristöhallinnon ohjeita 2 | 2014" from the Ministry of the Environment of Finland

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89



Scale 1:200 000

New WTG

Noise sensitive area

## WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.					Creator	Name		
1	397 208	7 115 412	87,7	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
2	397 754	7 114 856	87,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
3	398 503	7 115 243	95,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
4	398 570	7 114 265	90,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
5	398 871	7 113 427	90,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
6	399 272	7 114 459	97,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
7	399 647	7 113 488	95,9	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
8	400 360	7 113 628	101,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
9	401 168	7 113 504	105,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
10	402 041	7 114 329	106,3	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
11	402 216	7 112 963	108,3	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
12	402 852	7 113 666	105,8	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
13	402 975	7 115 189	106,7	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
14	395 254	7 117 093	87,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
15	395 819	7 117 022	82,9	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
16	396 195	7 116 379	82,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
17	396 858	7 116 145	84,9	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
18	396 894	7 117 531	90,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
19	397 303	7 113 442	87,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
20	397 417	7 117 093	90,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
21	397 854	7 116 507	90,9	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
22	398 058	7 113 189	91,9	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
23	398 529	7 116 484	94,1	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
24	399 116	7 116 184	97,3	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
25	399 762	7 116 032	97,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
26	399 974	7 114 812	98,7	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
27	400 456	7 116 139	99,7	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
28	400 698	7 115 062	103,2	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
29	401 155	7 116 430	99,6	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
30	401 348	7 114 680	105,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
31	401 706	7 117 283	100,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
32	401 754	7 116 113	102,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
33	401 837	7 118 791	95,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
34	402 023	7 115 337	105,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
35	402 362	7 116 825	105,0	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
36	402 365	7 117 878	100,5	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
37	402 692	7 118 655	96,3	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
38	402 733	7 116 070	109,7	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
39	402 975	7 117 005	104,3	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
40	403 021	7 118 167	96,4	GE WIND ENERGY GE158 - ...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0

## Calculation Results

## DECIBEL - Main Result

Calculation: VE3\_GE 158-6100\_107 dB+2dB

### Sound level

No.	Name	East	North	Z	Immission height	Demands Noise	Sound level From WTGs	Distance to noise demand	Demands fulfilled ?	2 dB penalty applied for one or more WTGs
				[m]	[m]	[dB(A)]	[dB(A)]	[m]		
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	4,0	40,0	35,4	911	Yes	No
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,8	4,0	40,0	34,6	1 041	Yes	No
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,2	4,0	40,0	31,7	1 275	Yes	No
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	4,0	40,0	31,4	1 320	Yes	No
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,1	4,0	40,0	31,3	1 615	Yes	No
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	4,0	40,0	36,5	776	Yes	No
G	Lomarakennus G (Antikantie)	399 889	7 118 156	90,8	4,0	40,0	38,2	518	Yes	No
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	4,0	40,0	37,8	674	Yes	No
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	4,0	40,0	32,9	1 143	Yes	No
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,3	4,0	40,0	33,7	988	Yes	No
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	4,0	40,0	34,0	1 099	Yes	No
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,4	4,0	40,0	35,7	817	Yes	No
M	Lomarakennus M (Silliäkuru)	404 833	7 114 443	100,0	4,0	40,0	34,7	1 011	Yes	No
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	87,9	4,0	40,0	32,3	1 395	Yes	No

### Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	2323	2666	4319	4678	4772	3539	3836	3839	6856	8376	8296	7618	7686	4332
2	2784	3182	5038	5446	5523	3875	3930	3970	6992	8215	7973	7152	7091	3862
3	3561	3936	5598	5867	5629	3369	3226	3289	6279	7381	7133	6351	6380	4453
4	3637	4061	6029	6453	6457	4342	4108	4190	7126	7946	7495	6494	6266	3590
5	4130	4574	6701	7210	7324	5179	4837	4937	7791	8324	7689	6506	6048	3062
6	4313	4728	6589	6927	6723	4179	3748	3856	6684	7302	6789	5766	5561	4124
7	4853	5291	7343	7781	7716	5196	4674	4797	7506	7776	7035	5781	5273	3653
8	5512	5945	7919	8290	8063	5234	4552	4695	7225	7239	6401	5086	4547	4298
9	6328	6760	8707	9044	8710	5650	4825	4984	7266	6922	5917	4472	3783	4911
10	7085	7496	9248	9448	8833	5403	4391	4568	6457	5792	4721	3285	2794	6084
11	7471	7907	9884	10222	9842	6628	5691	5862	7833	6998	5735	4077	3007	5645
12	7960	8383	10222	10460	9879	6428	5380	5560	7226	6139	4811	3130	2128	6494
13	8014	8402	9960	10029	9150	5443	4281	4466	5767	4646	3463	2043	2002	7336
14	2324	2204	2087	2129	2551	3797	4755	4657	7240	9547	9899	9588	9939	6220
15	2391	2377	2648	2668	2740	3319	4225	4134	6798	9023	9342	9019	9376	6026
16	2009	2130	3077	3300	3471	3378	4099	4039	6878	8875	9054	8602	8852	5332
17	2325	2556	3773	3991	3960	3095	3637	3602	6544	8354	8447	7935	8155	5053
18	3352	3436	3767	3563	2843	2133	3060	2959	5623	7849	8234	8024	8518	6439
19	2692	3140	5420	6089	6610	5357	5377	5428	8436	9441	9002	7955	7596	2386
20	3362	3532	4247	4163	3521	2006	2691	2625	5486	7480	7745	7440	7875	6024
21	3358	3610	4703	4751	4247	2275	2619	2603	5601	7297	7399	6950	7278	5500
22	3476	3924	6166	6782	7140	5457	5294	5370	8317	9058	8493	7346	6890	2400
23	3942	4225	5377	5399	4746	2130	2155	2178	5206	6702	6742	6274	6626	5636
24	4374	4694	5993	6050	5387	2449	2118	2195	5160	6344	6246	5677	5976	5557
25	4950	5289	6654	6711	5988	2769	2128	2252	5038	5899	5676	5032	5314	5714
26	5003	5402	7130	7370	6942	3989	3345	3479	6142	6559	6005	4994	4873	4832
27	5649	5991	7329	7345	6498	3005	2095	2256	4739	5291	4988	4337	4694	6180
28	5734	6123	7759	7925	7322	4049	3198	3357	5756	5891	5258	4230	4181	5501
29	6399	6734	8000	7955	6959	3252	2141	2323	4346	4578	4231	3651	4180	6833
30	6378	6780	8486	8673	8069	4713	3770	3940	6085	5816	4965	3735	3493	5723
31	7183	7489	8540	8369	7128	3250	2016	2192	3486	3598	3470	3298	4224	7844
32	6912	7265	8623	8609	7637	3912	2766	2950	4657	4410	3814	3039	3503	6991
33	7949	8194	8858	8490	6913	3106	2049	2142	2001	2750	3398	3983	5280	9151
34	7073	7456	8997	9076	8252	4634	3536	3718	5452	4904	4025	2879	2949	6661
35	7667	7999	9191	9075	7901	4038	2808	2987	4032	3475	2962	2531	3432	7925
36	8014	8306	9240	8992	7595	3700	2492	2640	3013	2711	2754	2996	4230	8719
37	8636	8904	9671	9333	7778	3955	2847	2959	2424	2007	2539	3291	4725	9532
38	7867	8228	9602	9574	8535	4732	3527	3710	4854	3923	3012	2061	2657	7676
39	8306	8637	9803	9661	8419	4530	3294	3464	4039	2984	2327	2021	3165	8485
40	8731	9022	9924	9645	8178	4306	3132	3267	3011	2029	2114	2706	4141	9362

Project:

Rahkola\_Hautakangas

Licensed user:

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+358104095666  
Miikka Saranpää / miikka.saranpaa@fcg.fi  
Calculated:  
11.1.2023 10.48/3.5.584

## DECIBEL - Assumptions for noise calculation

Calculation: VE3\_GE 158-6100\_107 dB+2dB

Noise calculation model:

ISO 9613-2 Finland

Wind speed (in 10 m height):

8,0 m/s

Ground attenuation:

General, terrain specific

Ground factor for porous ground: 0,4

Area object with hard ground: Area object (Roughness, Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_Rahkola\_Hautakangas\_0.w2r (1

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

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:

Pure tones penalty is added to total noise impact at receptors

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]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[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: GE WIND ENERGY GE158 - 6.1 MW 6100 158.0 IO!

Noise: GE 6.1.158 no STE 107.0 dB +2dB

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	30.5.2018	USER	23.11.2022 8.27

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data								
					63	125	250	500	1000	2000	4000	8000	
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	221,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8	

Noise sensitive area: A Lomarakennus A (Pökkylä)

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

Pure tone penalty: 0 dB

Noise sensitive area: B Asuinrakennus B (Pökkyläntie 418)

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

Pure tone penalty: 0 dB

Noise sensitive area: C Lomarakennus C (~Pökkyläntie 178)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

## DECIBEL - Assumptions for noise calculation

Calculation: VE3\_GE 158-6100\_107 dB+2dB

Noise demand: 40,0 dB(A)

No distance demand

Pure tone penalty: 0 dB

Noise sensitive area: D Asuinrakennus D (Luminevantie 162)

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

Pure tone penalty: 0 dB

Noise sensitive area: E Asuinrakennus E (Paratiisintie 231)

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

Pure tone penalty: 0 dB

Noise sensitive area: F Lomarakennus F (Isojärventie)

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

Pure tone penalty: 0 dB

Noise sensitive area: G Lomarakennus G (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: H Lomarakennus H (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: I Asuinrakennus I (Kalliokangas)

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

Pure tone penalty: 0 dB

Noise sensitive area: J Asuinrakennus J (Ojantakasentie 88)

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

Pure tone penalty: 0 dB



Project:

Rahkola\_Hautakangas

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Mikka Saranpää / mikka.saranpaa@fcg.fi

Calculated:

11.1.2023 10.48/3.5.584

## DECIBEL - Assumptions for noise calculation

Calculation: VE3\_GE 158-6100\_107 dB+2dB

Noise sensitive area: K Asuinrakennus K (Ollilantie 218)

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

Pure tone penalty: 0 dB

Noise sensitive area: L Asuinrakennus L (Uusi-Kaikola)

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

Pure tone penalty: 0 dB

Noise sensitive area: M Lomarakennus M (Siliäkuru)

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

Pure tone penalty: 0 dB

Noise sensitive area: N Asuinrakennus N (Pinolantie 406)

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)

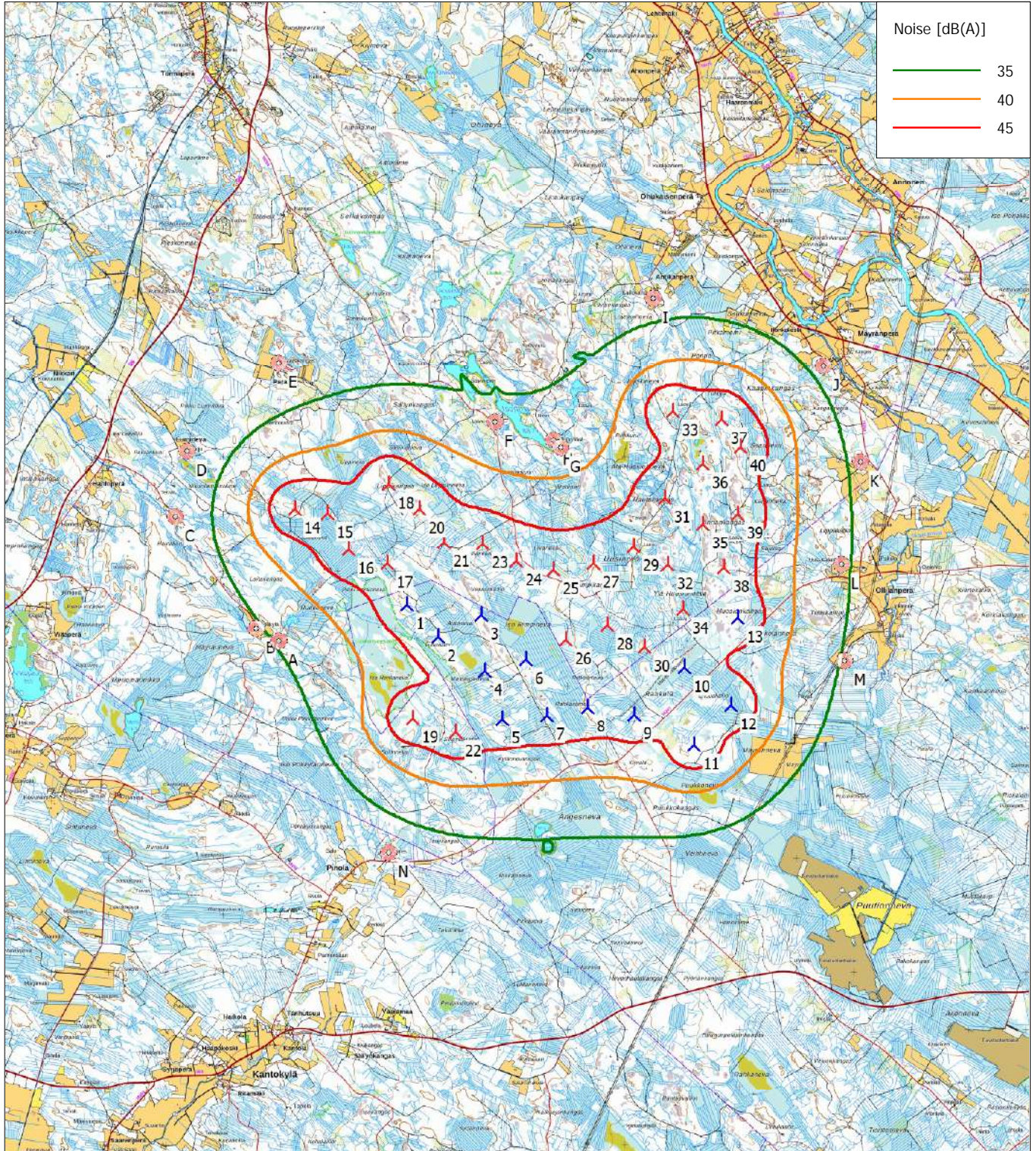
No distance demand

Pure tone penalty: 0 dB



## DECIBEL - Map 8,0 m/s

Calculation: VE3\_GE 158-6100\_107 dB+2dB



Map: Maastokarttarasteri50K , Print scale 1:100 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 137 North: 7 115 877

New WTG

Noise sensitive area

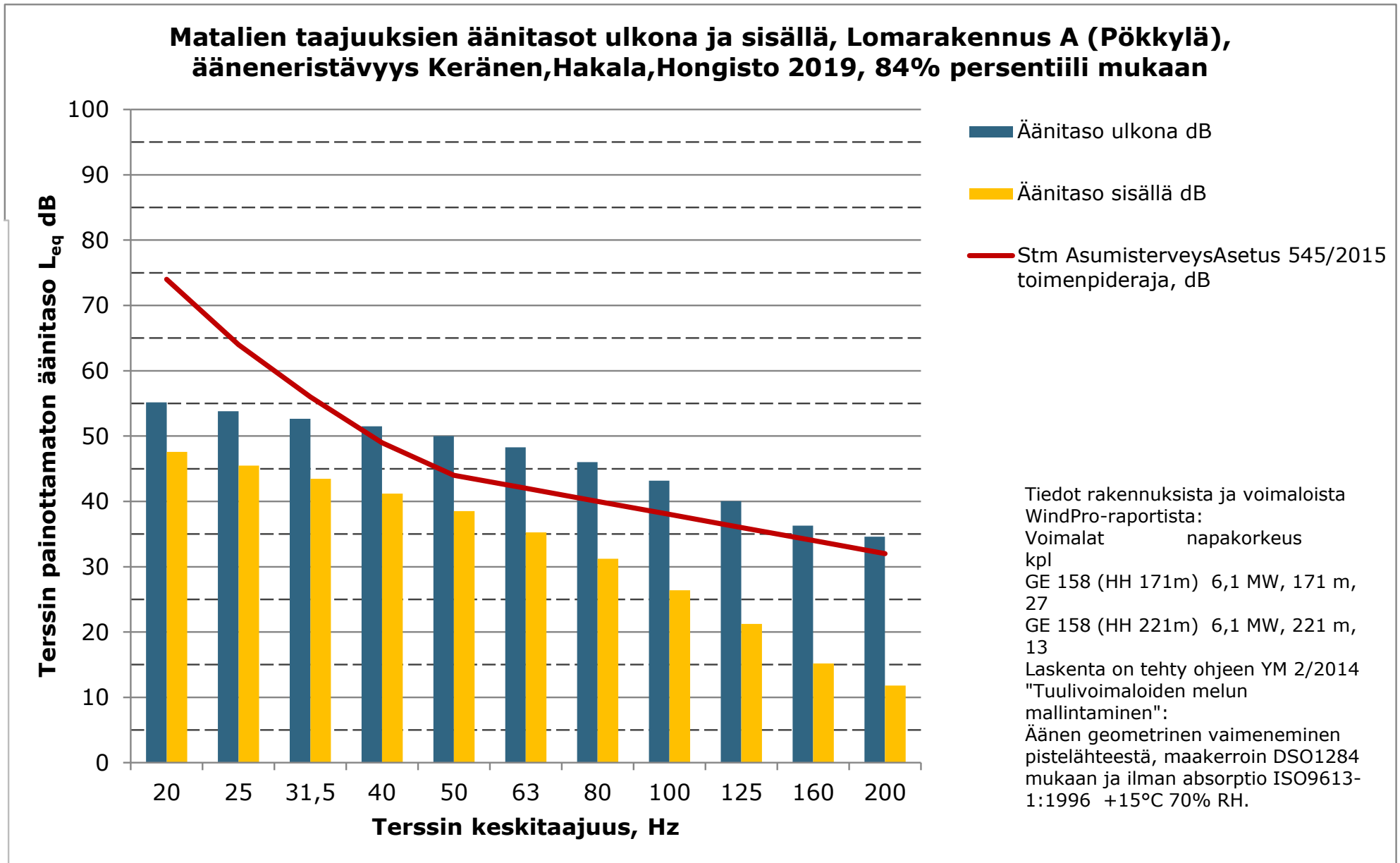
Noise calculation model: ISO 9613-2 Finland. Wind speed: 8,0 m/s  
Height above sea level from active line object



3.2.2023

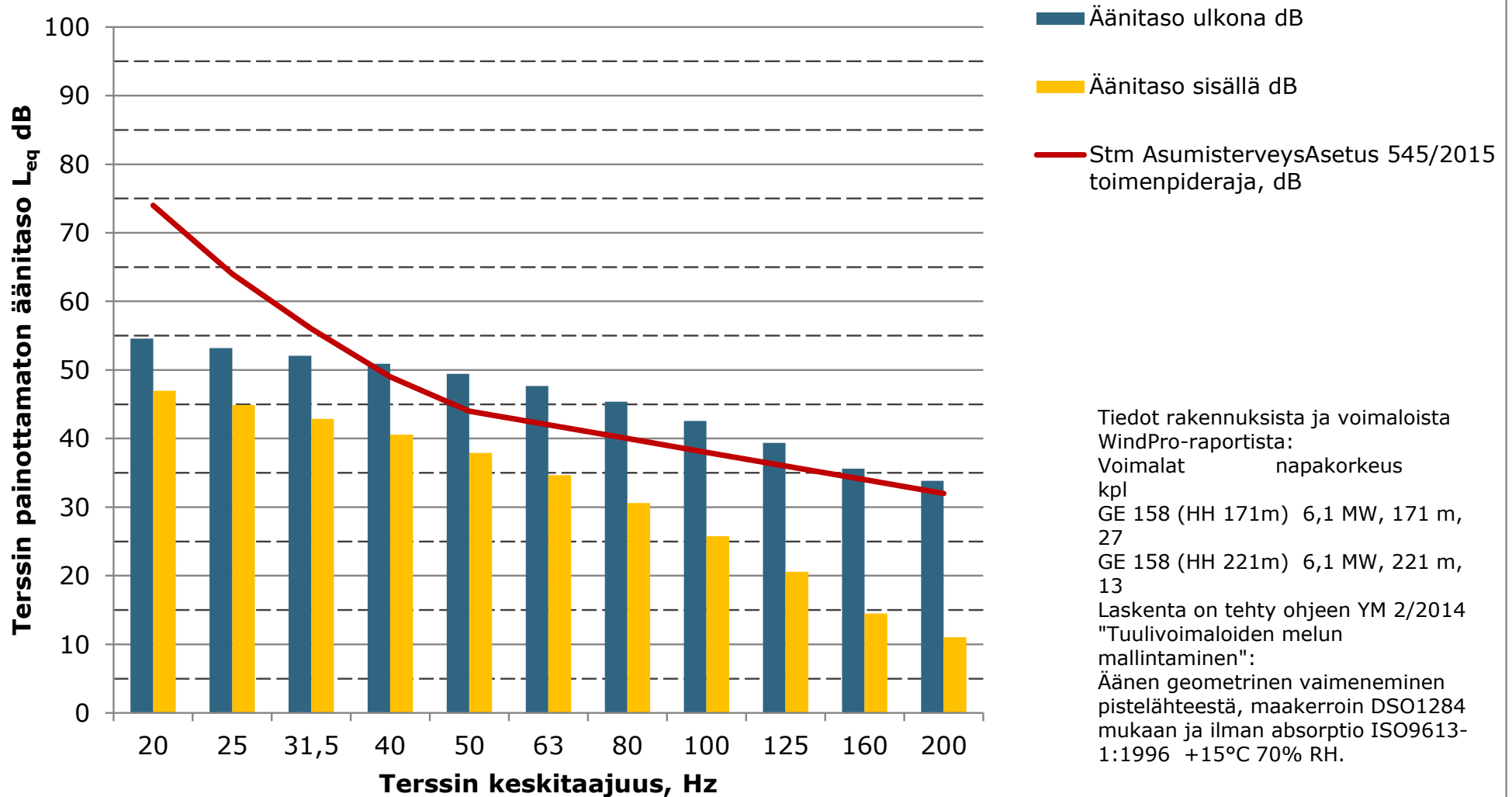
---

**Liite 4. Matalataajuisen melun rakennuskohtaiset arvot - Hankevaihtoehto 1**

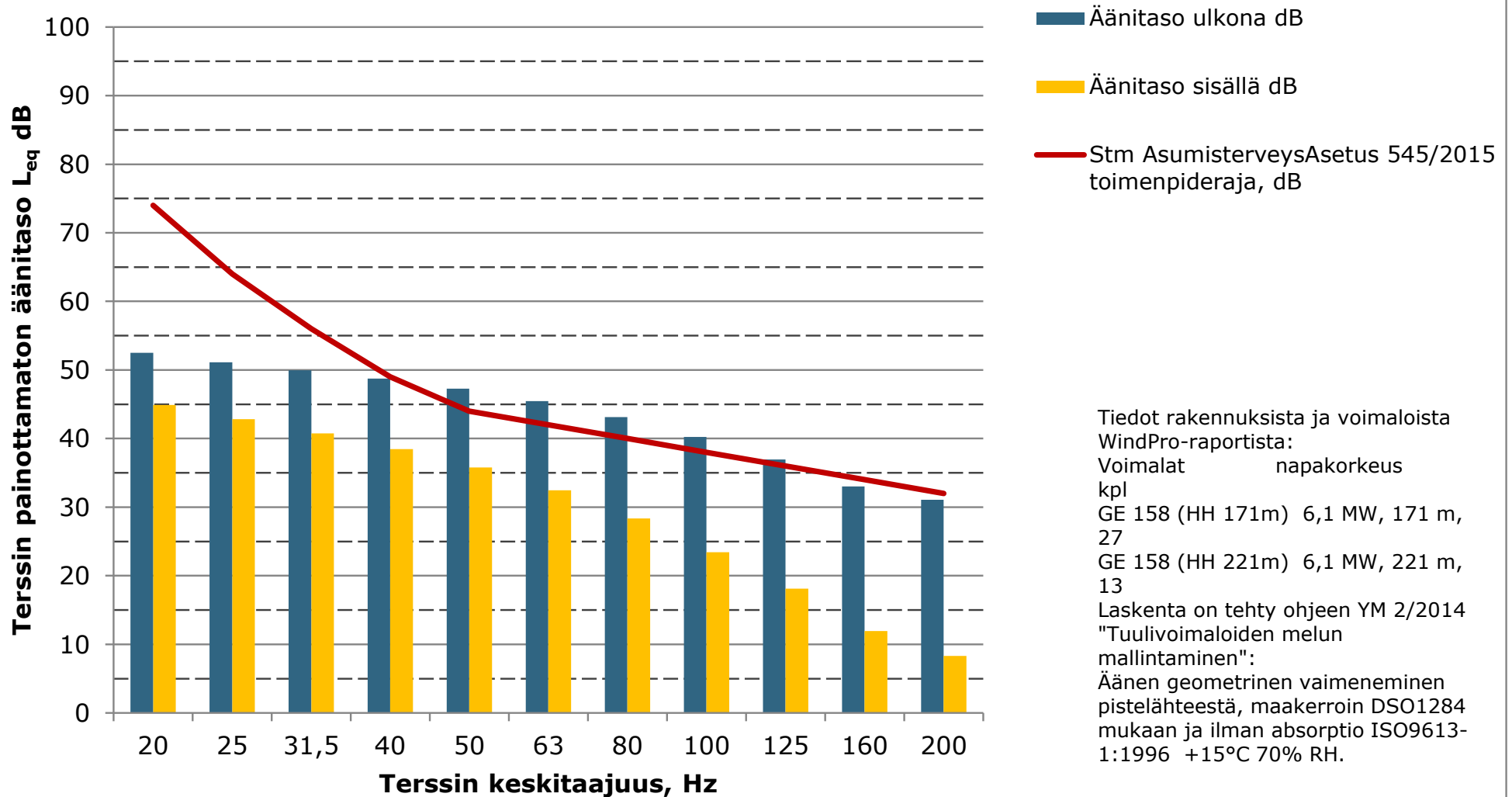




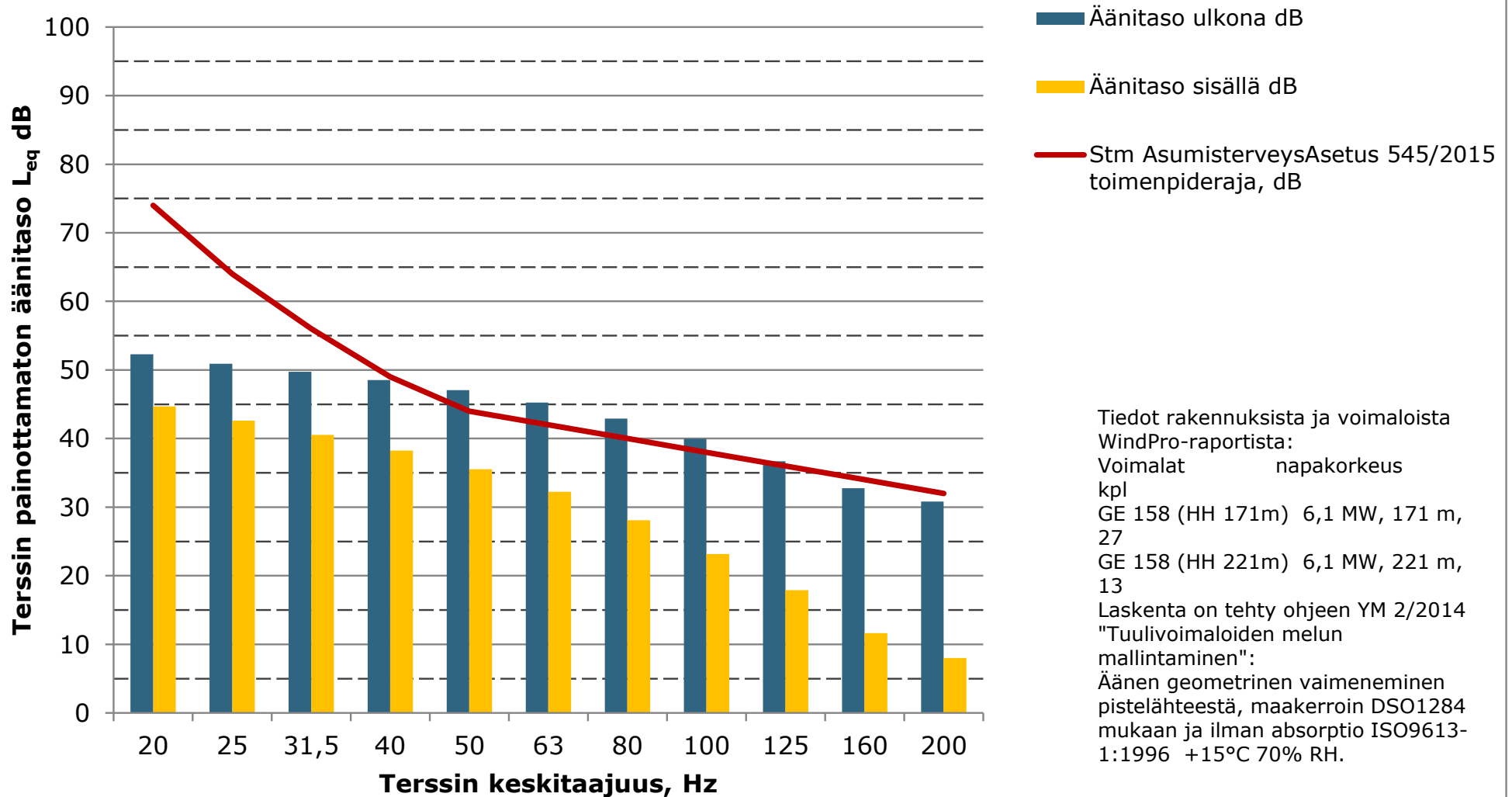
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus B (Pökkyläntie 418), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



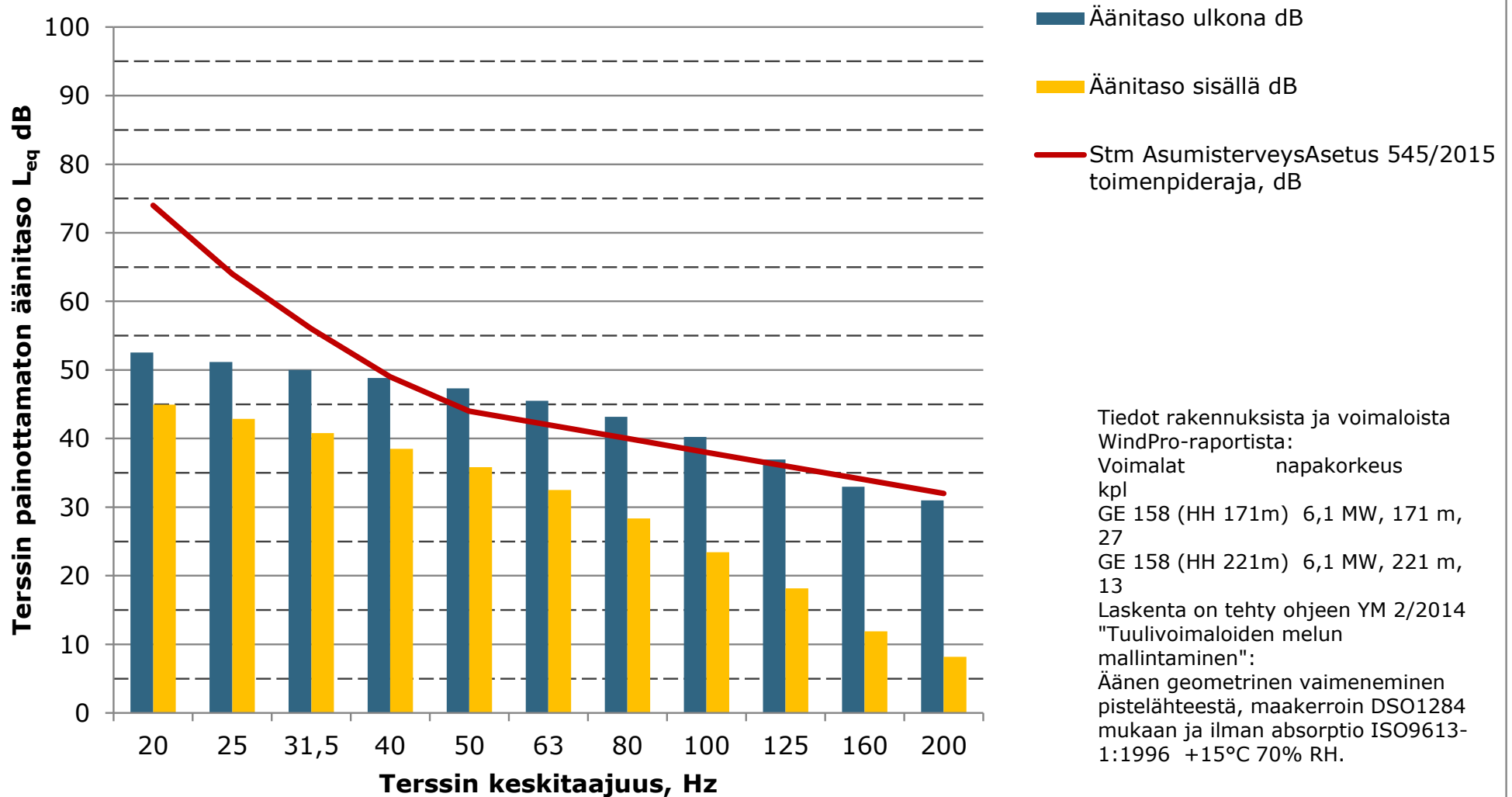
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus C  
(~Pökkyläntie 178), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persentiili mukaan**



**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus D  
(Luminevantie 162), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persenttiili mukaan**

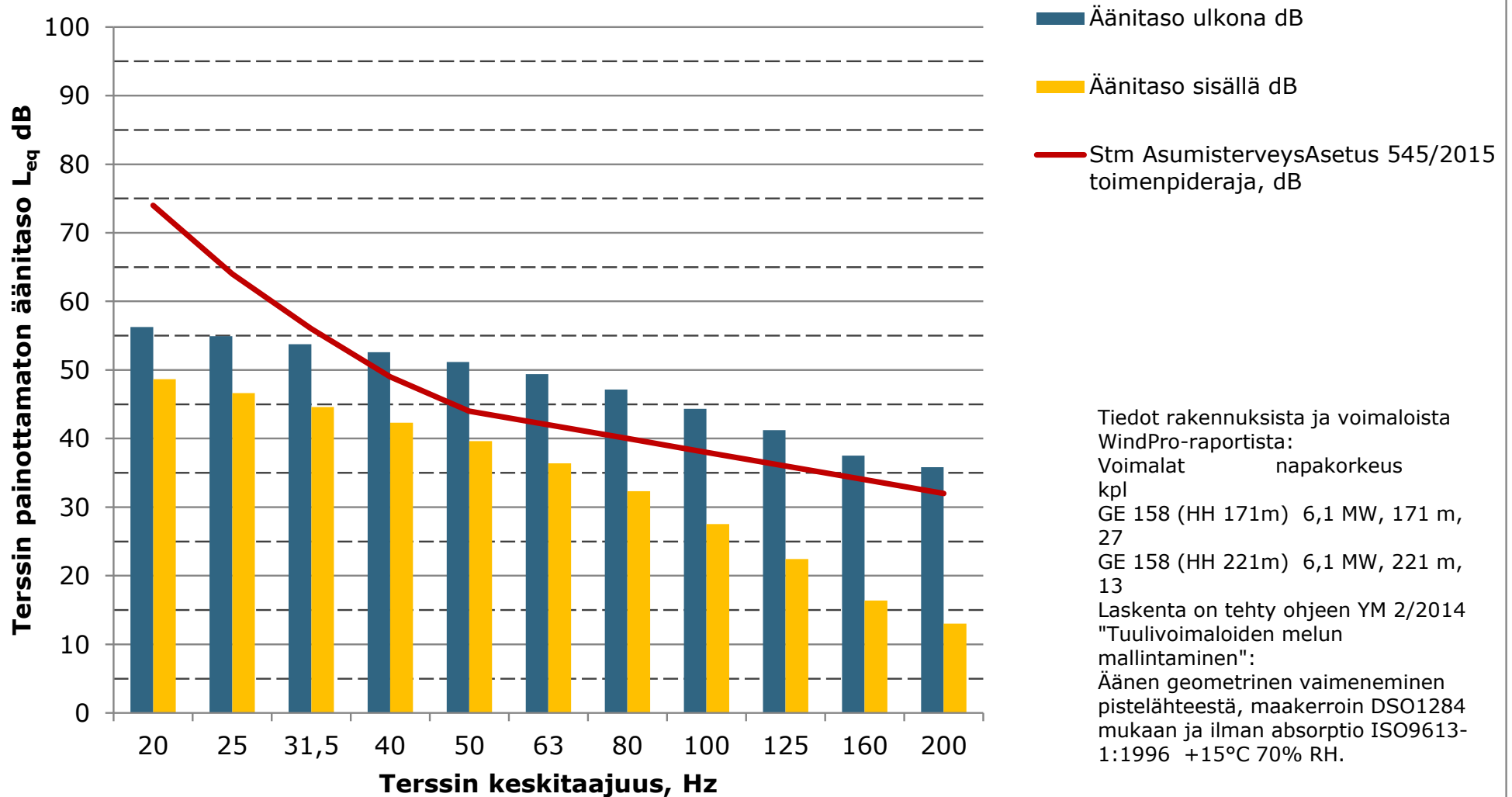


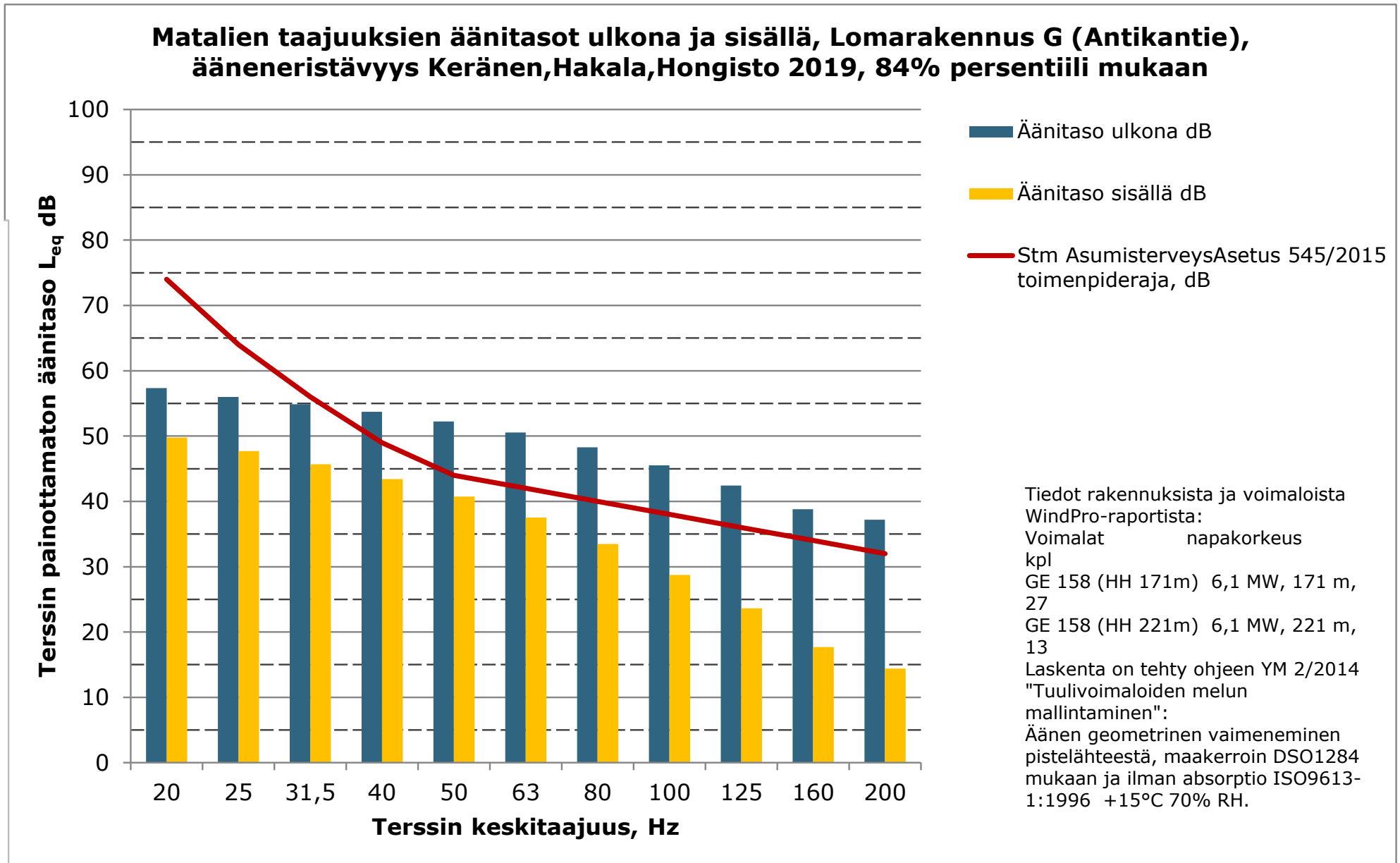
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus E (Paratiisintie 231), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan

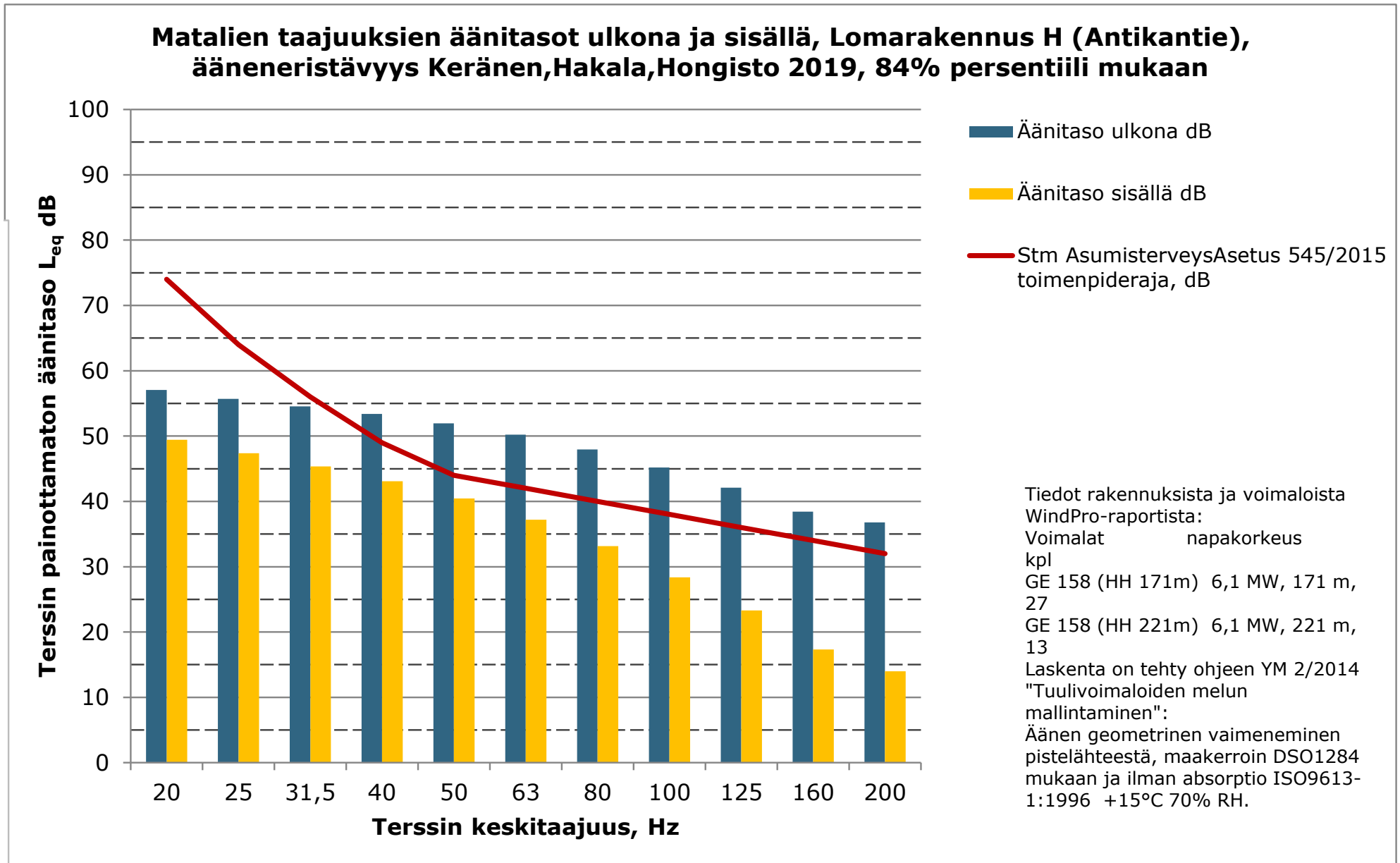




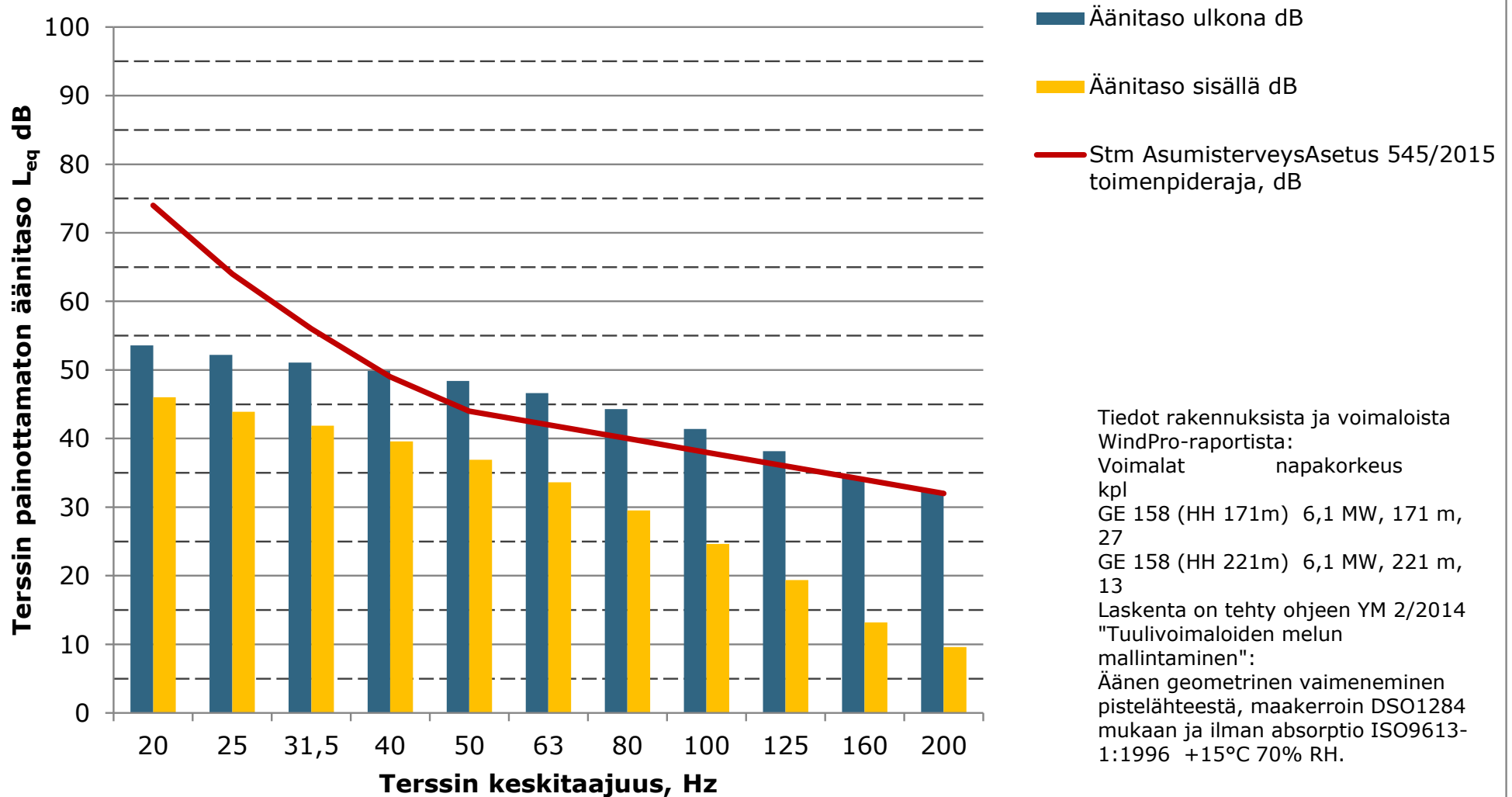
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus F  
(Isojärventie), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**





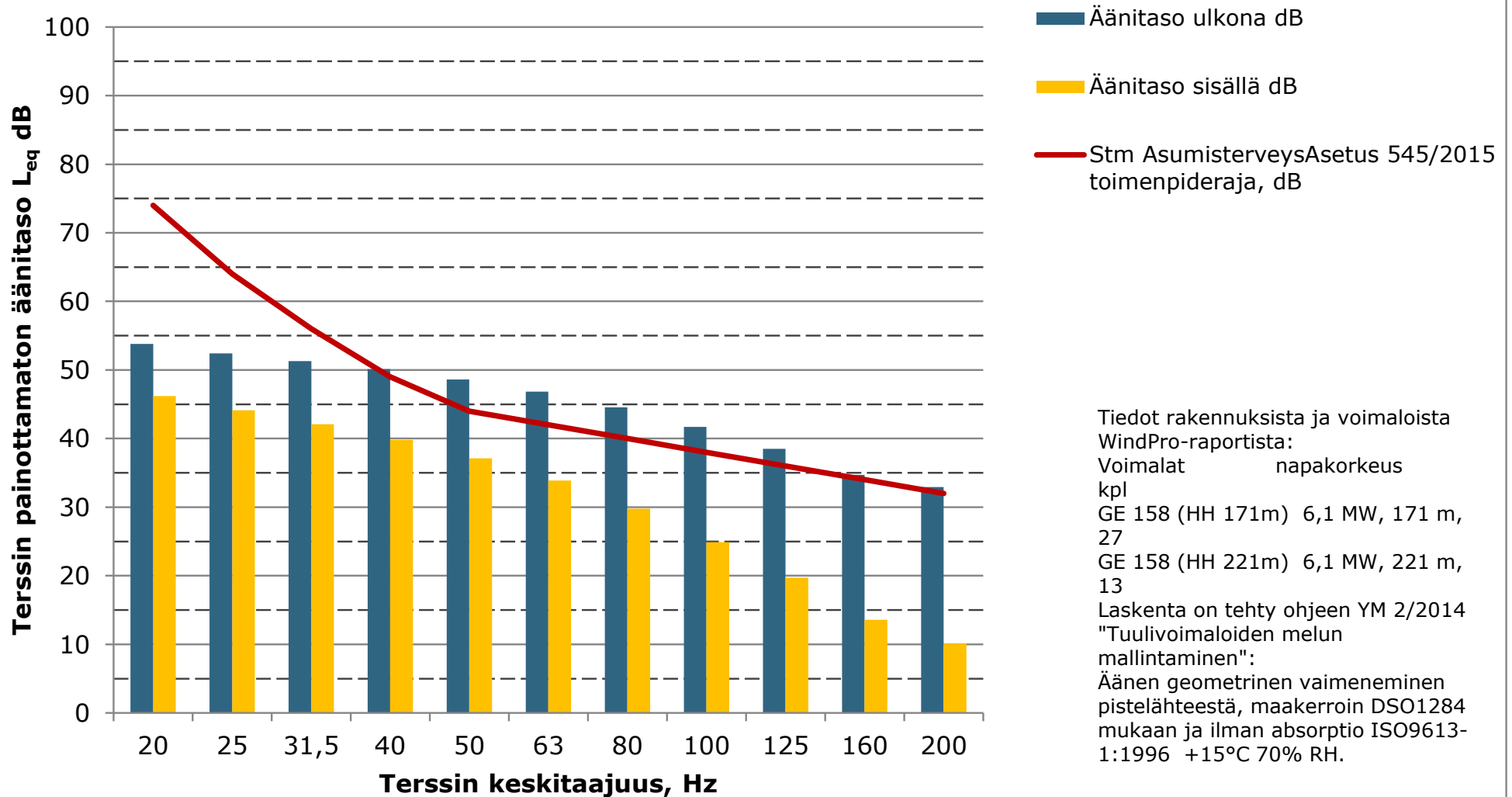


**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus I  
(Kalliokangas), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

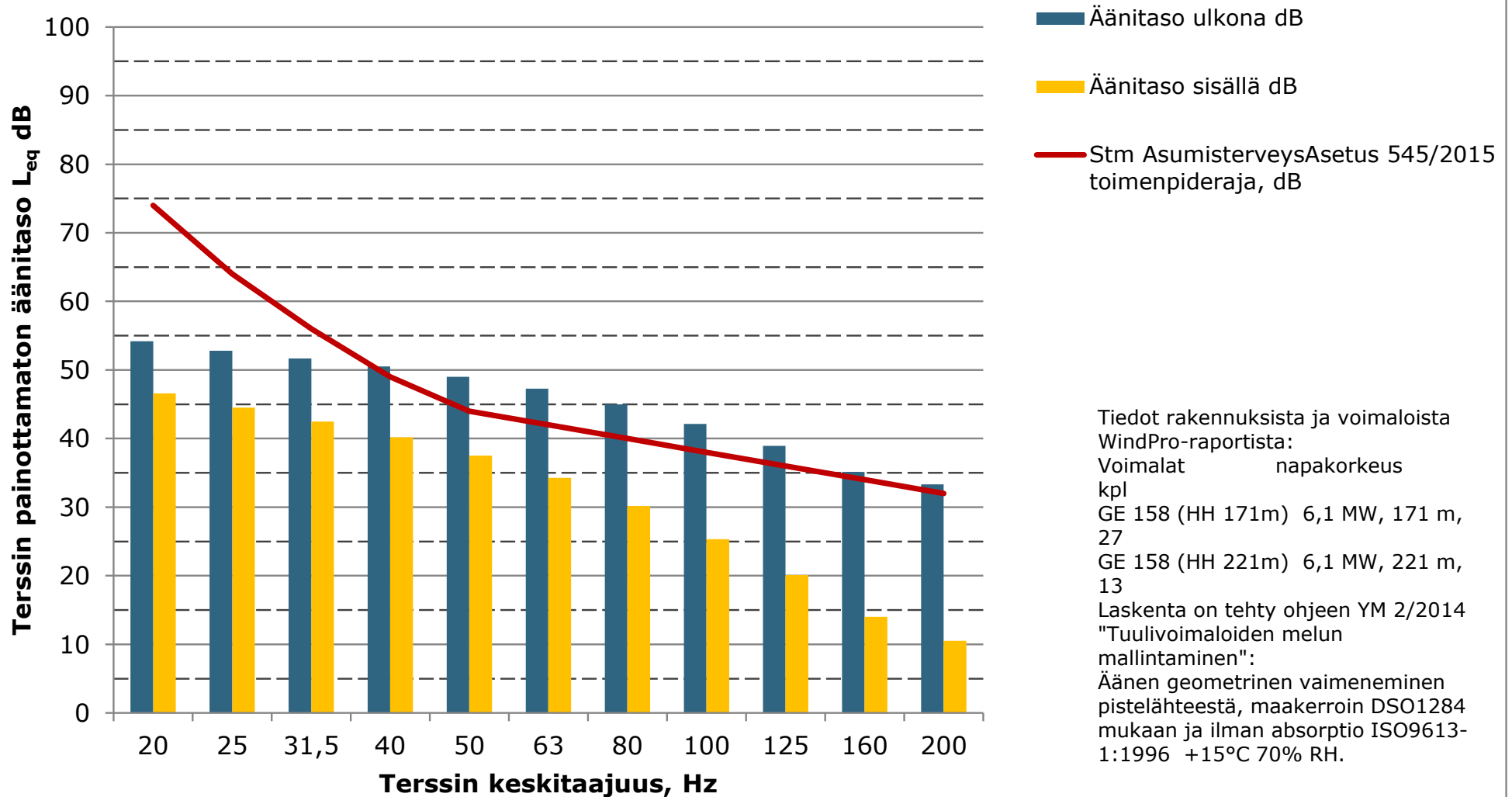




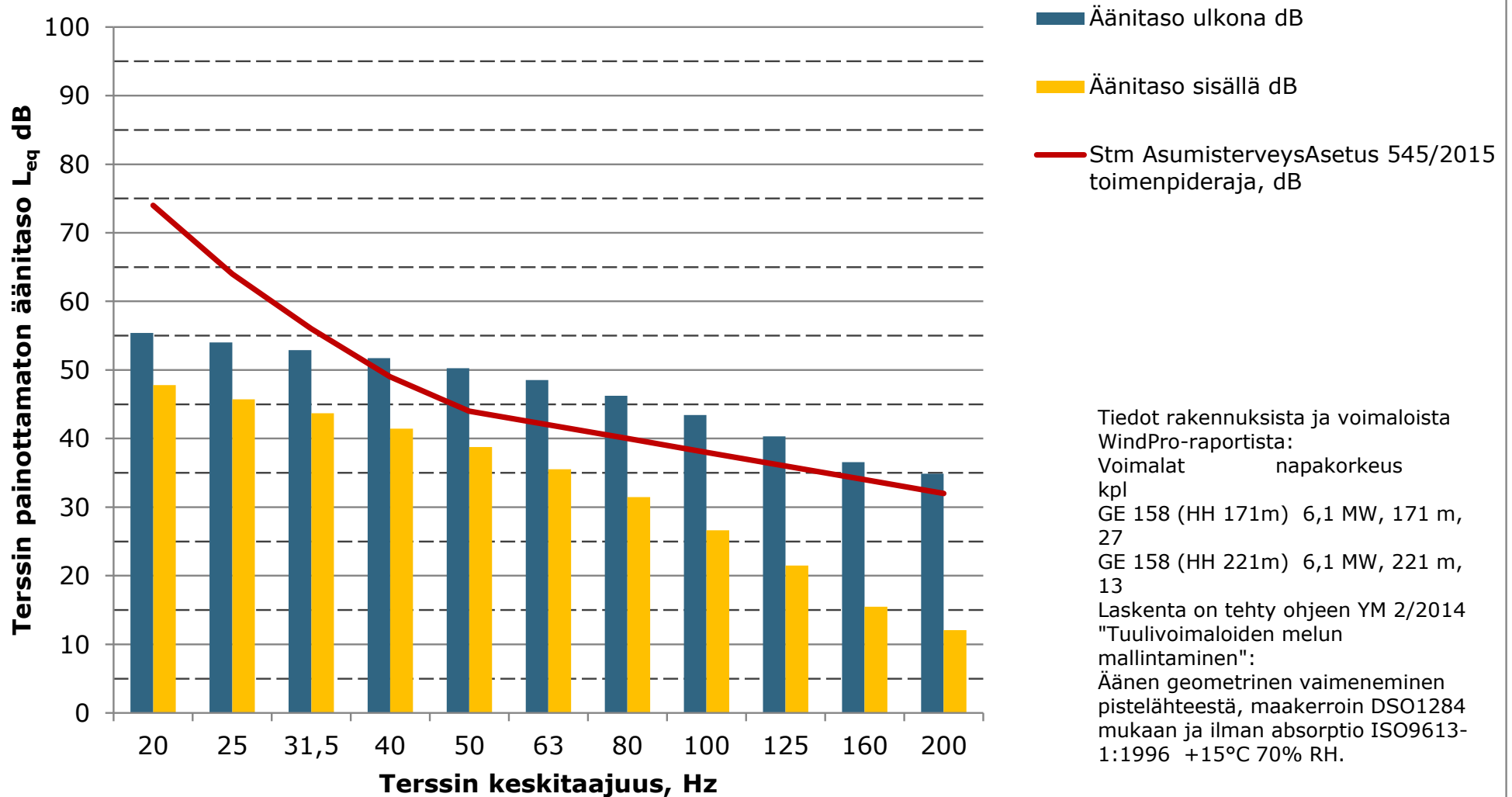
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus J  
(Ojantakasentie 88), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

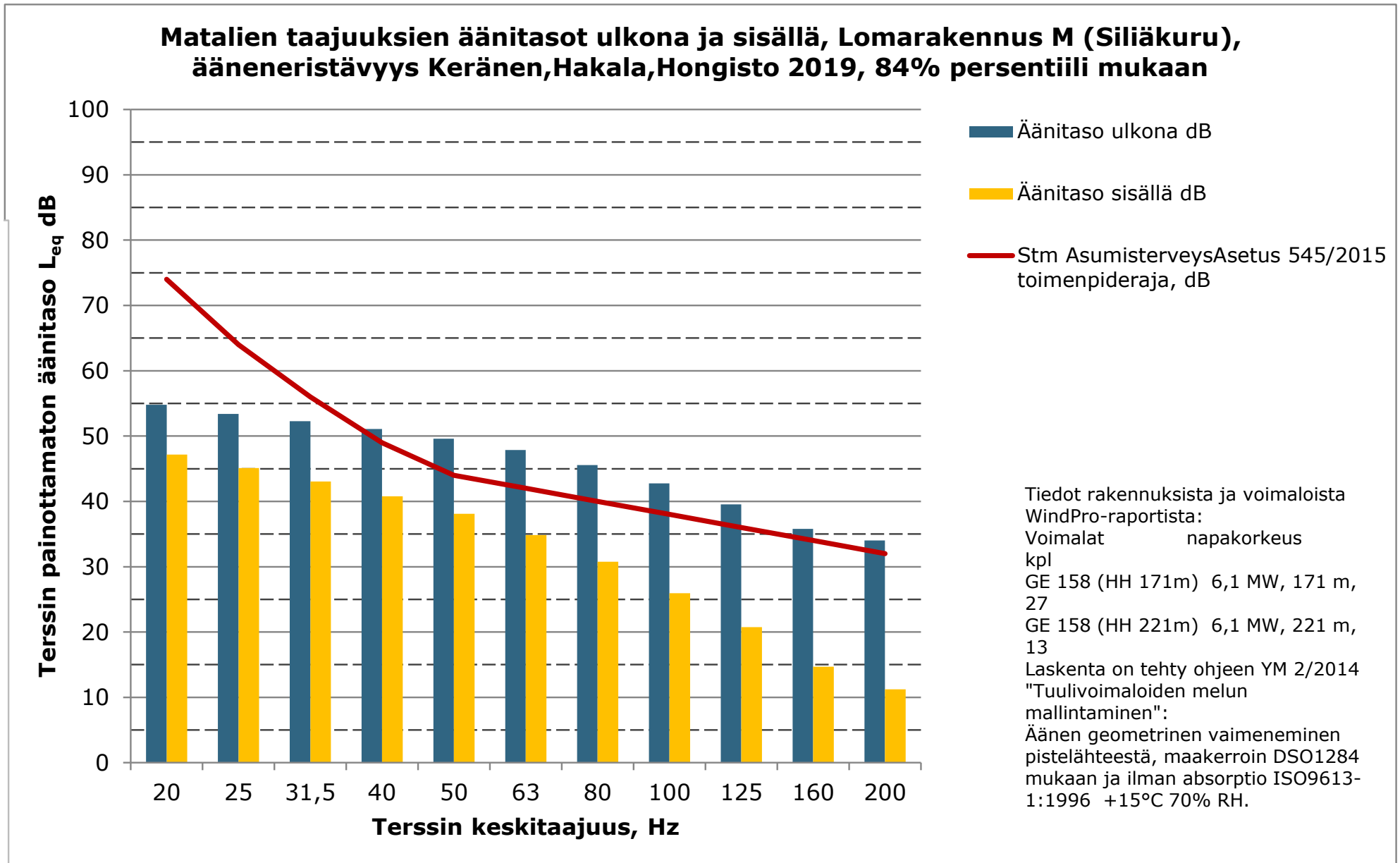


### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus K (Ollilantie 218), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



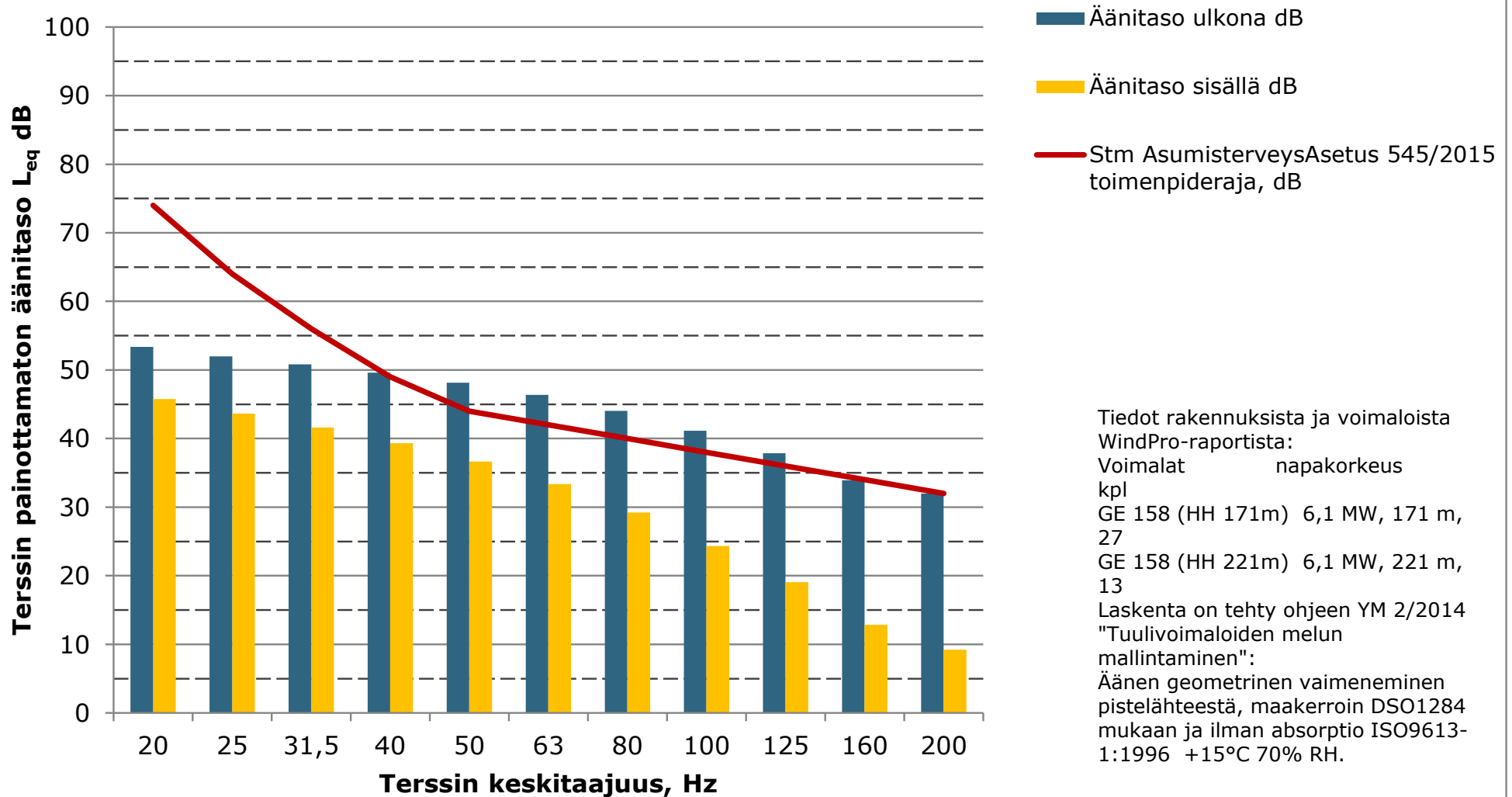
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus L (Uusi-Kaikola), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan







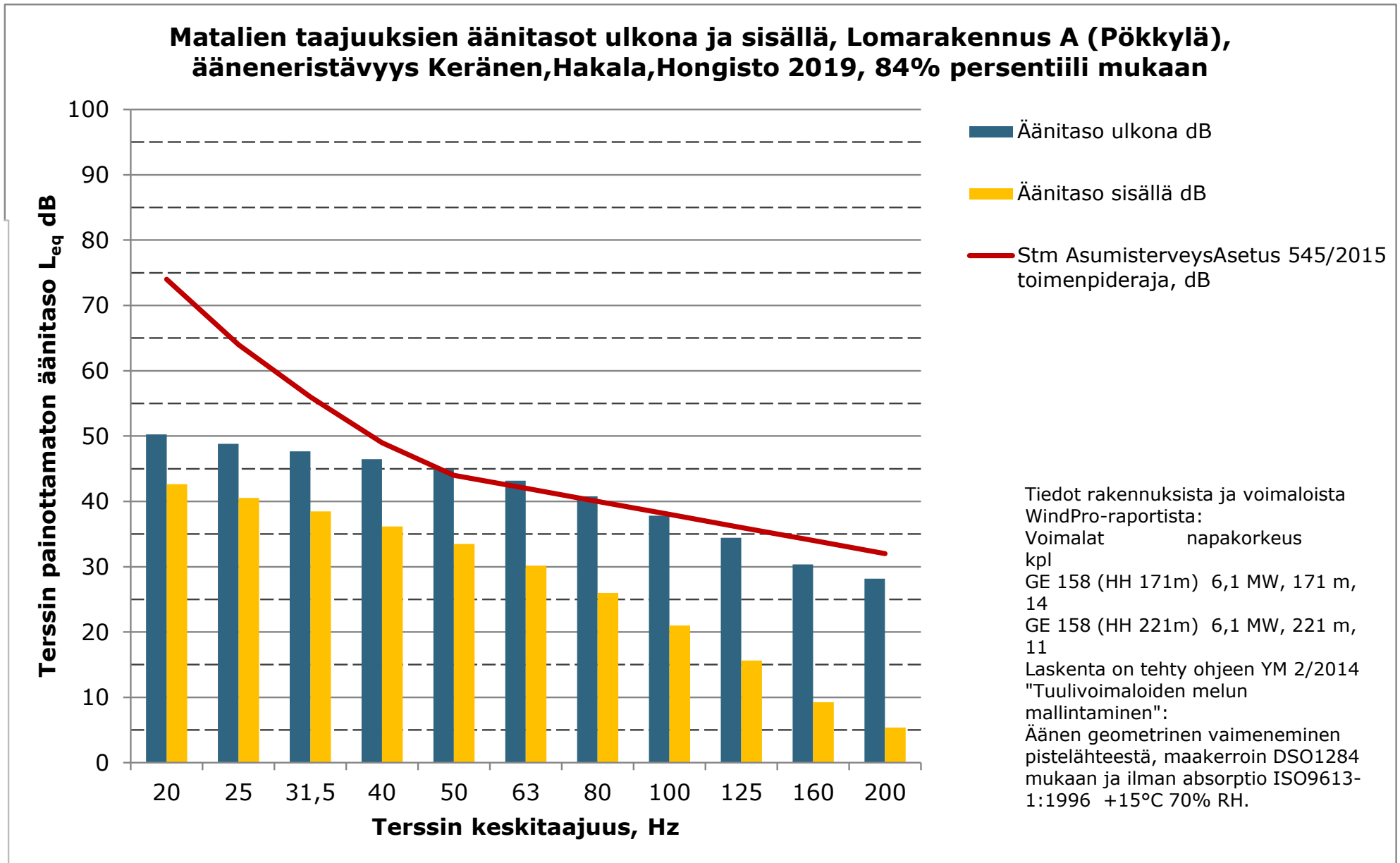
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus N (Pinolantie 406), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



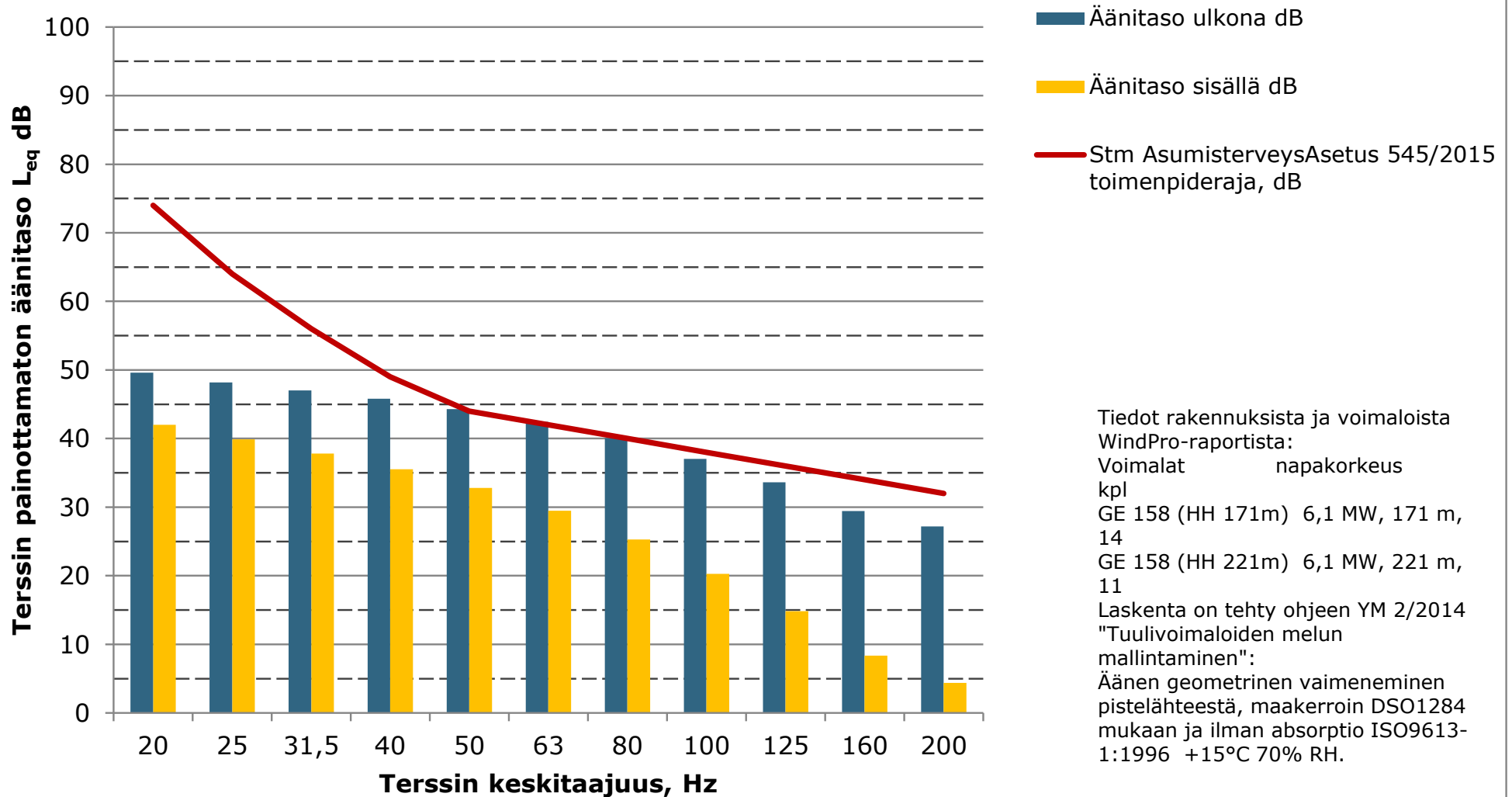
3.2.2023

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**Liite 5. Matalataajuisen melun rakennuskohtaiset arvot - Hankevaihtoehto 2**

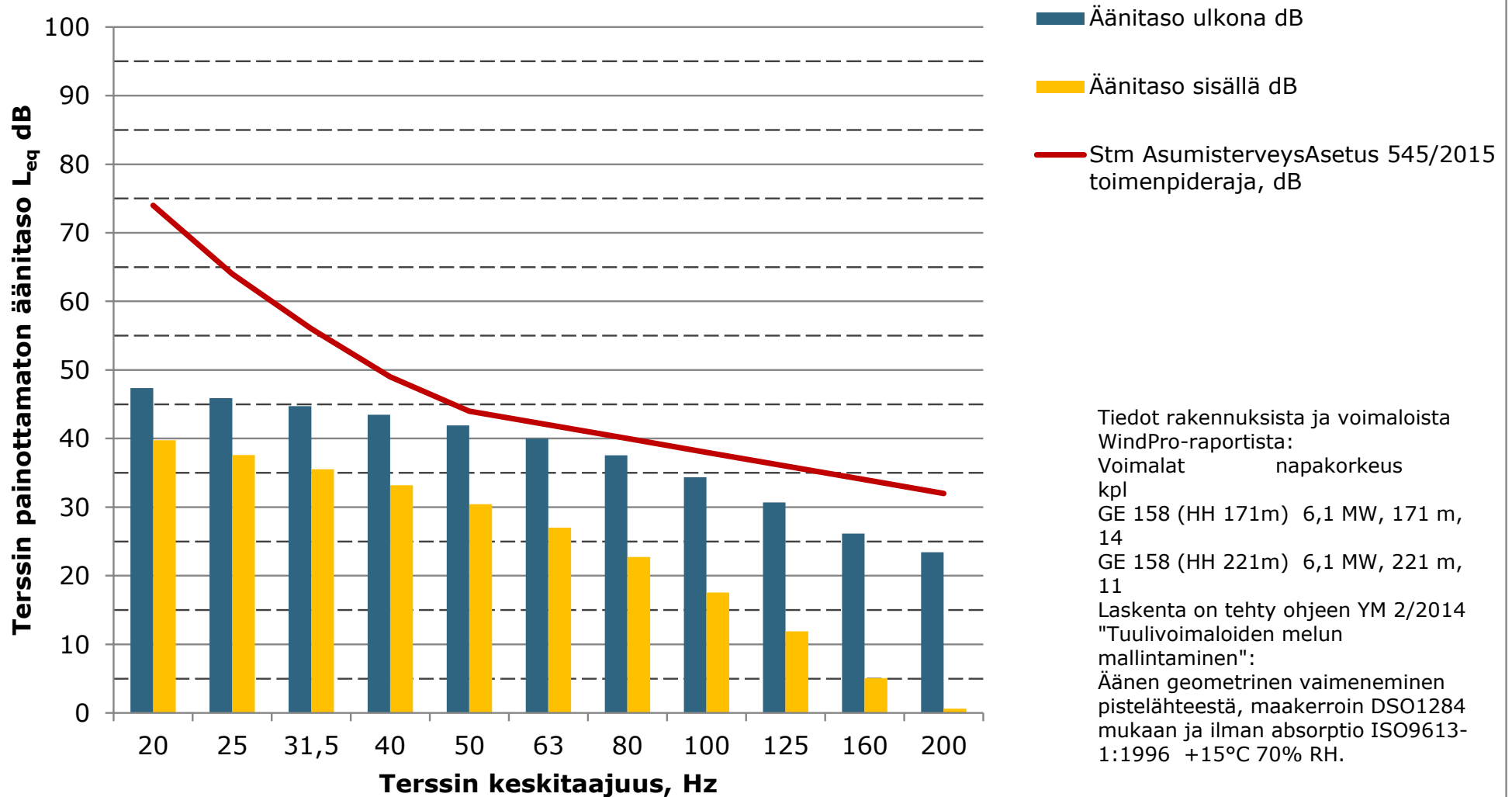


### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus B (Pökkyläntie 418), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentti mukaan

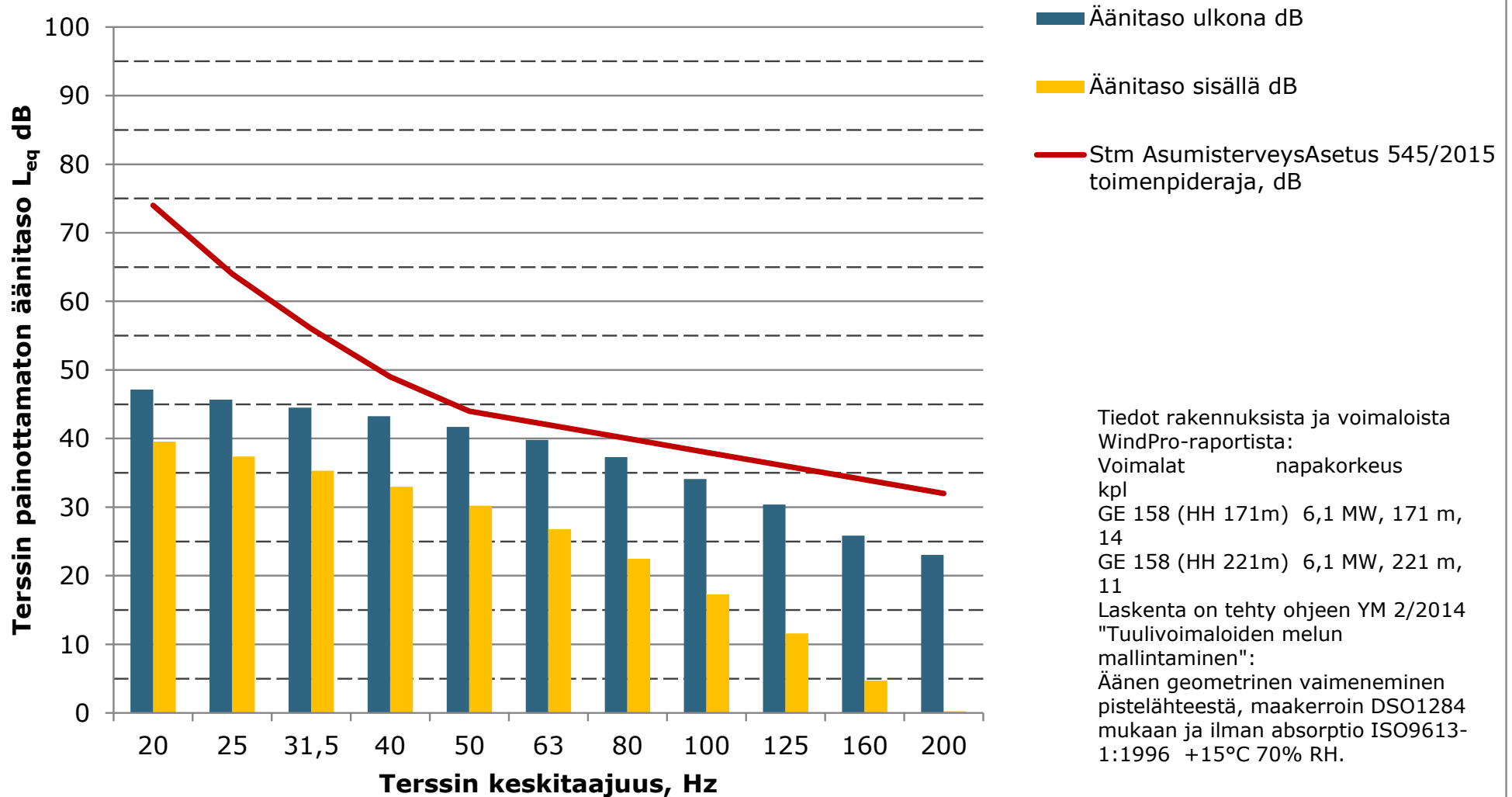




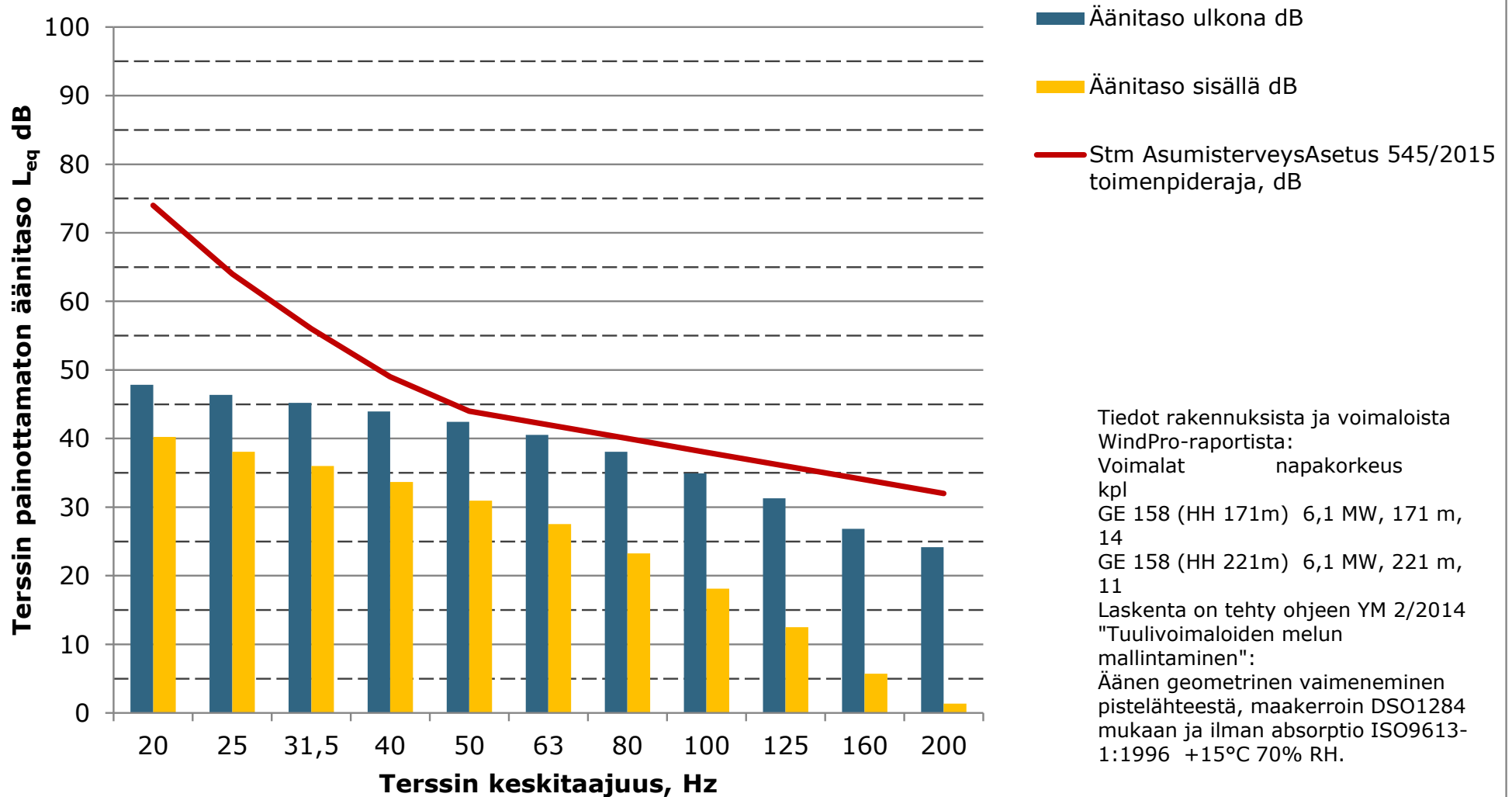
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus C  
(~Pökkyläntie 178), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persentiili mukaan**



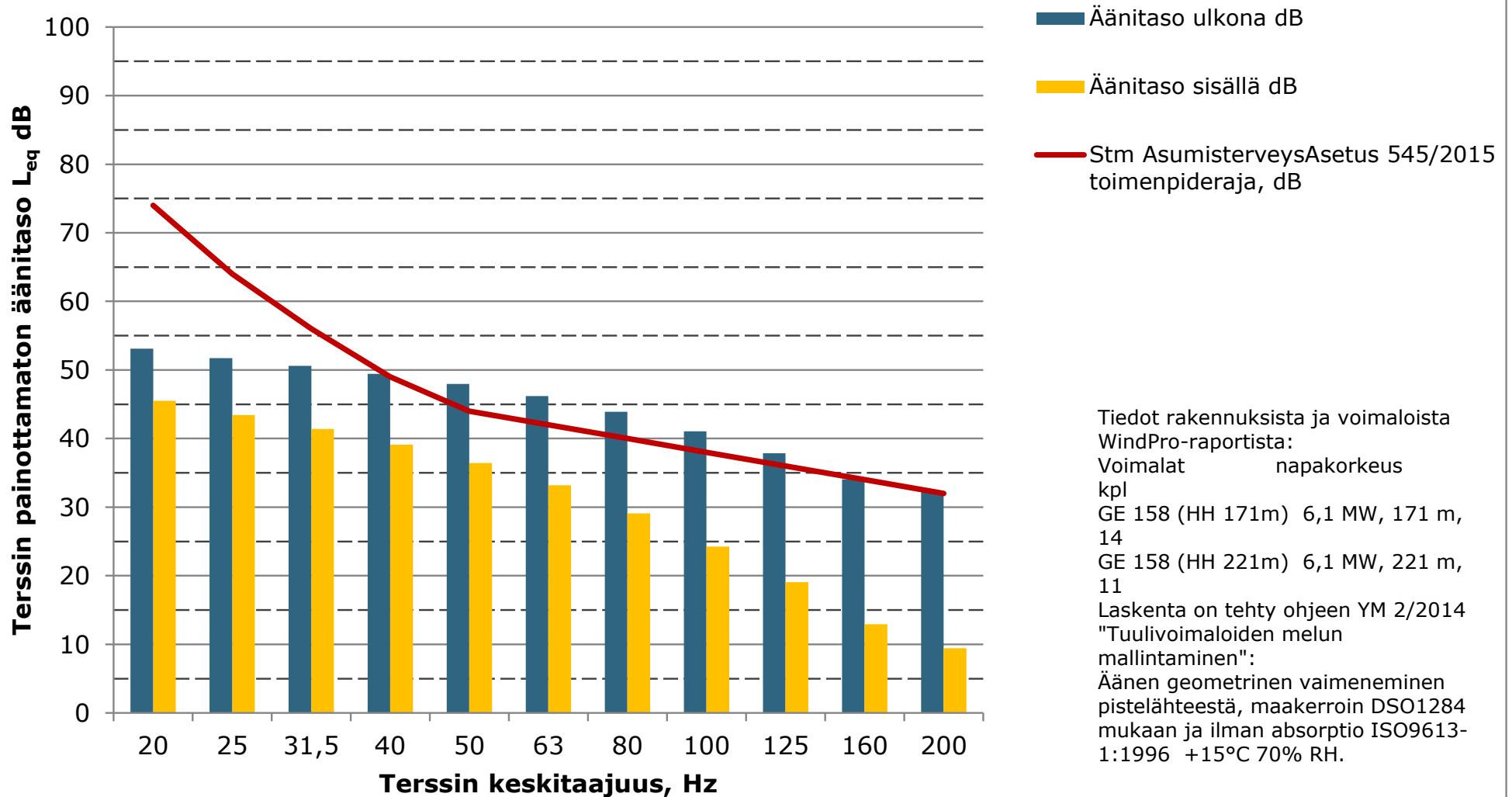
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus D  
(Luminevantie 162), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**



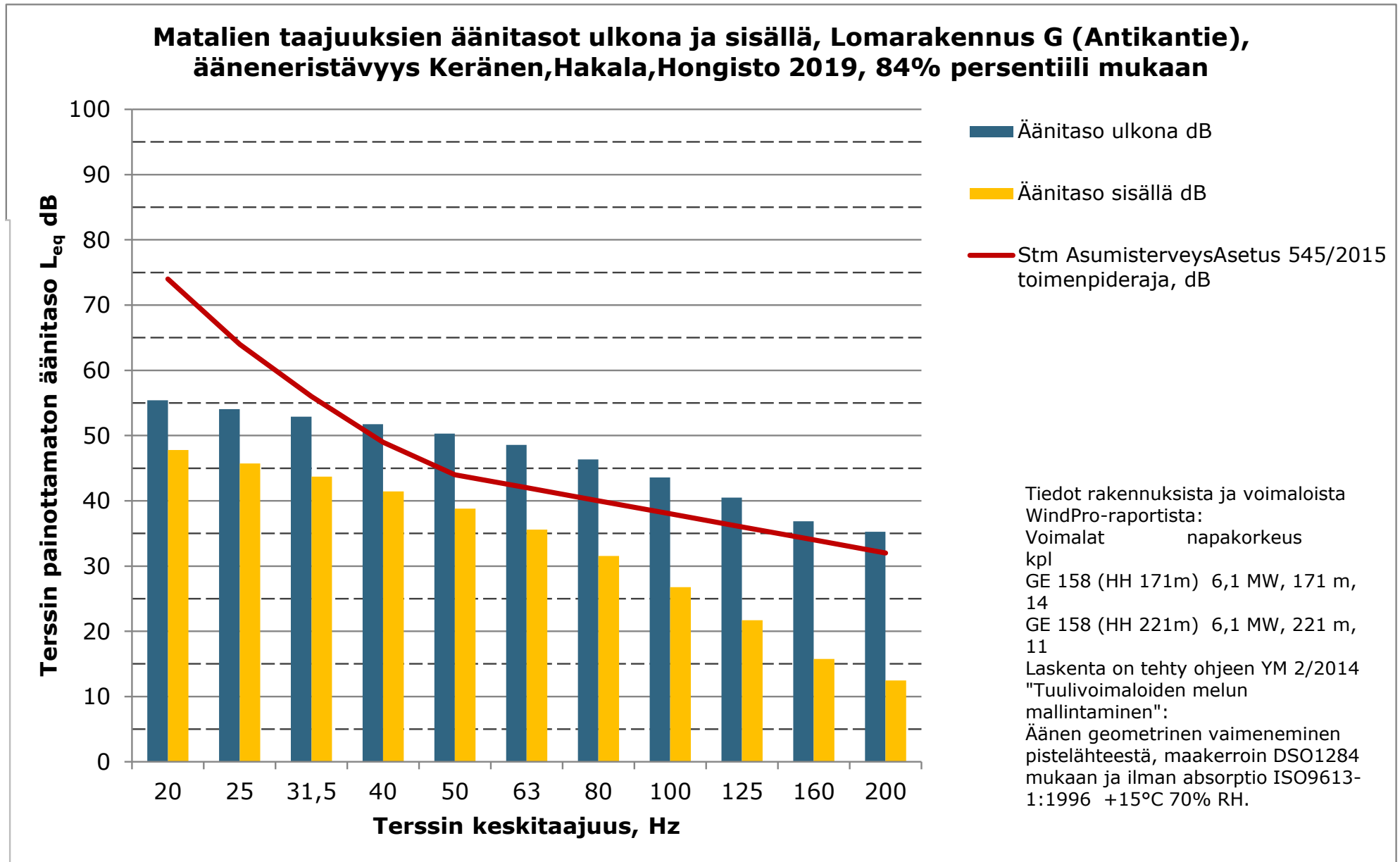
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus E (Paratiisintie 231), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentti mukaan

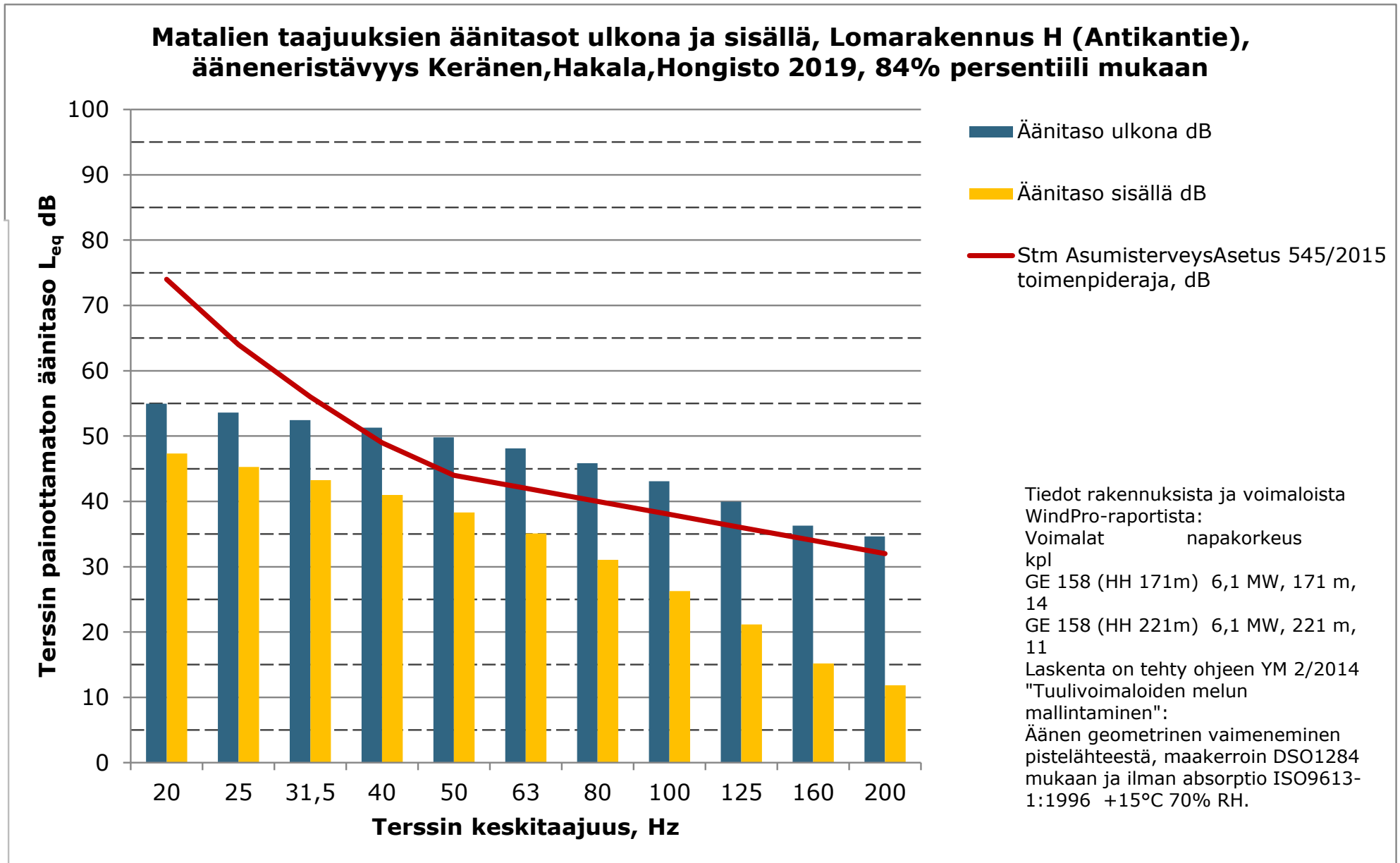


**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus F  
(Isojärventie), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

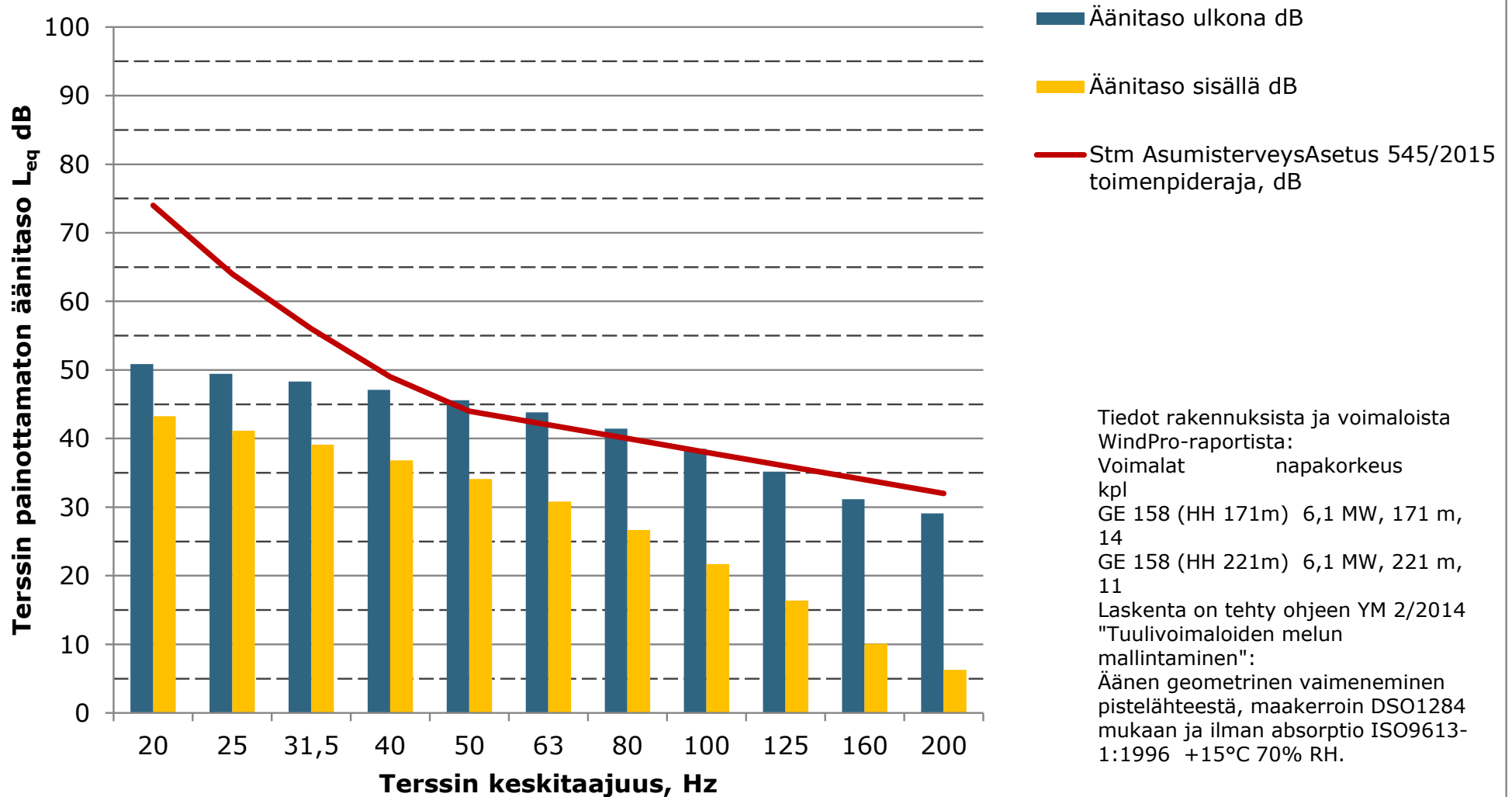




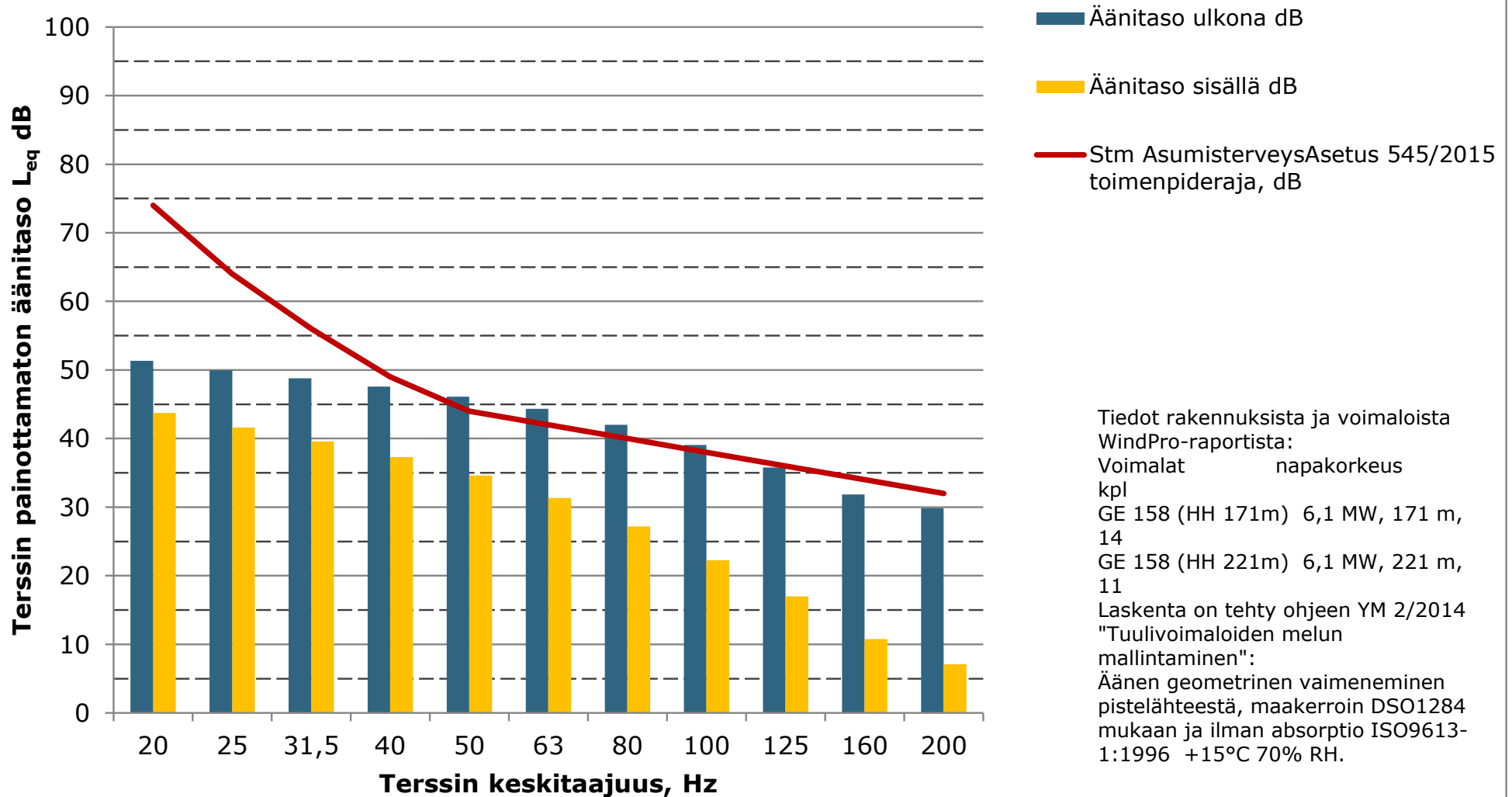




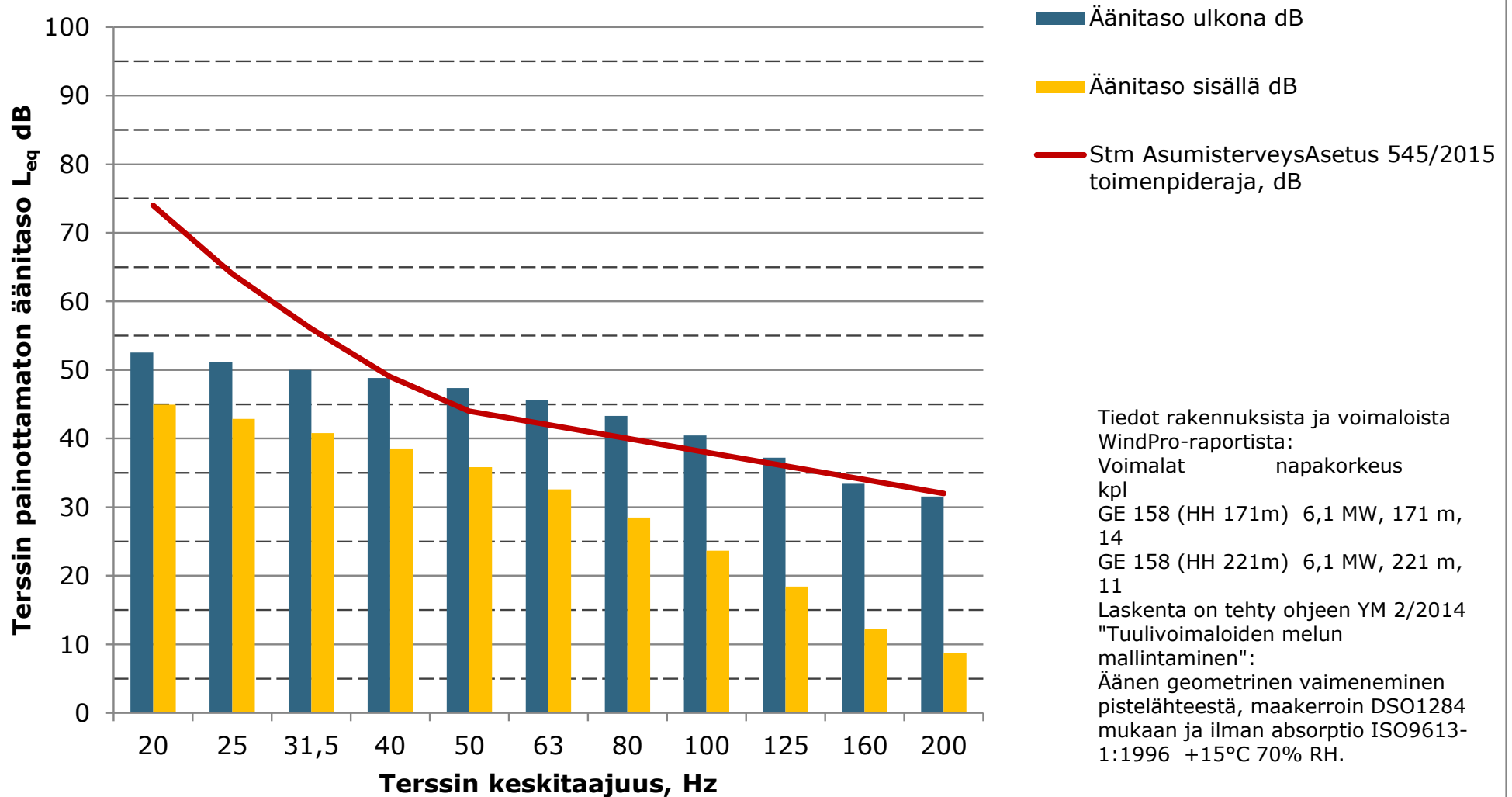
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus I  
(Kalliokangas), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**



**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus J  
(Ojantakasentie 88), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

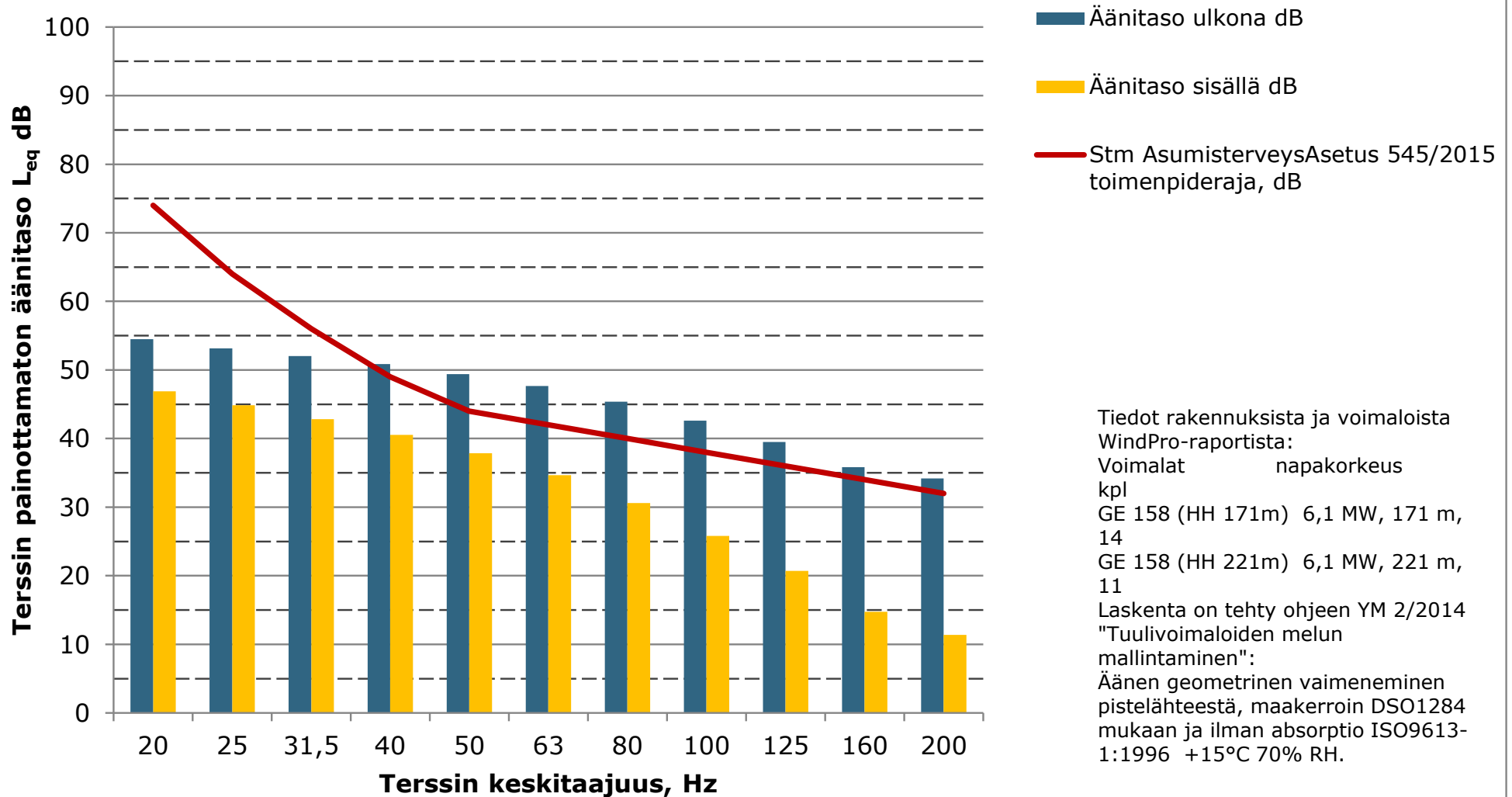


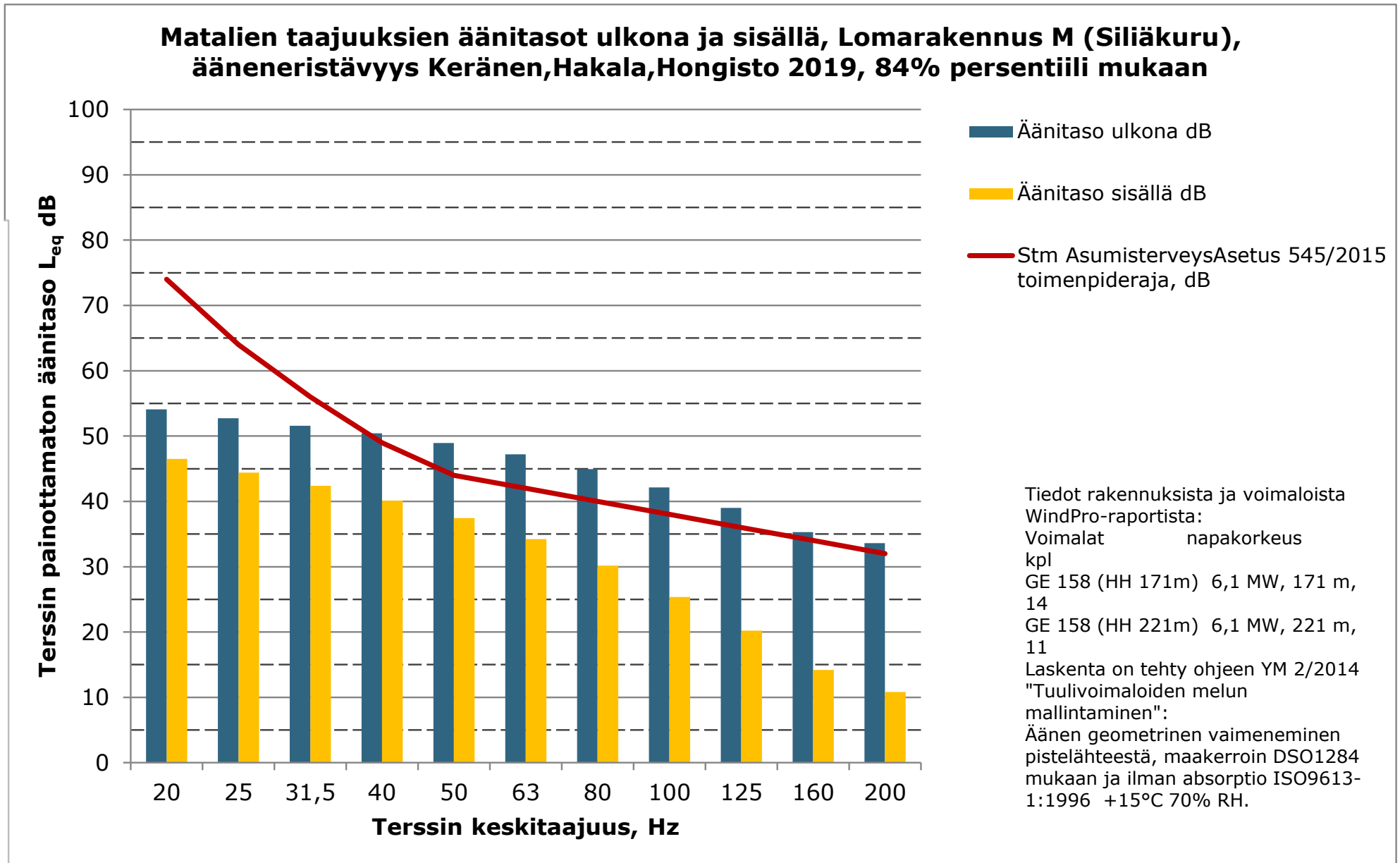
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus K (Ollilantie 218), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



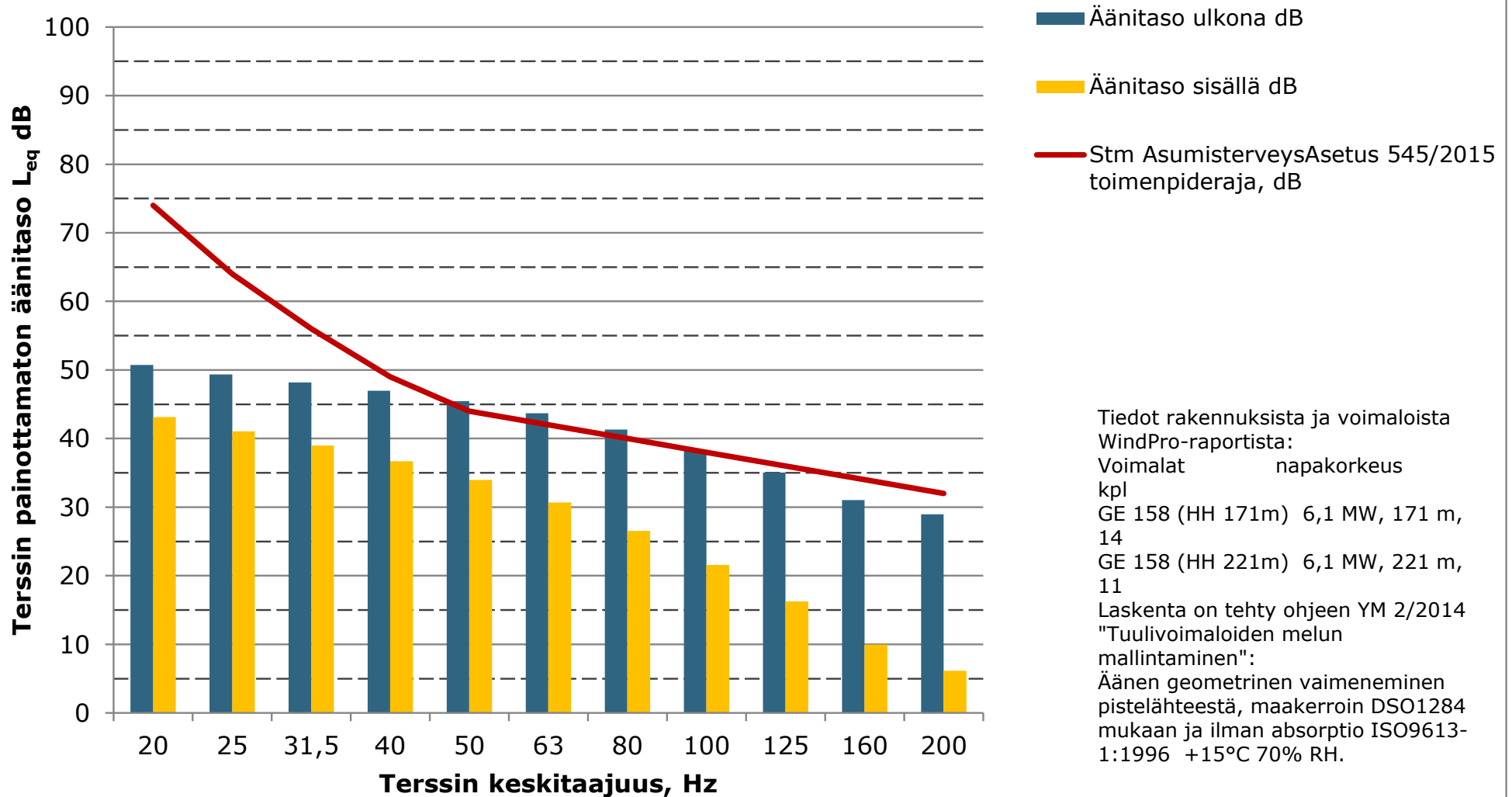


### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus L (Uusi-Kaikola), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan





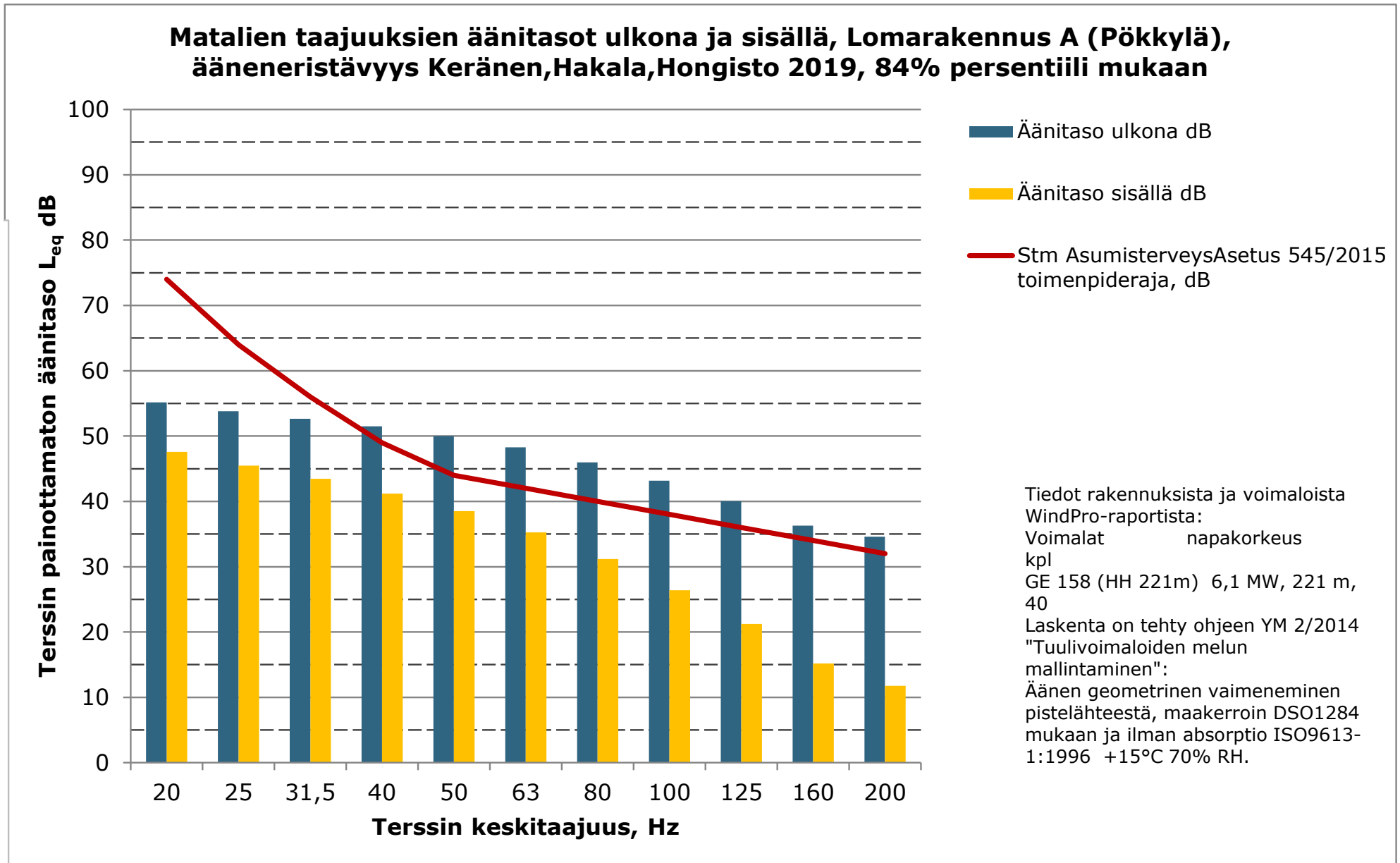
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus N (Pinolantie 406), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentti mukaan



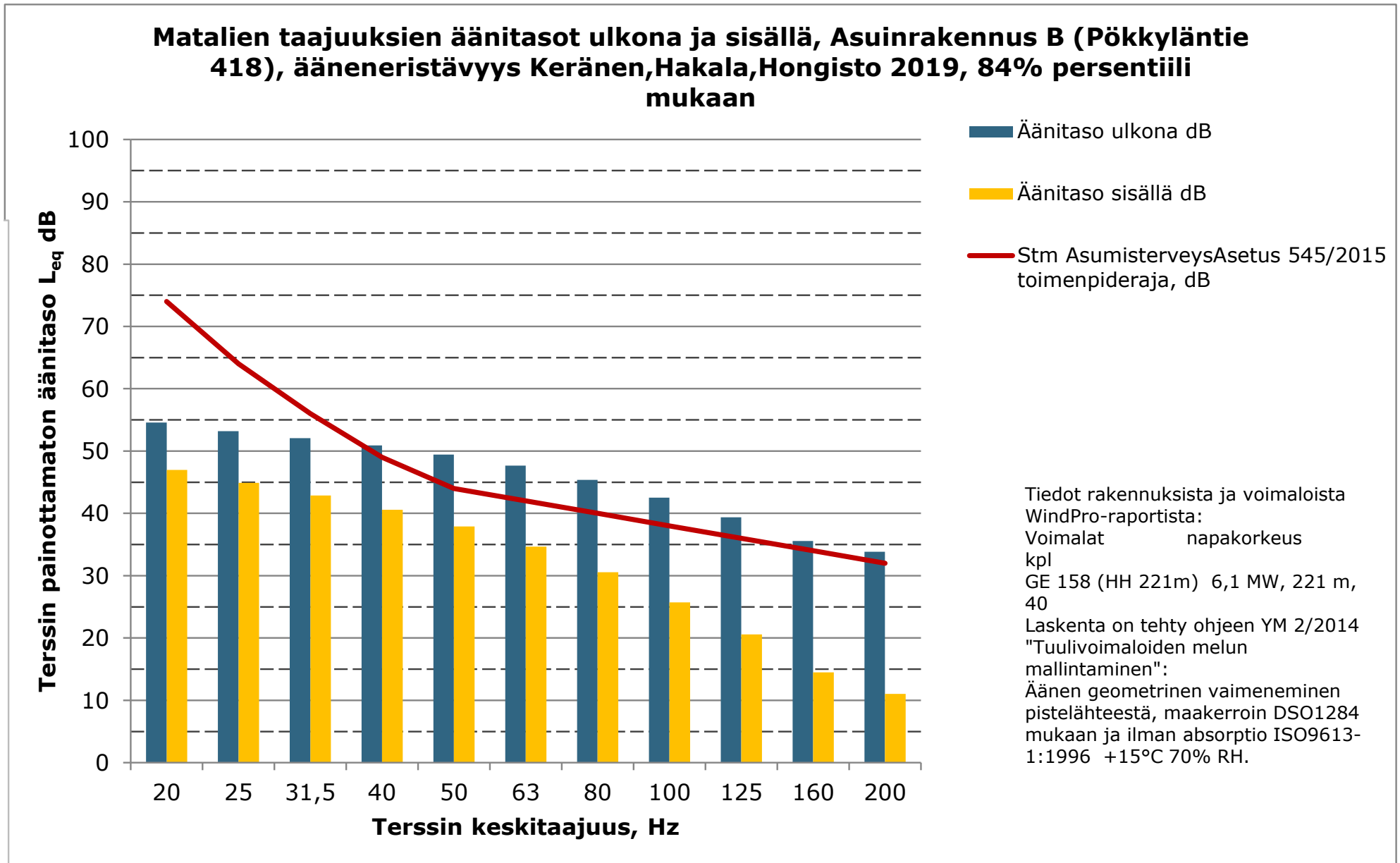
3.2.2023

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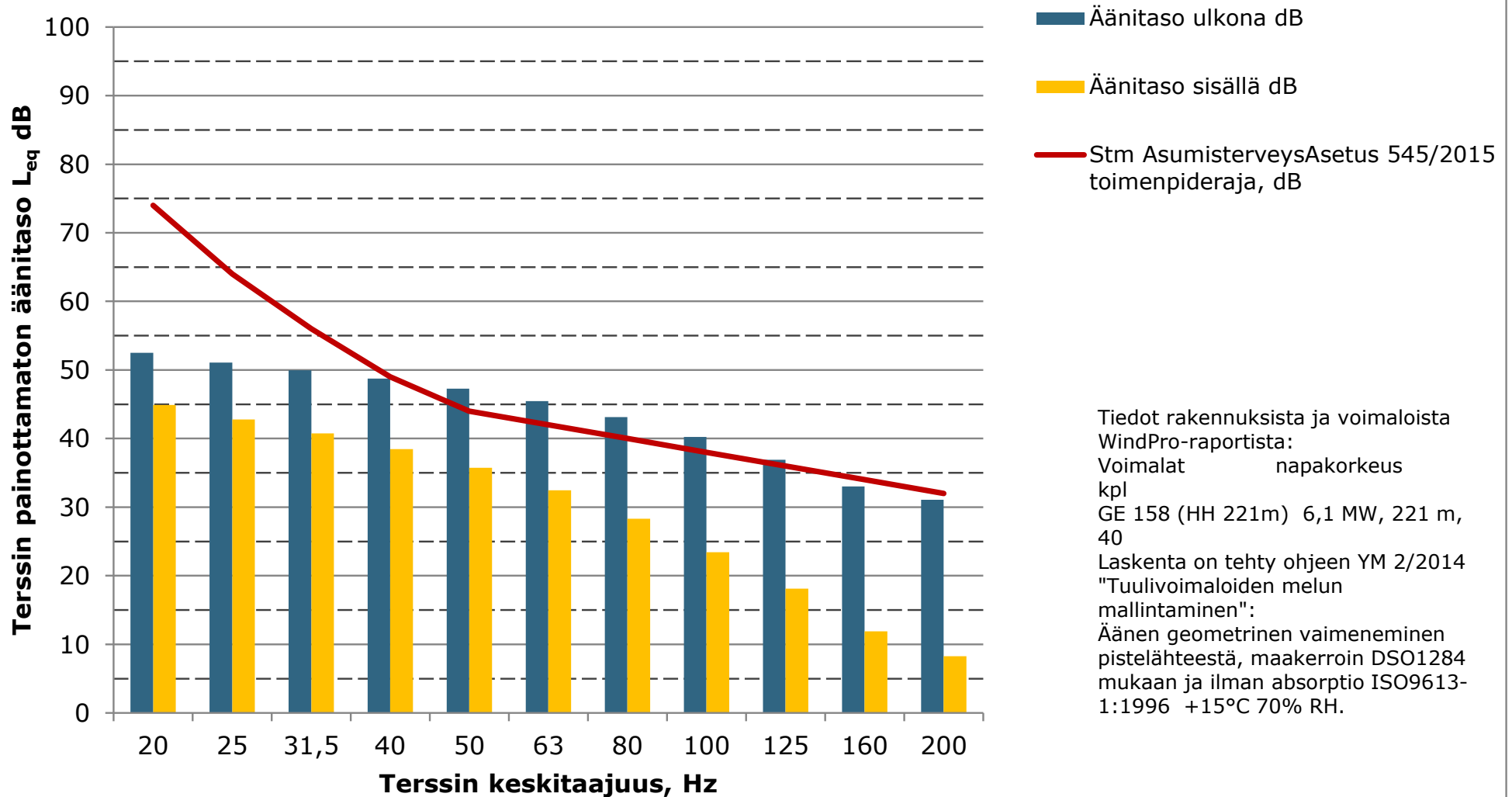
**Liite 6. Matalataajuisen melun rakennuskohtaiset arvot - Hankevaihtoehto 3**



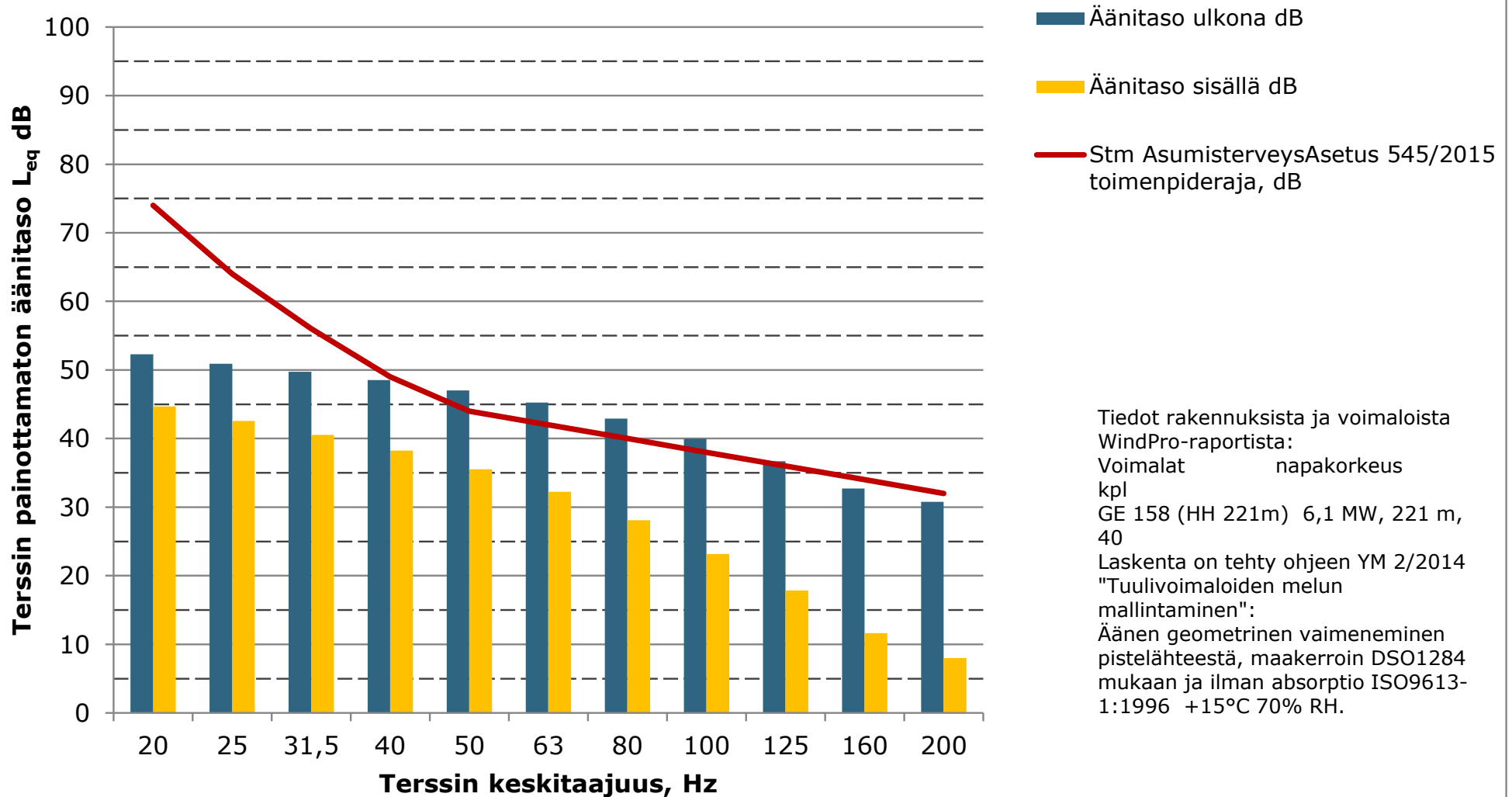




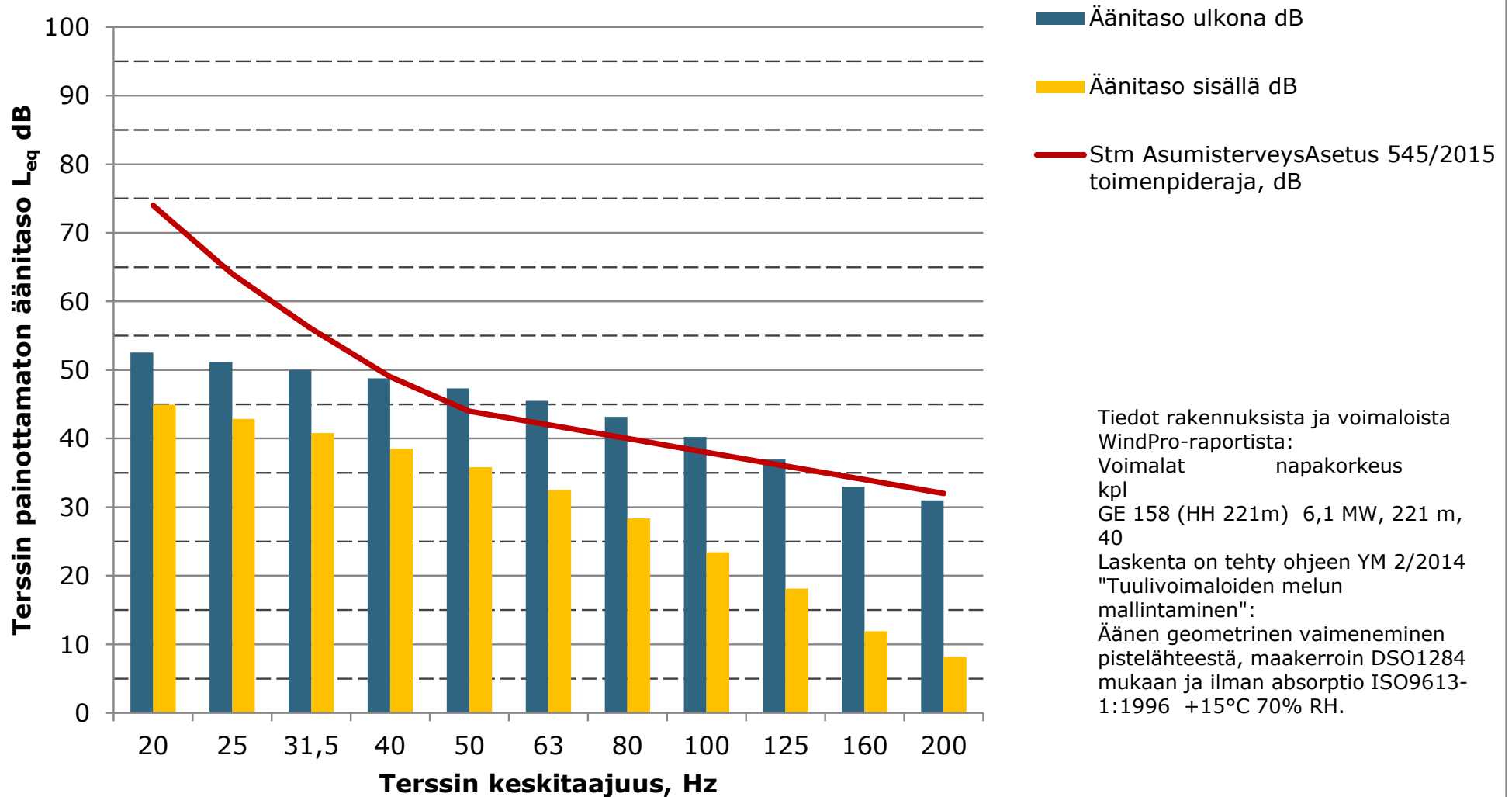
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus C  
(~Pökkyläntie 178), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persentiili mukaan**



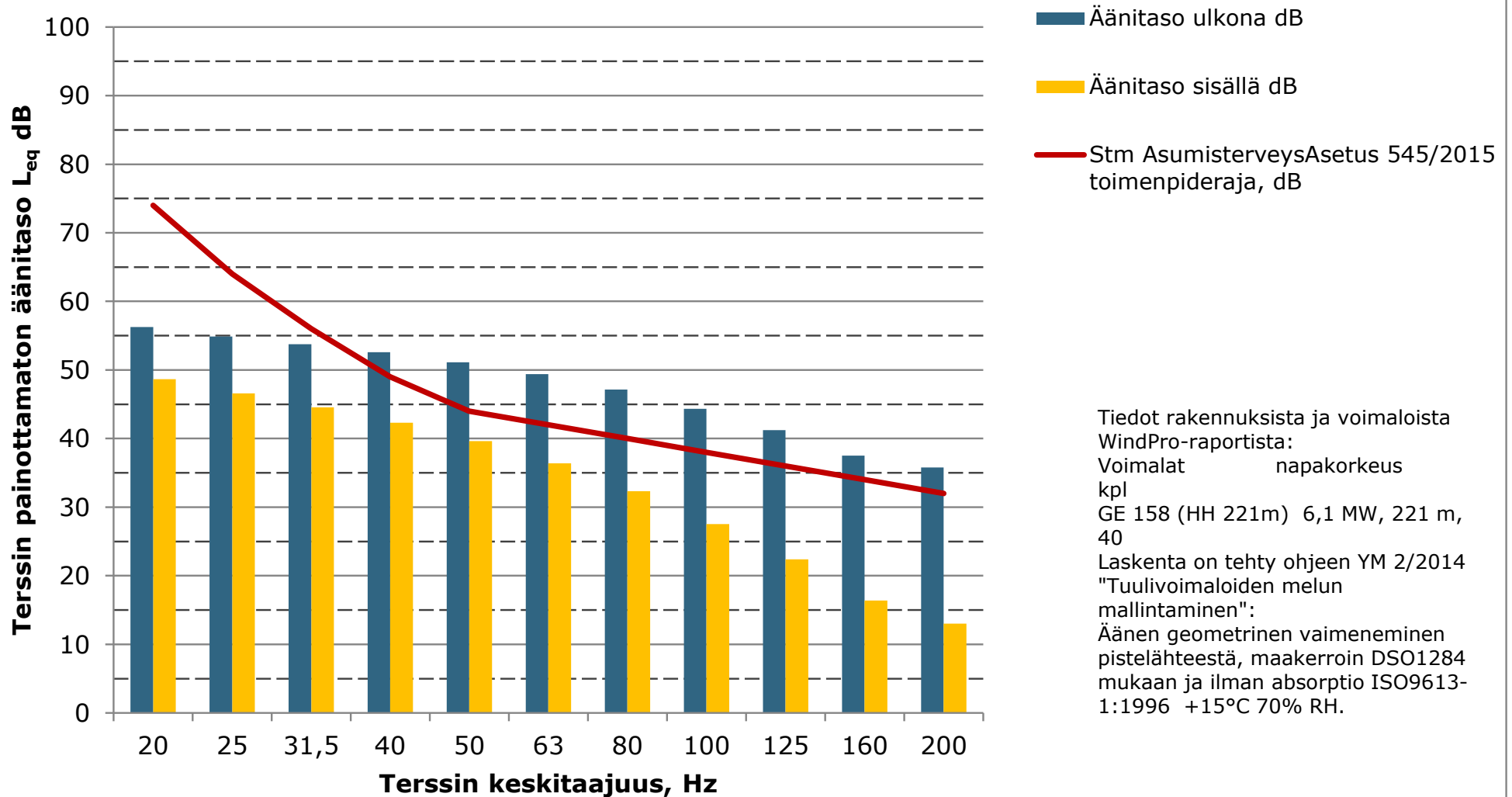
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus D  
(Luminevantie 162), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persenttiili mukaan**



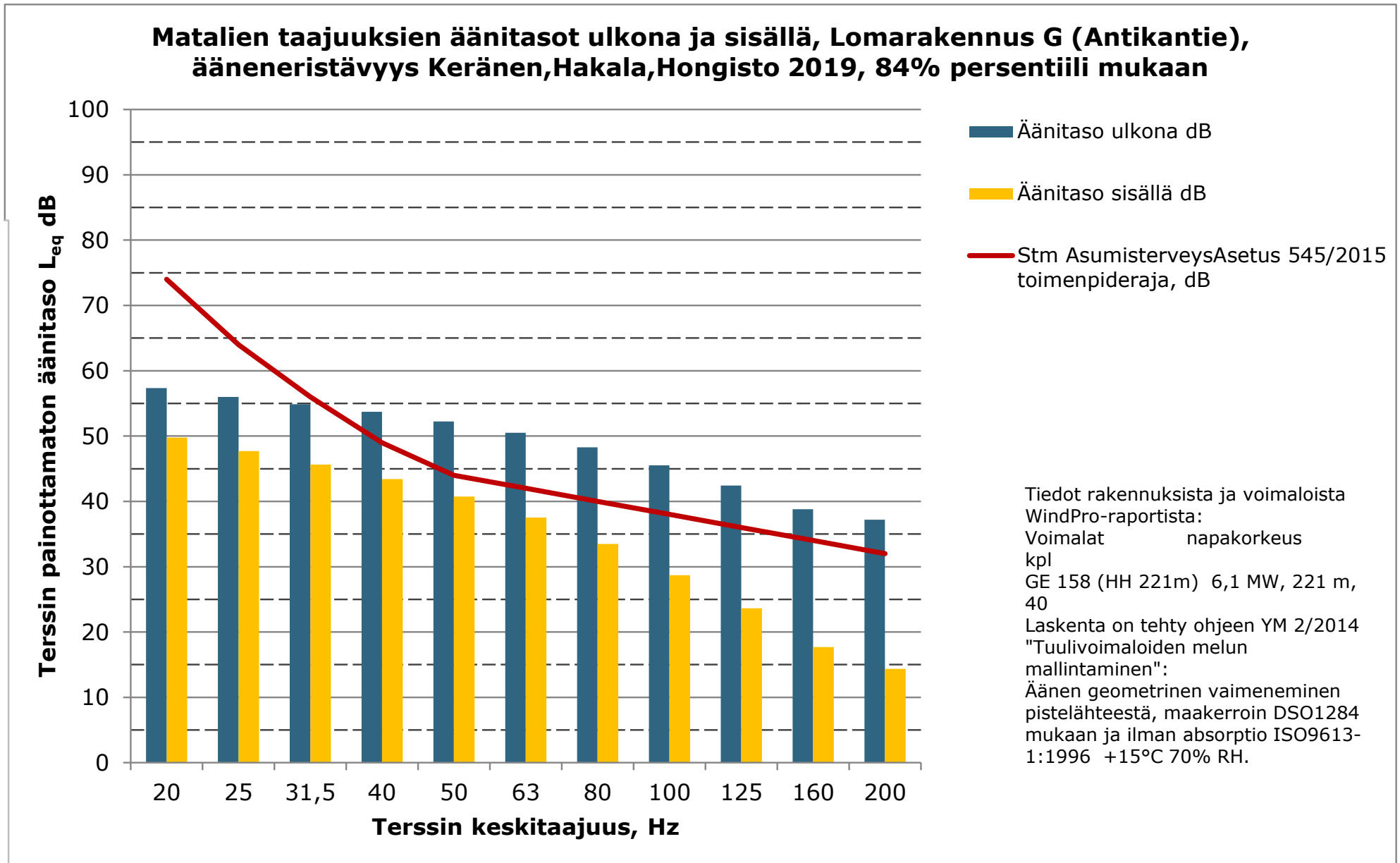
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus E (Paratiisintie 231), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan

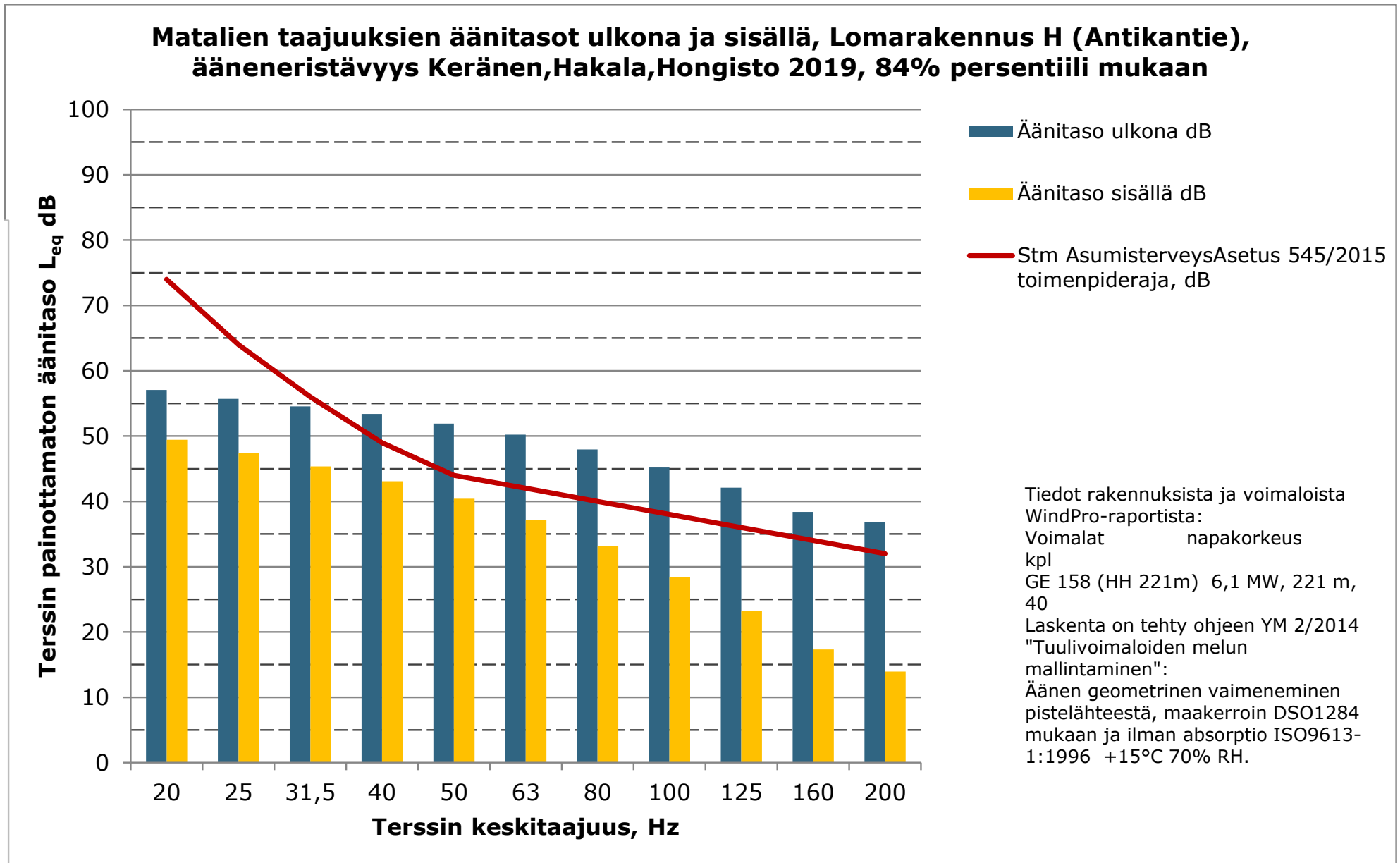


**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus F  
(Isojärventie), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

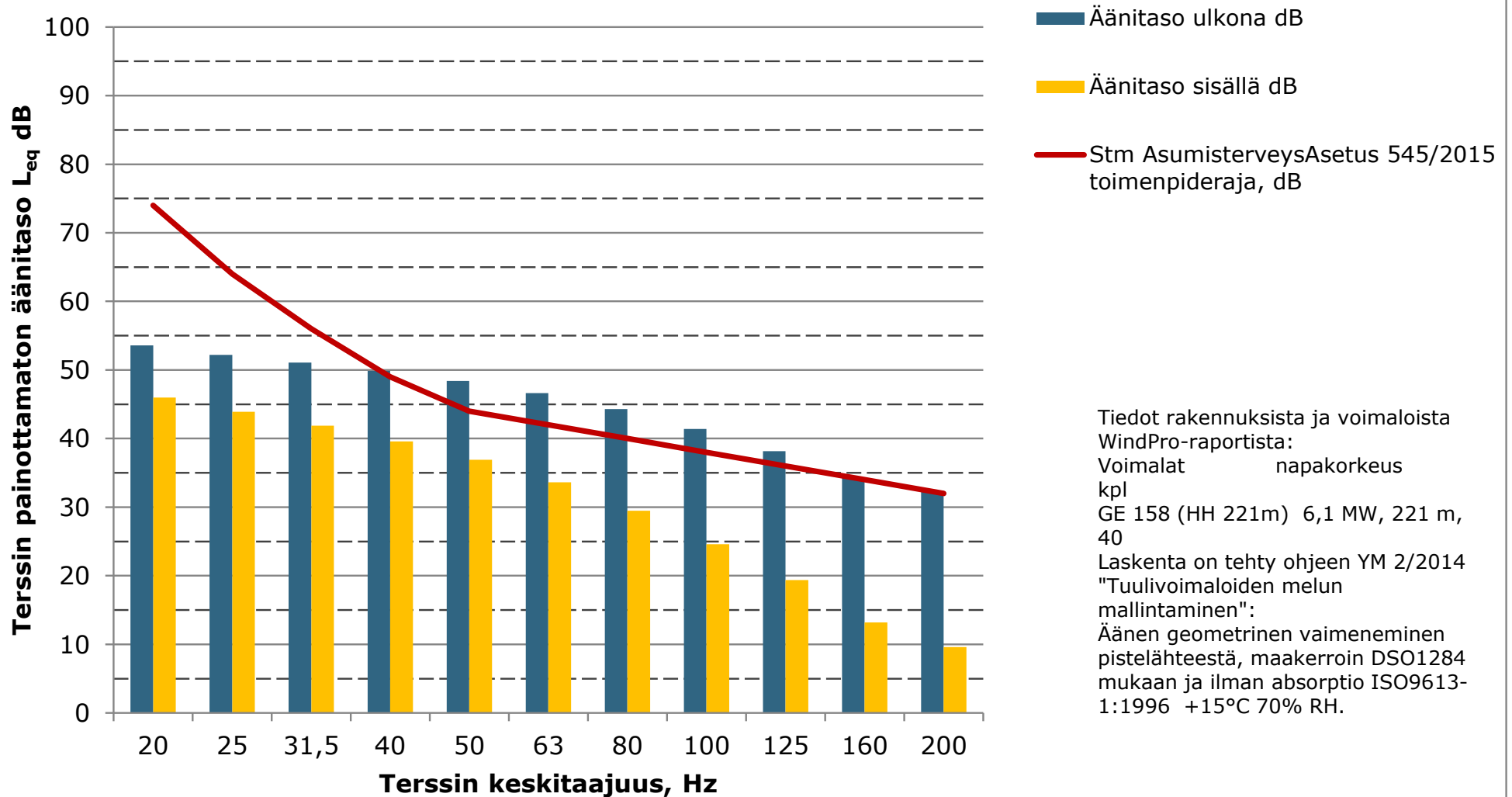




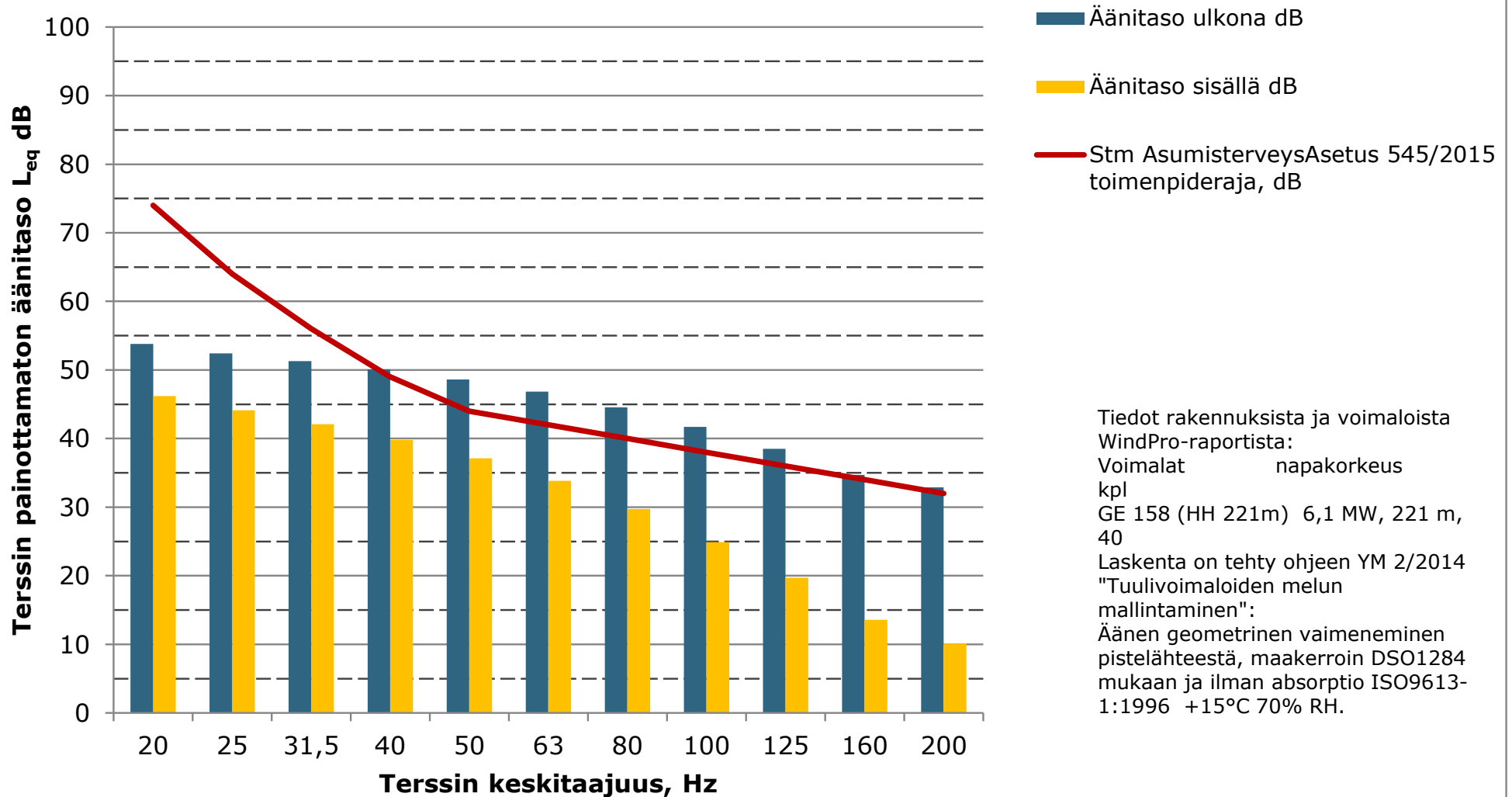




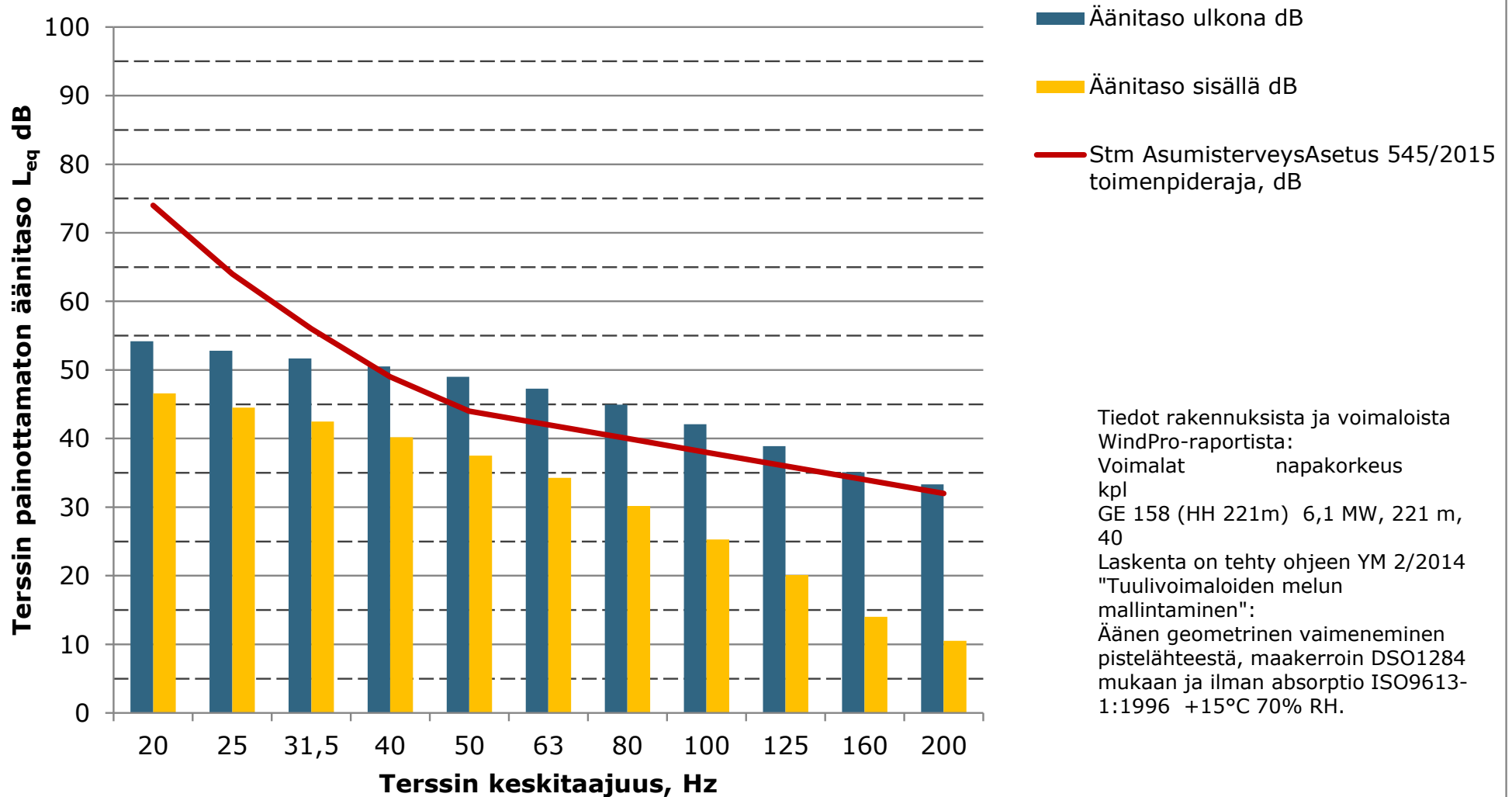
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus I  
(Kalliokangas), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**



**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus J  
(Ojantakasentie 88), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persentiili mukaan**

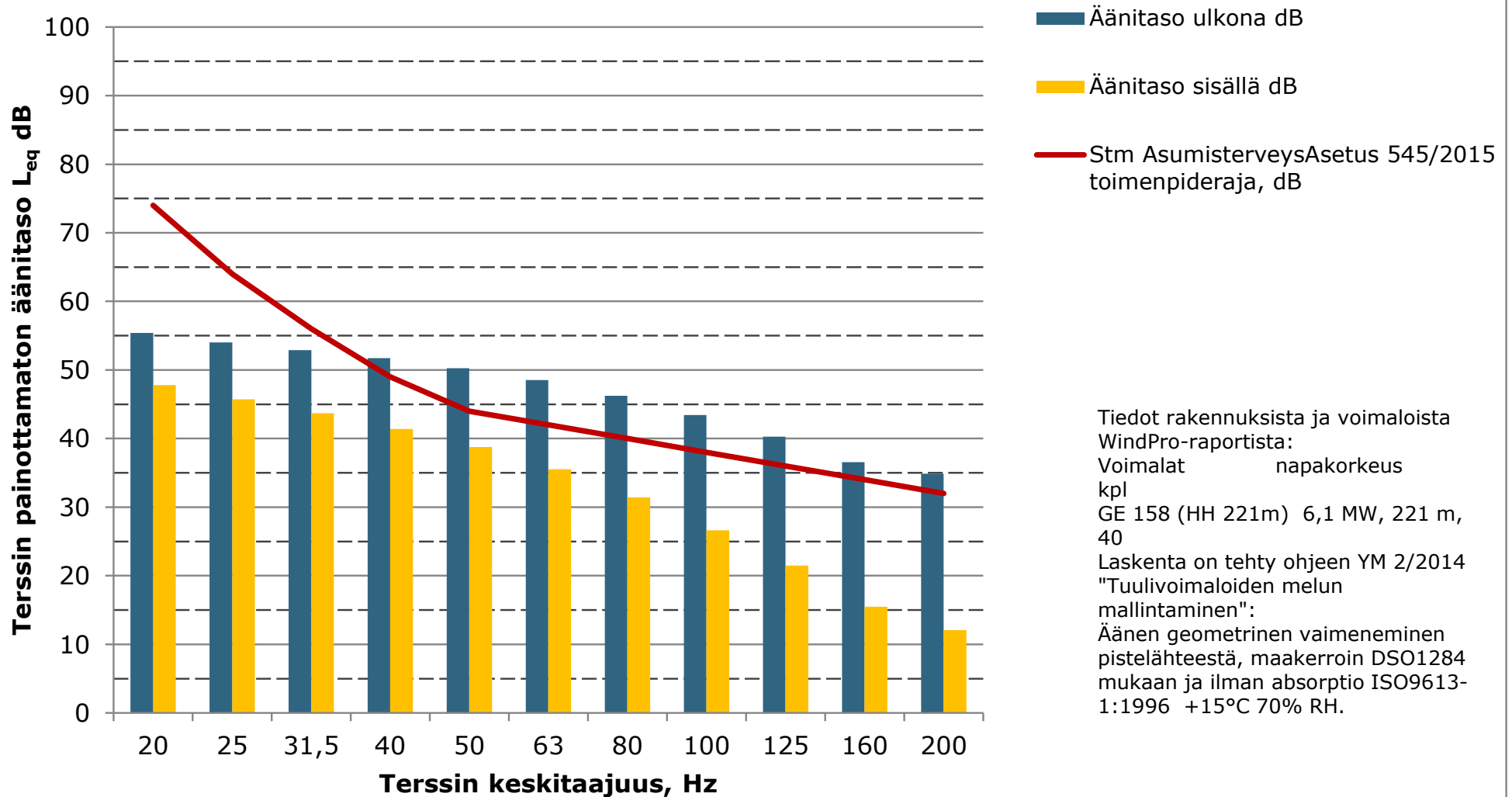


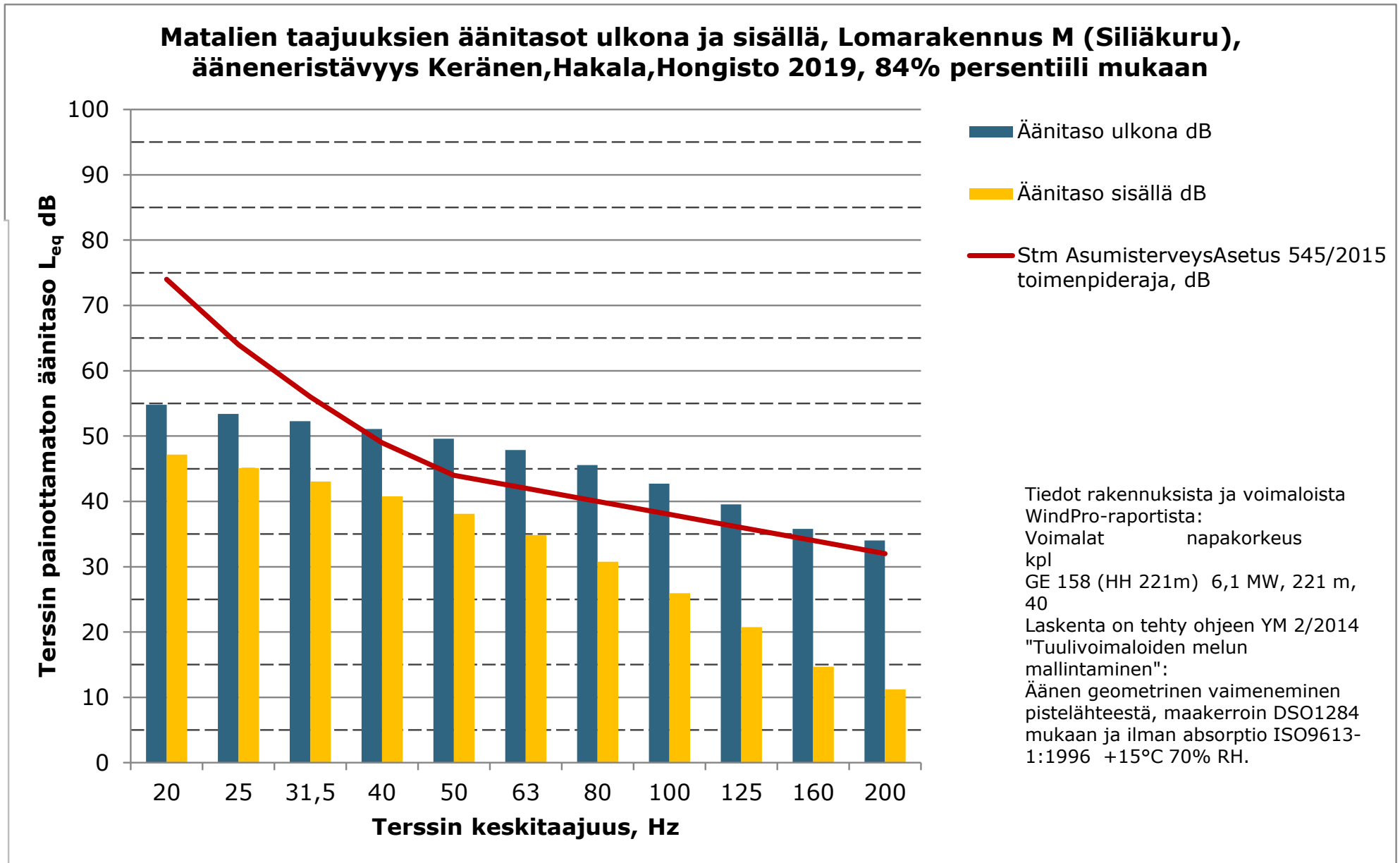
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus K (Ollilantie 218), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persenttiili mukaan



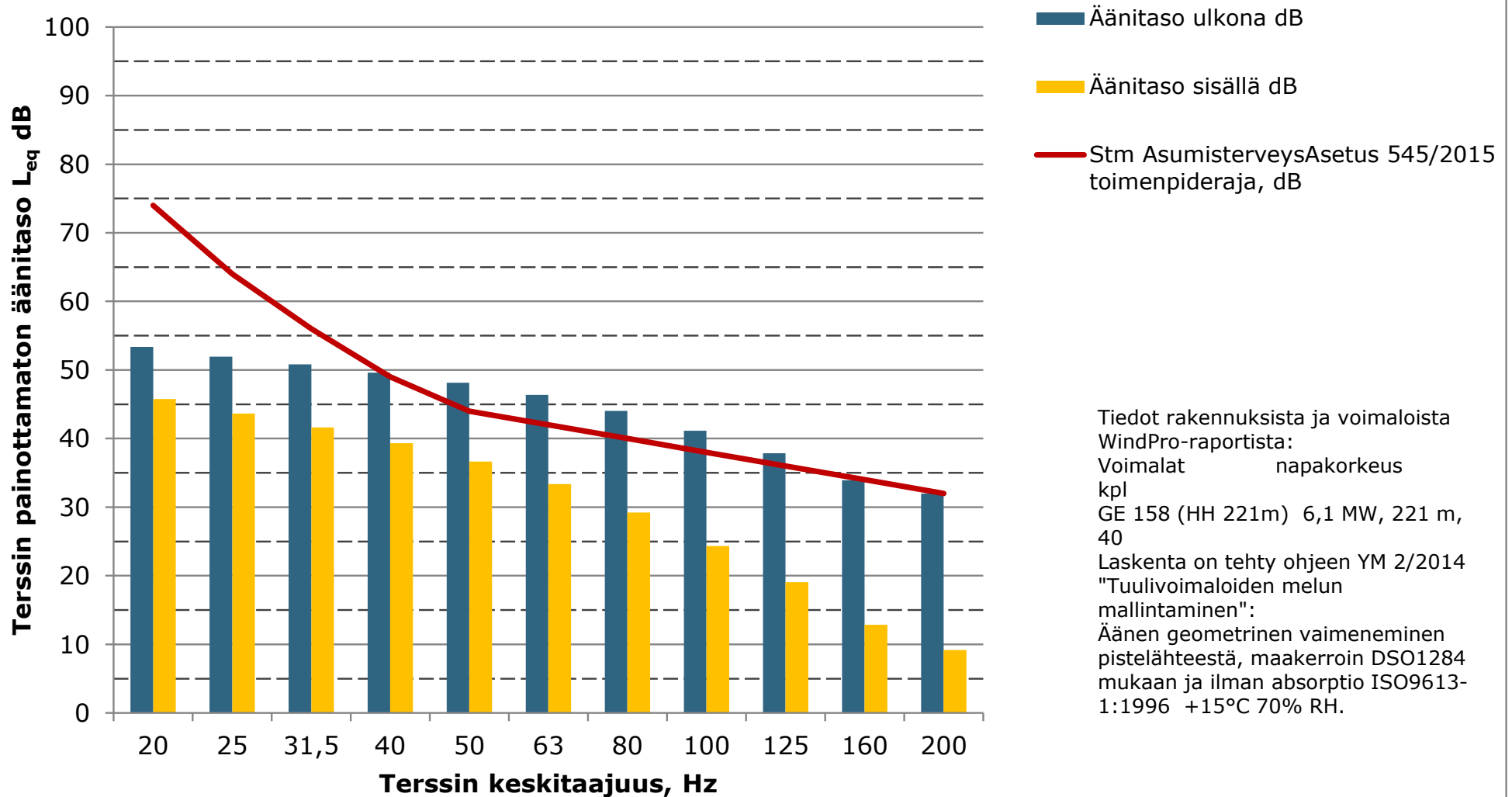


### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus L (Uusi-Kaikola), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persenttiili mukaan





### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus N (Pinolantie 406), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



3.2.2023

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**Liite 7. Varjostusmallinnuksen tulokset "real case, no forest" - Hankevaihtoehto 1**

## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoeto1\_RealCase\_NoForest\_RD200m

### Assumptions for shadow calculations

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

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

Sunshine probability S (Average daily sunshine hours) []  
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

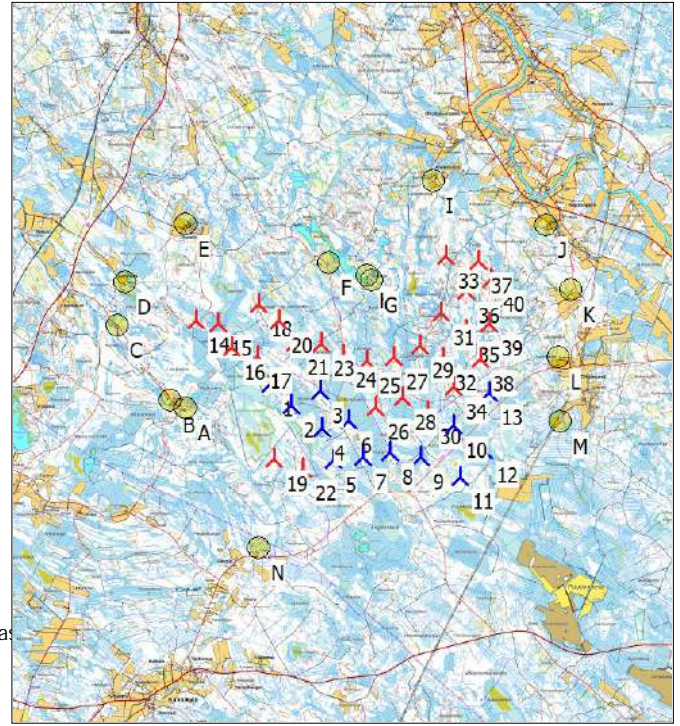
MERRA2\_N64.000\_E025.000 (1)

Operational time  
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
530 397 369 407 598 873 1 042 1 093 967 754 627 649 8 305  
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\_Rahkola\_Hautakangas  
Obstacles used in calculation  
Receptor grid resolution: 1,0 m

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89

### WTGs



Scale 1:200 000  
New WTG Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
			[m]									
1	397 208	7 115 412	87,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
2	397 754	7 114 856	87,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
3	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
4	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
5	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
6	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
7	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
8	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
9	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
10	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
11	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
12	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
13	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
14	395 254	7 117 093	87,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
15	395 819	7 117 022	82,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
16	396 195	7 116 379	82,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
17	396 858	7 116 145	84,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
18	396 894	7 117 531	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
19	397 303	7 113 442	87,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
20	397 417	7 117 093	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
21	397 854	7 116 507	90,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
22	398 058	7 113 189	92,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
23	398 529	7 116 484	94,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
24	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
25	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
26	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
27	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
28	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
29	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
30	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
31	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	

To be continued on next page...



## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihhtohto1\_RealCase\_NoForest\_RD200m

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
32	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
33	401 837	7 118 791	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
34	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
35	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
36	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
37	402 692	7 118 655	96,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
38	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
39	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
40	403 021	7 118 167	96,4	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4

## Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	a.g.l. [m]	[°]		[m]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:46
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	1:40
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	1:10
G	Lomarakennus G (Antikantie)	5:31
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	1:17
J	Asuinrakennus J (Ojantakasentie 88)	2:30
K	Asuinrakennus K (Ollilantie 218)	1:26
L	Asuinrakennus L (Uusi-Kaikola)	5:34
M	Lomarakennus M (Siliäkuru)	3:04
N	Asuinrakennus N (Pinolantie 406)	0:00

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

No.	Name	Expected [h/year]
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (121)	0:00
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (122)	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (123)	0:00
4	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (124)	0:00
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (125)	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (126)	0:00
7	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (127)	0:00

To be continued on next page...

## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihhtohto1\_RealCase\_NoForest\_RD200m

...continued from previous page

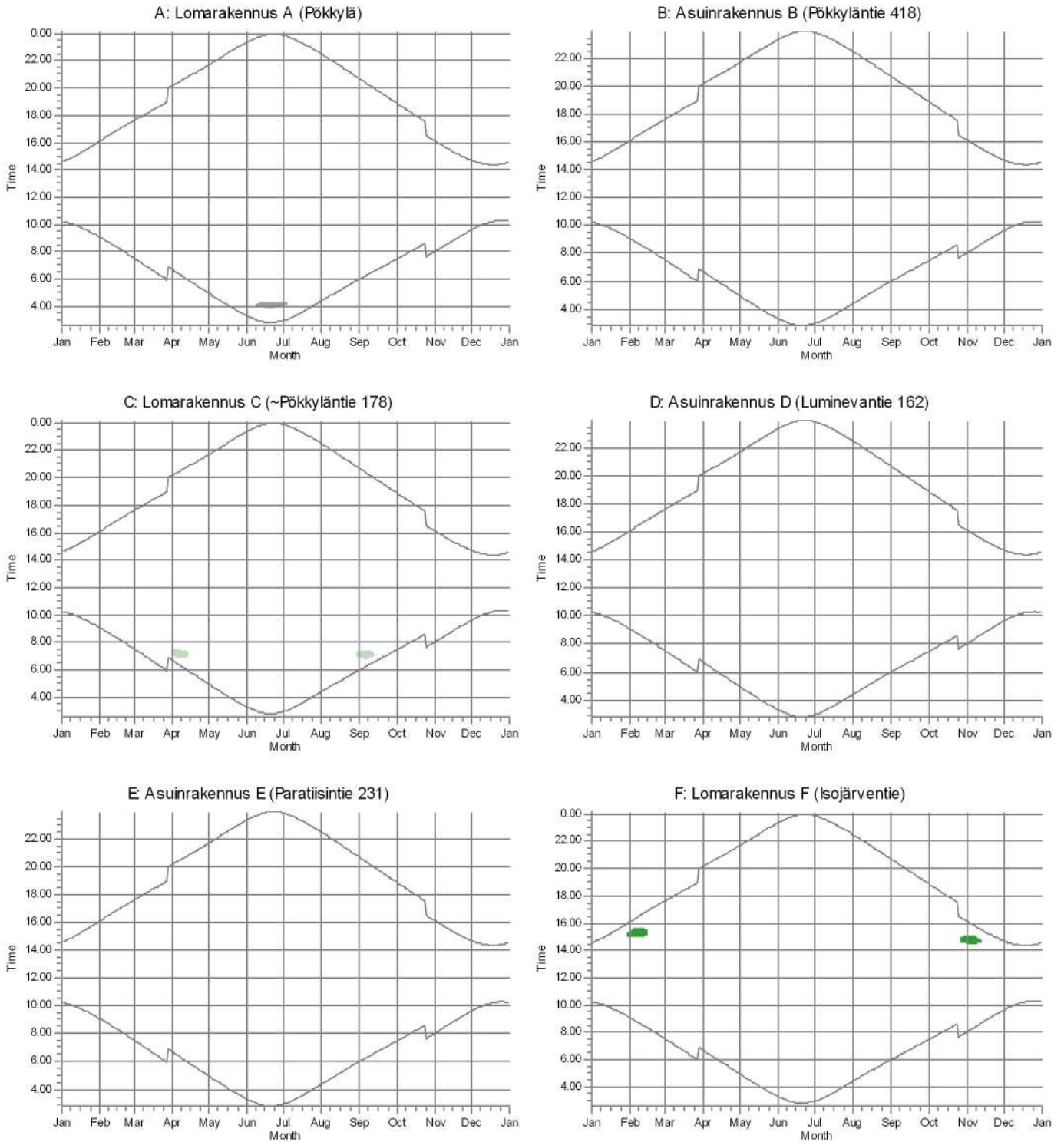
No.	Name	Expected [h/year]
8	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (128)	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (129)	0:00
10	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (130)	0:00
11	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (131)	0:00
12	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (132)	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (133)	4:37
14	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (134)	1:40
15	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (135)	0:00
16	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (136)	0:46
17	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (137)	0:00
18	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (138)	0:00
19	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (139)	0:00
20	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (140)	1:10
21	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (141)	0:00
22	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (142)	0:00
23	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (143)	0:00
24	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (144)	0:58
25	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (145)	0:00
26	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (146)	0:00
27	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (147)	1:05
28	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (148)	0:00
29	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (149)	0:00
30	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (150)	0:00
31	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (151)	1:19
32	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (152)	0:00
33	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (153)	3:19
34	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (154)	0:00
35	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (155)	0:00
36	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (156)	0:00
37	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (157)	1:16
38	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (158)	1:30
39	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (159)	2:31
40	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (160)	2:40

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, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto1\_RealCase\_NoForest\_RD200m

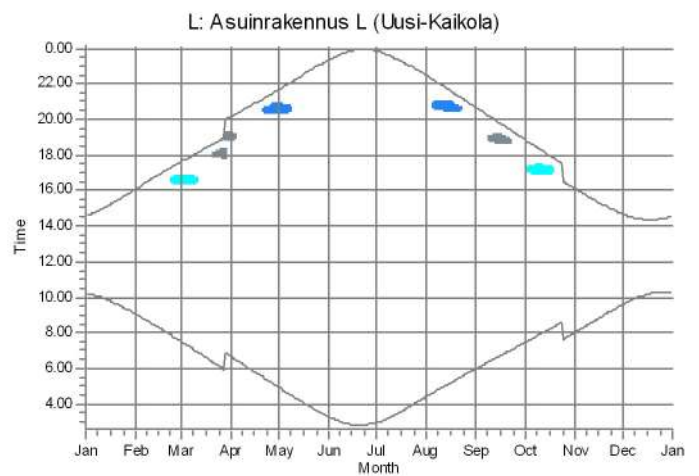
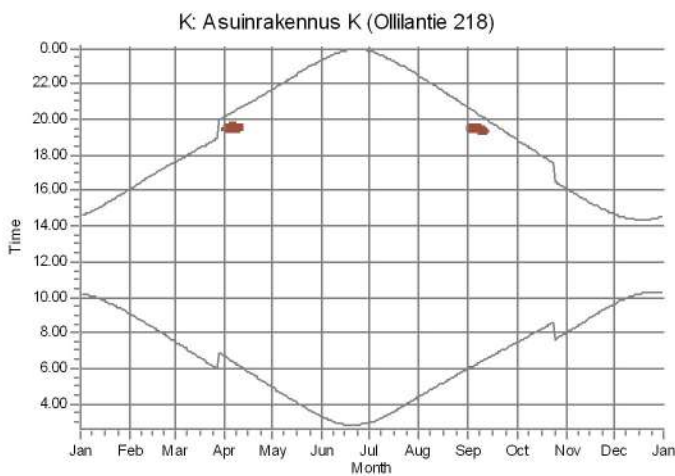
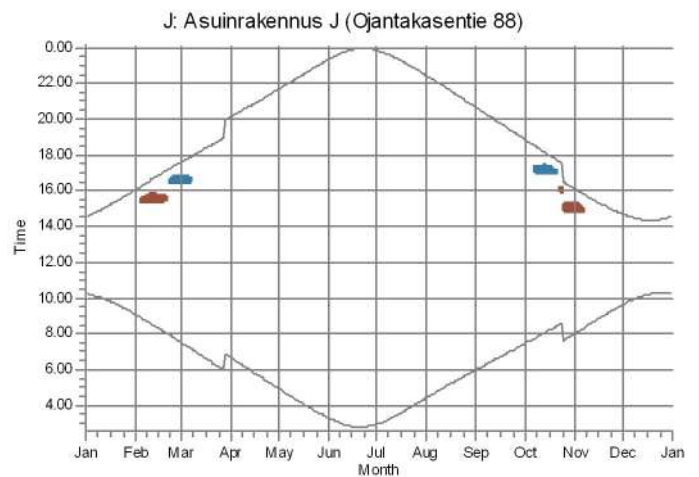
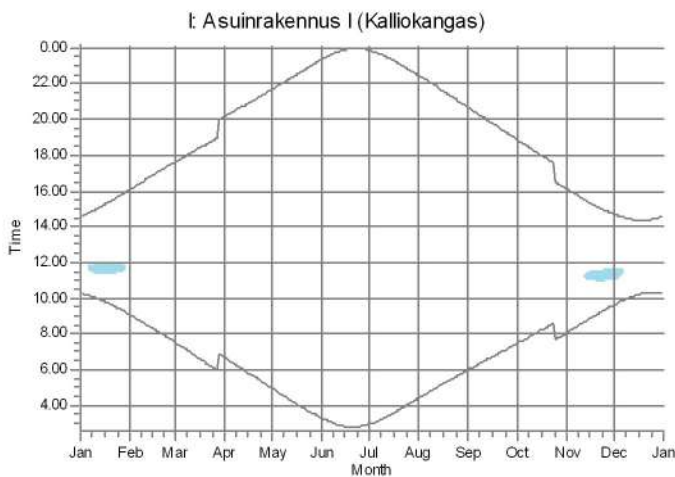
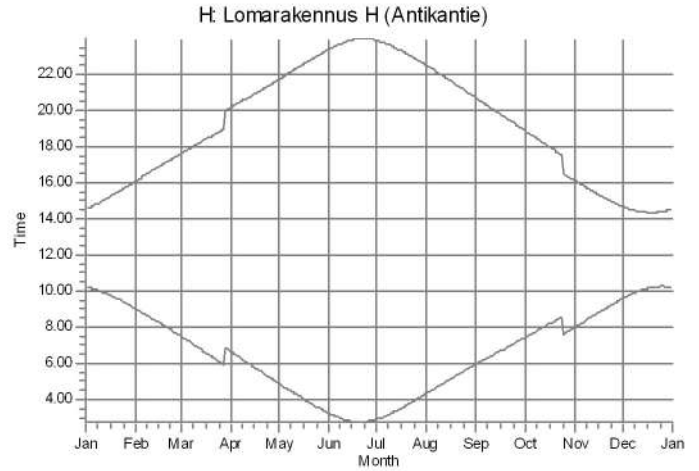
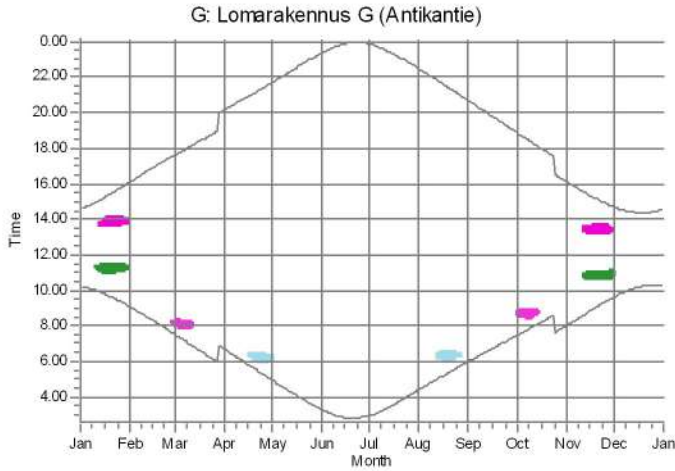


WTGs

14: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (134)      16: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (136)      20: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (140)

## SHADOW - Calendar, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto1\_RealCase\_NoForest\_RD200m

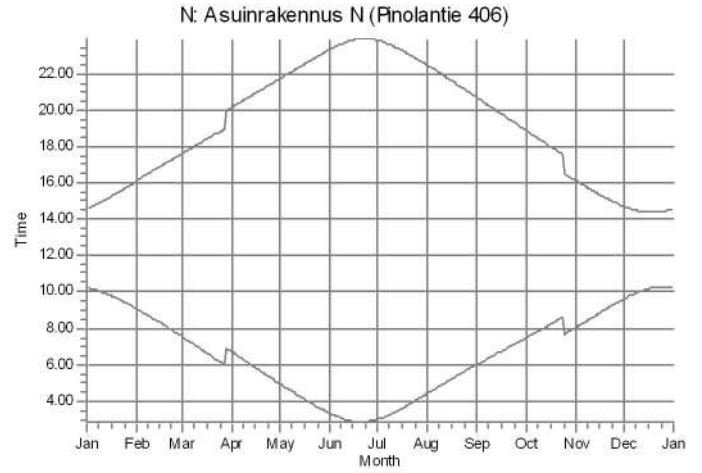
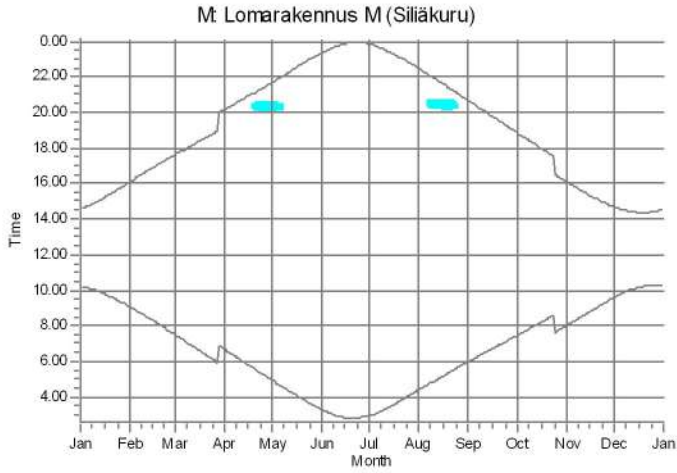


WTGs

- |   |   |  |
|---|---|--|
| <ul style="list-style-type: none"> <li><span style="color: cyan;">■</span> 13: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (133)</li> <li><span style="color: magenta;">■</span> 24: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (144)</li> <li><span style="color: green;">■</span> 27: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (147)</li> </ul> | <ul style="list-style-type: none"> <li><span style="color: pink;">■</span> 31: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (151)</li> <li><span style="color: cyan;">■</span> 33: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (153)</li> <li><span style="color: blue;">■</span> 37: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (157)</li> </ul> | <ul style="list-style-type: none"> <li><span style="color: grey;">■</span> 38: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (158)</li> <li><span style="color: blue;">■</span> 39: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (159)</li> <li><span style="color: brown;">■</span> 40: Generic Generic2 7000 200.0 10f hub: 150.0 m (TOT: 250.0 m) (160)</li> </ul> |
|---|---|--|

## SHADOW - Calendar, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto1\_RealCase\_NoForest\_RD200m



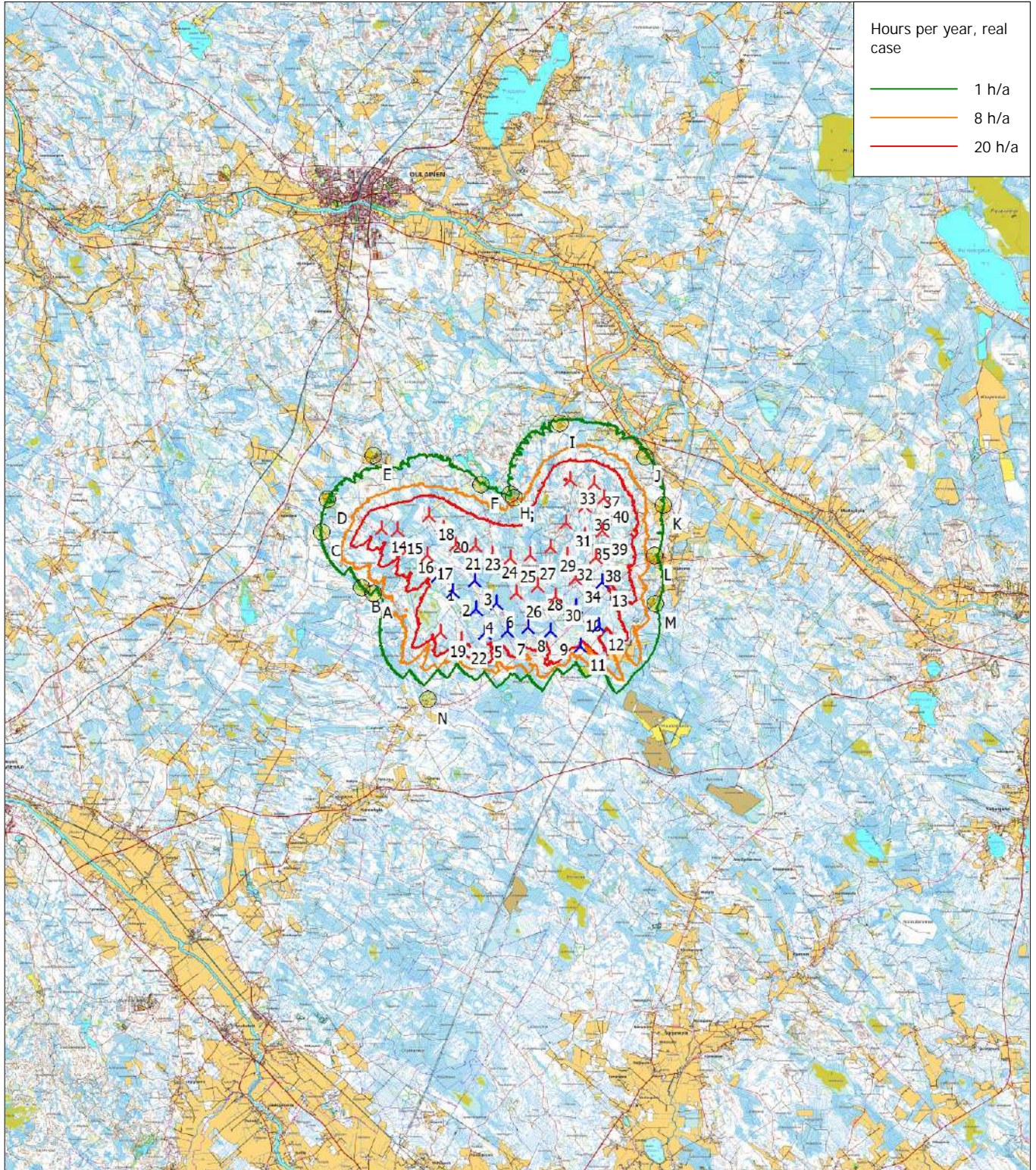
WTGs

13: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (133)





## SHADOW - Map

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoeto1\_RealCase\_NoForest\_RD200m



Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

 New WTG

 Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 8. Varjostusmallinnuksen tulokset "real case, no forest" - Hankevaihtoehto 2**

## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihhtoeto2\_RealCase\_NoForest\_RD200m

### Assumptions for shadow calculations

Maximum distance for influence

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

Please look in WTG table

Minimum sun height over horizon for influence 3 °

Day step for calculation 1 days

Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0,77	2,46	4,42	6,93	8,81	9,87	9,13	6,84	4,43	2,23	0,93	0,26

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

MERRA2\_N64.000\_E025.000 (1)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
532	399	370	408	600	876	1 045	1 097	970	756	629	651	8 333

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\_Rahkola\_Hautakangas

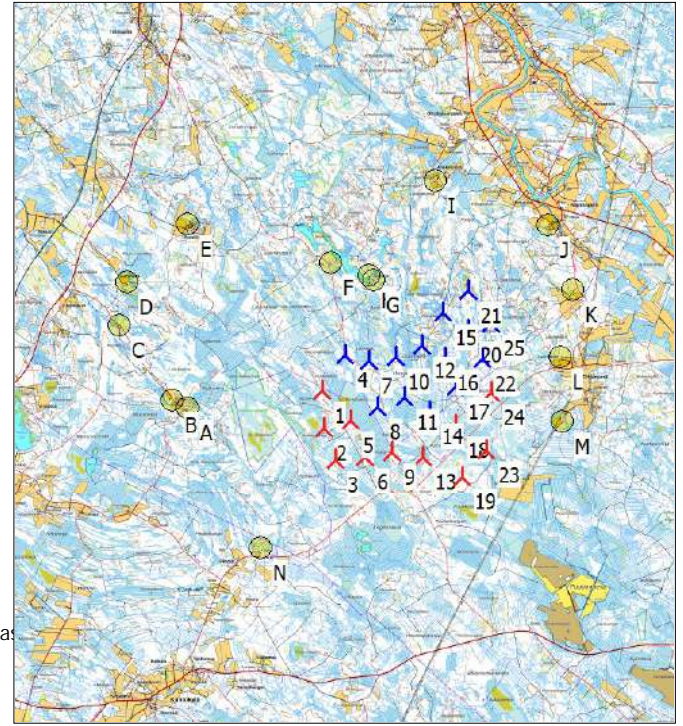
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

### WTGs



New WTG

Scale 1:200 000

Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
			[m]									
1	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
2	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
3	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
4	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
5	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
6	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
7	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
8	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
9	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
10	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
11	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
12	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
13	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
14	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
15	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
16	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
17	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
18	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
19	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
20	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
21	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
22	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	
23	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
24	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
25	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4	

## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto2\_RealCase\_NoForest\_RD200m

### 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]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

### Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:00
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	0:00
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	0:00
G	Lomarakennus G (Antikantie)	3:25
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	0:00
J	Asuinrakennus J (Ojantakasentie 88)	0:00
K	Asuinrakennus K (Ollilantie 218)	0:00
L	Asuinrakennus L (Uusi-Kaikola)	5:35
M	Lomarakennus M (Siliäkuru)	3:04
N	Asuinrakennus N (Pinolantie 406)	0:00

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

No.	Name	Expected [h/year]
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (267)	0:00
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (268)	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (269)	0:00
4	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (270)	0:59
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (271)	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (272)	0:00
7	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (273)	0:00
8	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (274)	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (275)	0:00
10	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (276)	1:05
11	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (277)	0:00
12	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (278)	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (279)	0:00
14	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (280)	0:00
15	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (281)	1:19
16	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (282)	0:00
17	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (283)	0:00
18	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (284)	0:00
19	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (285)	0:00
20	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (286)	0:00
21	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (287)	0:00
22	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (288)	1:31
23	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (289)	0:00

To be continued on next page...

Project:  
Rahkola\_Hautakangas

Licensed user:  
FCG Finnish Consulting Group Oy  
Osmontie 34, PO Box 950  
FI-00601 Helsinki  
+358104095666  
Miikka Saranpää / miikka.saranpaa@fcg.fi  
Calculated:  
30.1.2023 14.10/3.5.584

## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoeto2\_RealCase\_NoForest\_RD200m

...continued from previous page

No.	Name	Expected [h/year]
24	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (290)	4:38
25	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (291)	2:32

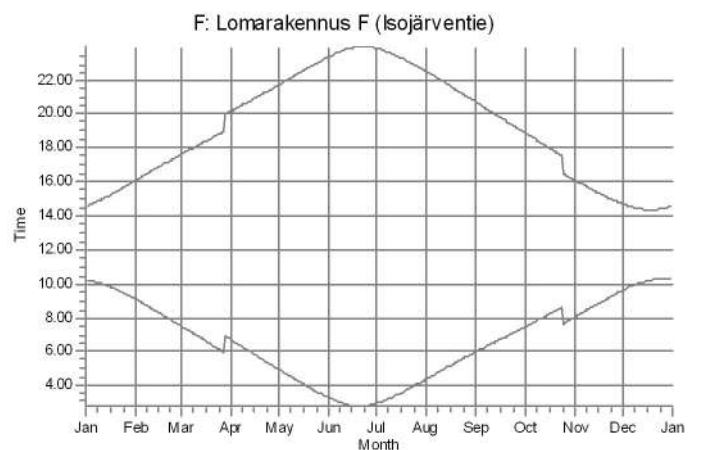
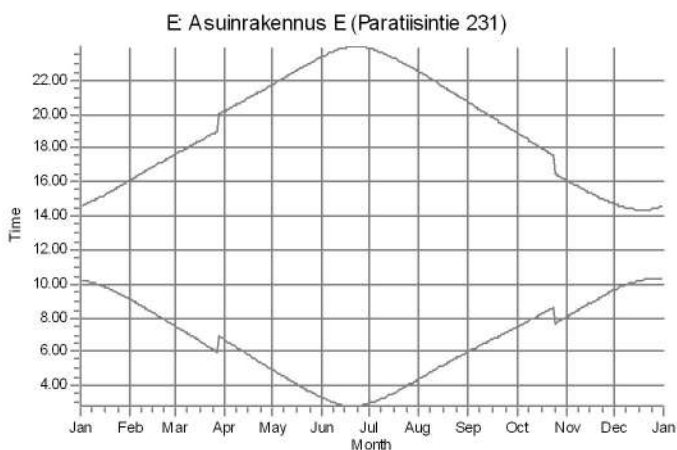
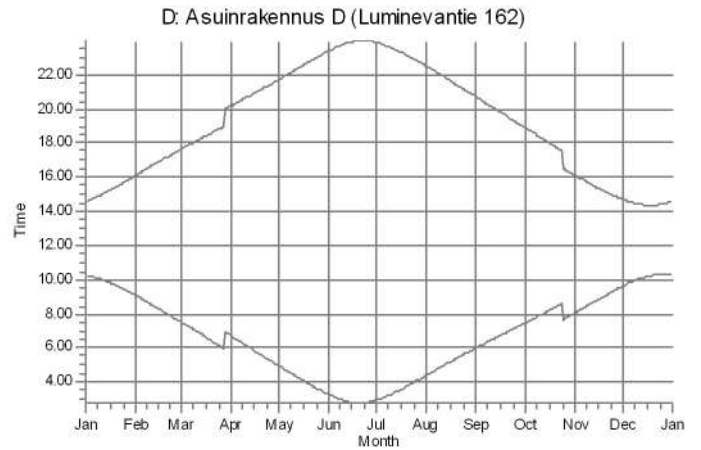
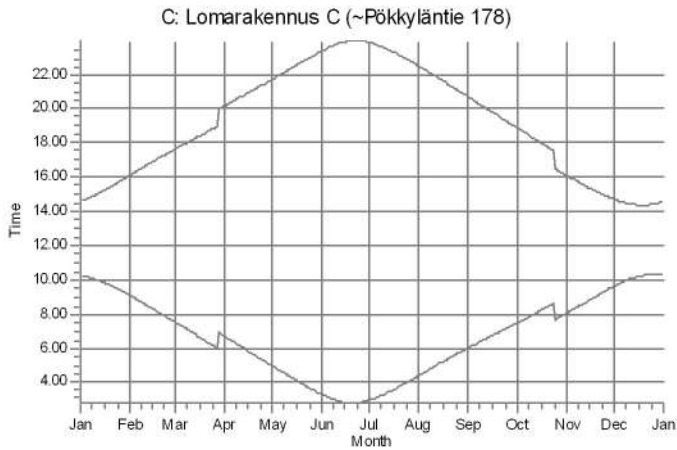
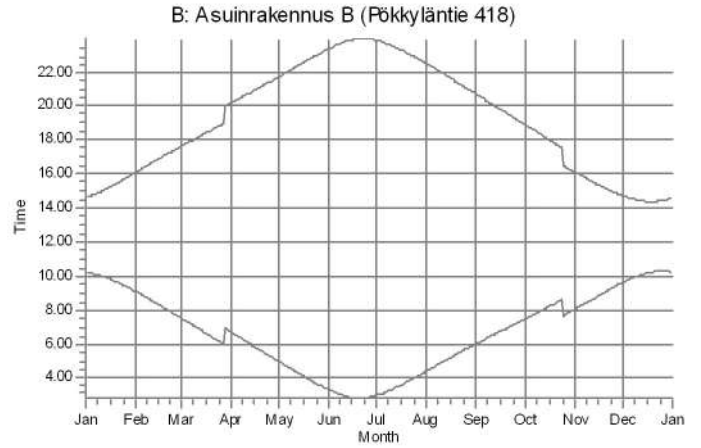
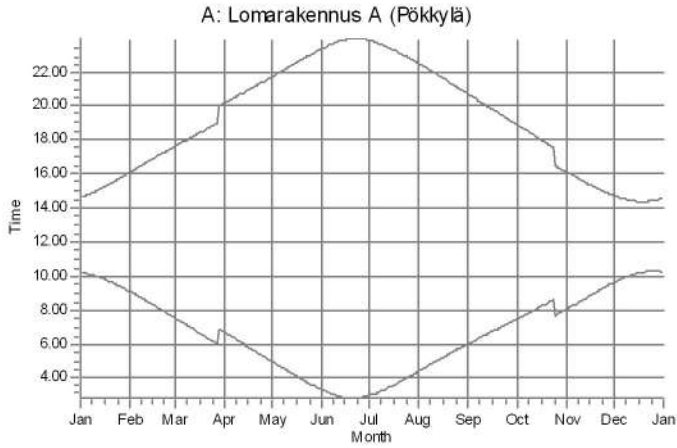
Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

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, graphical

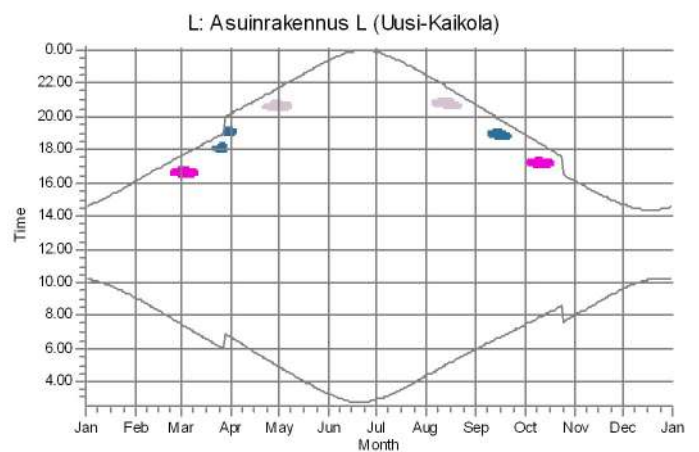
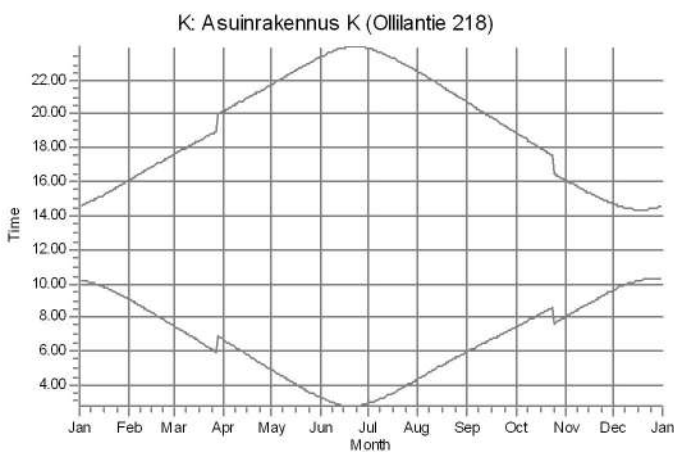
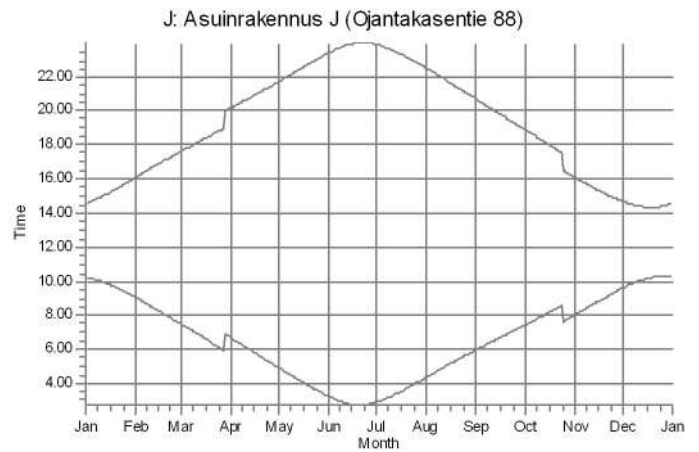
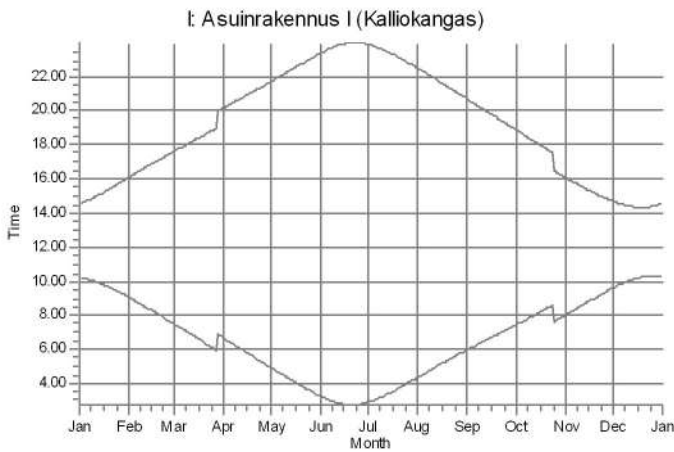
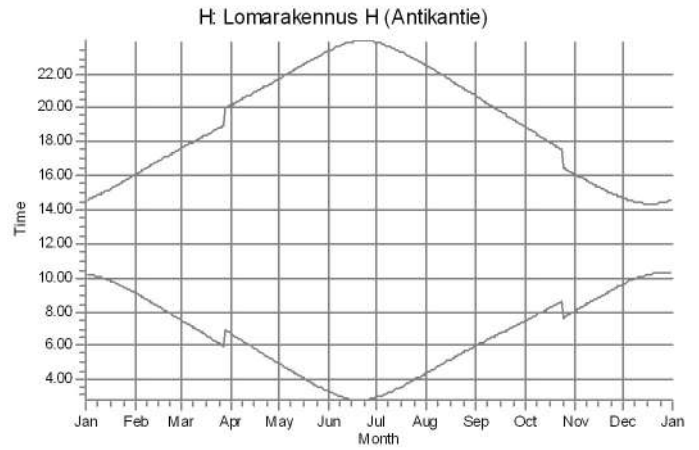
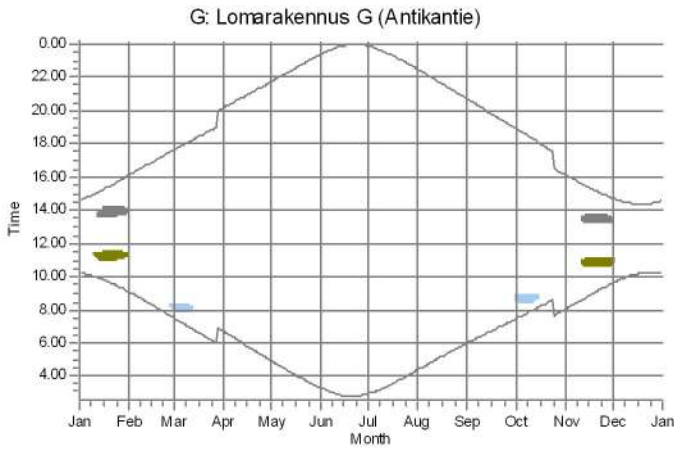
Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto2\_RealCase\_NoForest\_RD200m



WTGs

## SHADOW - Calendar, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto2\_RealCase\_NoForest\_RD200m

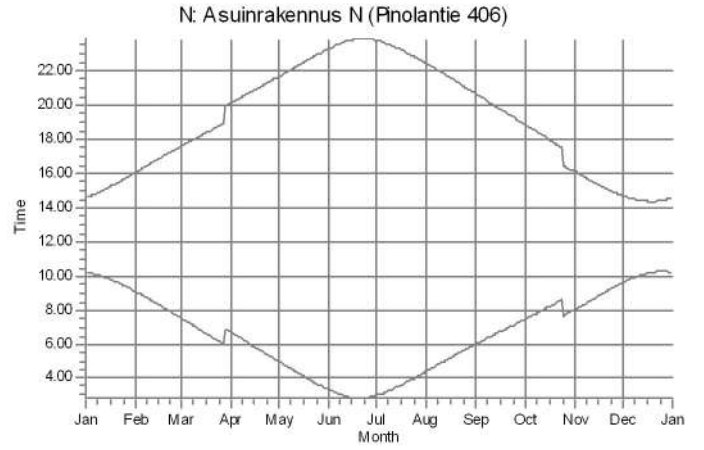
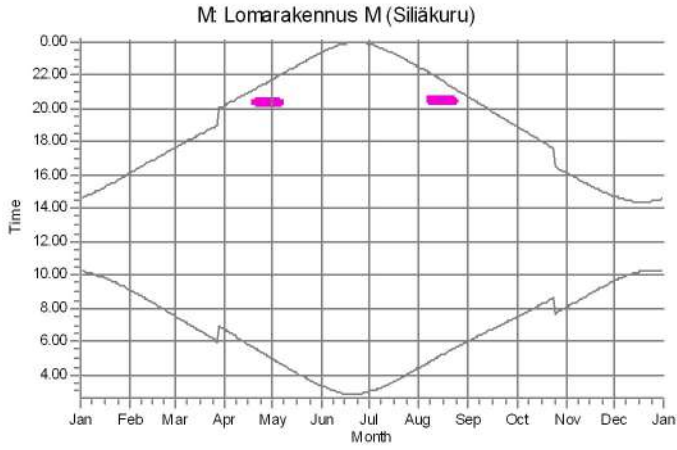


WTGs

- |  |   |   |
|--|---|---|
| <p>4: Generic Generic2 7000 200.0 IOI hub: 150.0 m (TOT: 250.0 m) (270)</p> <p>10: Generic Generic2 7000 200.0 IOI hub: 150.0 m (TOT: 250.0 m) (276)</p> | <p>15: Generic Generic2 7000 200.0 IOI hub: 150.0 m (TOT: 250.0 m) (281)</p> <p>22: Generic Generic2 7000 200.0 IOI hub: 150.0 m (TOT: 250.0 m) (288)</p> | <p>24: Generic Generic2 7000 200.0 IOI hub: 200.0 m (TOT: 300.0 m) (290)</p> <p>25: Generic Generic2 7000 200.0 IOI hub: 150.0 m (TOT: 250.0 m) (291)</p> |
|--|---|---|

## SHADOW - Calendar, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoeto2\_RealCase\_NoForest\_RD200m



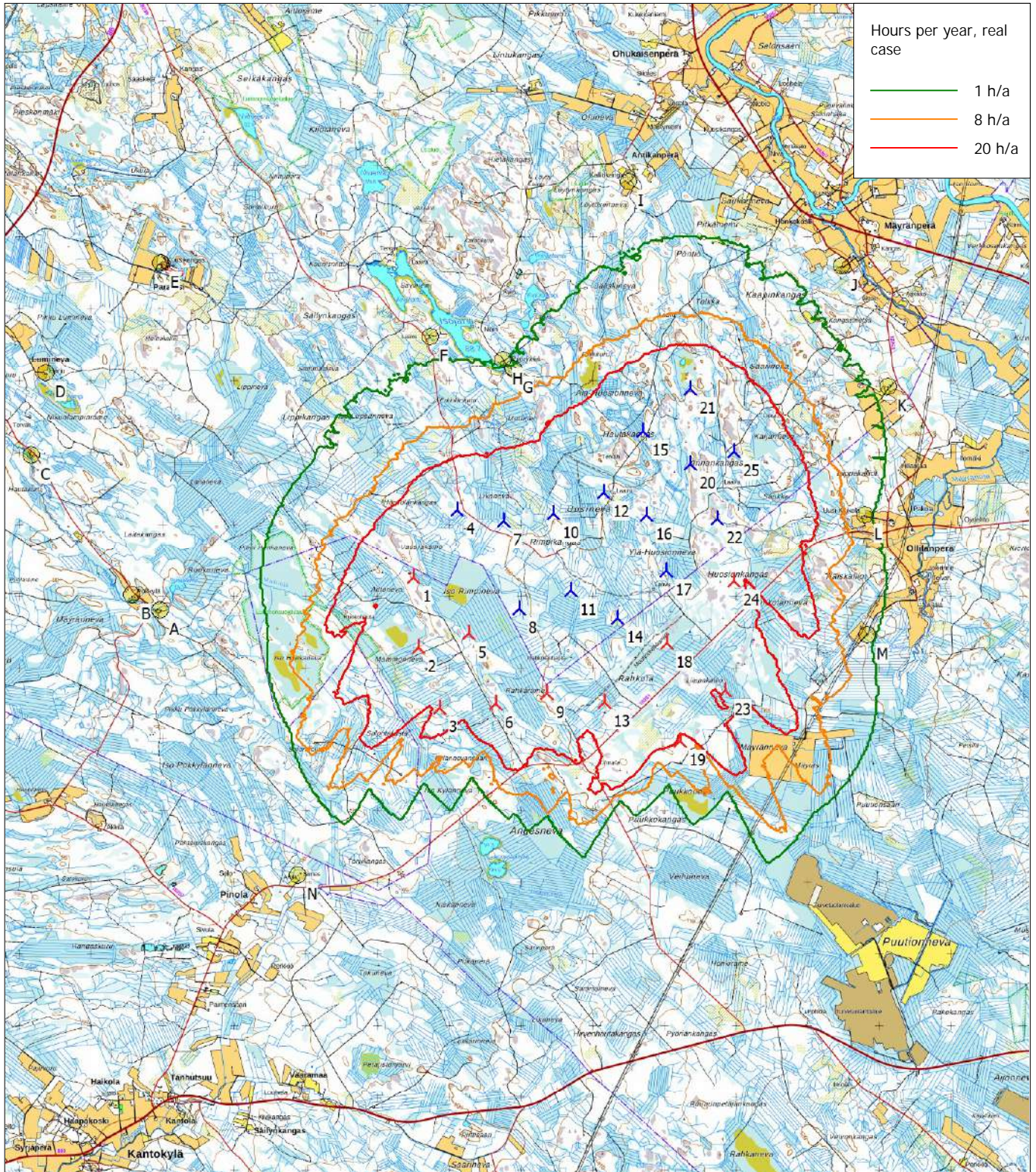
WTGs

24: Generic Generic2 7000 200.0 101 hub: 200.0 m (TOT: 300.0 m) (290)



## SHADOW - Map

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto2\_RealCase\_NoForest\_RD200m



Map: Maastokarttarasteri50K , Print scale 1:80 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

New WTG

Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 9. Varjostusmallinnuksen tulokset "real case, no forest" - Hankevaihtoehto 3**



## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihhtoeto3\_RealCase\_NoForest\_RD200m

### Assumptions for shadow calculations

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

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

Sunshine probability S (Average daily sunshine hours) []  
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

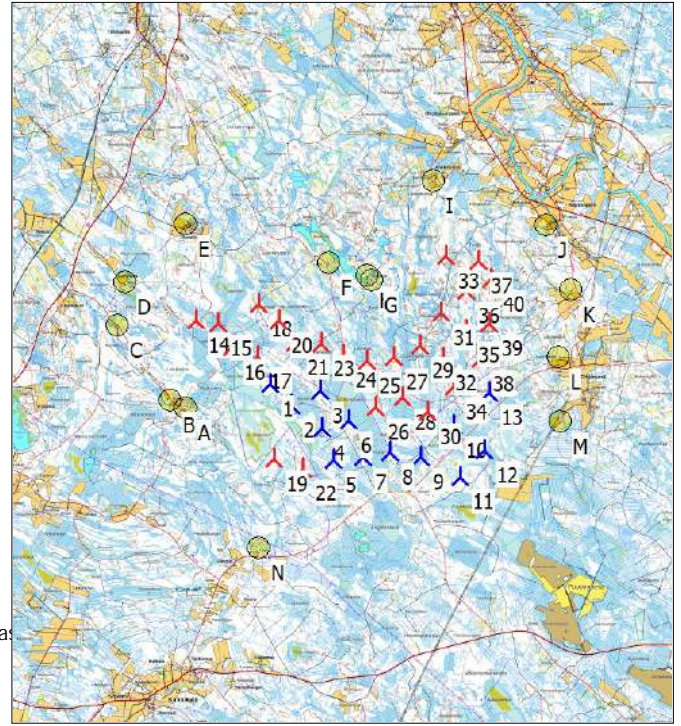
MERRA2\_N64.000\_E025.000 (1)

Operational time  
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
540 405 376 415 610 890 1 063 1 115 986 769 639 662 8 472  
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\_Rahkola\_Hautakangas  
Obstacles used in calculation  
Receptor grid resolution: 1,0 m

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89

### WTGs



Scale 1:200 000  
New WTG Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
			[m]									
1	397 208	7 115 412	87,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
2	397 754	7 114 856	87,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
3	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
4	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
5	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
6	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
7	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
8	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
9	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
10	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
11	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
12	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
13	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
14	395 254	7 117 093	87,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
15	395 819	7 117 022	82,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
16	396 195	7 116 379	82,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
17	396 858	7 116 145	84,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
18	396 894	7 117 531	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
19	397 303	7 113 442	87,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
20	397 417	7 117 093	90,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
21	397 854	7 116 507	90,9	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
22	398 058	7 113 189	92,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
23	398 529	7 116 484	94,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
24	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
25	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
26	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
27	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
28	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
29	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
30	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	
31	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O! ... Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4	

To be continued on next page...

## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_NoForest\_RD200m

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM
			[m]									
32	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
33	401 837	7 118 791	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
34	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
35	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
36	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
37	402 692	7 118 655	96,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
38	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
39	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
40	403 021	7 118 167	96,4	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4

## Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
				[m]	[m]	[m]	a.g.l. [m]	window [°]		(ZVI) a.g.l. [m]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:10
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	2:13
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	1:35
G	Lomarakennus G (Antikantie)	7:20
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	1:33
J	Asuinrakennus J (Ojantakasentie 88)	3:10
K	Asuinrakennus K (Ollilantie 218)	2:02
L	Asuinrakennus L (Uusi-Kaikola)	6:56
M	Lomarakennus M (Siliäkuru)	3:07
N	Asuinrakennus N (Pinolantie 406)	0:00

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

No.	Name	Expected [h/year]
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (490)	0:00
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (491)	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (492)	0:00
4	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (493)	0:00
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (494)	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (495)	0:00
7	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (496)	0:00

To be continued on next page...

## SHADOW - Main Result

Calculation: Copy of Rahkola-Hautakangas Hankevaihhtohto3\_RealCase\_NoForest\_RD200m

...continued from previous page

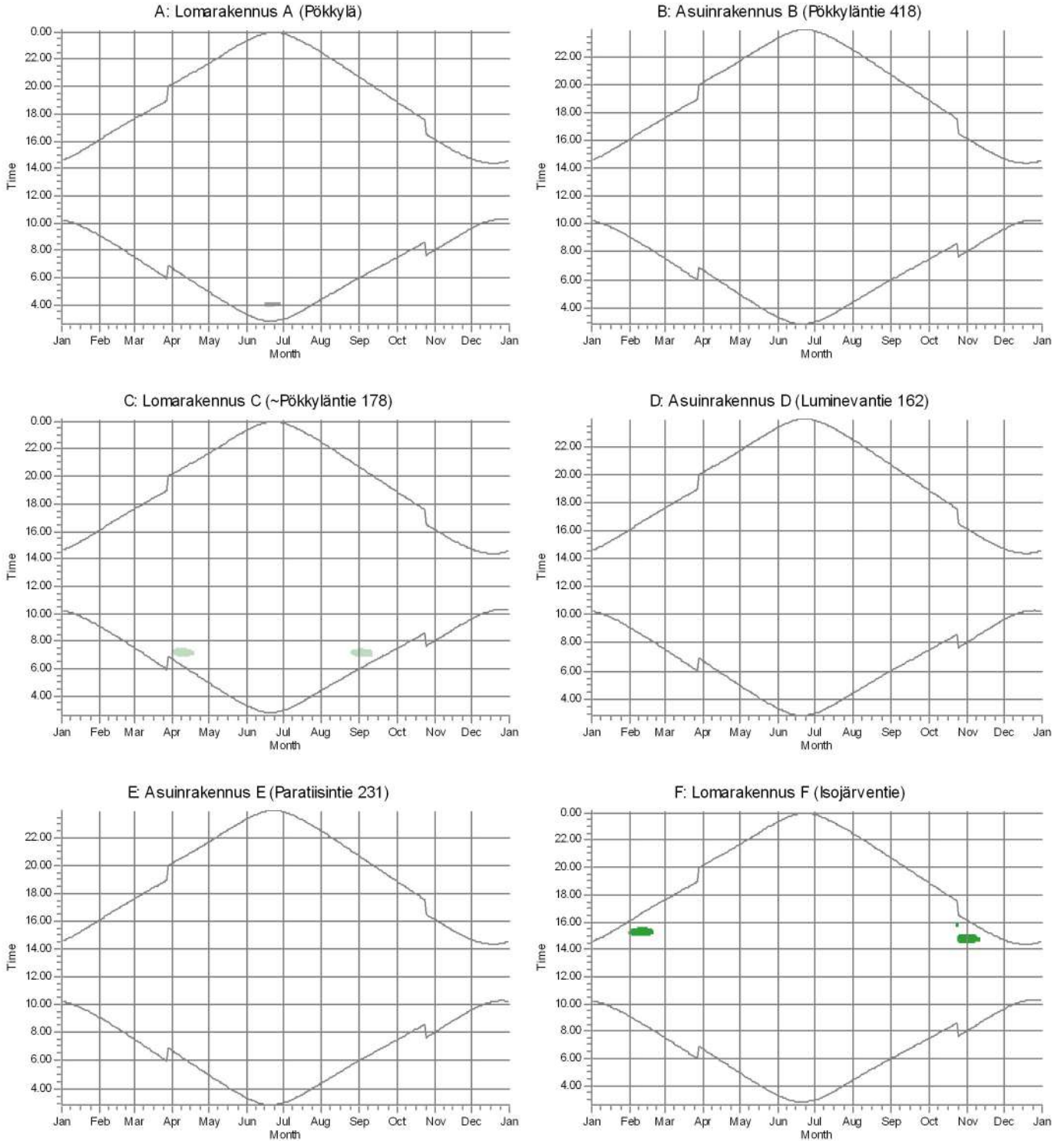
No.	Name	Expected [h/year]
8	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (497)	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (498)	0:00
10	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (499)	0:00
11	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (500)	0:00
12	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (501)	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (502)	4:42
14	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (503)	2:13
15	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (504)	0:00
16	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (505)	0:10
17	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (506)	0:00
18	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (507)	0:00
19	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (508)	0:00
20	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (509)	1:35
21	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (510)	0:00
22	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (511)	0:00
23	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (512)	0:00
24	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (513)	1:18
25	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (514)	0:00
26	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (515)	0:00
27	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (516)	1:22
28	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (517)	0:00
29	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (518)	0:00
30	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (519)	0:00
31	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (520)	1:44
32	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (521)	0:00
33	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (522)	4:20
34	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (523)	0:00
35	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (524)	0:00
36	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (525)	0:00
37	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (526)	1:37
38	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (527)	1:57
39	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (528)	3:25
40	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (529)	3:35

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, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto3\_RealCase\_NoForest\_RD200m



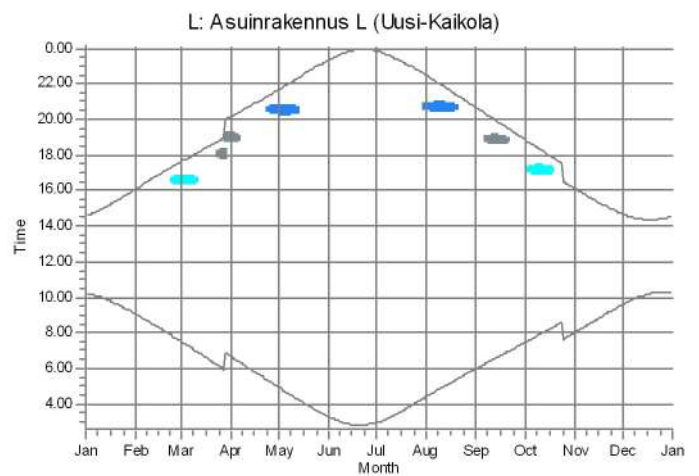
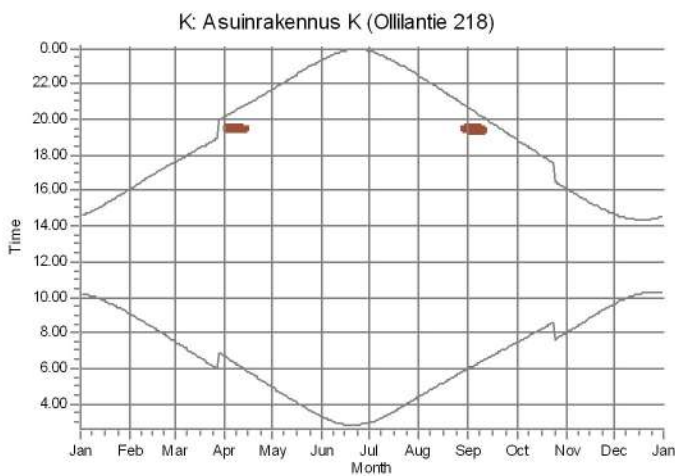
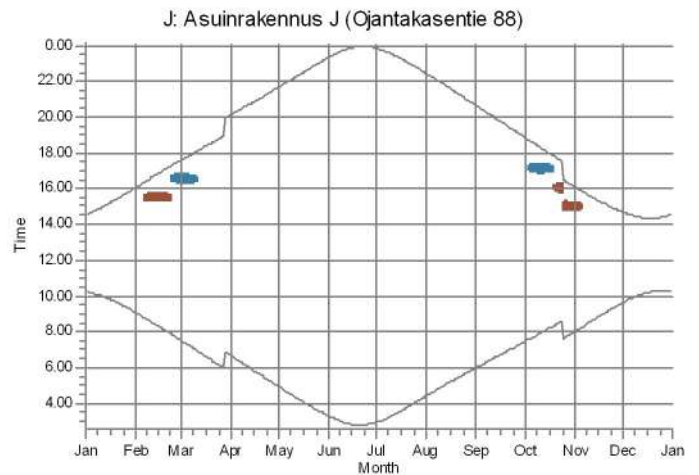
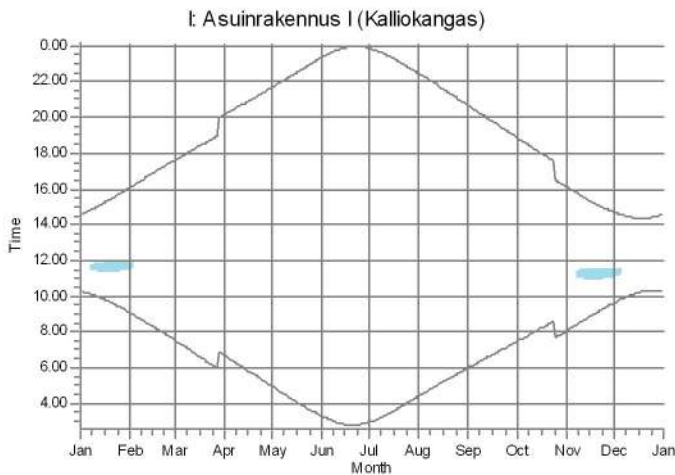
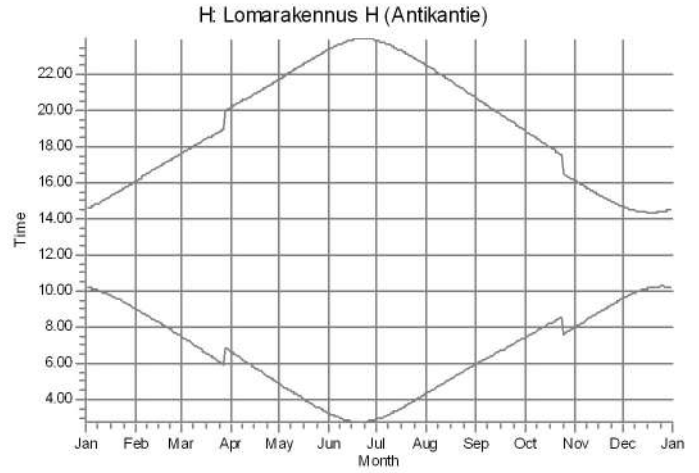
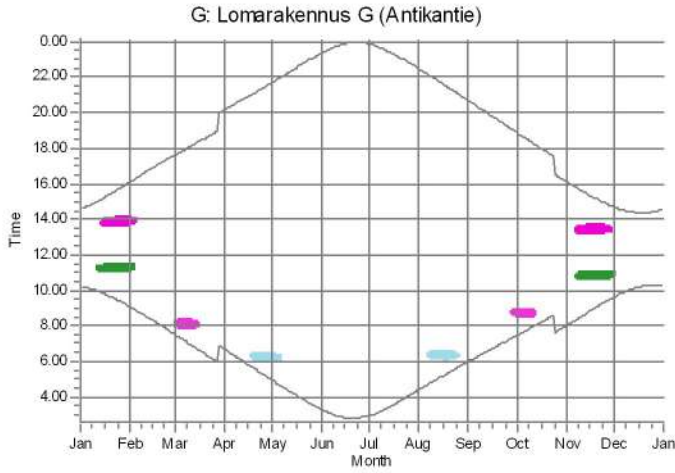
WTGs

14: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (503)      16: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (505)      20: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (509)












## SHADOW - Calendar, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoehto3\_RealCase\_NoForest\_RD200m



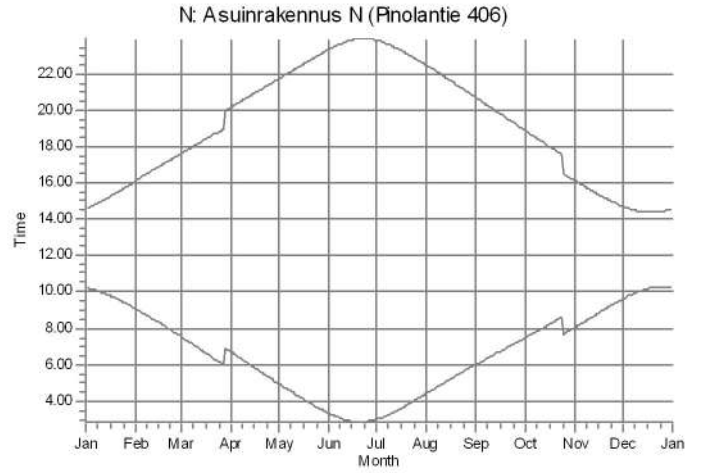
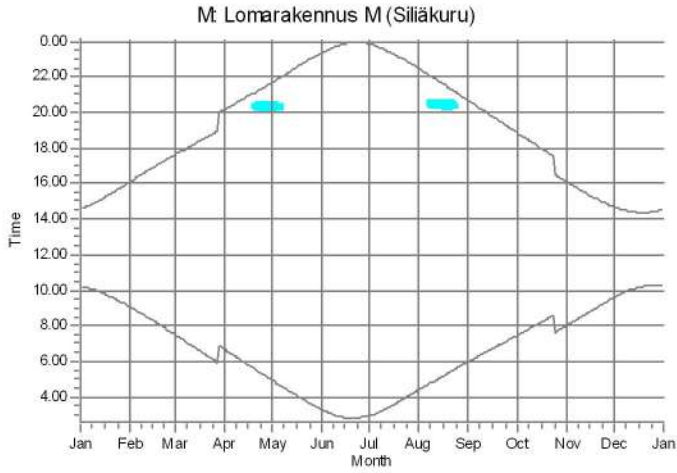
WTGs

- |   |   |   |
|---|---|---|
|  13: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (502) |  31: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (520) |  38: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (527) |
|  24: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (513) |  33: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (522) |  39: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (528) |
|  27: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (516) |  37: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (526) |  40: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (529) |



## SHADOW - Calendar, graphical

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoeto3\_RealCase\_NoForest\_RD200m



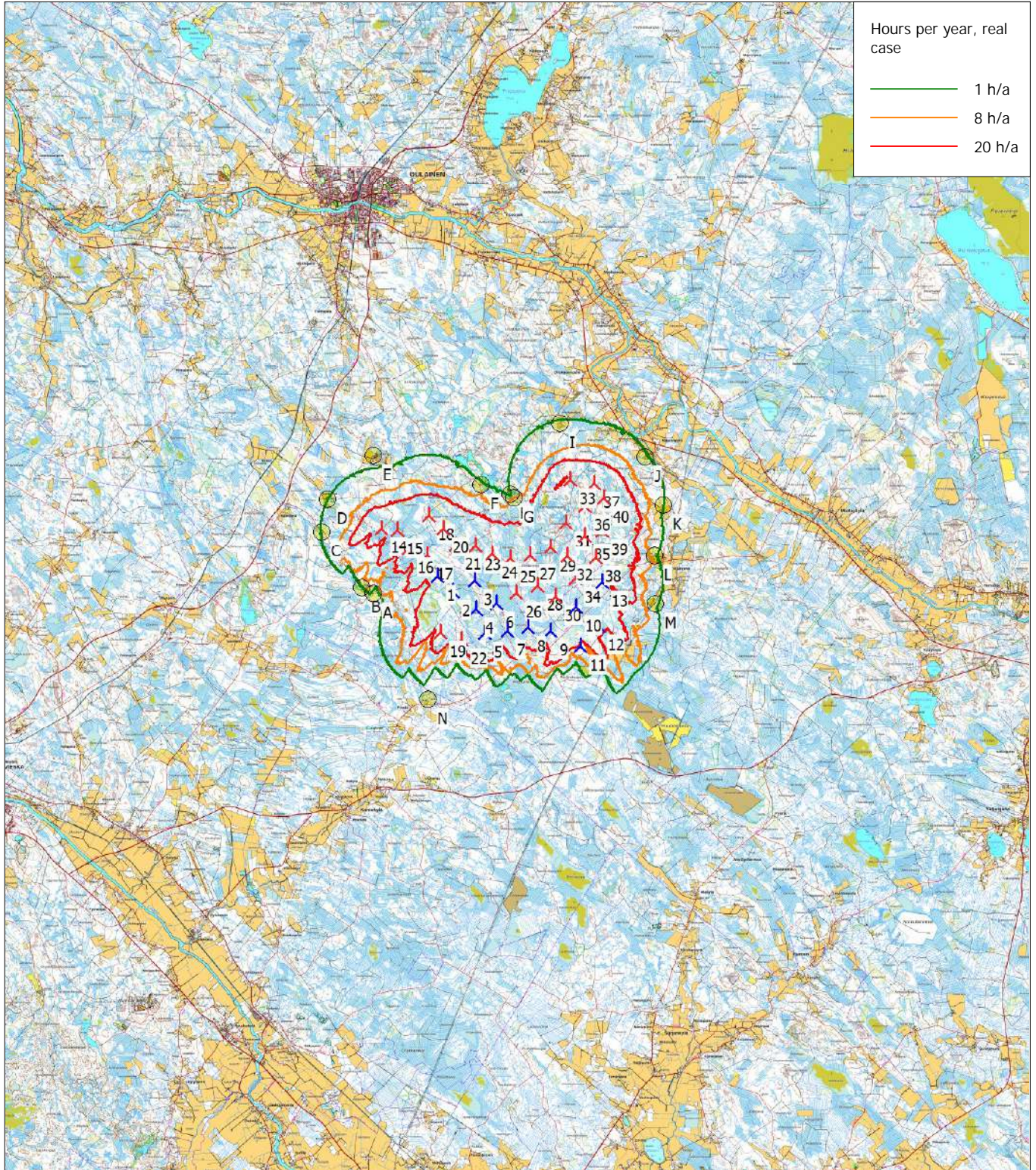
WTGs

13: Generic Generic2 7000 200.0 10f hub: 200.0 m (TOT: 300.0 m) (502)

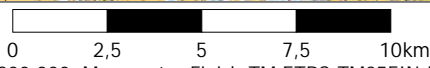


## SHADOW - Map

Calculation: Copy of Rahkola-Hautakangas Hankevaihtoeto3\_RealCase\_NoForest\_RD200m



Hours per year, real case	
	1 h/a
	8 h/a
	20 h/a



Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

New WTG

Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 10. Melun yhteismallinnusten (Rahkola-Hautakangas + Puutionsaari) tulokset VE1**

## DECIBEL - Main Result

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

Calculation is done according to Finnish guideline " Ympäristöhallinnon ohjeita 2 | 2014" from the Ministry of the Environment of Finland

All coordinates are in  
 Finish TM ETRS-TM35FIN-ETRS89



Scale 1:200 000  
 🚩 New WTG     🟡 Noise sensitive area

## WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.					Creator	Name		
			[m]											
1	398 896	7 112 332	92,5	PUU01	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
1	397 208	7 115 412	87,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
2	399 097	7 111 286	95,0	PUU02	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
2	397 754	7 114 856	87,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
3	399 784	7 111 972	97,5	PUU03	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
3	398 503	7 115 243	95,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
4	398 570	7 114 265	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
4	399 264	7 110 151	97,0	PUU04	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
5	398 871	7 113 427	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
5	399 536	7 110 832	95,5	PUU05	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
6	400 239	7 111 382	97,5	PUU06	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
6	399 272	7 114 459	97,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
7	399 647	7 113 488	95,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
7	400 444	7 112 292	97,3	PUU07	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
8	400 360	7 113 628	101,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
8	400 019	7 109 649	100,0	PUU08	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
9	401 168	7 113 504	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
9	400 380	7 110 348	100,0	PUU09	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
10	400 876	7 110 966	99,5	PUU10	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
10	402 041	7 114 329	106,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
11	401 152	7 111 752	100,0	PUU11	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
11	402 216	7 112 963	108,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
12	400 549	7 109 232	102,5	PUU12	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
12	402 852	7 113 666	105,8	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
13	402 975	7 115 189	106,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158_107,0 +2 dB HH221	8,0	109,0
13	400 953	7 110 020	102,5	PUU13	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
14	395 254	7 117 093	87,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
14	401 537	7 111 046	104,4	PUU14	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
15	401 068	7 108 792	105,8	PUU15	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
15	395 819	7 117 022	82,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
16	396 195	7 116 379	82,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
16	401 564	7 109 758	104,3	PUU16	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
17	402 089	7 110 702	107,5	PUU17	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
17	396 858	7 116 145	84,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
18	402 589	7 111 603	107,5	PUU18	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
18	396 894	7 117 531	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
19	402 455	7 109 148	112,3	PUU19	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
19	397 303	7 113 442	87,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
20	402 889	7 109 778	110,0	PUU20	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
20	397 417	7 117 093	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
21	397 854	7 116 507	90,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
21	403 318	7 110 593	107,8	PUU21	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
22	403 622	7 111 352	106,3	PUU22	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
22	398 058	7 113 189	91,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
23	404 117	7 112 276	103,9	PUU23	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
23	398 529	7 116 484	94,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
24	399 116	7 116 184	97,1	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
24	403 379	7 109 327	115,0	PUU24	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
25	399 762	7 116 032	97,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
25	403 790	7 110 129	108,4	PUU25	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
26	404 210	7 111 152	105,6	PUU26	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
26	399 974	7 114 812	98,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0
27	404 739	7 112 199	105,0	PUU27	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
27	400 456	7 116 139	99,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107,0 +2 dB HH171	8,0	109,0

To be continued on next page...

## DECIBEL - Main Result

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

...continued from previous page

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.					Creator	Name		
28	405	100	7 112 943	100,4 PUU28	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
28	400	698	7 115 062	103,2 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
29	401	155	7 116 430	99,6 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
29	404	061	7 109 351	110,0 PUU29	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
30	404	420	7 110 174	106,8 PUU30	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
30	401	348	7 114 680	105,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
31	401	706	7 117 283	100,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
31	404	900	7 111 381	105,3 PUU31	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
32	401	754	7 116 113	102,5 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
32	405	395	7 112 030	102,4 PUU32	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
33	401	837	7 118 791	95,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
33	405	740	7 112 891	100,2 PUU33	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
34	405	042	7 110 380	105,8 PUU34	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
34	402	023	7 115 337	105,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
35	405	532	7 111 130	103,4 PUU35	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
35	402	362	7 116 825	105,0 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
36	406	114	7 112 133	103,2 PUU36	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
36	402	365	7 117 878	100,5 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
37	402	692	7 118 655	96,3 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
37	406	380	7 113 067	107,2 PUU37	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
38	405	707	7 108 791	111,3 PUU38	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
38	402	733	7 116 070	109,7 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
39	405	822	7 109 587	108,8 PUU39	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
39	402	975	7 117 005	104,3 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
40	405	893	7 110 455	105,0 PUU40	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
40	403	021	7 118 167	96,4 GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158_107.0 +2 dB HH171	8,0	109,0
41	406	257	7 111 298	104,0 PUU41	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
42	406	558	7 109 872	106,8 PUU42	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
43	406	638	7 110 744	105,9 PUU43	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
44	407	324	7 109 954	108,4 PUU44	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
45	407	269	7 110 957	112,6 PUU45	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
46	407	963	7 109 542	113,4 PUU46	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
47	407	809	7 110 582	116,1 PUU47	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
48	408	414	7 110 457	120,0 PUU48	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
49	408	786	7 109 772	117,5 PUU49	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0

## Calculation Results

### Sound level

#### Noise sensitive area

No.	Name	East	North	Z	Immission height	Demands Noise [dB(A)]	Sound level From WTGs [dB(A)]	Distance to noise demand [m]	Demands fulfilled ?	
									Noise	2 dB penalty applied for one or more WTGs
A	Lomarakennus A (Pöykkylä)	394 971	7 114 786	80,0	4,0	40,0	35,8	883	Yes	No
B	Asuinrakennus B (Pöykkyläntie 418)	394 575	7 114 996	77,8	4,0	40,0	34,9	1 017	Yes	No
C	Lomarakennus C (~Pöykkyläntie 178)	393 172	7 116 951	75,2	4,0	40,0	32,1	1 256	Yes	No
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	4,0	40,0	31,7	1 302	Yes	No
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,1	4,0	40,0	31,7	1 597	Yes	No
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	4,0	40,0	36,8	747	Yes	No
G	Lomarakennus G (Antikantie)	399 889	7 118 156	90,8	4,0	40,0	38,4	471	Yes	No
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	4,0	40,0	38,0	627	Yes	No
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	4,0	40,0	33,3	1 122	Yes	No
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,3	4,0	40,0	34,2	965	Yes	No
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	4,0	40,0	34,7	1 065	Yes	No
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,4	4,0	40,0	36,8	737	Yes	No
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	4,0	40,0	38,7	370	Yes	No
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	87,9	4,0	40,0	35,7	1 064	Yes	No

### Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	4629	5076	7355	7980	8284	6274	5908	6014	8822	9149	8356	7010	6301	2358
1	2323	2666	4319	4678	4772	3539	3836	3839	6856	8376	8296	7618	7686	4332
2	5410	5849	8197	8893	9306	7327	6915	7029	9776	9888	8951	7472	6547	2215
2	2784	3182	5038	5446	5523	3875	3930	3970	6992	8215	7973	7152	7091	3862
3	5575	6023	8277	8863	9042	6714	6185	6312	8956	8942	7982	6505	5621	3025
3	3561	3936	5598	5867	5629	3369	3226	3289	6279	7381	7133	6351	6380	4453
4	3637	4061	6029	6453	6457	4342	4108	4190	7126	7946	7495	6494	6266	3590
4	6318	6742	9130	9888	10403	8469	8029	8148	10844	10777	9719	8138	7031	2554
5	4130	4574	6701	7210	7324	5179	4837	4937	7791	8324	7689	6506	6048	3062
5	6039	6477	8828	9523	9909	7813	7332	7455	10122	10050	9014	7458	6411	2659

To be continued on next page...



## DECIBEL - Main Result

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
6	6272	6719	8997	9600	9784	7376	6783	6919	9465	9232	8150	6573	5520	3361
6	4313	4728	6589	6927	6723	4179	3748	3856	6684	7302	6789	5766	5561	4124
7	4853	5291	7343	7781	7716	5196	4674	4797	7506	7776	7035	5781	5273	3653
7	6014	6462	8636	9145	9151	6539	5890	6031	8536	8333	7308	5795	4888	3751
8	5512	5945	7919	8290	8063	5234	4552	4695	7225	7239	6401	5086	4547	4298
8	7202	7631	10010	10745	11182	9046	8508	8639	11212	10890	9708	8043	6794	3446
9	6328	6760	8707	9044	8710	5650	4825	4984	7266	6922	5917	4472	3783	4911
9	6997	7436	9775	10444	10740	8418	7823	7960	10474	10104	8923	7267	6050	3568
10	7033	7479	9756	10348	10482	7932	7257	7403	9817	9341	8137	6475	5268	3988
10	7085	7496	9248	9448	8833	5403	4391	4568	6457	5792	4721	3285	2794	6084
11	6885	7333	9524	10035	10010	7265	6527	6679	9017	8509	7324	5688	4560	4313
11	7471	7907	9884	10222	9842	6628	5691	5862	7833	6998	5735	4077	3007	5645
12	7871	8301	10677	11402	11797	9546	8948	9087	11570	11073	9807	8092	6746	4105
12	7960	8383	10222	10460	9879	6428	5380	5560	7226	6139	4811	3130	2128	6494
13	8014	8402	9960	10029	9150	5443	4281	4466	5767	4646	3463	2043	2002	7336
13	7648	8089	10420	11073	11317	8865	8205	8350	10757	10194	8921	7210	5884	4202
14	2324	2204	2087	2129	2551	3797	4755	4657	7240	9547	9899	9588	9939	6220
14	7556	8004	10239	10784	10804	8060	7298	7454	9717	9031	7742	6031	4733	4647
15	8550	8980	11354	12071	12432	10085	9438	9582	11979	11319	9976	8222	6790	4769
15	2391	2377	2648	2668	2740	3319	4225	4134	6798	9023	9342	9019	9376	6026
16	2009	2130	3077	3300	3471	3378	4099	4039	6878	8875	9054	8602	8852	5332
16	8291	8734	11053	11685	11868	9287	8563	8716	11005	10250	8893	7136	5713	4861
17	8206	8654	10889	11427	11415	8583	7772	7933	10078	9199	7818	6057	4639	5214
17	2325	2556	3773	3991	3960	3095	3637	3602	6544	8354	8447	7935	8155	5053
18	8256	8703	10830	11270	11063	7991	7087	7257	9225	8203	6795	5028	3620	5722
18	3352	3436	3767	3563	2843	2133	3060	2959	5623	7849	8234	8024	8518	6439
19	9370	9813	12127	12747	12876	10161	9366	9526	11655	10632	9157	7355	5804	5895
19	2692	3140	5420	6089	6610	5357	5377	5428	8436	9441	9002	7955	7596	2386
20	9369	9816	12078	12636	12636	9754	8899	9065	11073	9936	8431	6624	5054	6141
20	3362	3532	4247	4163	3521	2006	2691	2625	5486	7480	7745	7440	7875	6024
21	3358	3610	4703	4751	4247	2275	2619	2603	5601	7297	7399	6950	7278	5500
21	9341	9789	11973	12455	12298	9228	8304	8476	10332	9068	7534	5722	4137	6447
22	9308	9753	11855	12266	11970	8744	7761	7937	9648	8279	6726	4912	3320	6737
22	3476	3924	6166	6782	7140	5457	5294	5370	8317	9058	8493	7346	6890	2400
23	9484	9922	11902	12216	11732	8306	7242	7424	8883	7320	5721	3905	2282	7323
23	3942	4225	5377	5399	4746	2130	2155	2178	5206	6702	6742	6274	6626	5636
24	4374	4694	5993	6050	5387	2449	2118	2195	5160	6344	6246	5677	5976	5557
24	10025	10471	12740	13302	13295	10373	9494	9662	11590	10319	8757	6941	5319	6725
25	4950	5289	6654	6711	5988	2769	2128	2252	5038	5899	5676	5032	5314	5714
25	9973	10421	12621	13111	12960	9867	8925	9098	10879	9483	7893	6076	4438	6967
26	9928	10373	12469	12868	12536	9246	8230	8408	9987	8440	6818	5004	3349	7320
26	5003	5402	7130	7370	6942	3989	3345	3479	6142	6559	6005	4994	4873	4832
27	10105	10542	12505	12801	12269	8778	7682	7865	9158	7394	5723	3923	2246	7927
27	5649	5991	7329	7345	6498	3005	2095	2256	4739	5291	4988	4337	4694	6180
28	10295	10723	12583	12806	12133	8517	7371	7555	8611	6675	4966	3194	1524	8416
28	5734	6123	7759	7925	7322	4049	3198	3357	5756	5891	5258	4230	4181	5501
29	6399	6734	8000	7955	6959	3252	2141	2323	4346	4578	4231	3651	4180	6833
29	10591	11038	13279	13807	13718	10675	9743	9916	11697	10245	8623	6810	5150	7379
30	10514	10962	13132	13591	13364	10167	9178	9355	10986	9414	7766	5960	4289	7586
30	6378	6780	8486	8673	8069	4713	3770	3940	6085	5816	4965	3735	3493	5723
31	7183	7489	8540	8369	7128	3250	2016	2192	3486	3598	3470	3298	4224	7844
31	10497	10939	12983	13337	12905	9495	8427	8609	9981	8218	6532	4742	3063	8015
32	6912	7265	8623	8609	7637	3912	2766	2950	4657	4410	3814	3039	3503	6991
32	10782	11219	13176	13462	12896	9357	8237	8421	9564	7614	5885	4136	2478	8556
33	7949	8194	8858	8490	6913	3106	2049	2142	2001	2750	3398	3983	5280	9151
33	10934	11362	13207	13414	12700	9038	7871	8056	8944	6816	5056	3367	1798	9031
34	10993	11440	13567	13986	13671	10363	9328	9509	10972	9226	7529	5747	4068	8183
34	7073	7456	8997	9076	8252	4634	3536	3718	5452	4904	4025	2879	2949	6661
35	11176	11619	13662	14010	13553	10101	9011	9195	10445	8524	6792	5046	3386	8642
35	7667	7999	9191	9075	7901	4038	2808	2987	4032	3475	2962	2531	3432	7925
36	11454	11889	13810	14064	13426	9813	8662	8846	9788	7634	5861	4202	2641	9282
36	8014	8306	9240	8992	7595	3700	2492	2640	3013	2711	2754	2996	4230	8719
37	8636	8904	9671	9333	7778	3955	2847	2959	2424	2007	2539	3291	4725	9532
37	11538	11961	13767	13942	13158	9438	8248	8432	9115	6795	5003	3443	2070	9693
38	12296	12744	14957	15447	15252	12036	11025	11204	12691	10868	9137	7388	5719	9112
38	7867	8228	9602	9574	8535	4732	3527	3710	4854	3923	3012	2061	2657	7676
39	12032	12480	14637	15076	14782	11467	10422	10603	11984	10092	8352	6615	4956	9058

To be continued on next page...

Project:

Rahkola\_Hautakangas

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Johanna Harju / johanna.harju@fcg.fi  
Calculated:  
21.1.2022 9.03/3.4.388

## DECIBEL - Main Result

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
39	8306	8637	9803	9661	8419	4530	3294	3464	4039	2984	2327	2021	3165	8485
40	11749	12195	14284	14664	14261	10845	9765	9948	11207	9243	7494	5773	4126	9025
40	8731	9022	9924	9645	8178	4306	3132	3267	3011	2029	2114	2706	4141	9362
41	11813	12253	14254	14564	14024	10485	9359	9543	10595	8481	6708	5041	3452	9369
42	12586	13032	15142	15536	15145	11722	10635	10818	12010	9938	8165	6494	4886	9745
43	12347	12790	14828	15163	14662	11145	10024	10208	11262	9106	7324	5686	4116	9754
44	13264	13710	15787	16150	15688	12188	11070	11254	12280	10048	8255	6667	5134	10496
45	12880	13321	15318	15619	15045	11457	10310	10494	11380	9074	7277	5728	4253	10380
46	14010	14456	16543	16910	16445	12932	11806	11991	12952	10636	8837	7304	5815	11181
47	13509	13951	15963	16271	15702	12110	10959	11143	11980	9605	7805	6308	4875	10931
48	14123	14564	16568	16866	16271	12650	11487	11671	12413	9947	8148	6723	5358	11541
49	14697	15141	17185	17514	16968	13379	12225	12409	13189	10723	8925	7501	6119	11969

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Johanna Harju / johanna.harju@fcg.fi  
Calculated:  
21.1.2022 9.03/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

Noise calculation model:

ISO 9613-2 Finland

Wind speed (in 10 m height):

8,0 m/s

Ground attenuation:

General, terrain specific

Ground factor for porous ground: 0,4

Area object with hard ground: Area object (Roughness, Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_Rahkola\_Hautakangas\_0.w2r (1

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

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:

Pure tones penalty is added to total noise impact at receptors

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]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[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: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH221

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 14.20
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63	125	250	500	1000	2000	4000	8000
From Windcat	221,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8

WTG: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH171

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 13.57
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63	125	250	500	1000	2000	4000	8000
From Windcat	171,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8

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Calculated:  
21.1.2022 9.03/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

WTG: GE WIND ENERGY 5.3-158 Thrust 700 5300 158.0 !O!

Noise: 5.3-158 106.0 +2 dB HH200

Source	Source/Date	Creator	Edited
Noise_Emission-NO_5.3-158-50Hz_IEC_EN_r01	12.3.2018	USER	17.1.2022 15.40

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63 [dB]	125 [dB]	250 [dB]	500 [dB]	1000 [dB]	2000 [dB]	4000 [dB]	8000 [dB]
From Windcat	200,0	8,0	108,0	No	89,2	94,6	99,2	101,6	103,3	101,1	93,7	78,0

### Noise sensitive area: A Lomarakennus A (Pökkylä)

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

Pure tone penalty: 0 dB

### Noise sensitive area: B Asuinrakennus B (Pökkyläntie 418)

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

Pure tone penalty: 0 dB

### Noise sensitive area: C Lomarakennus C (~Pökkyläntie 178)

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

Pure tone penalty: 0 dB

### Noise sensitive area: D Asuinrakennus D (Luminevantie 162)

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

Pure tone penalty: 0 dB

### Noise sensitive area: E Asuinrakennus E (Paratiisintie 231)

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

Pure tone penalty: 0 dB

### Noise sensitive area: F Lomarakennus F (Isojärventie)

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

Pure tone penalty: 0 dB

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

Noise sensitive area: G Lomarakennus G (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: H Lomarakennus H (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: I Asuinrakennus I (Kalliokangas)

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

Pure tone penalty: 0 dB

Noise sensitive area: J Asuinrakennus J (Ojantakasentie 88)

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

Pure tone penalty: 0 dB

Noise sensitive area: K Asuinrakennus K (Ollilantie 218)

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

Pure tone penalty: 0 dB

Noise sensitive area: L Asuinrakennus L (Uusi-Kaikola)

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

Pure tone penalty: 0 dB

Noise sensitive area: M Lomarakennus M (Siliäkuru)

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

Pure tone penalty: 0 dB

Noise sensitive area: N Asuinrakennus N (Pinolantie 406)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model



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Calculated:

21.1.2022 9.03/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

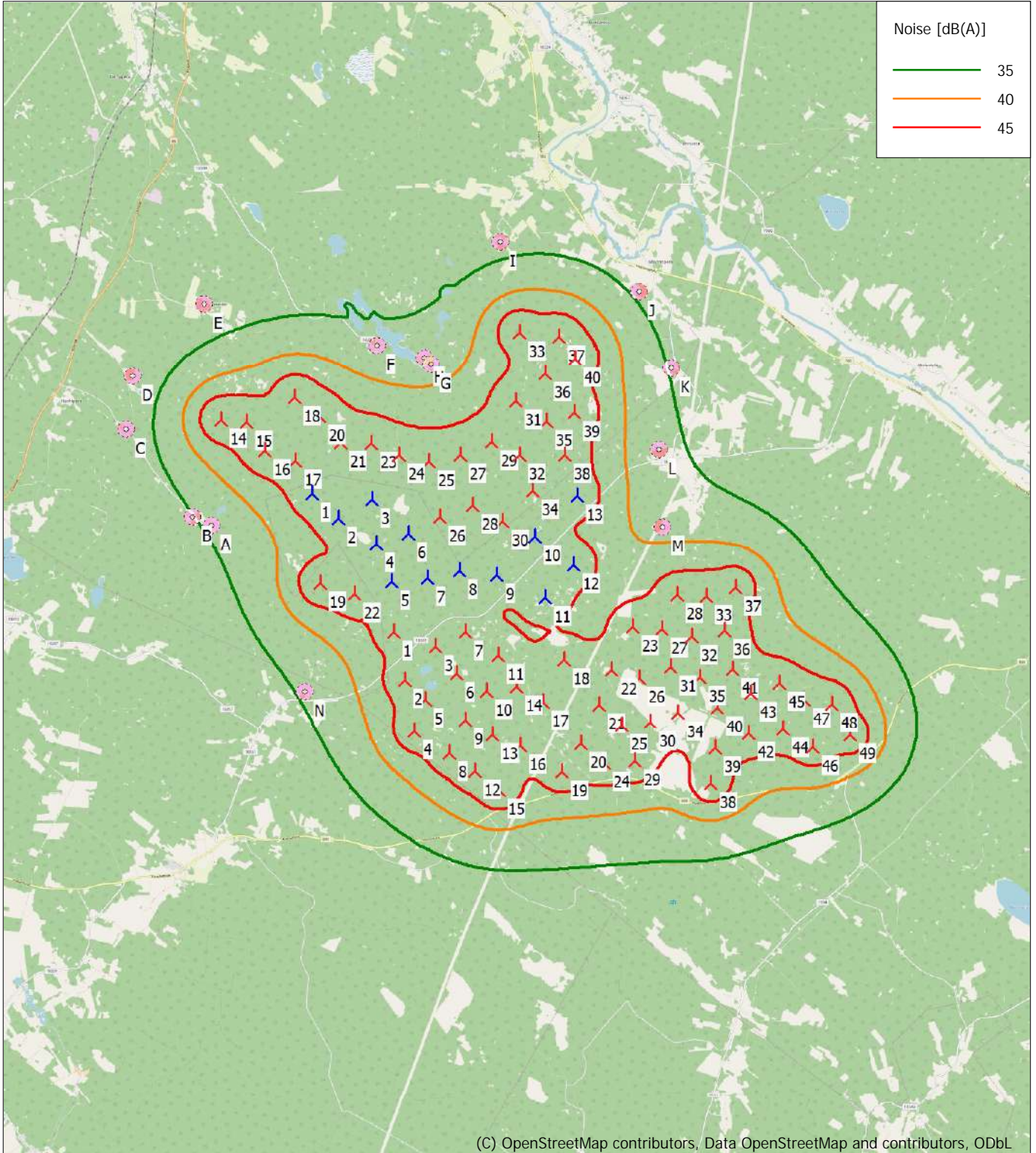
Noise demand: 40,0 dB(A)

No distance demand

Pure tone penalty: 0 dB

### DECIBEL - Map 8,0 m/s

Calculation: Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 402 020 North: 7 113 791  
New WTG Noise sensitive area  
Noise calculation model: ISO 9613-2 Finland. Wind speed: 8,0 m/s  
Height above sea level from active line object

3.2.2023

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**Liite 11. Melun yhteismallinnusten (Rahkola-Hautakangas + Puutionsaari) tulokset VE2**

## DECIBEL - Main Result

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari

Calculation is done according to Finnish guideline " Ympäristöhallinnon ohjeita 2 | 2014" from the Ministry of the Environment of Finland

All coordinates are in  
 Finish TM ETRS-TM35FIN-ETRS89



Scale 1:200 000  
 New WTG Noise sensitive area

## WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.					Creator	Name		
			[m]											
1	398 503	7 115 243	95,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
1	398 896	7 112 332	92,5	PUU01	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
2	398 570	7 114 265	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
2	399 097	7 111 286	95,0	PUU02	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
3	399 784	7 111 972	97,5	PUU03	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
3	398 871	7 113 427	90,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
4	399 116	7 116 184	97,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
4	399 264	7 110 151	97,0	PUU04	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
5	399 272	7 114 459	97,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
5	399 536	7 110 832	95,6	PUU05	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
6	399 647	7 113 488	95,9	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
6	400 239	7 111 382	97,5	PUU06	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
7	400 444	7 112 292	97,3	PUU07	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
7	399 762	7 116 032	97,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
8	400 019	7 109 649	100,0	PUU08	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
8	399 974	7 114 812	98,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
9	400 360	7 113 628	101,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
9	400 380	7 110 348	100,0	PUU09	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
10	400 456	7 116 139	99,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
10	400 876	7 110 966	99,5	PUU10	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
11	401 152	7 111 752	100,0	PUU11	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
11	400 698	7 115 062	103,2	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
12	400 549	7 109 232	102,5	PUU12	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
12	401 155	7 116 430	99,6	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
13	400 953	7 110 020	102,5	PUU13	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
13	401 168	7 113 504	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
14	401 537	7 111 046	104,4	PUU14	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
14	401 348	7 114 680	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
15	401 706	7 117 283	100,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
15	401 068	7 108 792	105,8	PUU15	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
16	401 754	7 116 113	102,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
16	401 564	7 109 758	104,3	PUU16	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
17	402 089	7 110 702	107,5	PUU17	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
17	402 023	7 115 337	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
18	402 589	7 111 603	107,5	PUU18	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
18	402 041	7 114 329	106,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
19	402 455	7 109 148	112,3	PUU19	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
19	402 216	7 112 963	108,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
20	402 362	7 116 825	105,0	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
20	402 889	7 109 778	110,0	PUU20	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
21	402 365	7 117 878	100,5	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
21	403 318	7 110 593	107,8	PUU21	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
22	402 733	7 116 070	109,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
22	403 622	7 111 352	106,3	PUU22	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
23	404 117	7 112 276	103,9	PUU23	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
23	402 852	7 113 666	105,8	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
24	403 379	7 109 327	115,0	PUU24	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
24	402 975	7 115 189	106,7	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	221,0	USER	GE 158 _107,0 +2 dB HH221	8,0	109,0
25	402 975	7 117 005	104,3	GE WIND ENERGY 4.x/5.x/6...	Yes	GE WIND ENERGY	4.x/5.x/6.x-158 - 50-6 100	6 100	158,0	171,0	USER	GE 158 _107,0 +2 dB HH171	8,0	109,0
25	403 790	7 110 129	108,4	PUU25	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
26	404 210	7 111 152	105,6	PUU26	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
27	404 739	7 112 199	105,0	PUU27	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
28	405 100	7 112 943	100,4	PUU28	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0
29	404 061	7 109 351	110,0	PUU29	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106,0 +2 dB HH200	8,0	108,0

To be continued on next page...



## DECIBEL - Main Result

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]		
					Valid	Manufact.	Type-generator				Creator	Name				
30	404	420	7 110	174	106,8	PUU30	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
31	404	900	7 111	381	105,3	PUU31	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
32	405	395	7 112	030	102,4	PUU32	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
33	405	740	7 112	891	100,2	PUU33	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
34	405	042	7 110	380	105,8	PUU34	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
35	405	532	7 111	130	103,4	PUU35	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
36	406	114	7 112	133	103,2	PUU36	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
37	406	380	7 113	067	107,2	PUU37	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
38	405	707	7 108	791	111,3	PUU38	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
39	405	822	7 109	587	108,8	PUU39	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
40	405	893	7 110	455	105,0	PUU40	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
41	406	257	7 111	298	104,0	PUU41	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
42	406	558	7 109	872	106,6	PUU42	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
43	406	638	7 110	744	105,9	PUU43	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
44	407	324	7 109	954	108,4	PUU44	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
45	407	269	7 110	957	112,6	PUU45	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
46	407	963	7 109	542	113,4	PUU46	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
47	407	809	7 110	582	116,1	PUU47	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
48	408	414	7 110	457	120,9	PUU48	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
49	408	786	7 109	772	117,5	PUU49	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0

## Calculation Results

### Sound level

No.	Name	East	North	Z	Immission height	Demands Noise	Sound level From WTGs	Distance to noise demand	Demands fulfilled ?	
									Noise	2 dB penalty applied for one or more WTGs
				[m]	[m]	[dB(A)]	[dB(A)]	[m]		
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	4,0	40,0	29,6	2 554	Yes	No
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,8	4,0	40,0	28,7	2 955	Yes	No
C	Lomarakennus C (-Pökkyläntie 178)	393 172	7 116 951	75,2	4,0	40,0	25,2	4 674	Yes	No
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	4,0	40,0	24,8	4 935	Yes	No
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,1	4,0	40,0	25,5	4 454	Yes	No
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	4,0	40,0	33,0	1 457	Yes	No
G	Lomarakennus G (Antikantie)	399 889	7 118 156	90,8	4,0	40,0	36,6	718	Yes	No
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	4,0	40,0	36,0	888	Yes	No
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	4,0	40,0	29,8	2 140	Yes	No
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,3	4,0	40,0	30,9	1 804	Yes	No
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	4,0	40,0	33,0	1 369	Yes	No
L	Asuinrakennus L (Jusi-Kaikola)	404 793	7 116 122	94,4	4,0	40,0	36,3	799	Yes	No
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	4,0	40,0	38,6	388	Yes	No
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	87,9	4,0	40,0	34,4	1 177	Yes	No

### Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	3561	3936	5598	5867	5629	3369	3226	3289	6279	7381	7133	6351	6380	4453
1	4629	5076	7355	7980	8284	6274	5908	6014	8822	9149	8356	7010	6301	2358
2	3637	4061	6029	6453	6457	4342	4108	4190	7126	7946	7495	6494	6266	3590
2	5410	5849	8197	8893	9306	7327	6915	7029	9776	9888	8951	7472	6547	2215
3	5575	6023	8277	8863	9042	6714	6185	6312	8956	8942	7982	6505	5621	3025
3	4130	4574	6701	7210	7324	5179	4837	4937	7791	8324	7689	6506	6048	3062
4	4374	4694	5993	6050	5387	2449	2118	2195	5160	6344	6246	5677	5976	5557
4	6318	6742	9130	9888	10403	8469	8029	8148	10844	10777	9719	8138	7031	2554
5	4313	4728	6589	6927	6723	4179	3748	3856	6684	7302	6789	5766	5561	4124
5	6039	6477	8828	9523	9909	7813	7332	7455	10122	10050	9014	7458	6411	2659
6	4853	5291	7343	7781	7716	5196	4674	4797	7506	7776	7035	5781	5273	3653
6	6272	6719	8997	9600	9784	7376	6783	6919	9465	9232	8150	6573	5520	3361
7	6014	6462	8636	9145	9151	6539	5890	6031	8536	8333	7308	5795	4888	3751
7	4950	5289	6654	6711	5988	2769	2128	2252	5038	5899	5676	5032	5314	5714
8	7202	7631	10010	10745	11182	9046	8508	8639	11212	10890	9708	8043	6794	3446
8	5003	5402	7130	7370	6942	3989	3345	3479	6142	6559	6005	4994	4873	4832
9	5512	5945	7919	8290	8063	5234	4552	4695	7225	7239	6401	5086	4547	4298
9	6997	7436	9775	10444	10740	8418	7823	7960	10474	10104	8923	7267	6050	3568
10	5649	5991	7329	7345	6498	3005	2095	2256	4739	5291	4988	4337	4694	6180
10	7033	7479	9756	10348	10482	7932	7257	7403	9817	9341	8137	6475	5268	3988
11	6885	7333	9524	10035	10010	7265	6527	6679	9017	8509	7324	5688	4560	4313

To be continued on next page...



## DECIBEL - Main Result

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
11	5734	6123	7759	7925	7322	4049	3198	3357	5756	5891	5258	4230	4181	5501
12	7871	8301	10677	11402	11797	9546	8948	9087	11570	11073	9807	8092	6746	4105
12	6399	6734	8000	7955	6959	3252	2141	2323	4346	4578	4231	3651	4180	6833
13	7648	8089	10420	11073	11317	8865	8205	8350	10757	10194	8921	7210	5884	4202
13	6328	6760	8707	9044	8710	5650	4825	4984	7266	6922	5917	4472	3783	4911
14	7556	8004	10239	10784	10804	8060	7298	7454	9717	9031	7742	6031	4733	4647
14	6378	6780	8486	8673	8069	4713	3770	3940	6085	5816	4965	3735	3493	5723
15	7183	7489	8540	8369	7128	3250	2016	2192	3486	3598	3470	3298	4224	7844
15	8550	8980	11354	12071	12432	10085	9438	9582	11979	11319	9976	8222	6790	4769
16	6912	7265	8623	8609	7637	3912	2766	2950	4657	4410	3814	3039	3503	6991
16	8291	8734	11053	11685	11868	9287	8563	8716	11005	10250	8893	7136	5713	4861
17	8206	8654	10889	11427	11415	8583	7772	7933	10078	9199	7818	6057	4639	5214
17	7073	7456	8997	9076	8252	4634	3536	3718	5452	4904	4025	2879	2949	6661
18	8256	8703	10830	11270	11063	7991	7087	7257	9225	8203	6795	5028	3620	5722
18	7085	7496	9248	9448	8833	5403	4391	4568	6457	5792	4721	3285	2794	6084
19	9370	9813	12127	12747	12876	10161	9366	9526	11655	10632	9157	7355	5804	5895
19	7471	7907	9884	10222	9842	6628	5691	5862	7833	6998	5735	4077	3007	5645
20	7667	7999	9191	9075	7901	4038	2808	2987	4032	3475	2962	2531	3432	7925
20	9369	9816	12078	12636	12636	9754	8899	9065	11073	9936	8431	6624	5054	6141
21	8014	8306	9240	8992	7595	3700	2492	2640	3013	2711	2754	2996	4230	8719
21	9341	9789	11973	12455	12298	9228	8304	8476	10332	9068	7534	5722	4137	6447
22	7867	8228	9602	9574	8535	4732	3527	3710	4854	3923	3012	2061	2657	7676
22	9308	9753	11855	12266	11970	8744	7761	7937	9648	8279	6726	4912	3320	6737
23	9484	9922	11902	12216	11732	8306	7242	7424	8883	7320	5721	3905	2282	7323
23	7960	8383	10222	10460	9879	6428	5380	5560	7226	6139	4811	3130	2128	6494
24	10025	10471	12740	13302	13295	10373	9494	9662	11590	10319	8757	6941	5319	6725
24	8014	8402	9960	10029	9150	5443	4281	4466	5767	4646	3463	2043	2002	7336
25	8306	8637	9803	9661	8419	4530	3294	3464	4039	2984	2327	2021	3165	8485
25	9973	10421	12621	13111	12960	9867	8925	9098	10879	9483	7893	6076	4438	6967
26	9928	10373	12469	12868	12536	9246	8230	8408	9987	8440	6818	5004	3349	7320
27	10105	10542	12505	12801	12269	8778	7682	7865	9158	7394	5723	3923	2246	7927
28	10295	10723	12583	12806	12133	8517	7371	7555	8611	6675	4966	3194	1524	8416
29	10591	11038	13279	13807	13718	10675	9743	9916	11697	10245	8623	6810	5150	7379
30	10514	10962	13132	13591	13364	10167	9178	9355	10986	9414	7766	5960	4289	7586
31	10497	10939	12983	13337	12905	9495	8427	8609	9981	8218	6532	4742	3063	8015
32	10782	11219	13176	13462	12896	9357	8237	8421	9564	7614	5885	4136	2478	8556
33	10934	11362	13207	13414	12700	9038	7871	8056	8944	6816	5056	3367	1798	9031
34	10993	11440	13567	13986	13671	10363	9328	9509	10972	9226	7529	5747	4068	8183
35	11176	11619	13662	14010	13553	10101	9011	9195	10445	8524	6792	5046	3386	8642
36	11454	11889	13810	14064	13426	9813	8662	8846	9788	7634	5861	4202	2641	9282
37	11538	11961	13767	13942	13158	9438	8248	8432	9115	6795	5003	3443	2070	9693
38	12296	12744	14957	15447	15252	12036	11025	11204	12691	10868	9137	7388	5719	9112
39	12032	12480	14637	15076	14782	11467	10422	10603	11984	10092	8352	6615	4956	9058
40	11749	12195	14284	14664	14261	10845	9765	9948	11207	9243	7494	5773	4126	9025
41	11813	12253	14254	14564	14024	10485	9359	9543	10595	8481	6708	5041	3452	9369
42	12586	13032	15142	15536	15145	11722	10635	10818	12010	9938	8165	6494	4886	9745
43	12347	12790	14828	15163	14662	11145	10024	10208	11262	9106	7324	5686	4116	9754
44	13264	13710	15787	16150	15688	12188	11070	11254	12280	10048	8255	6667	5134	10496
45	12880	13321	15318	15619	15045	11457	10310	10494	11380	9074	7277	5728	4253	10380
46	14010	14456	16543	16910	16445	12932	11806	11991	12952	10636	8837	7304	5815	11181
47	13509	13951	15963	16271	15702	12110	10959	11143	11980	9605	7805	6308	4875	10931
48	14123	14564	16568	16866	16271	12650	11487	11671	12413	9947	8148	6723	5358	11541
49	14697	15141	17185	17514	16968	13379	12225	12409	13189	10723	8925	7501	6119	11969

Project:

Rahkola\_Hautakangas

Licensed user:

FCG Finnish Consulting Group Oy  
Osmontie 34, PO Box 950  
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Johanna Harju / johanna.harju@fcg.fi  
Calculated:  
21.1.2022 9.29/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari

Noise calculation model:

ISO 9613-2 Finland

Wind speed (in 10 m height):

8,0 m/s

Ground attenuation:

General, terrain specific

Ground factor for porous ground: 0,4

Area object with hard ground: Area object (Roughness, Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_Rahkola\_Hautakangas\_0.w2r (1

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

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:

Pure tones penalty is added to total noise impact at receptors

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]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[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: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH221

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 14.20
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data								
					63	125	250	500	1000	2000	4000	8000	
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	221,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8	

WTG: GE WIND ENERGY 4.x/5.x/6.x-158 - 50 6100 158.0 !O!

Noise: GE 158\_107.0 +2 dB HH171

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	10.8.2021	USER	3.1.2022 13.57
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01			

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data								
					63	125	250	500	1000	2000	4000	8000	
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	171,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8	

Project:

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Johanna Harju / johanna.harju@fcg.fi  
Calculated:  
21.1.2022 9.29/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari

WTG: GE WIND ENERGY 5.3-158 Thrust 700 5300 158.0 !O!

Noise: 5.3-158 106.0 +2 dB HH200

Source	Source/Date	Creator	Edited
Noise_Emission-NO_5.3-158-50Hz_IEC_EN_r01	12.3.2018	USER	17.1.2022 15.40

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63 [dB]	125 [dB]	250 [dB]	500 [dB]	1000 [dB]	2000 [dB]	4000 [dB]	8000 [dB]
From Windcat	200,0	8,0	108,0	No	89,2	94,6	99,2	101,6	103,3	101,1	93,7	78,0

### Noise sensitive area: A Lomarakenus A (Pökkylä)

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

Pure tone penalty: 0 dB

### Noise sensitive area: B Asuinrakennus B (Pökkyläntie 418)

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

Pure tone penalty: 0 dB

### Noise sensitive area: C Lomarakenus C (~Pökkyläntie 178)

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

Pure tone penalty: 0 dB

### Noise sensitive area: D Asuinrakennus D (Luminevantie 162)

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

Pure tone penalty: 0 dB

### Noise sensitive area: E Asuinrakennus E (Paratiisintie 231)

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

Pure tone penalty: 0 dB

### Noise sensitive area: F Lomarakenus F (Isojärventie)

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

Pure tone penalty: 0 dB

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari

Noise sensitive area: G Lomarakennus G (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: H Lomarakennus H (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: I Asuinrakennus I (Kalliokangas)

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

Pure tone penalty: 0 dB

Noise sensitive area: J Asuinrakennus J (Ojantakasentie 88)

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

Pure tone penalty: 0 dB

Noise sensitive area: K Asuinrakennus K (Ollilantie 218)

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

Pure tone penalty: 0 dB

Noise sensitive area: L Asuinrakennus L (Uusi-Kaikola)

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

Pure tone penalty: 0 dB

Noise sensitive area: M Lomarakennus M (Siliäkuru)

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

Pure tone penalty: 0 dB

Noise sensitive area: N Asuinrakennus N (Pinolantie 406)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

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Calculated:

21.1.2022 9.29/3.4.388

## DECIBEL - Assumptions for noise calculation

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari

Noise demand: 40,0 dB(A)

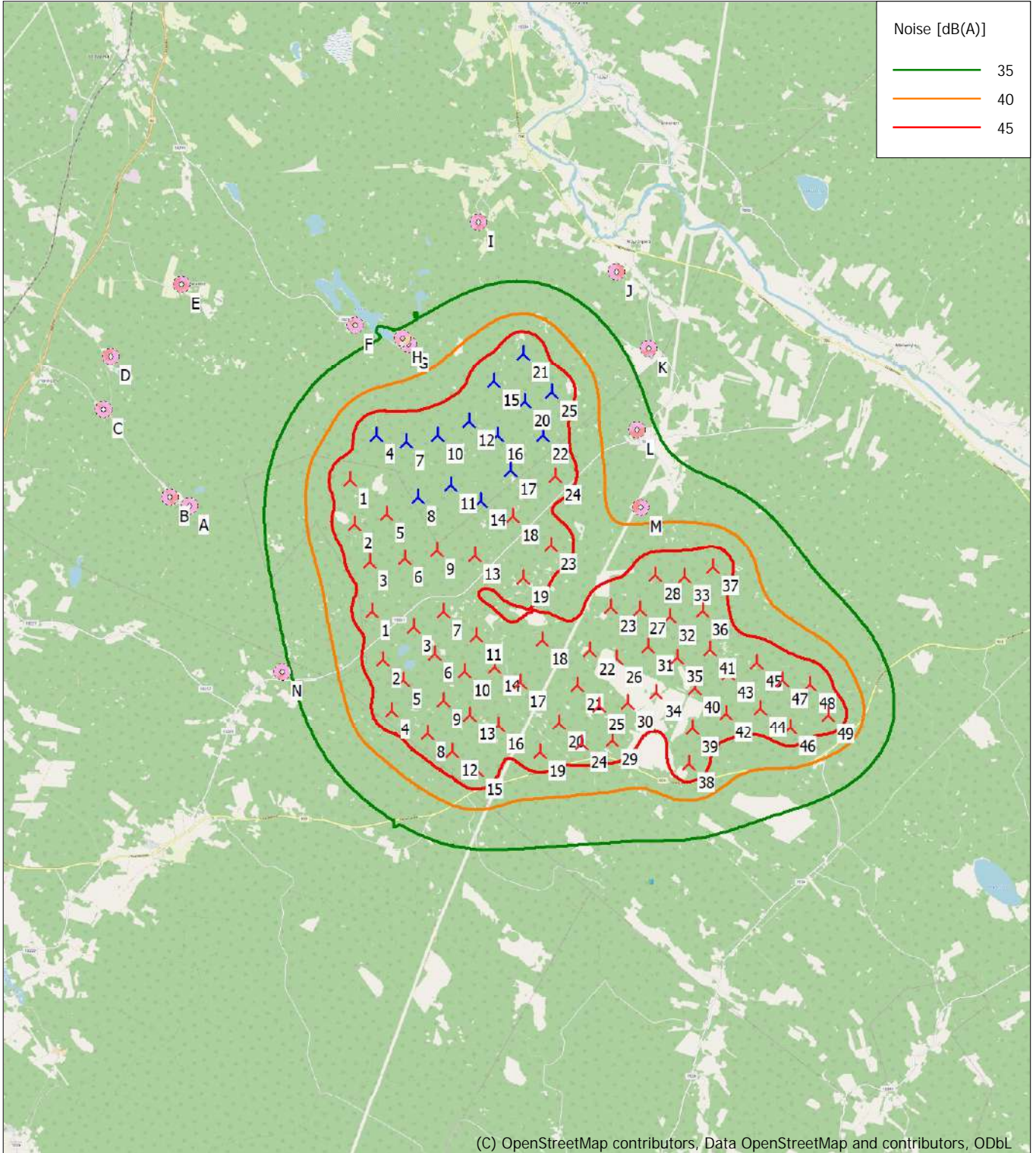
No distance demand

Pure tone penalty: 0 dB



## DECIBEL - Map 8,0 m/s

Calculation: Yhteisvaikutus\_GE 158-6100\_107 dB+2dB\_\_VE2\_Puutionsaari



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 402 479 North: 7 113 335  
 🚧 New WTG      🏠 Noise sensitive area  
 Noise calculation model: ISO 9613-2 Finland. Wind speed: 8,0 m/s  
 Height above sea level from active line object

3.2.2023

---

## **Liite 12. Melun yhteismallinnusten (Rahkola-Hautakangas + Puutionsaari) tulokset VE3**

Project:

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Mikka Saranpää / mikka.saranpaa@fcg.fi

Calculated:

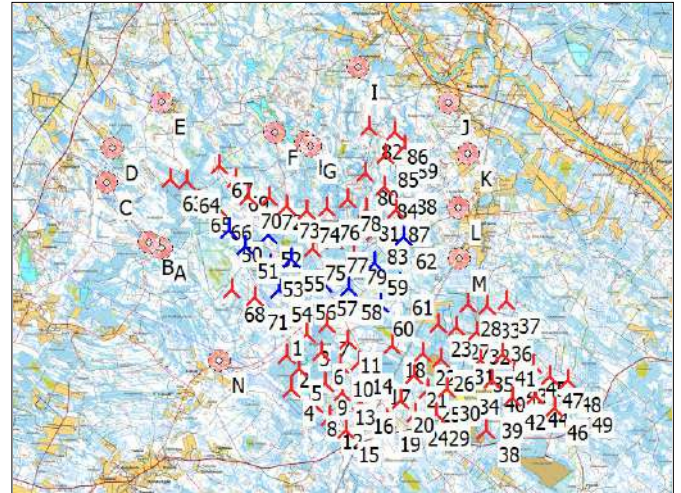
11.1.2023 10.59/3.5.584

## DECIBEL - Main Result

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

Calculation is done according to Finnish guideline " Ympäristöhallinnon ohjeita 2 | 2014" from the Ministry of the Environment of Finland

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89



Scale 1:250 000

New WTG

Noise sensitive area

## WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.					Creator	Name		
1	398 896	7 112 332	92,5	PUU01	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
2	399 097	7 111 286	95,0	PUU02	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
3	399 784	7 111 972	97,0	PUU03	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
4	399 264	7 110 151	97,0	PUU04	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
5	399 536	7 110 832	95,6	PUU05	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
6	400 239	7 111 382	97,5	PUU06	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
7	400 444	7 112 292	97,3	PUU07	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
8	400 019	7 109 649	100,0	PUU08	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
9	400 380	7 110 348	100,0	PUU09	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
10	400 876	7 110 966	99,5	PUU10	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
11	401 152	7 111 752	100,0	PUU11	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
12	400 549	7 109 232	102,5	PUU12	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
13	400 953	7 110 020	102,5	PUU13	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
14	401 537	7 111 046	104,4	PUU14	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
15	401 068	7 108 792	105,8	PUU15	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
16	401 564	7 109 758	104,3	PUU16	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
17	402 089	7 110 702	107,5	PUU17	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
18	402 589	7 111 603	107,5	PUU18	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
19	402 455	7 109 148	112,3	PUU19	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
20	402 889	7 109 778	110,0	PUU20	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
21	403 318	7 110 593	107,8	PUU21	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
22	403 622	7 111 352	106,3	PUU22	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
23	404 117	7 112 276	103,9	PUU23	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
24	403 379	7 109 327	115,0	PUU24	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
25	403 790	7 110 129	108,4	PUU25	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
26	404 210	7 111 152	105,6	PUU26	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
27	404 739	7 112 199	105,0	PUU27	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
28	405 100	7 112 943	100,4	PUU28	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
29	404 061	7 109 351	110,0	PUU29	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
30	404 420	7 110 174	106,8	PUU30	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
31	404 900	7 111 381	105,3	PUU31	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
32	405 395	7 112 030	102,4	PUU32	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
33	405 740	7 112 891	100,2	PUU33	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
34	405 042	7 110 380	105,8	PUU34	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
35	405 532	7 111 130	103,4	PUU35	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
36	406 114	7 112 133	103,2	PUU36	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
37	406 380	7 113 067	107,2	PUU37	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
38	405 707	7 108 791	111,3	PUU38	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
39	405 822	7 109 587	108,8	PUU39	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
40	405 893	7 110 455	105,0	PUU40	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
41	406 257	7 111 298	104,0	PUU41	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
42	406 558	7 109 872	106,8	PUU42	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
43	406 638	7 110 744	105,9	PUU43	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
44	407 324	7 109 954	108,4	PUU44	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
45	407 269	7 110 957	112,6	PUU45	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
46	407 963	7 109 542	113,4	PUU46	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
47	407 809	7 110 582	116,1	PUU47	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
48	408 414	7 110 457	120,0	PUU48	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
49	408 786	7 109 772	115,5	PUU49	Yes	GE WIND ENERGY	5.3-158 Thrust 700-5 300	5 300	158,0	200,0	USER	5.3-158 106.0 +2 dB HH200	8,0	108,0
50	397 208	7 115 412	87,7	GE WIND ENERGY GE158 - 6...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
51	397 754	7 114 856	85,5	GE WIND ENERGY GE158 - 6...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
52	398 503	7 115 243	97,0	GE WIND ENERGY GE158 - 6...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
53	398 570	7 114 265	90,0	GE WIND ENERGY GE158 - 6...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
54	398 871	7 113 427	90,0	GE WIND ENERGY GE158 - 6...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
55	399 272	7 114 459	97,5	GE WIND ENERGY GE158 - 6...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0
56	399 647	7 113 488	95,9	GE WIND ENERGY GE158 - 6...	Yes	GE WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107.0 dB +2dB	8,0	109,0

To be continued on next page...



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Calculated:

11.1.2023 10.59/3.5.584

## DECIBEL - Main Result

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.	Type-generator				Creator	Name		
57	400 360	7 113 628	101,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
58	401 168	7 113 504	105,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
59	402 041	7 114 329	106,3	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
60	402 216	7 112 963	108,3	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
61	402 852	7 113 666	105,8	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
62	402 975	7 115 189	106,7	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
63	395 254	7 117 093	87,5	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
64	395 819	7 117 022	82,9	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
65	396 195	7 116 379	82,5	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
66	396 858	7 116 145	84,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
67	396 894	7 117 531	80,5	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
68	397 303	7 113 442	87,5	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
69	397 417	7 117 093	90,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
70	397 854	7 116 507	90,9	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
71	398 058	7 113 189	91,9	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
72	398 529	7 116 484	94,1	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
73	399 116	7 116 184	97,3	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
74	399 762	7 116 032	97,5	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
75	399 974	7 114 812	98,7	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
76	400 456	7 116 139	99,7	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
77	400 698	7 115 062	103,2	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
78	401 155	7 116 430	99,6	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
79	401 348	7 114 680	105,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
80	401 706	7 117 283	100,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
81	401 754	7 116 113	102,5	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
82	401 837	7 118 791	95,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
83	402 023	7 115 337	105,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
84	402 362	7 116 825	105,0	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
85	402 365	7 117 878	100,5	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
86	402 692	7 118 655	96,3	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
87	402 733	7 116 070	109,7	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
88	402 975	7 117 005	104,3	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0
89	403 021	7 118 167	96,4	GE WIND ENERGY GE158 - 6...Yes	GE	WIND ENERGY	GE158 - 6.1 MW-6 100	6 100	158,0	221,0	USER	GE 6.1.158 no STE 107,0 dB +2dB	8,0	109,0

## Calculation Results

### Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height	Demands Noise	Sound level From WTGs	Distance to noise demand	Demands fulfilled ?	
									Noise	2 dB penalty applied for one or more WTGs
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	4,0	40,0	35,8	890	Yes	No
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,8	4,0	40,0	34,9	1 025	Yes	No
C	Lomarakennus C (-Pökkyläntie 178)	393 172	7 116 951	75,2	4,0	40,0	32,0	1 267	Yes	No
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	4,0	40,0	31,7	1 313	Yes	No
E	Asuinrakennus E (Paratisintie 231)	394 975	7 119 629	79,1	4,0	40,0	31,6	1 607	Yes	No
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	4,0	40,0	36,8	754	Yes	No
G	Lomarakennus G (Antikantie)	399 889	7 118 156	90,8	4,0	40,0	38,3	478	Yes	No
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	4,0	40,0	38,0	635	Yes	No
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	4,0	40,0	33,3	1 132	Yes	No
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,3	4,0	40,0	34,1	974	Yes	No
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	4,0	40,0	34,6	1 073	Yes	No
L	Asuinrakennus L (Jusi-Kaikola)	404 793	7 116 122	94,4	4,0	40,0	36,8	743	Yes	No
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	4,0	40,0	38,7	371	Yes	No
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	87,9	4,0	40,0	35,6	1 066	Yes	No

### Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	4629	5076	7355	7980	8284	6274	5908	6014	8822	9149	8356	7010	6301	2358
2	5410	5849	8197	8893	9306	7327	6915	7029	9776	9888	8951	7472	6547	2215
3	5575	6023	8277	8863	9042	6714	6185	6312	8956	8942	7982	6505	5621	3025
4	6318	6742	9130	9888	10403	8469	8029	8148	10844	10777	9719	8138	7031	2554
5	6039	6477	8828	9523	9909	7813	7332	7455	10122	10050	9014	7458	6411	2659
6	6272	6719	8997	9600	9784	7376	6783	6919	9465	9232	8150	6573	5520	3361
7	6014	6462	8636	9145	9151	6539	5890	6031	8536	8333	7308	5795	4888	3751
8	7202	7631	10010	10745	11182	9046	8508	8639	11212	10890	9708	8043	6794	3446
9	6997	7436	9775	10444	10740	8418	7823	7960	10474	10104	8923	7267	6050	3568
10	7033	7479	9756	10348	10482	7932	7257	7403	9817	9341	8137	6475	5268	3988
11	6885	7333	9524	10035	10010	7265	6527	6679	9017	8509	7324	5688	4560	4313

To be continued on next page...

## DECIBEL - Main Result

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
12	7871	8301	10677	11402	11797	9546	8948	9087	11570	11073	9807	8092	6746	4105
13	7648	8089	10420	11073	11317	8865	8205	8350	10757	10194	8921	7210	5884	4202
14	7556	8004	10239	10784	10804	8060	7298	7454	9717	9031	7742	6031	4733	4647
15	8550	8980	11354	12071	12432	10085	9438	9582	11979	11319	9976	8222	6790	4769
16	8291	8734	11053	11685	11868	9287	8563	8716	11005	10250	8893	7136	5713	4861
17	8206	8654	10889	11427	11415	8583	7772	7933	10078	9199	7818	6057	4639	5214
18	8256	8703	10830	11270	11063	7991	7087	7257	9225	8203	6795	5028	3620	5722
19	9370	9813	12127	12747	12876	10161	9366	9526	11655	10632	9157	7355	5804	5895
20	9369	9816	12078	12636	12636	9754	8899	9065	11073	9936	8431	6624	5054	6141
21	9341	9789	11973	12455	12298	9228	8304	8476	10332	9068	7534	5722	4137	6447
22	9308	9753	11855	12266	11970	8744	7761	7937	9648	8279	6726	4912	3320	6737
23	9484	9922	11902	12216	11732	8306	7242	7424	8883	7320	5721	3905	2282	7323
24	10025	10471	12740	13302	13295	10373	9494	9662	11590	10319	8757	6941	5319	6725
25	9973	10421	12621	13111	12960	9867	8925	9098	10879	9483	7893	6076	4438	6967
26	9928	10373	12469	12868	12536	9246	8230	8408	9987	8440	6818	5004	3349	7320
27	10105	10542	12505	12801	12269	8778	7682	7865	9158	7394	5723	3923	2246	7927
28	10295	10723	12583	12806	12133	8517	7371	7555	8611	6675	4966	3194	1524	8416
29	10591	11038	13279	13807	13718	10675	9743	9916	11697	10245	8623	6810	5150	7379
30	10514	10962	13132	13591	13364	10167	9178	9355	10986	9414	7766	5960	4289	7586
31	10497	10939	12983	13337	12905	9495	8427	8609	9981	8218	6532	4742	3063	8015
32	10782	11219	13176	13462	12896	9357	8237	8421	9564	7614	5885	4136	2478	8556
33	10934	11362	13207	13414	12700	9038	7871	8056	8944	6816	5056	3367	1798	9031
34	10993	11440	13567	13986	13671	10363	9328	9509	10972	9226	7529	5747	4068	8183
35	11176	11619	13662	14010	13553	10101	9011	9195	10445	8524	6792	5046	3386	8642
36	11454	11889	13810	14064	13426	9813	8662	8846	9788	7634	5861	4202	2641	9282
37	11538	11961	13767	13942	13158	9438	8248	8432	9115	6795	5003	3443	2070	9693
38	12296	12744	14957	15447	15252	12036	11025	11204	12691	10868	9137	7388	5719	9112
39	12032	12480	14637	15076	14782	11467	10422	10603	11984	10092	8352	6615	4956	9058
40	11749	12195	14284	14664	14261	10845	9765	9948	11207	9243	7494	5773	4126	9025
41	11813	12253	14254	14564	14024	10485	9359	9543	10595	8481	6708	5041	3452	9369
42	12586	13032	15142	15536	15145	11722	10635	10818	12010	9938	8165	6494	4886	9745
43	12347	12790	14828	15163	14662	11145	10024	10208	11262	9106	7324	5686	4116	9754
44	13264	13710	15787	16150	15688	12188	11070	11254	12280	10048	8255	6667	5134	10496
45	12880	13321	15318	15619	15045	11457	10310	10494	11380	9074	7277	5728	4253	10380
46	14010	14456	16543	16910	16445	12932	11806	11991	12952	10636	8837	7304	5815	11181
47	13509	13951	15963	16271	15702	12110	10959	11143	11980	9605	7805	6308	4875	10931
48	14123	14564	16568	16866	16271	12650	11487	11671	12413	9947	8148	6723	5358	11541
49	14697	15141	17185	17514	16968	13379	12225	12409	13189	10723	8925	7501	6119	11969
50	2323	2666	4319	4678	4772	3539	3836	3839	6856	8376	8296	7618	7686	4332
51	2784	3182	5038	5446	5523	3875	3930	3970	6992	8215	7973	7152	7091	3862
52	3561	3936	5598	5867	5629	3369	3226	3289	6279	7381	7133	6351	6380	4453
53	3637	4061	6029	6453	6457	4342	4108	4190	7126	7946	7495	6494	6266	3590
54	4130	4574	6701	7210	7324	5179	4837	4937	7791	8324	7689	6506	6048	3062
55	4313	4728	6589	6927	6723	4179	3748	3856	6684	7302	6789	5766	5561	4124
56	4853	5291	7343	7781	7716	5196	4674	4797	7506	7776	7035	5781	5273	3653
57	5512	5945	7919	8290	8063	5234	4552	4695	7225	7239	6401	5086	4547	4298
58	6328	6760	8707	9044	8710	5650	4825	4984	7266	6922	5917	4472	3783	4911
59	7085	7496	9248	9448	8833	5403	4391	4568	6457	5792	4721	3285	2794	6084
60	7471	7907	9884	10222	9842	6628	5691	5862	7833	6998	5735	4077	3007	5645
61	7960	8383	10222	10460	9879	6428	5380	5560	7226	6139	4811	3130	2128	6494
62	8014	8402	9960	10029	9150	5443	4281	4466	5767	4646	3463	2043	2002	7336
63	2324	2204	2087	2129	2551	3797	4755	4657	7240	9547	9899	9588	9939	6220
64	2391	2377	2648	2668	2740	3319	4225	4134	6798	9023	9342	9019	9376	6026
65	2009	2130	3077	3300	3471	3378	4099	4039	6878	8875	9054	8602	8852	5332
66	2325	2556	3773	3991	3960	3095	3637	3602	6544	8354	8447	7935	8155	5053
67	3352	3436	3767	3563	2843	2133	3060	2959	5623	7849	8234	8024	8518	6439
68	2692	3140	5420	6089	6610	5357	5377	5428	8436	9441	9002	7955	7596	2386
69	3362	3532	4247	4163	3521	2006	2691	2625	5486	7480	7745	7440	7875	6024
70	3358	3610	4703	4751	4247	2275	2619	2603	5601	7297	7399	6950	7278	5500
71	3476	3924	6166	6782	7140	5457	5294	5370	8317	9058	8493	7346	6890	2400
72	3942	4225	5377	5399	4746	2130	2155	2178	5206	6702	6742	6274	6626	5636
73	4374	4694	5993	6050	5387	2449	2118	2195	5160	6344	6246	5677	5976	5557
74	4950	5289	6654	6711	5988	2769	2128	2252	5038	5899	5676	5032	5314	5714
75	5003	5402	7130	7370	6942	3989	3345	3479	6142	6559	6005	4994	4873	4832
76	5649	5991	7329	7345	6498	3005	2095	2256	4739	5291	4988	4337	4694	6180
77	5734	6123	7759	7925	7322	4049	3198	3357	5756	5891	5258	4230	4181	5501

To be continued on next page...



Project:

Rahkola\_Hautakangas

Licensed user:

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FI-00601 Helsinki

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Mikka Saranpää / mikka.saranpaa@fcg.fi

Calculated:

11.1.2023 10.59/3.5.584

## DECIBEL - Main Result

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

...continued from previous page

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N
78	6399	6734	8000	7955	6959	3252	2141	2323	4346	4578	4231	3651	4180	6833
79	6378	6780	8486	8673	8069	4713	3770	3940	6085	5816	4965	3735	3493	5723
80	7183	7489	8540	8369	7128	3250	2016	2192	3486	3598	3470	3298	4224	7844
81	6912	7265	8623	8609	7637	3912	2766	2950	4657	4410	3814	3039	3503	6991
82	7949	8194	8858	8490	6913	3106	2049	2142	2001	2750	3398	3983	5280	9151
83	7073	7456	8997	9076	8252	4634	3536	3718	5452	4904	4025	2879	2949	6661
84	7667	7999	9191	9075	7901	4038	2808	2987	4032	3475	2962	2531	3432	7925
85	8014	8306	9240	8992	7595	3700	2492	2640	3013	2711	2754	2996	4230	8719
86	8636	8904	9671	9333	7778	3955	2847	2959	2424	2007	2539	3291	4725	9532
87	7867	8228	9602	9574	8535	4732	3527	3710	4854	3923	3012	2061	2657	7676
88	8306	8637	9803	9661	8419	4530	3294	3464	4039	2984	2327	2021	3165	8485
89	8731	9022	9924	9645	8178	4306	3132	3267	3011	2029	2114	2706	4141	9362

Project:  
Rahkola\_Hautakangas

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Miikka Saranpää / miikka.saranpaa@fcg.fi  
Calculated:  
11.1.2023 10.59/3.5.584

## DECIBEL - Assumptions for noise calculation

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

Noise calculation model:

ISO 9613-2 Finland

Wind speed (in 10 m height):

8,0 m/s

Ground attenuation:

General, terrain specific

Ground factor for porous ground: 0,4

Area object with hard ground: Area object (Roughness, Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REGIONS\_Rahkola\_Hautakangas\_0.w2r (1

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

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:

Pure tones penalty is added to total noise impact at receptors

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]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[dB/km]	[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: GE WIND ENERGY 5.3-158 Thrust 700 5300 158.0 !O!

Noise: 5.3-158 106.0 +2 dB HH200

Source	Source/Date	Creator	Edited
Noise_Emission-NO_5.3-158-50Hz_IEC_EN_r01	12.3.2018	USER	14.11.2022 12.12

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data								
					63	125	250	500	1000	2000	4000	8000	
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	200,0	8,0	108,0	No	89,2	94,6	99,2	101,6	103,3	101,1	93,7	78,0	

WTG: GE WIND ENERGY GE158 - 6.1 MW 6100 158.0 !O!

Noise: GE 6.1.158 no STE 107.0 dB +2dB

Source	Source/Date	Creator	Edited
Noise_Emission_4.x_5.x_6.x-158-50Hz_IEC_EN_r01	30.5.2018	USER	23.11.2022 8.27

Status	Hub height [m]	Wind speed [m/s]	LwA,ref [dB(A)]	Pure tones	Octave data							
					63	125	250	500	1000	2000	4000	8000
					[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
From Windcat	221,0	8,0	109,0	No	90,2	95,4	99,9	102,4	104,4	102,3	94,8	78,8

Noise sensitive area: A Lomarakennus A (Pökkylä)

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

Pure tone penalty: 0 dB

## DECIBEL - Assumptions for noise calculation

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

Noise sensitive area: B Asuinrakennus B (Pökkyläntie 418)

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

Pure tone penalty: 0 dB

Noise sensitive area: C Lomarakennus C (~Pökkyläntie 178)

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

Pure tone penalty: 0 dB

Noise sensitive area: D Asuinrakennus D (Luminevantie 162)

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

Pure tone penalty: 0 dB

Noise sensitive area: E Asuinrakennus E (Paratiisintie 231)

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

Pure tone penalty: 0 dB

Noise sensitive area: F Lomarakennus F (Isojärventie)

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

Pure tone penalty: 0 dB

Noise sensitive area: G Lomarakennus G (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: H Lomarakennus H (Antikantie)

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

Pure tone penalty: 0 dB

Noise sensitive area: I Asuinrakennus I (Kalliokangas)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Project:

Rahkola\_Hautakangas

Licensed user:

FCG Finnish Consulting Group Oy  
Osmontie 34, PO Box 950  
FI-00601 Helsinki  
+358104095666  
Miikka Saranpää / miikka.saranpaa@fcg.fi  
Calculated:  
11.1.2023 10.59/3.5.584

## DECIBEL - Assumptions for noise calculation

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB

Noise demand: 40,0 dB(A)

No distance demand

Pure tone penalty: 0 dB

Noise sensitive area: J Asuinrakennus J (Ojantakasentie 88)

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

Pure tone penalty: 0 dB

Noise sensitive area: K Asuinrakennus K (Ollilantie 218)

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

Pure tone penalty: 0 dB

Noise sensitive area: L Asuinrakennus L (Uusi-Kaikola)

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

Pure tone penalty: 0 dB

Noise sensitive area: M Lomarakennus M (Siliäkuru)

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

Pure tone penalty: 0 dB

Noise sensitive area: N Asuinrakennus N (Pinolantie 406)

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)

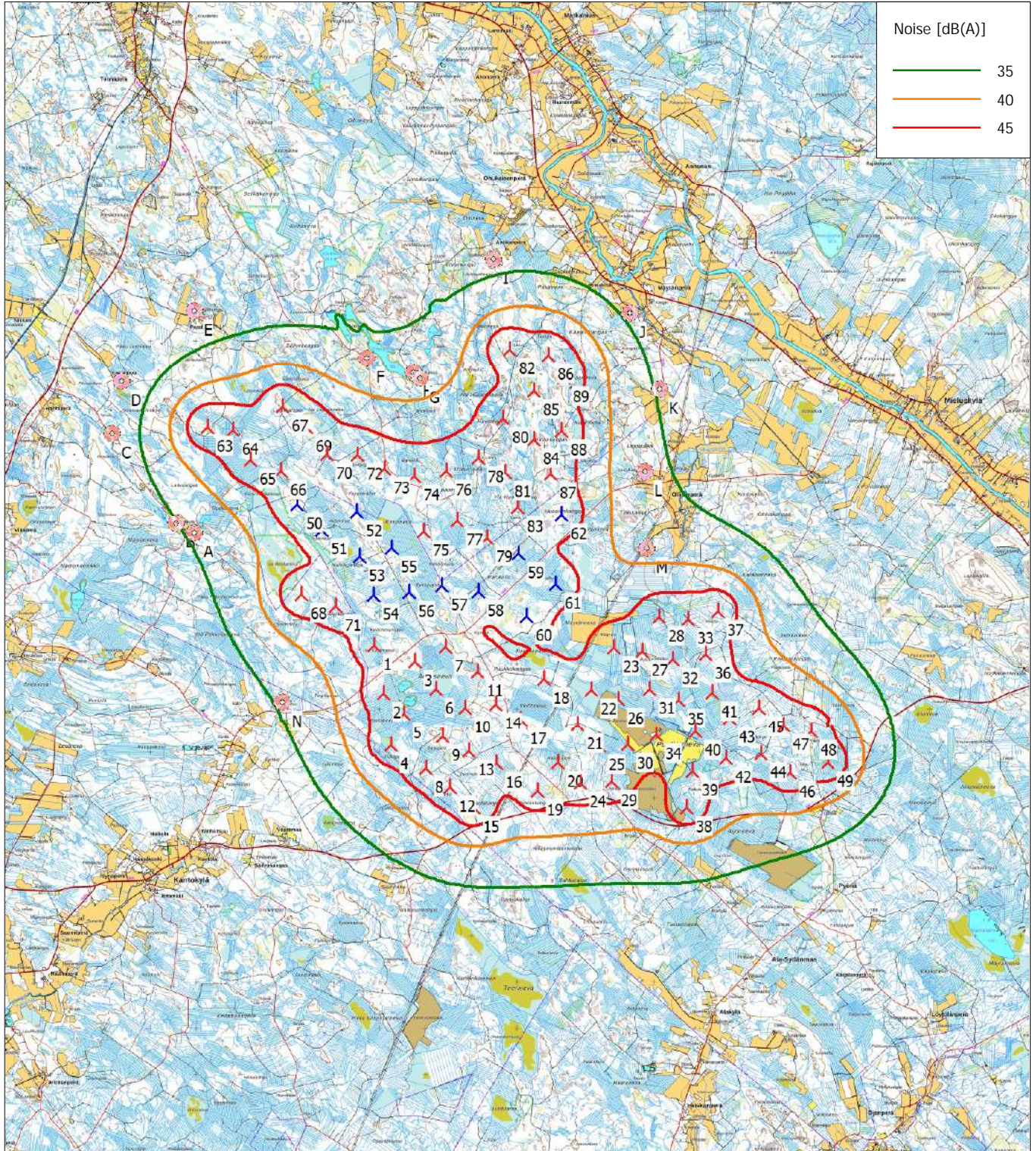
No distance demand

Pure tone penalty: 0 dB



## DECIBEL - Map 8,0 m/s

Calculation: VE3\_Yhteisvaikutus\_Puutionsaari\_GE 158-6100\_107 dB+2dB



0 2,5 5 7,5 10km

Map: Maastokarttarasteri50K , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 402 020 North: 7 113 791

🚧 New WTG

🏠 Noise sensitive area

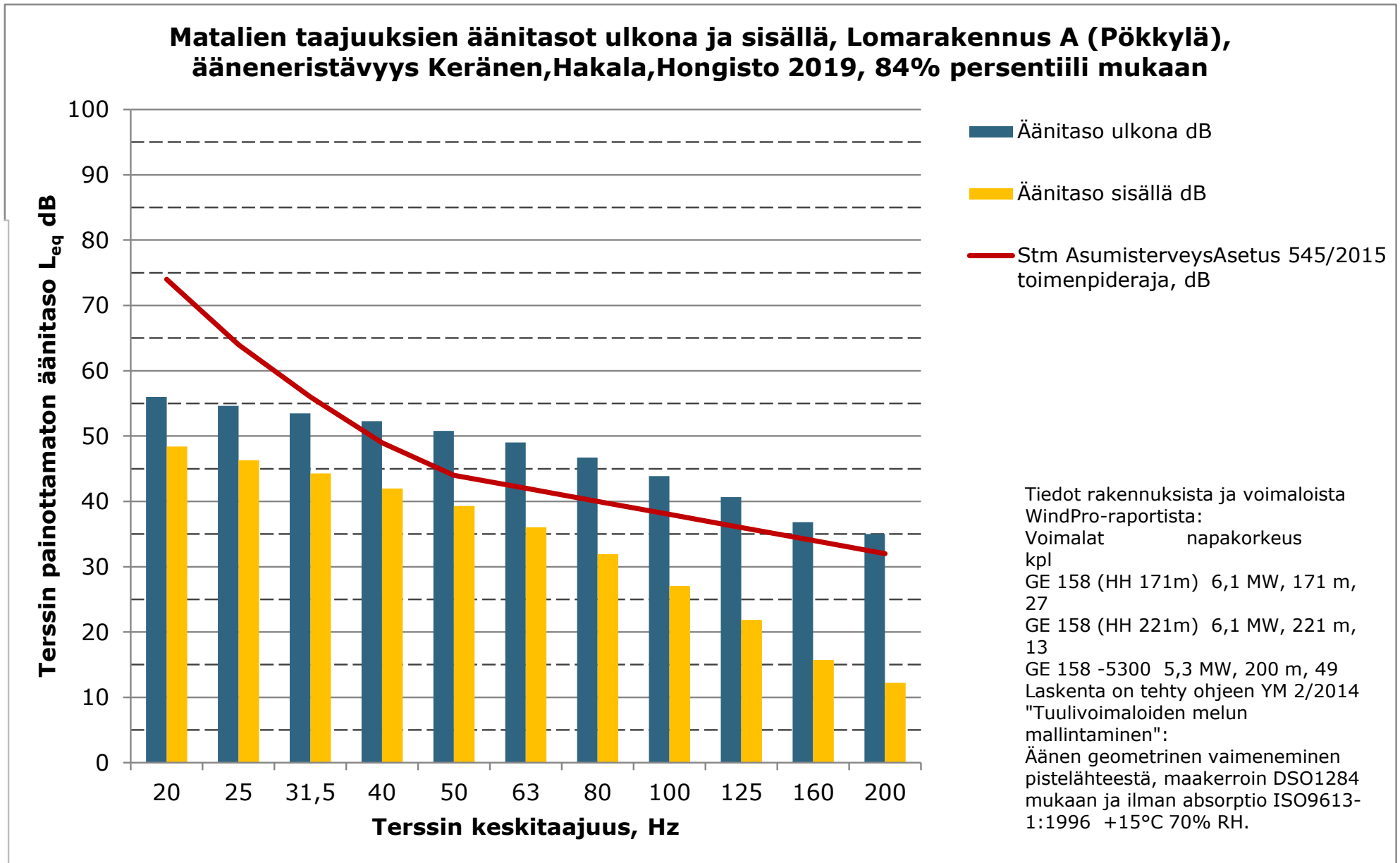
Noise calculation model: ISO 9613-2 Finland. Wind speed: 8,0 m/s  
Height above sea level from active line object



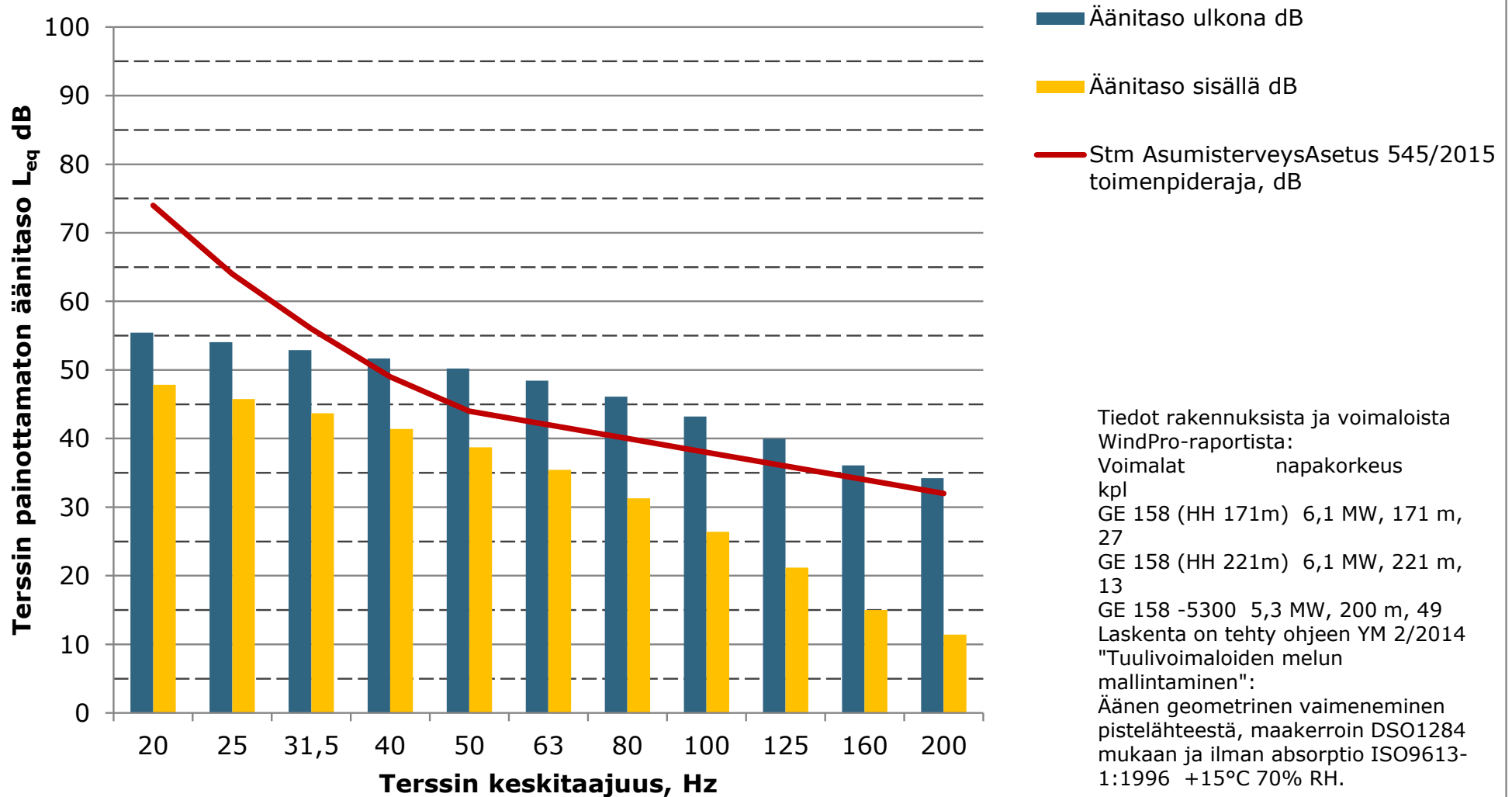
3.2.2023

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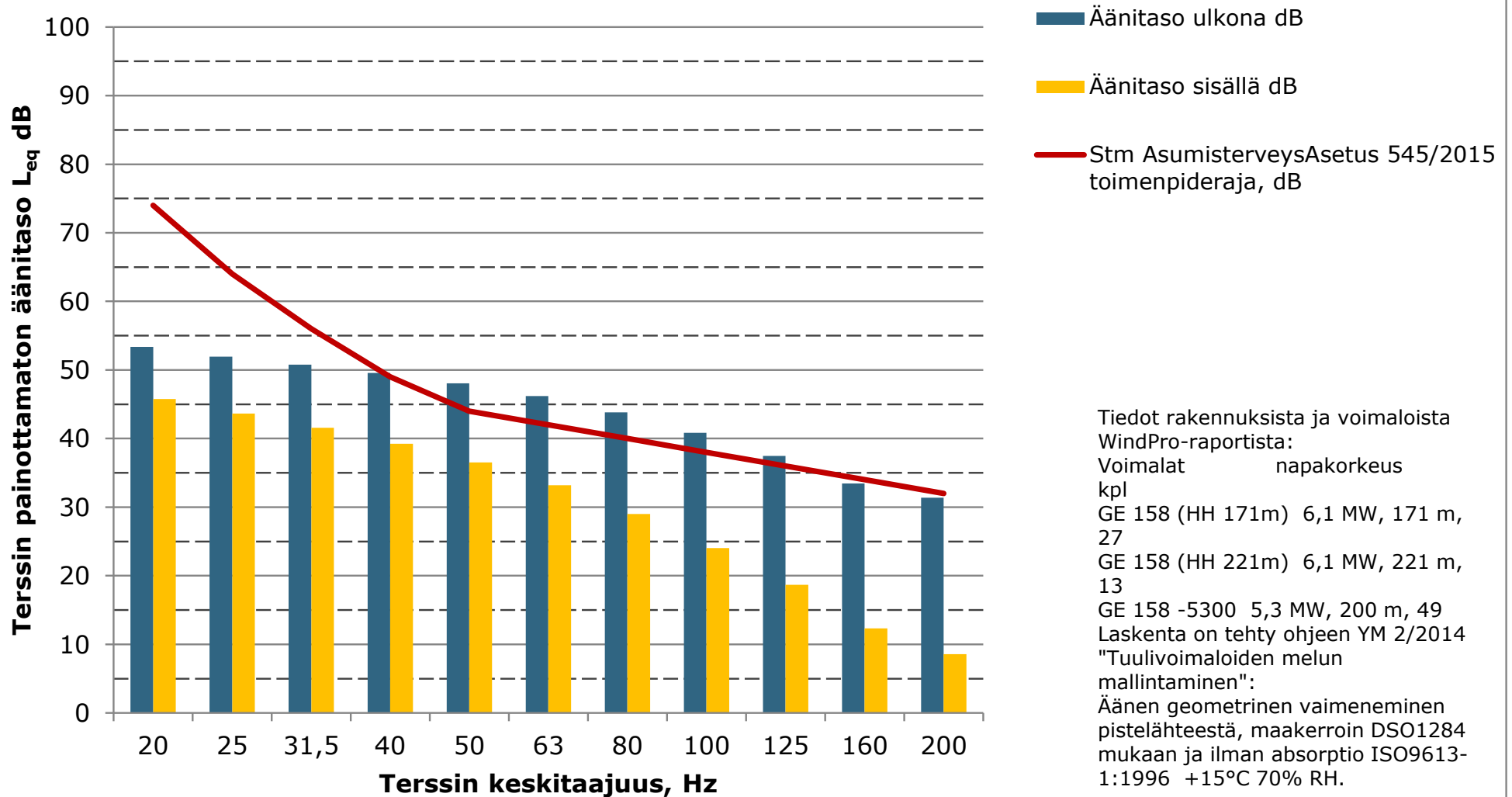
**Liite 13. Matalataajuisen melun yhteisvaikutuksen rakennuskohtaiset arvot – VE1**



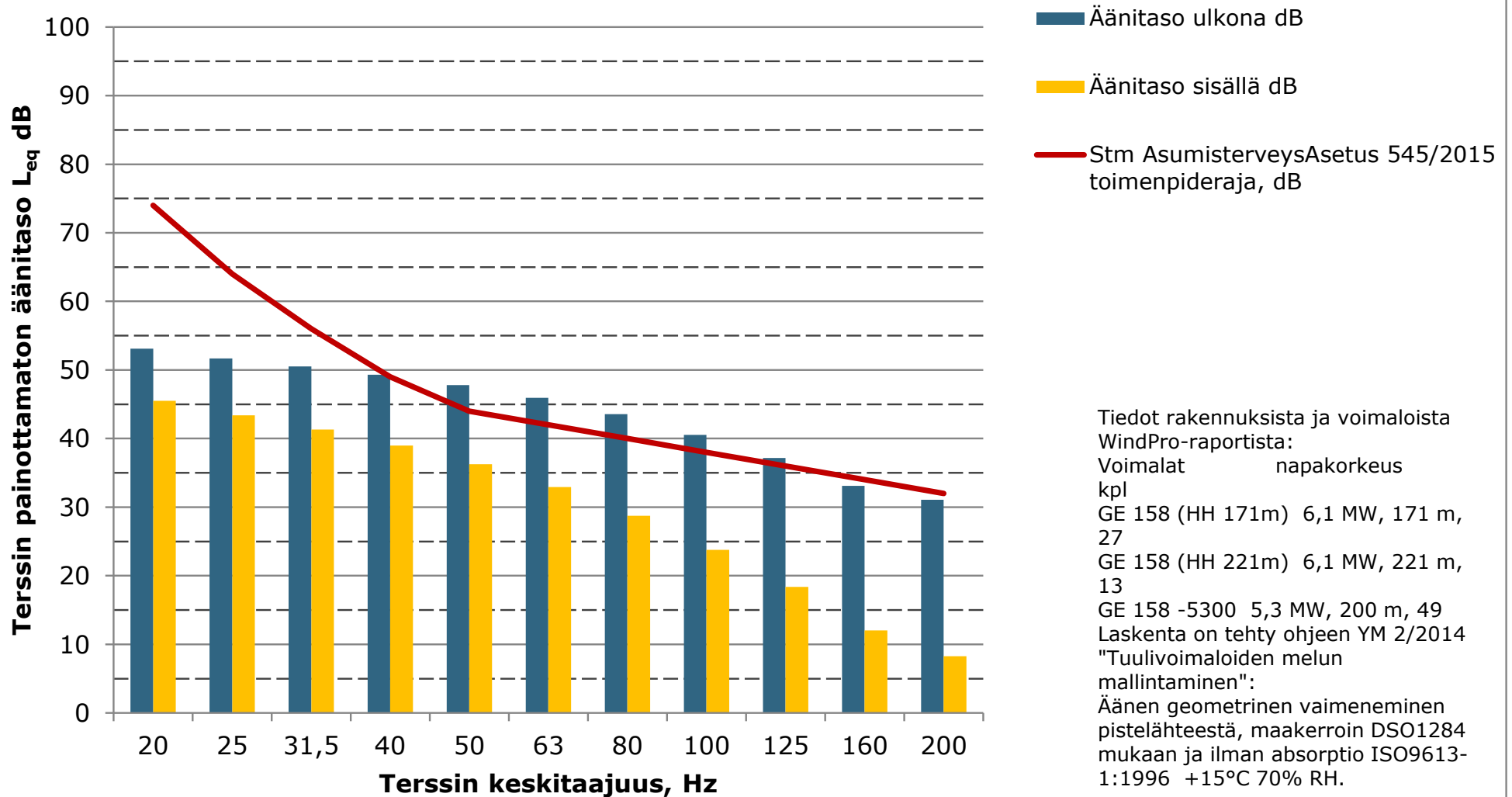
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus B (Pökkyläntie 418), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus C  
(~Pökkyläntie 178), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persentiili mukaan**

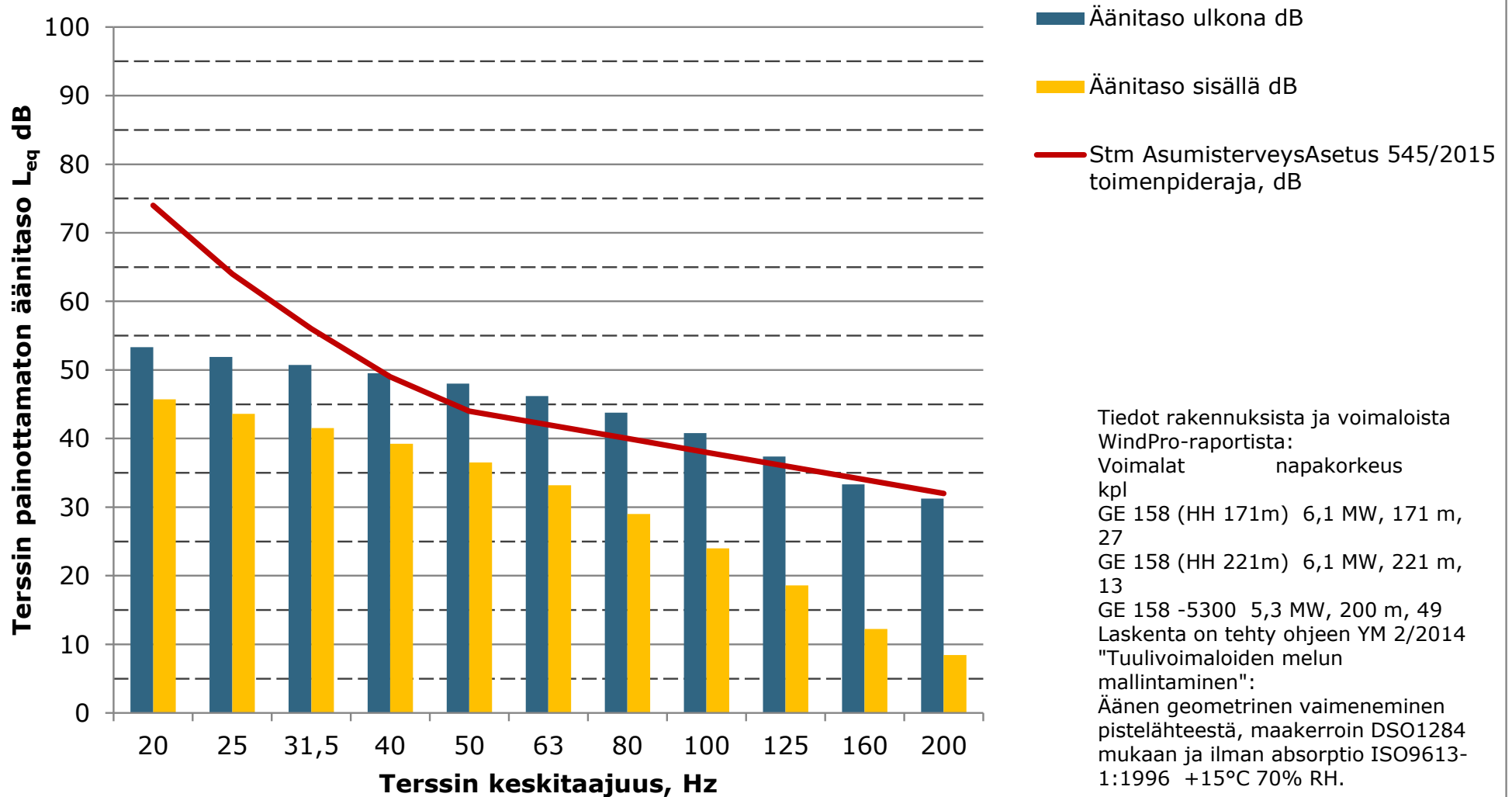


**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus D  
(Luminevantie 162), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persenttiili mukaan**

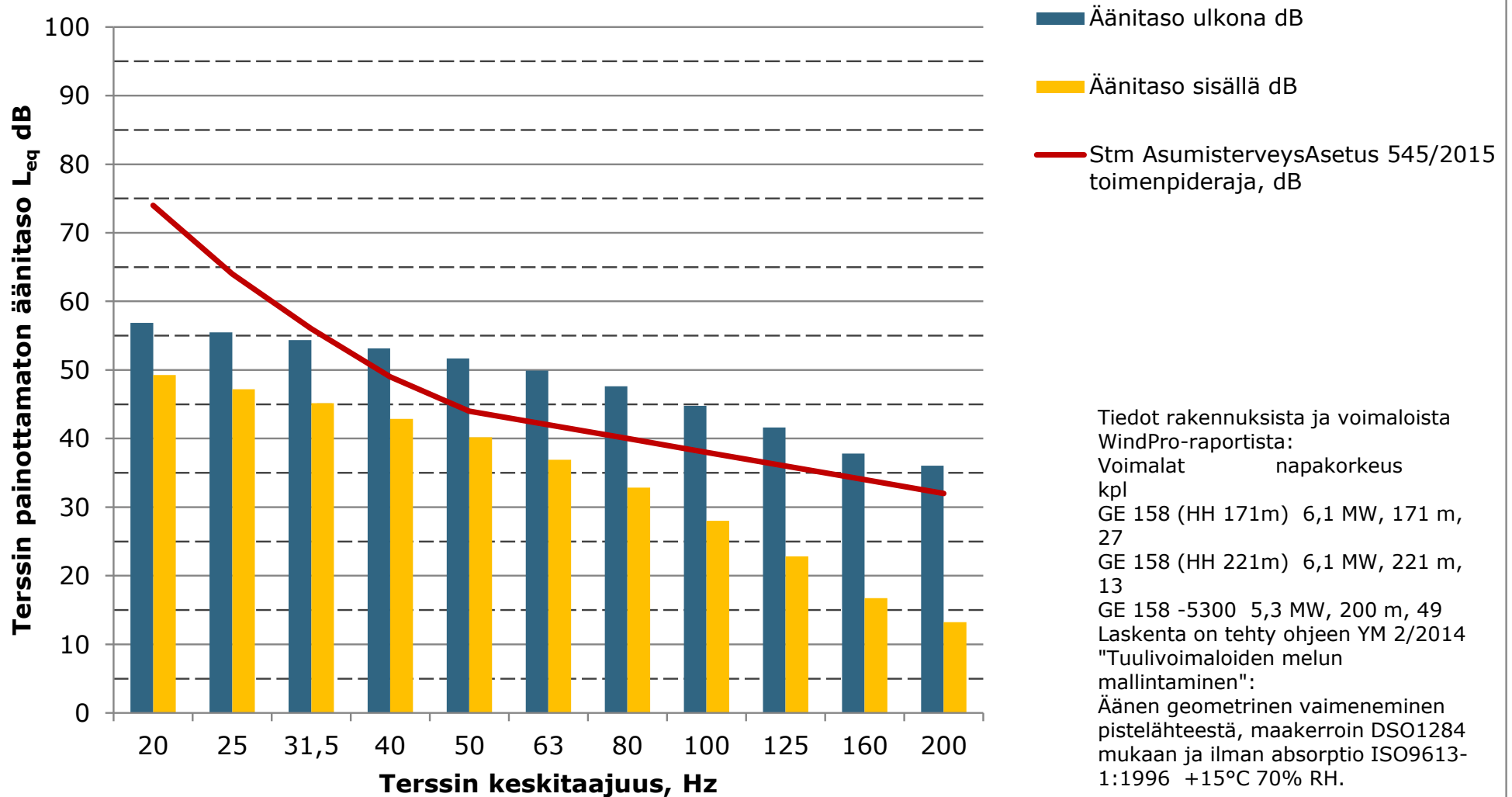


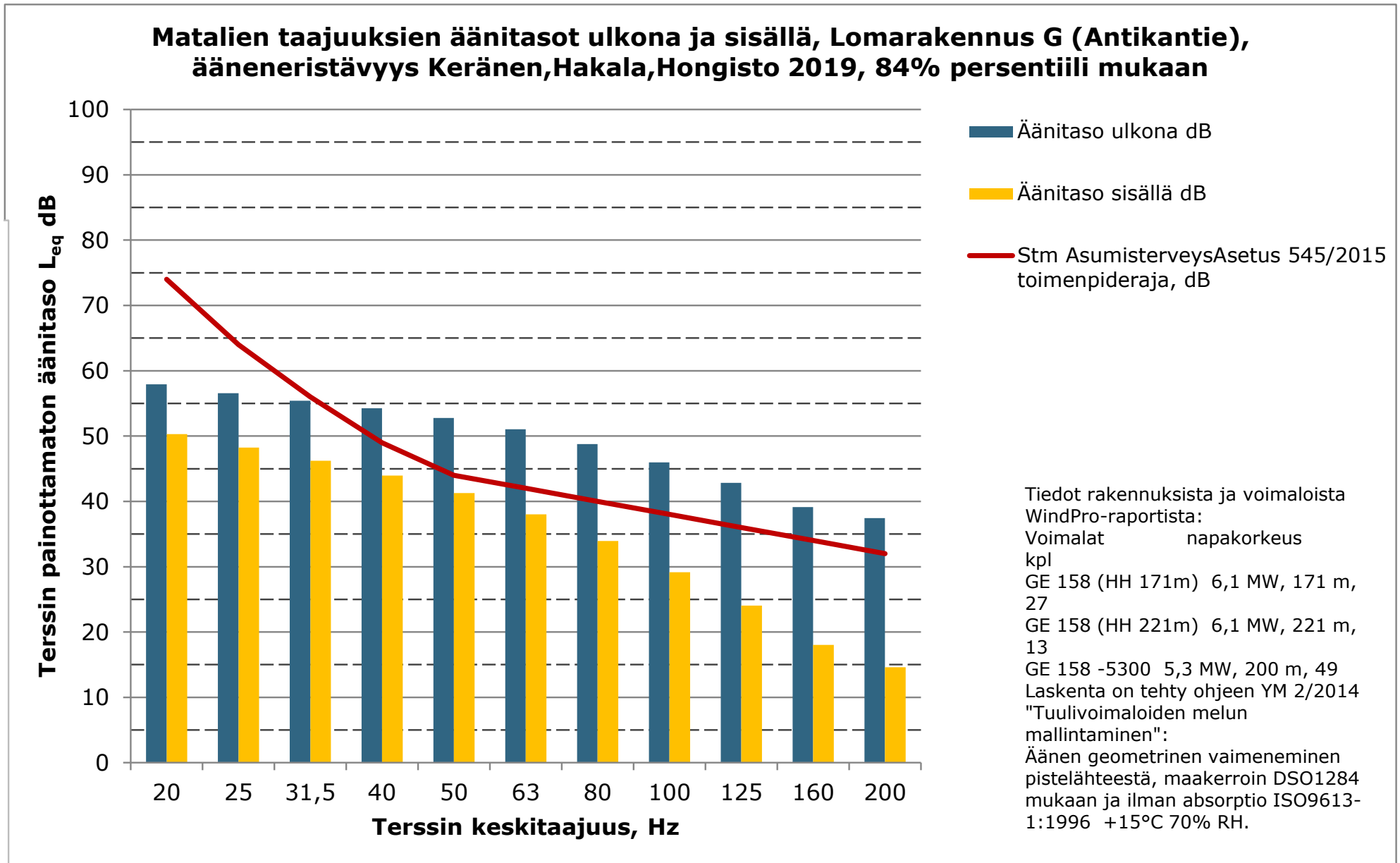


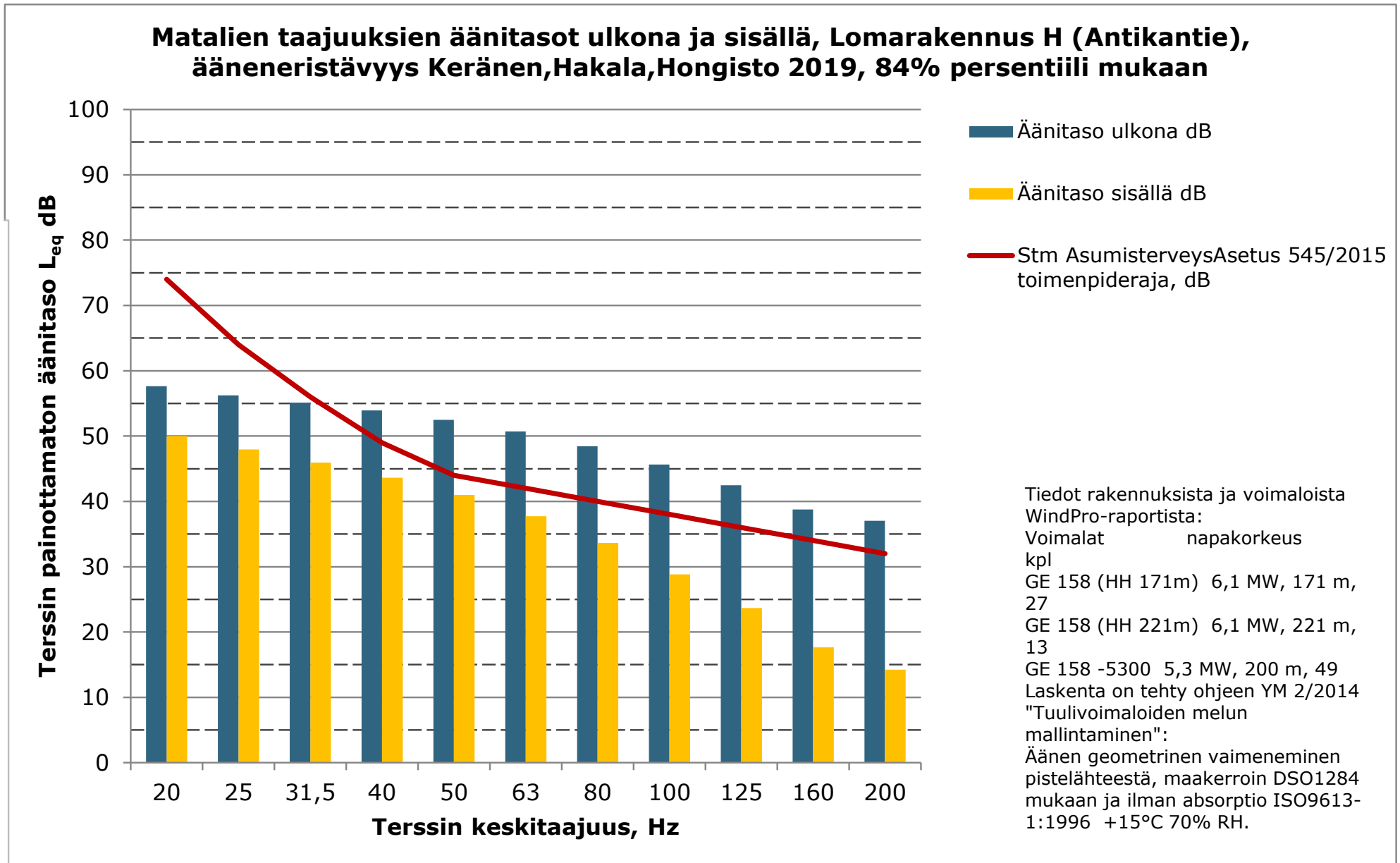
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus E (Paratiisintie 231), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persenttiili mukaan



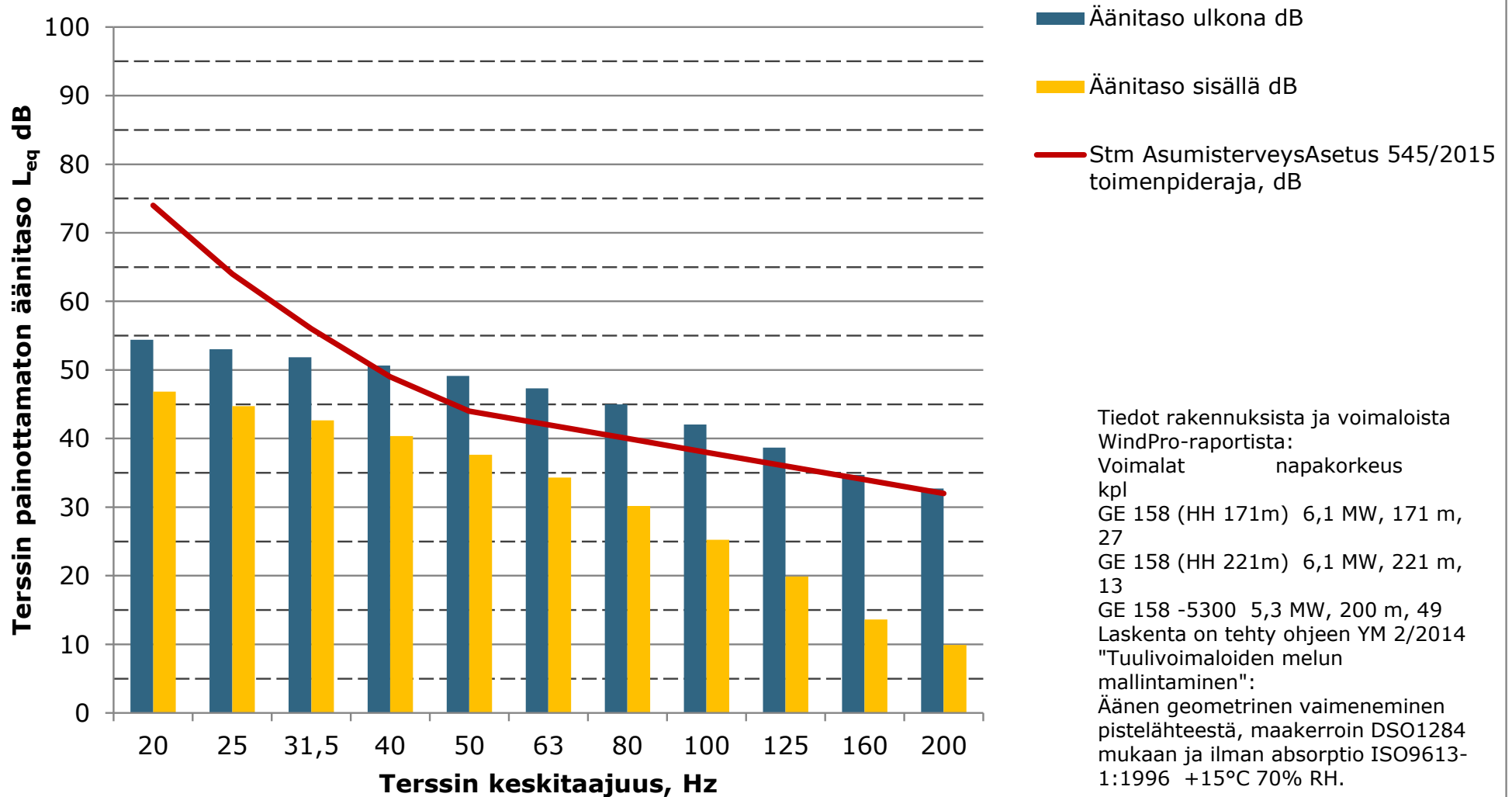
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus F  
(Isojärventie), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**





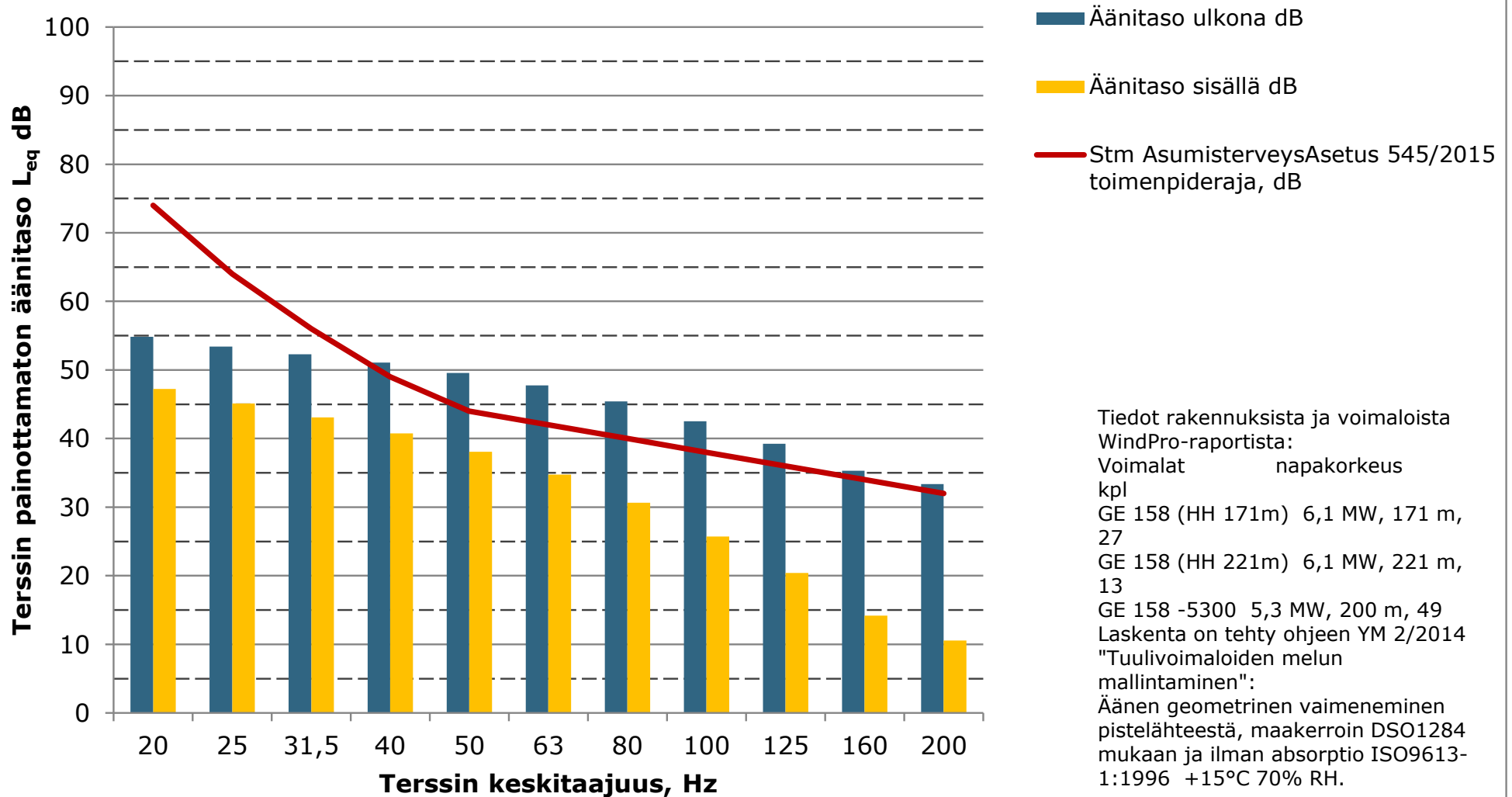


**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus I  
(Kalliokangas), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

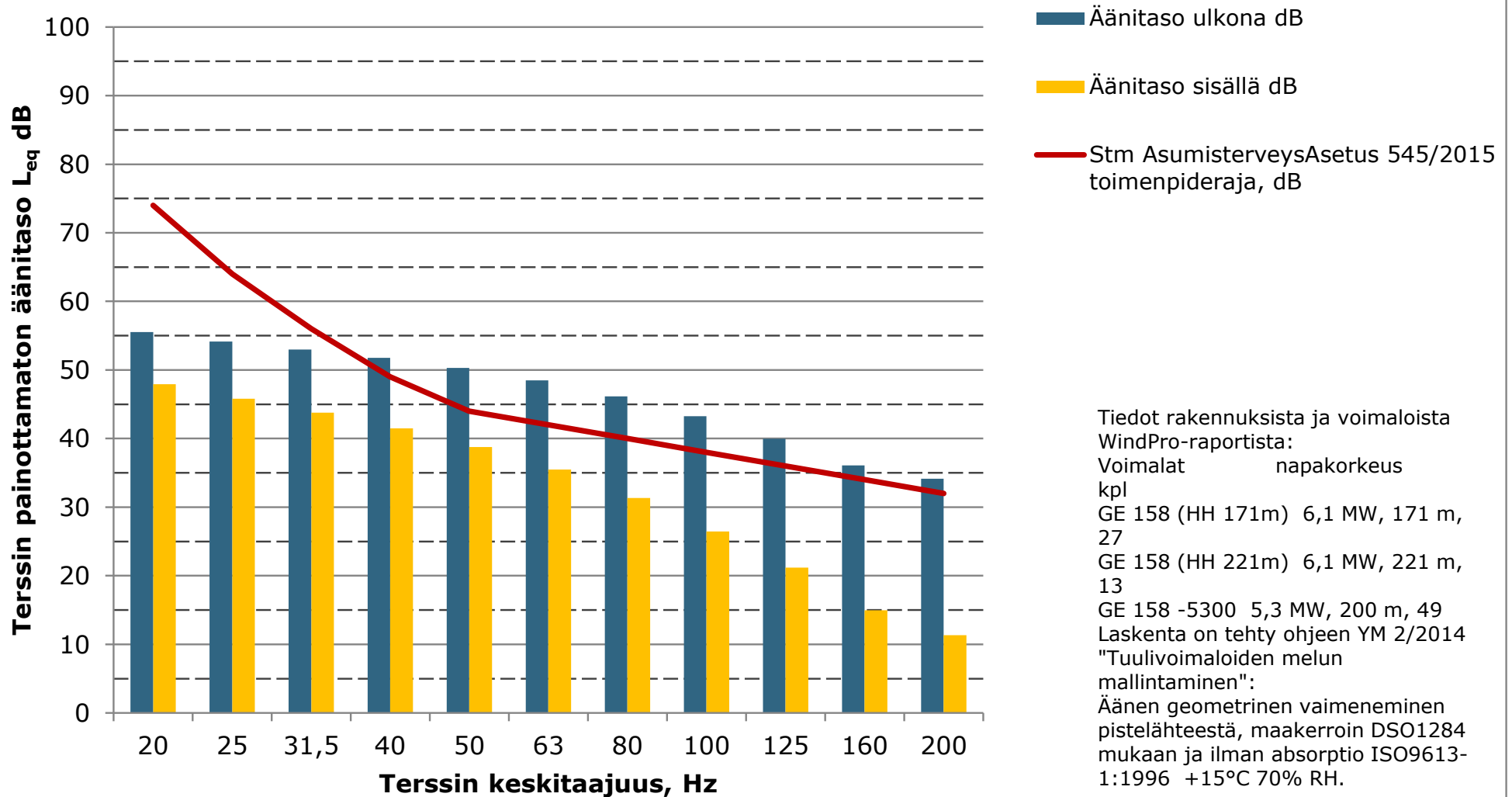




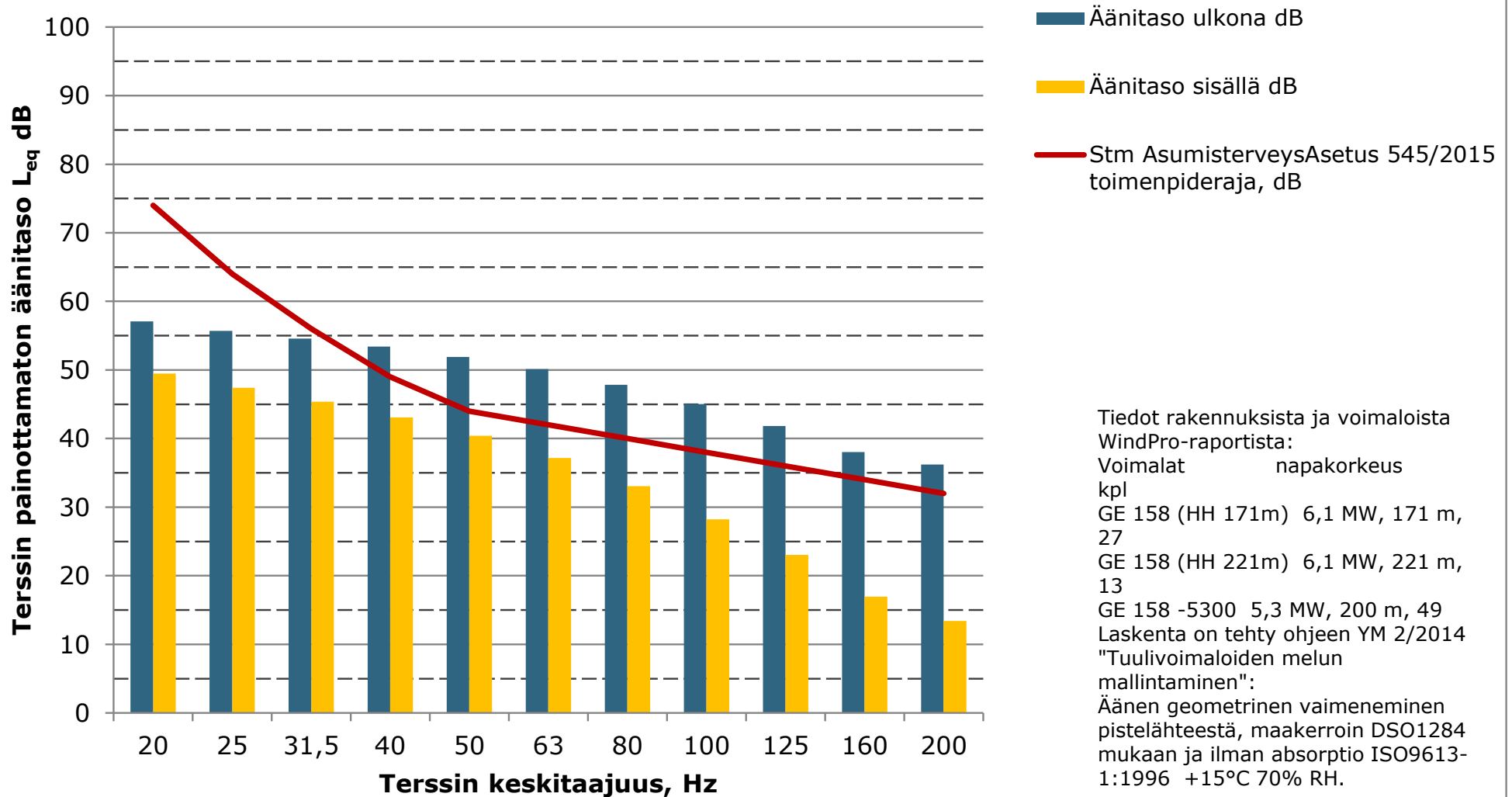
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus J  
(Ojantakasentie 88), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

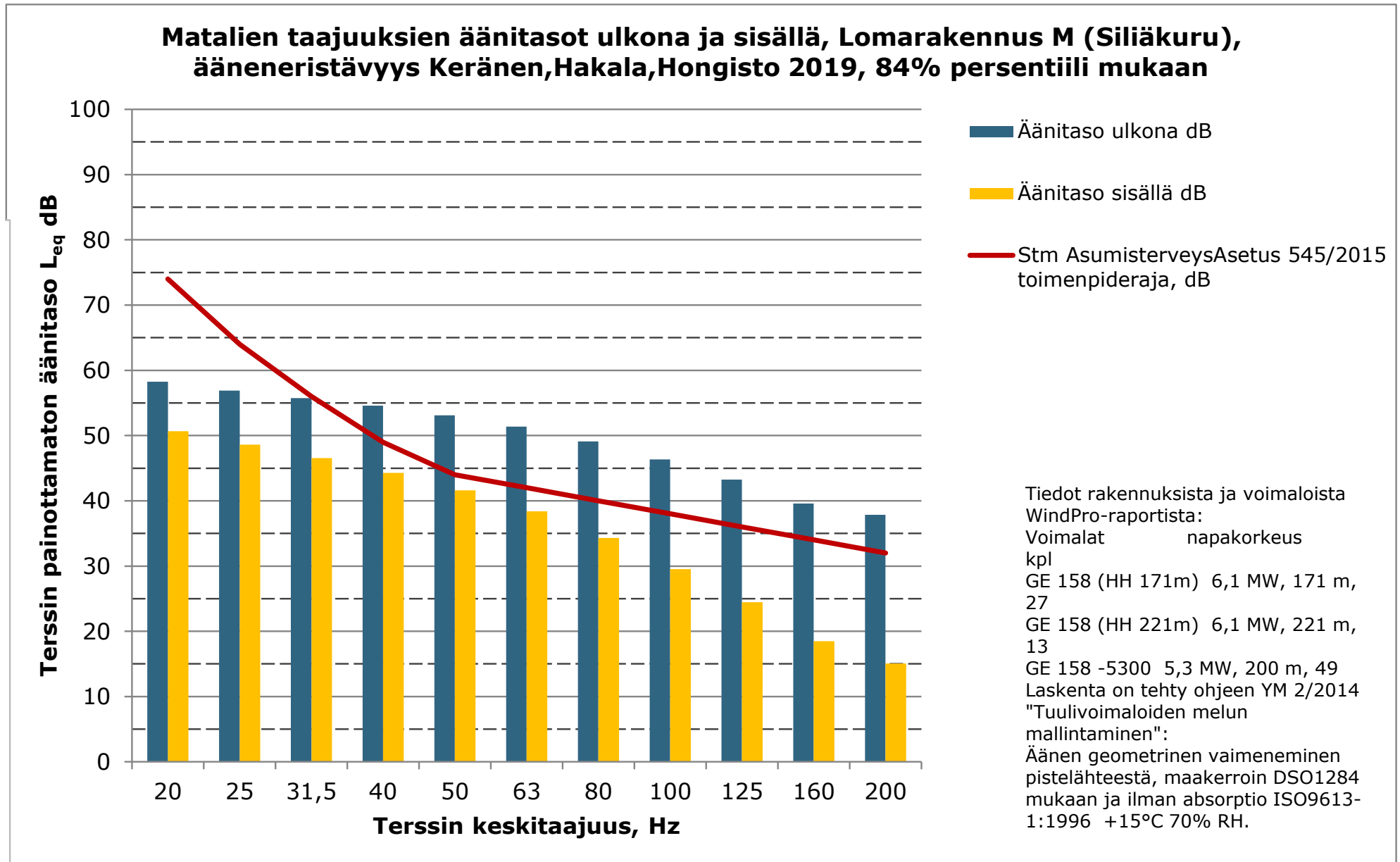


### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus K (Ollilantie 218), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan

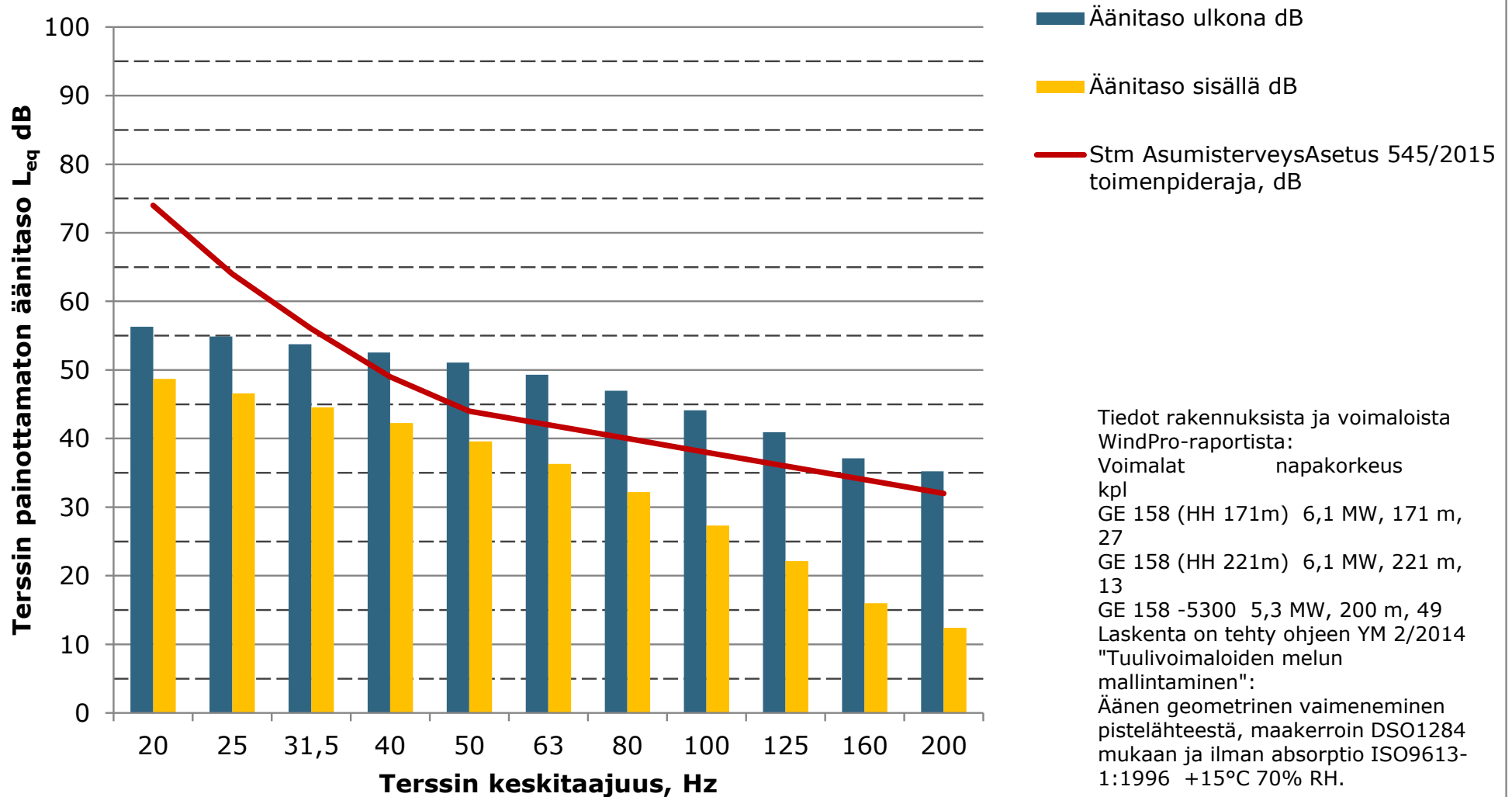


**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus L (Uusi-Kaikola), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan**





### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus N (Pinolantie 406), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



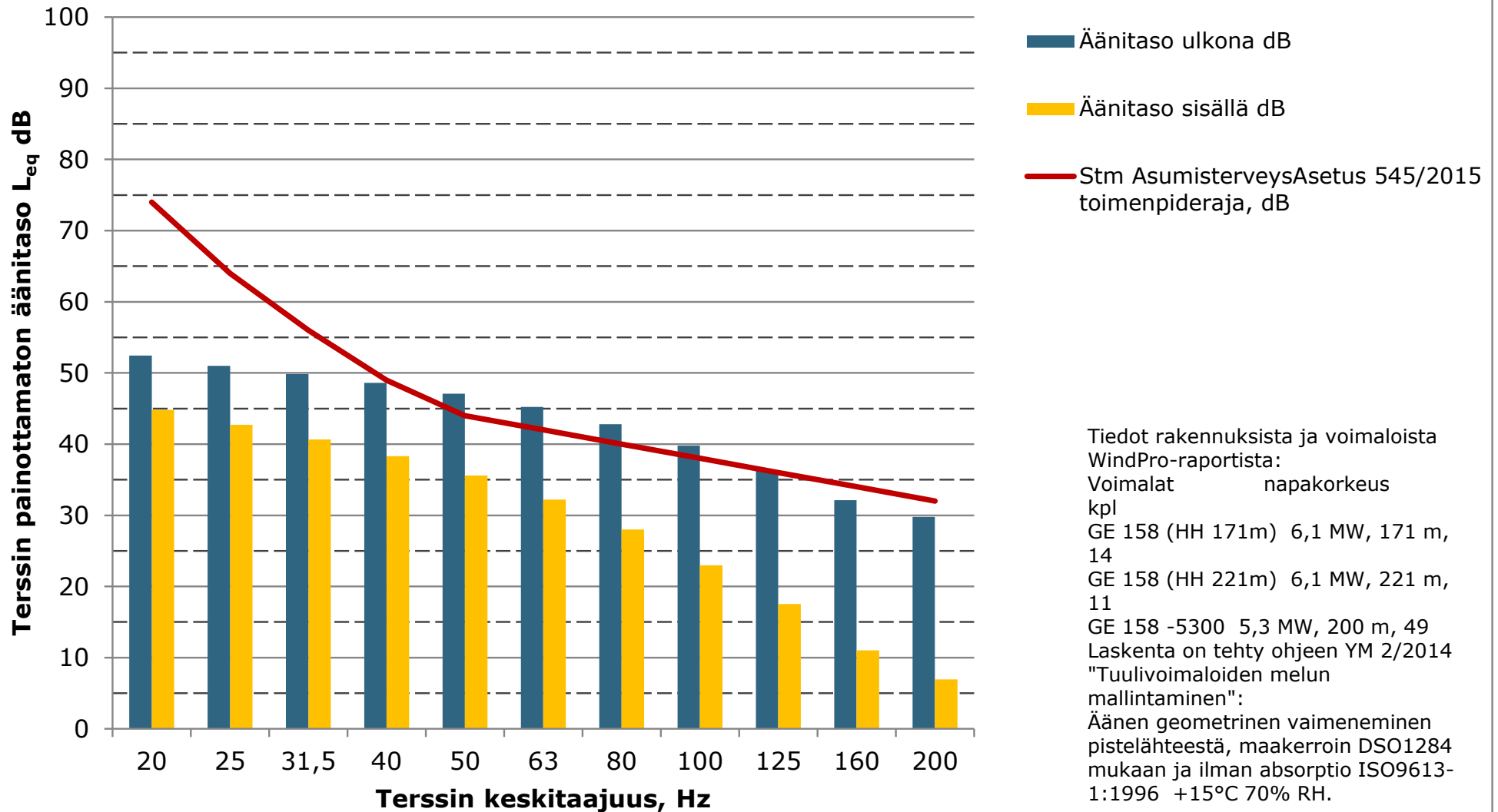


3.2.2023

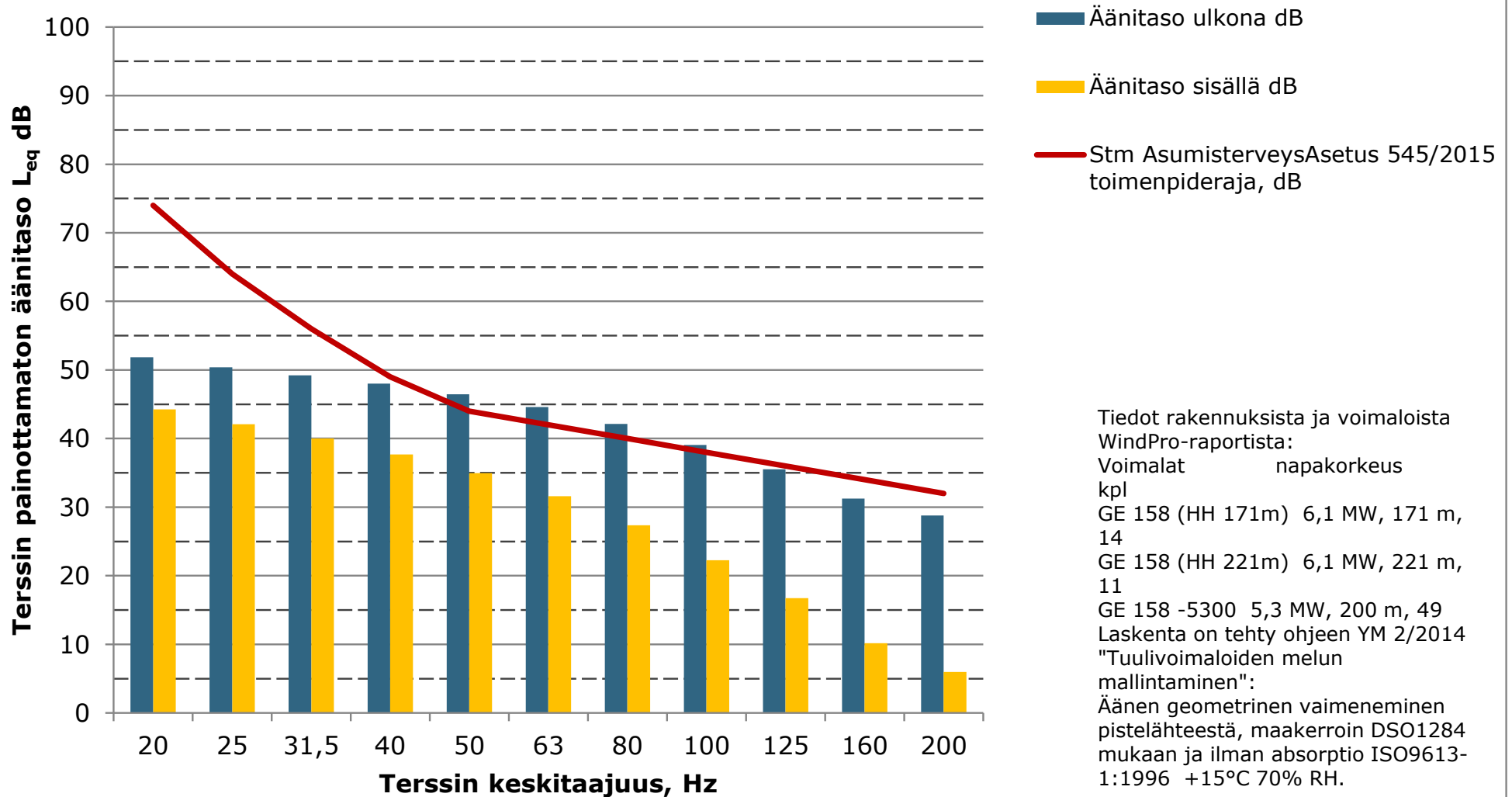
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## **Liite 14. Matalataajuisen melun yhteisvaikutuksen rakennuskohtaiset arvot - VE2**

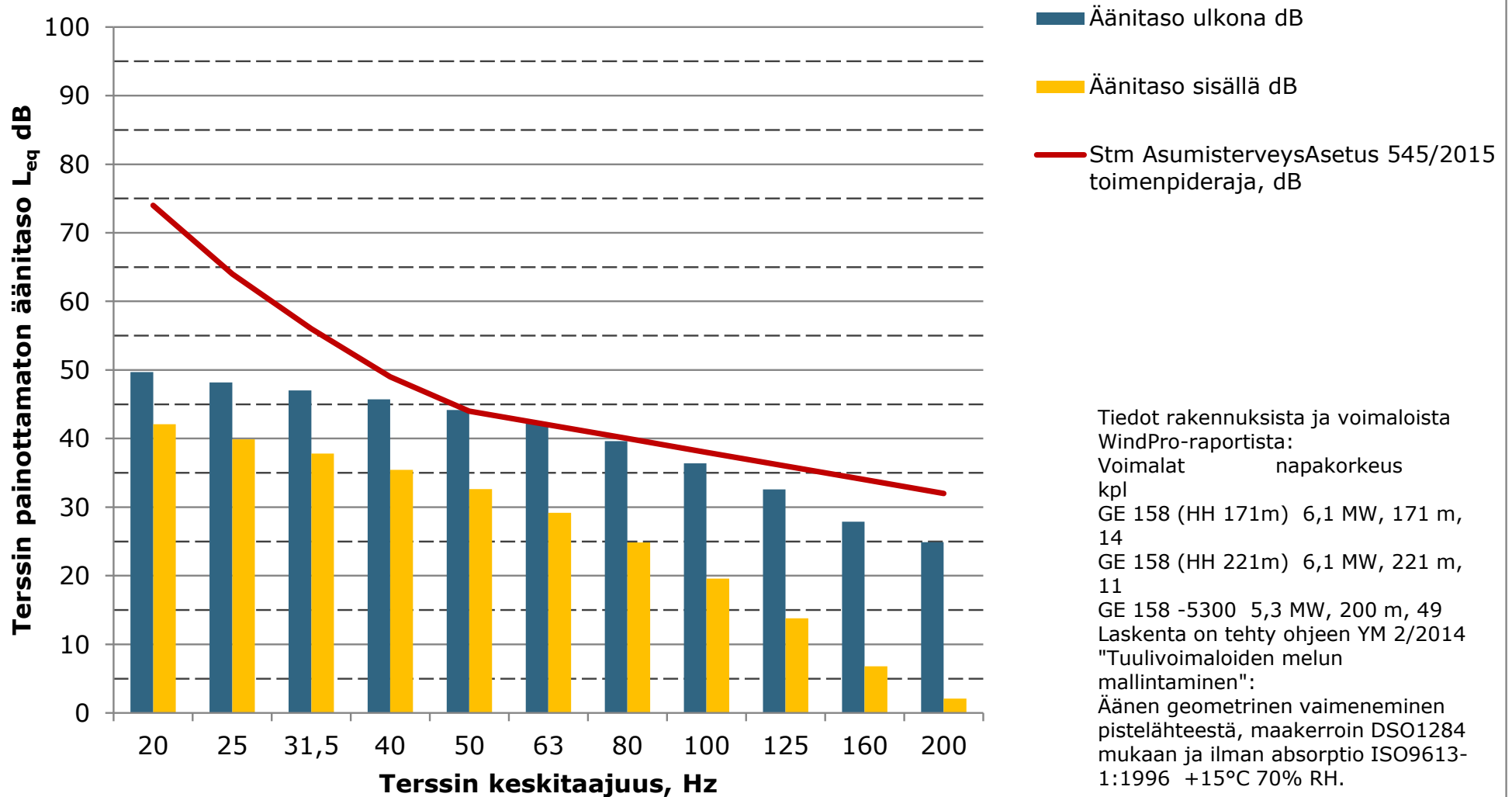
### Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus A (Pökkylä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



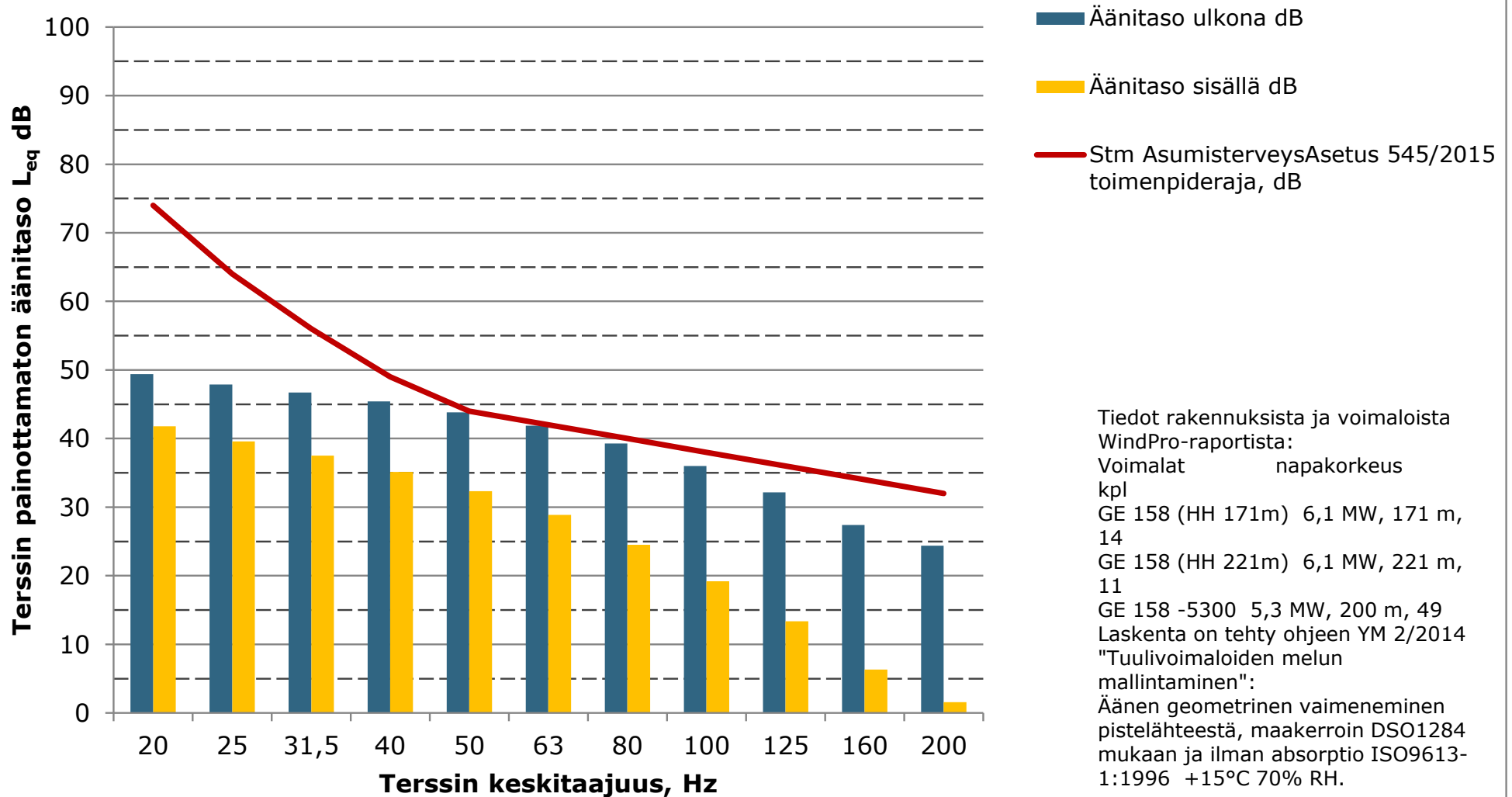
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus B (Pökkyläntie 418), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persenttiili mukaan



**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus C  
(~Pökkyläntie 178), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persentiili mukaan**

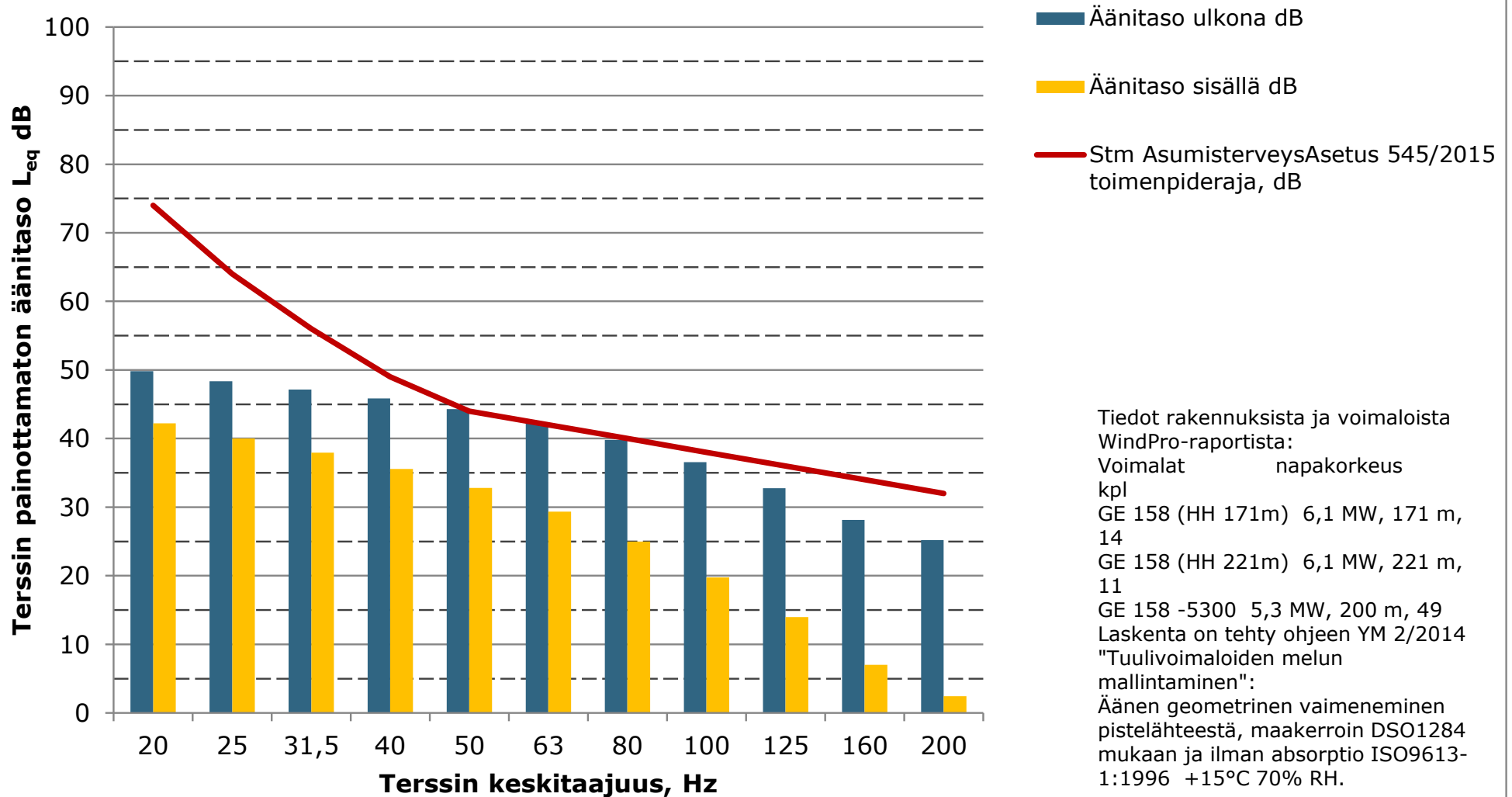


**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus D  
(Luminevantie 162), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persenttiili mukaan**

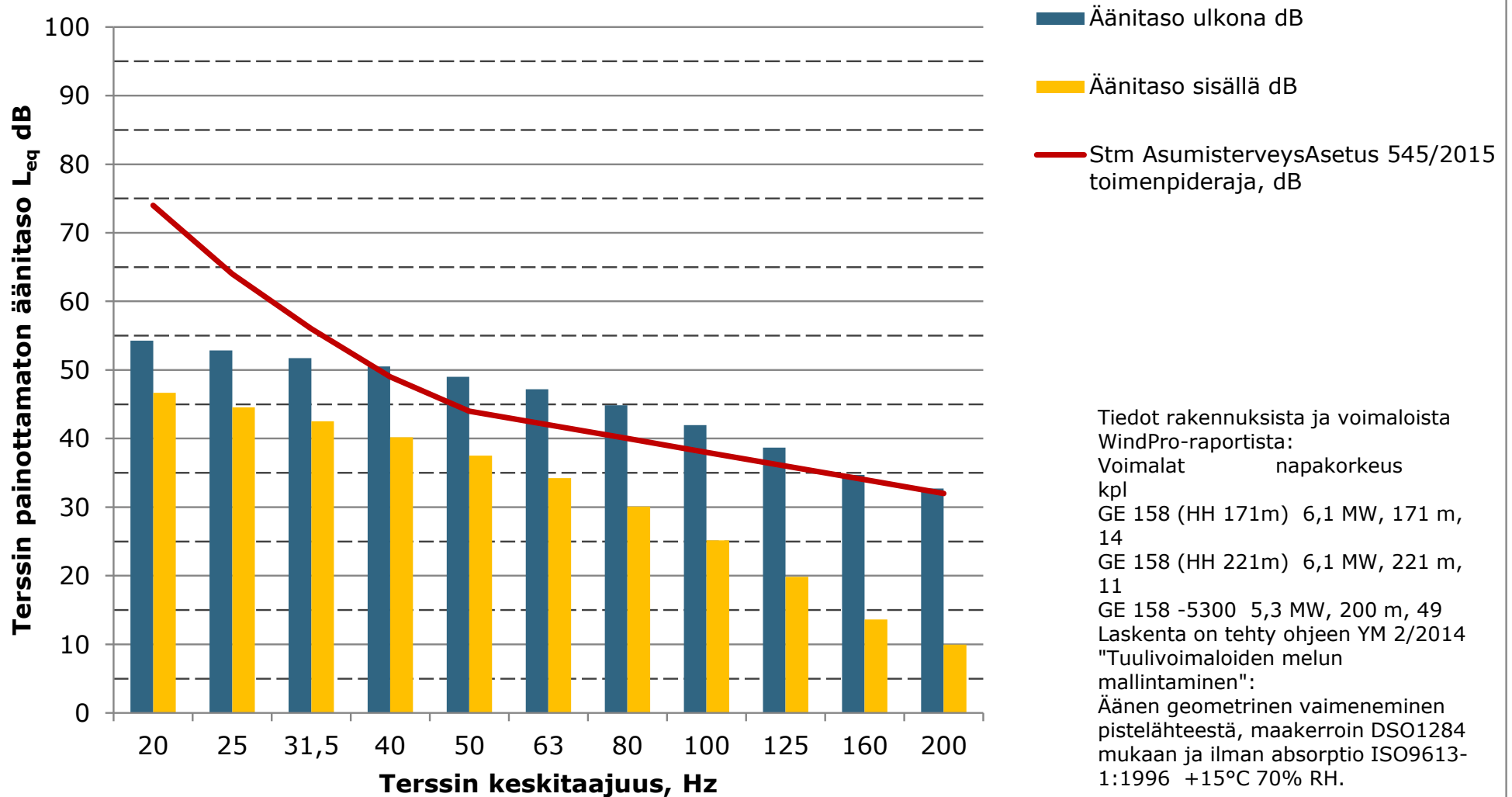


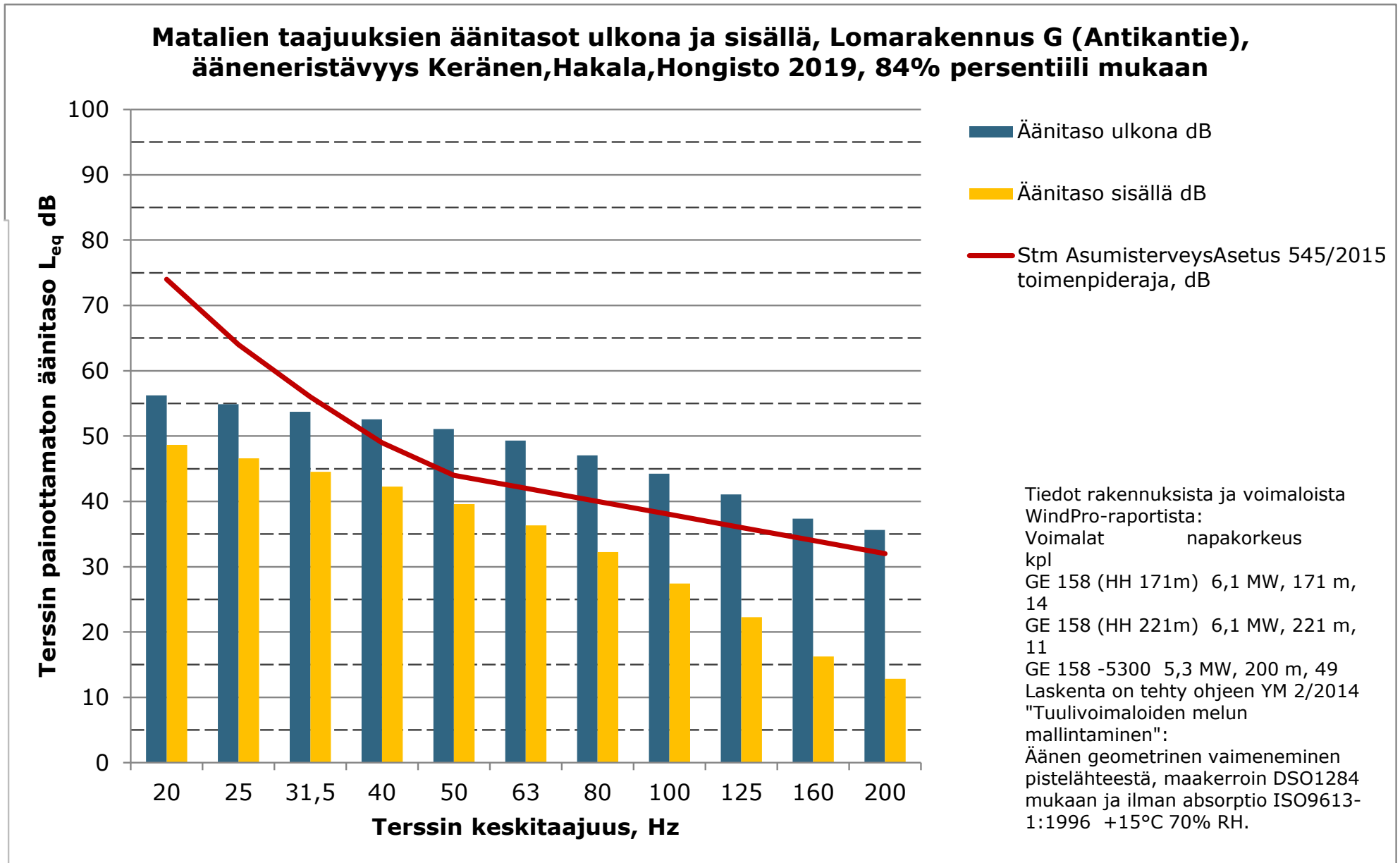


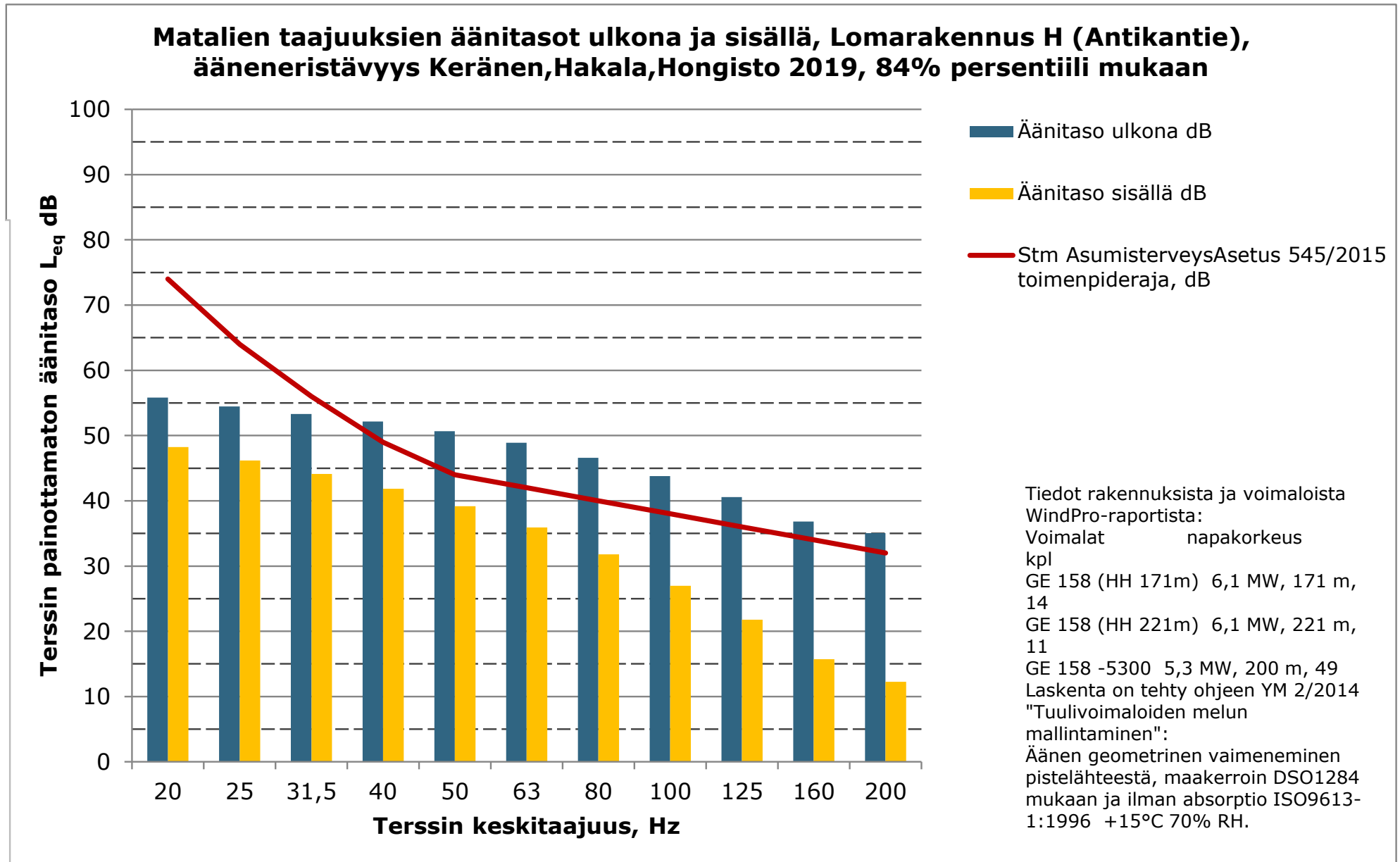
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus E (Paratiisintie 231), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persenttiili mukaan



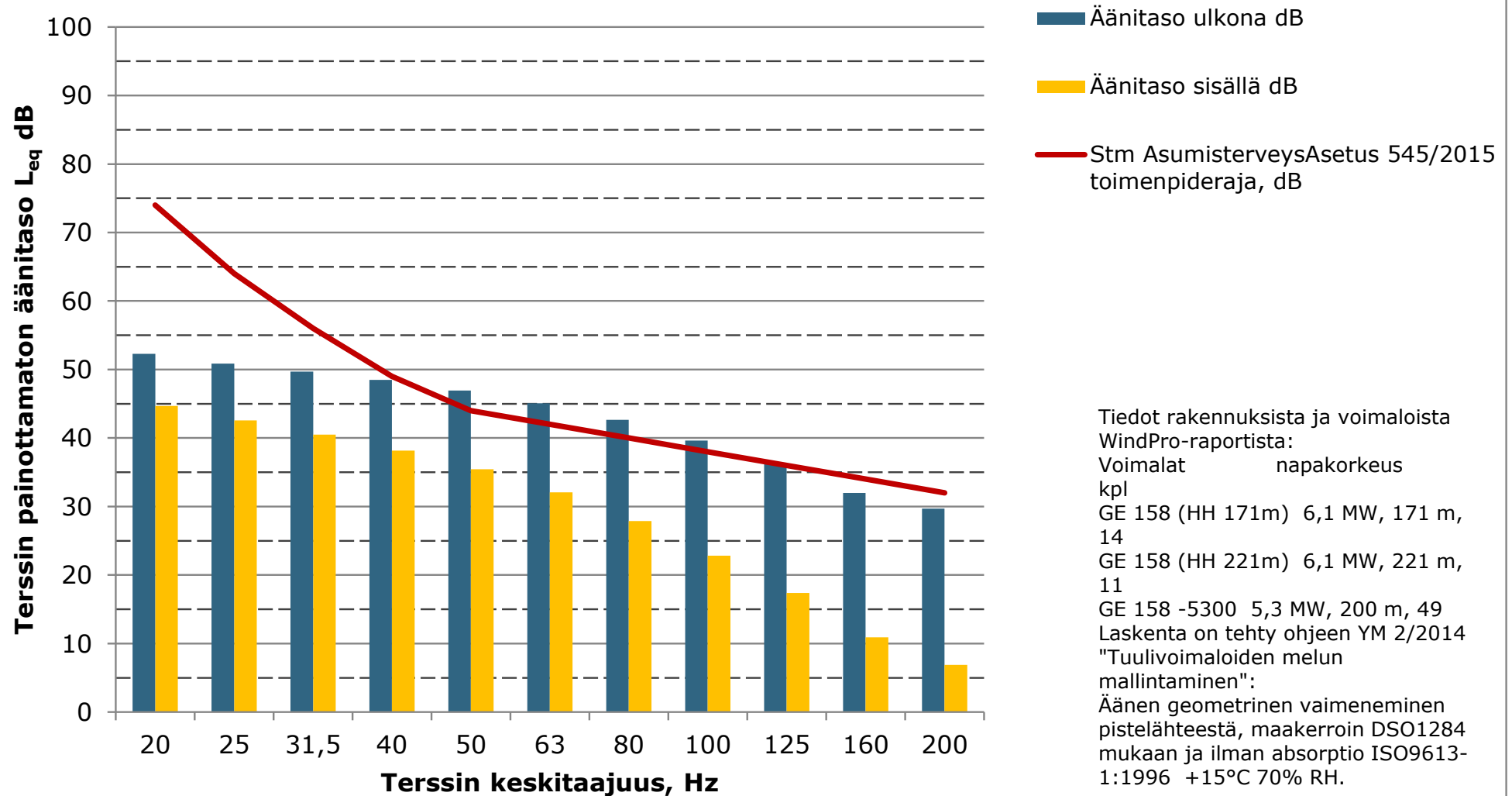
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus F  
(Isojärventie), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**





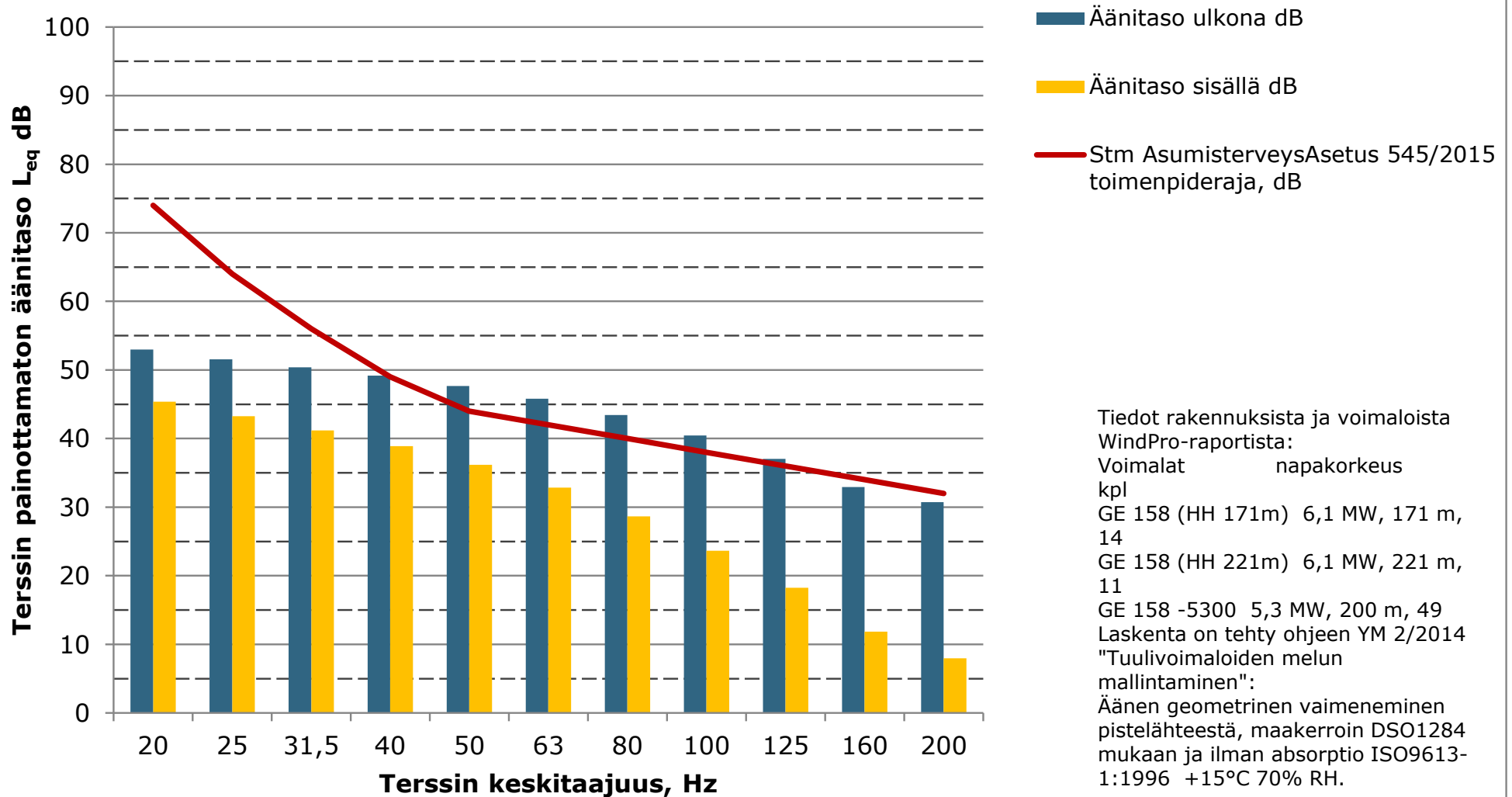


**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus I  
(Kalliokangas), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

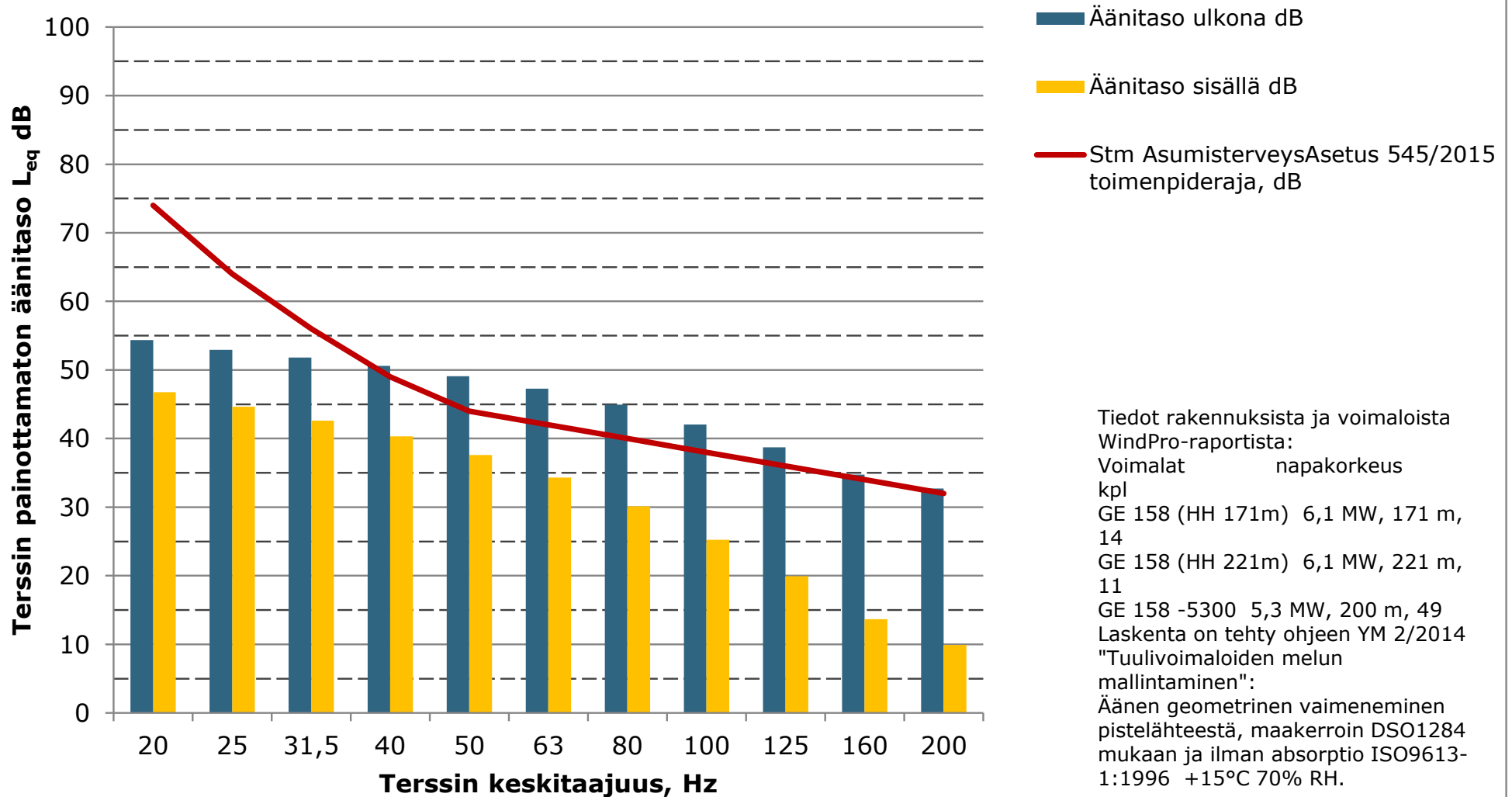




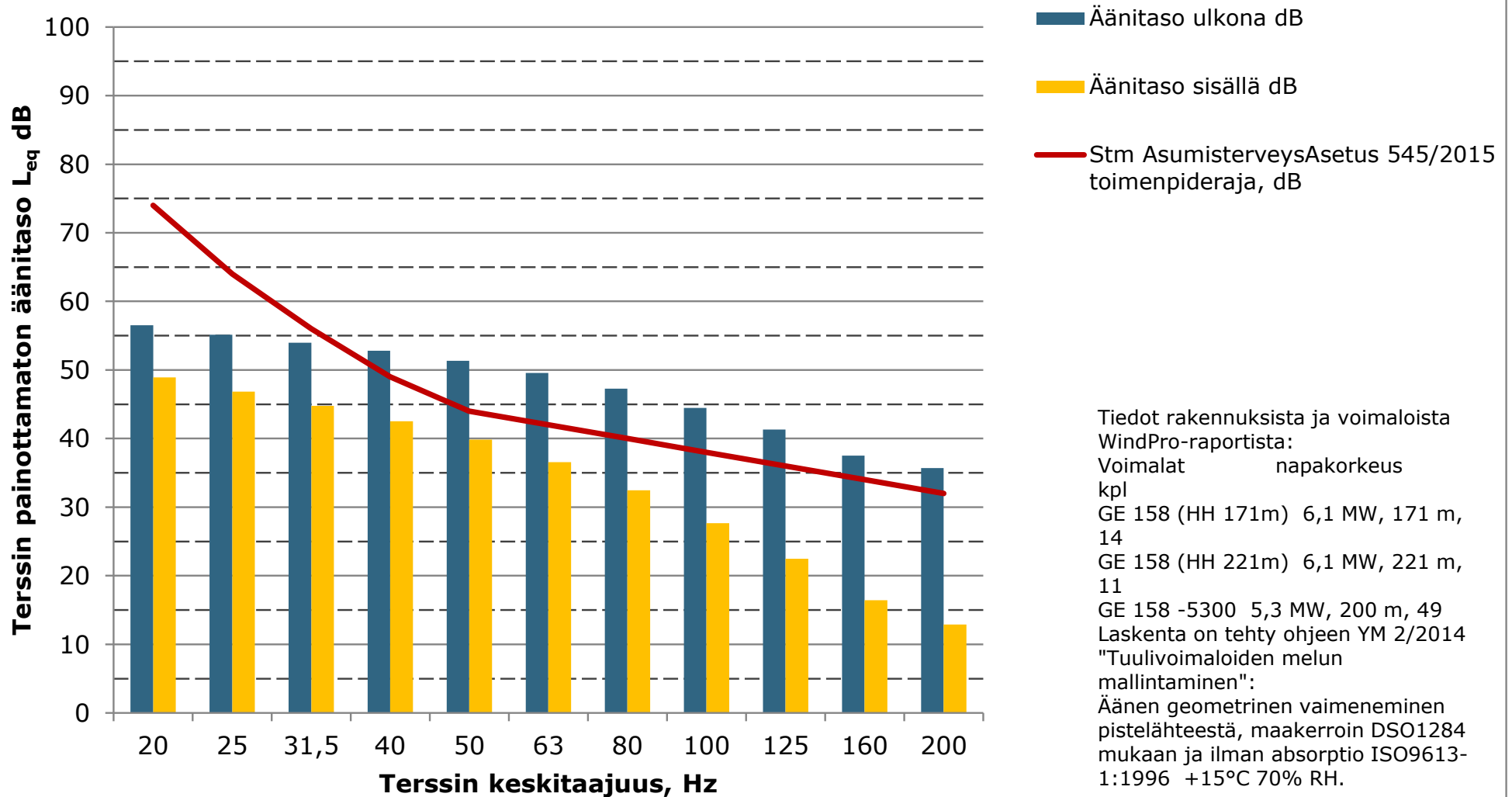
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus J  
(Ojantakasentie 88), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

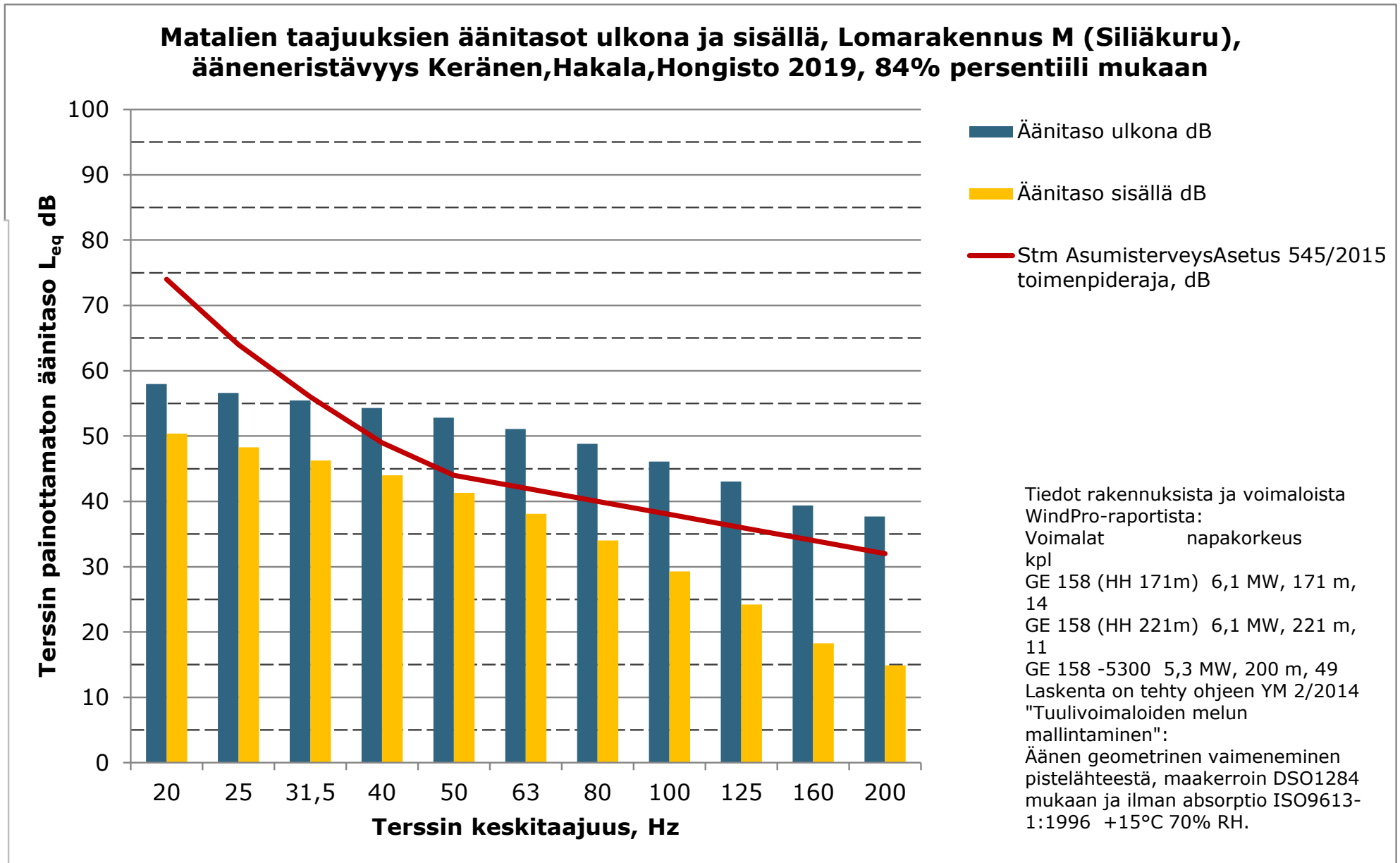


### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus K (Ollilantie 218), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan

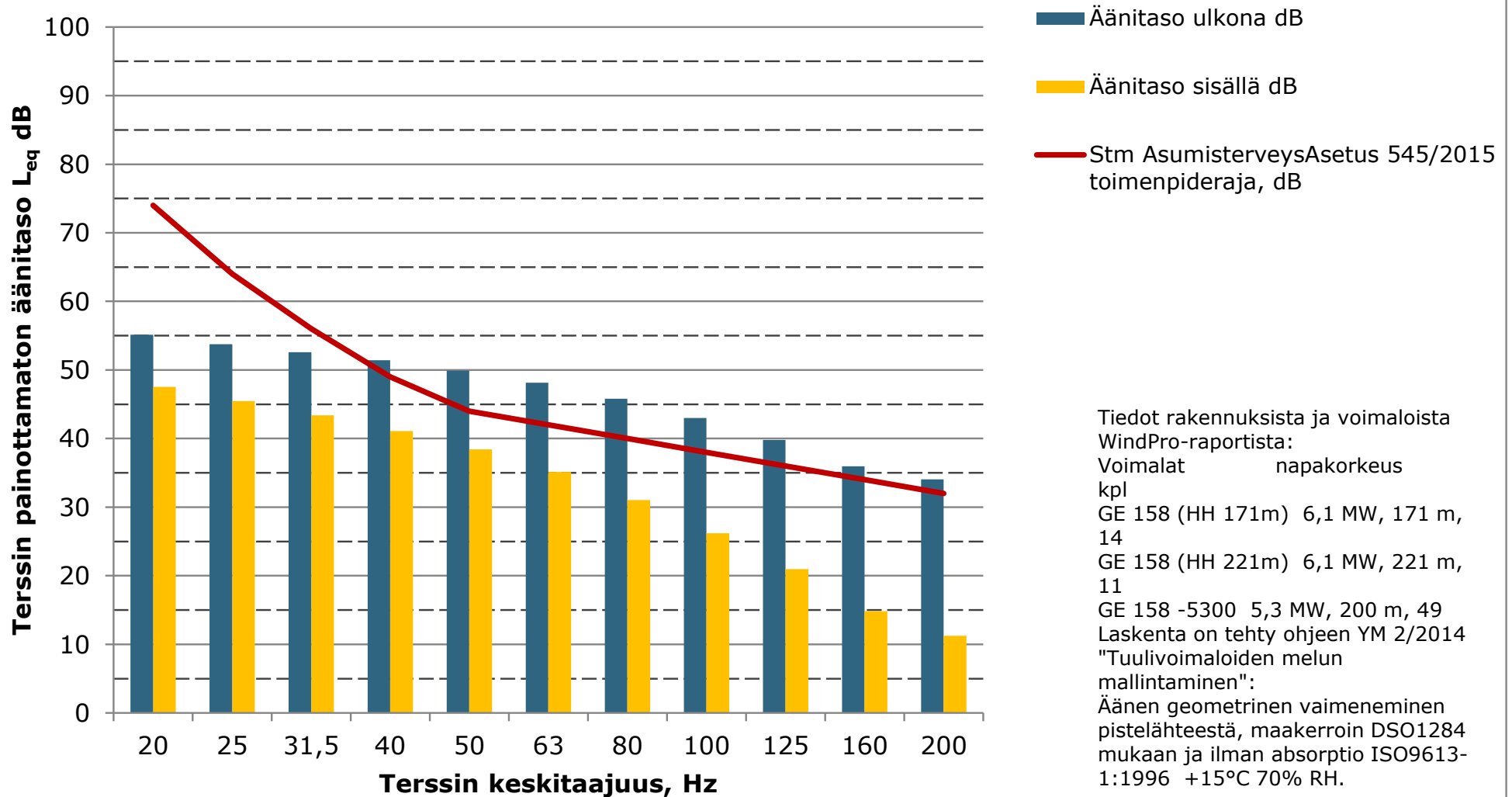


### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus L (Uusi-Kaikola), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan





### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus N (Pinolantie 406), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persenttiili mukaan

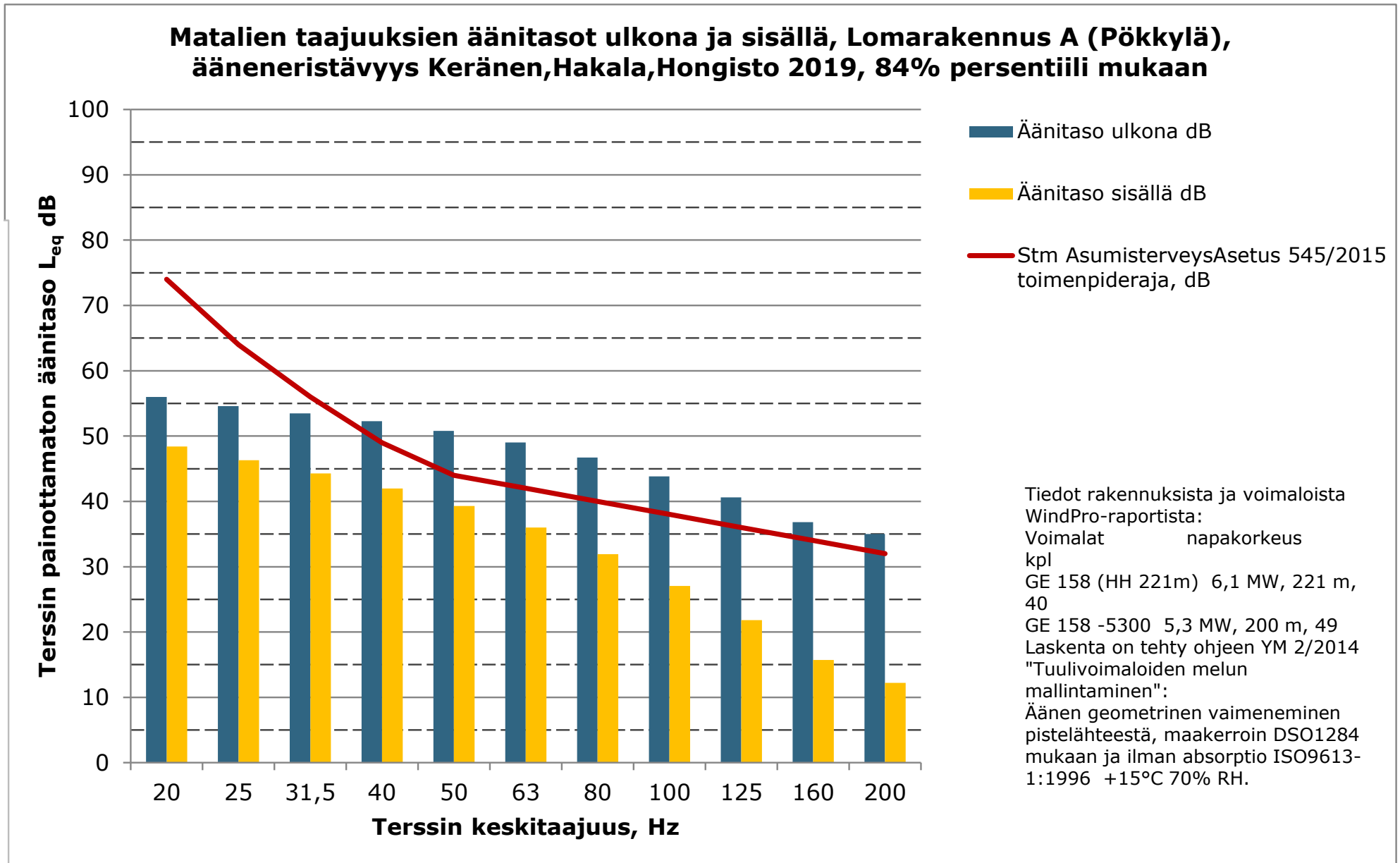


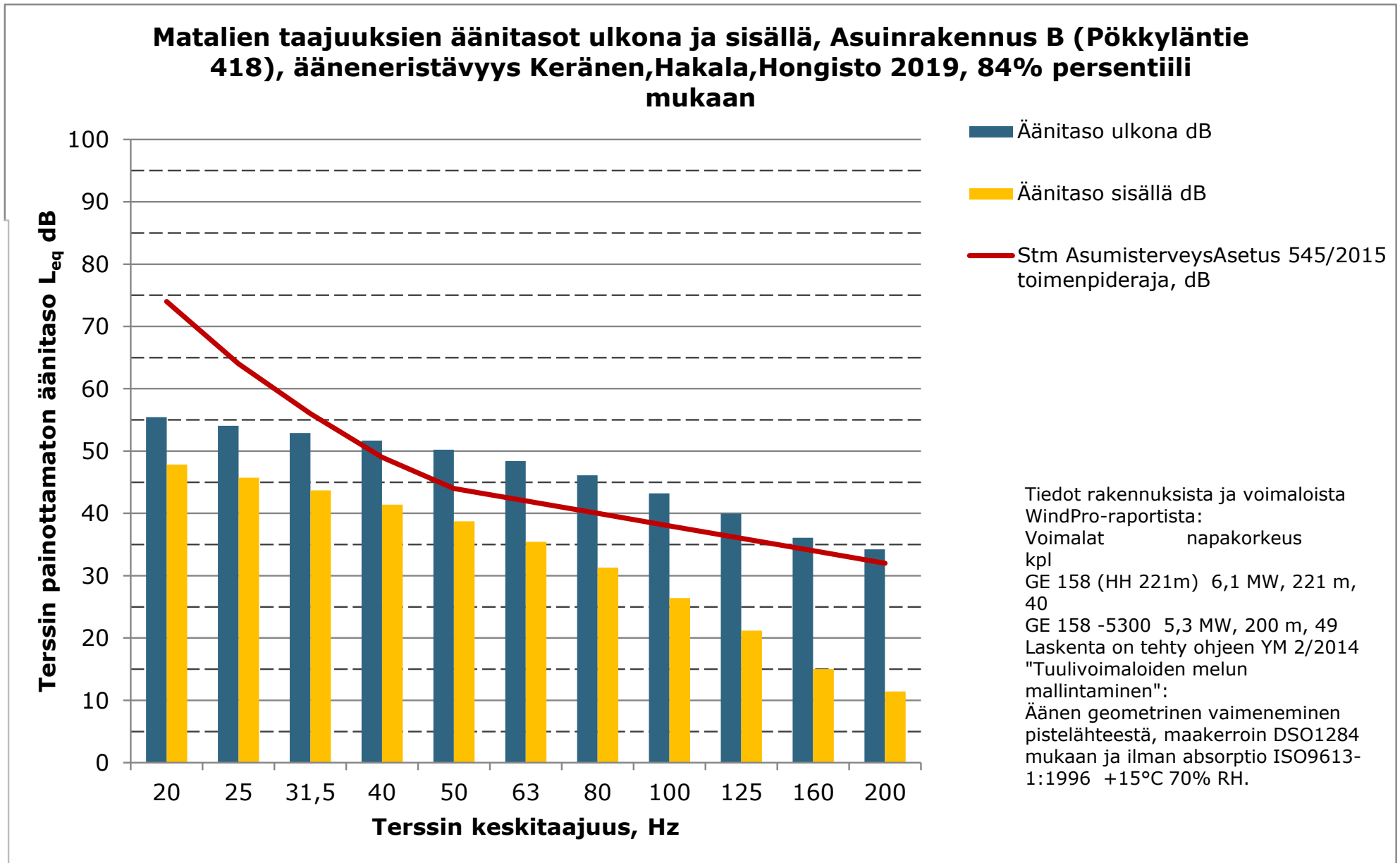


3.2.2023

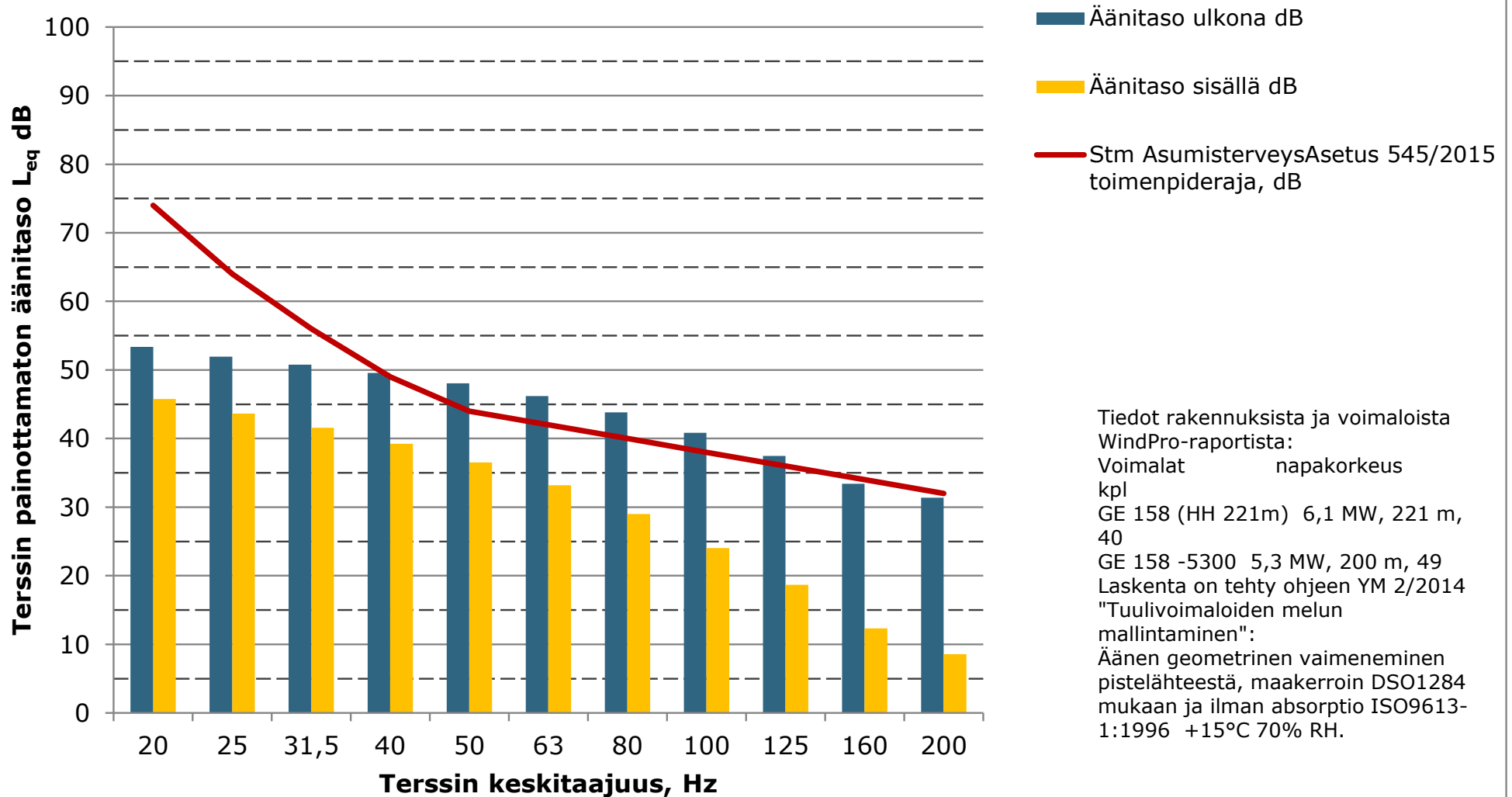
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## **Liite 15. Matalataajuisen melun yhteisvaikutuksen rakennuskohtaiset arvot - VE3**

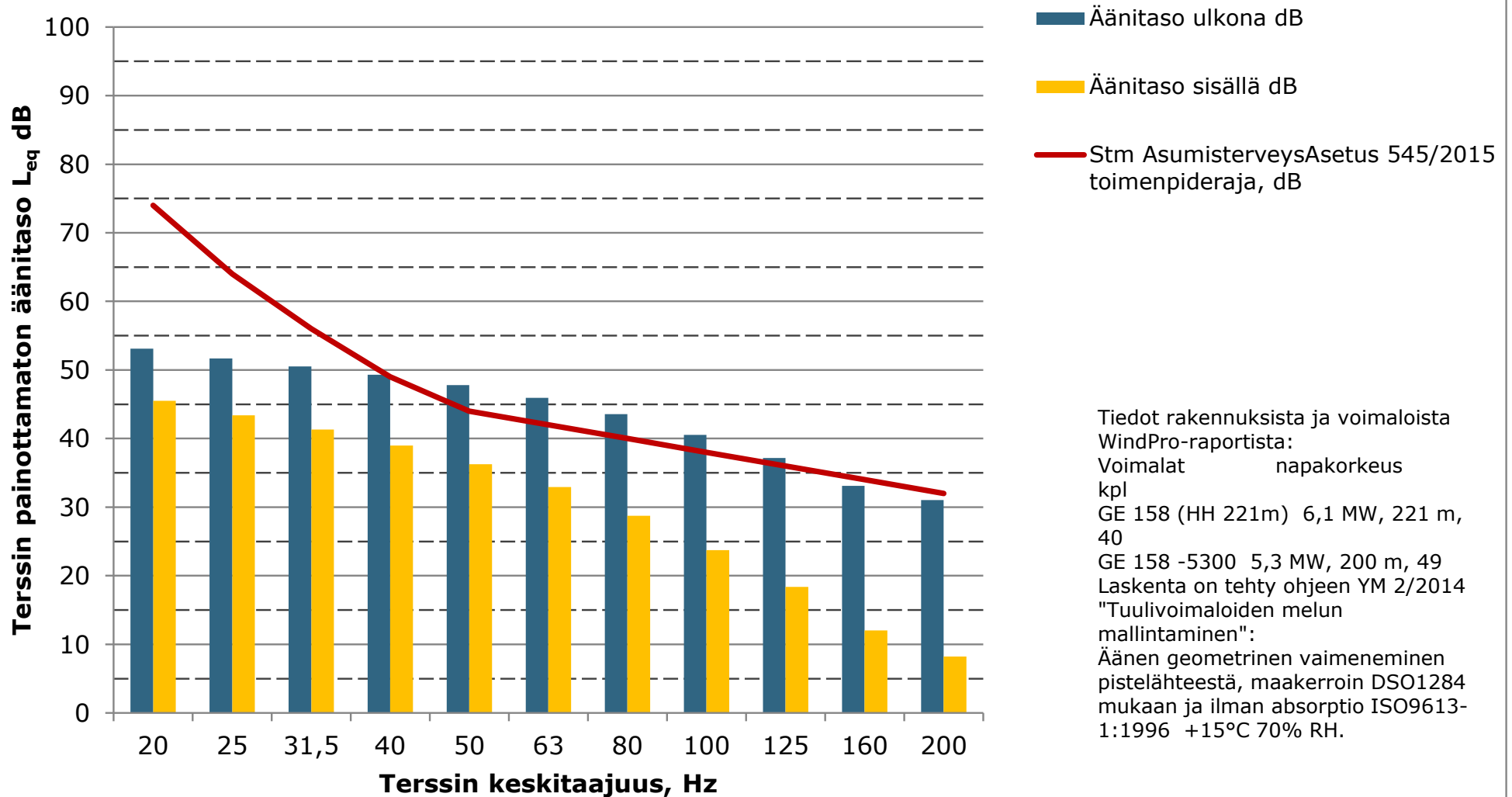




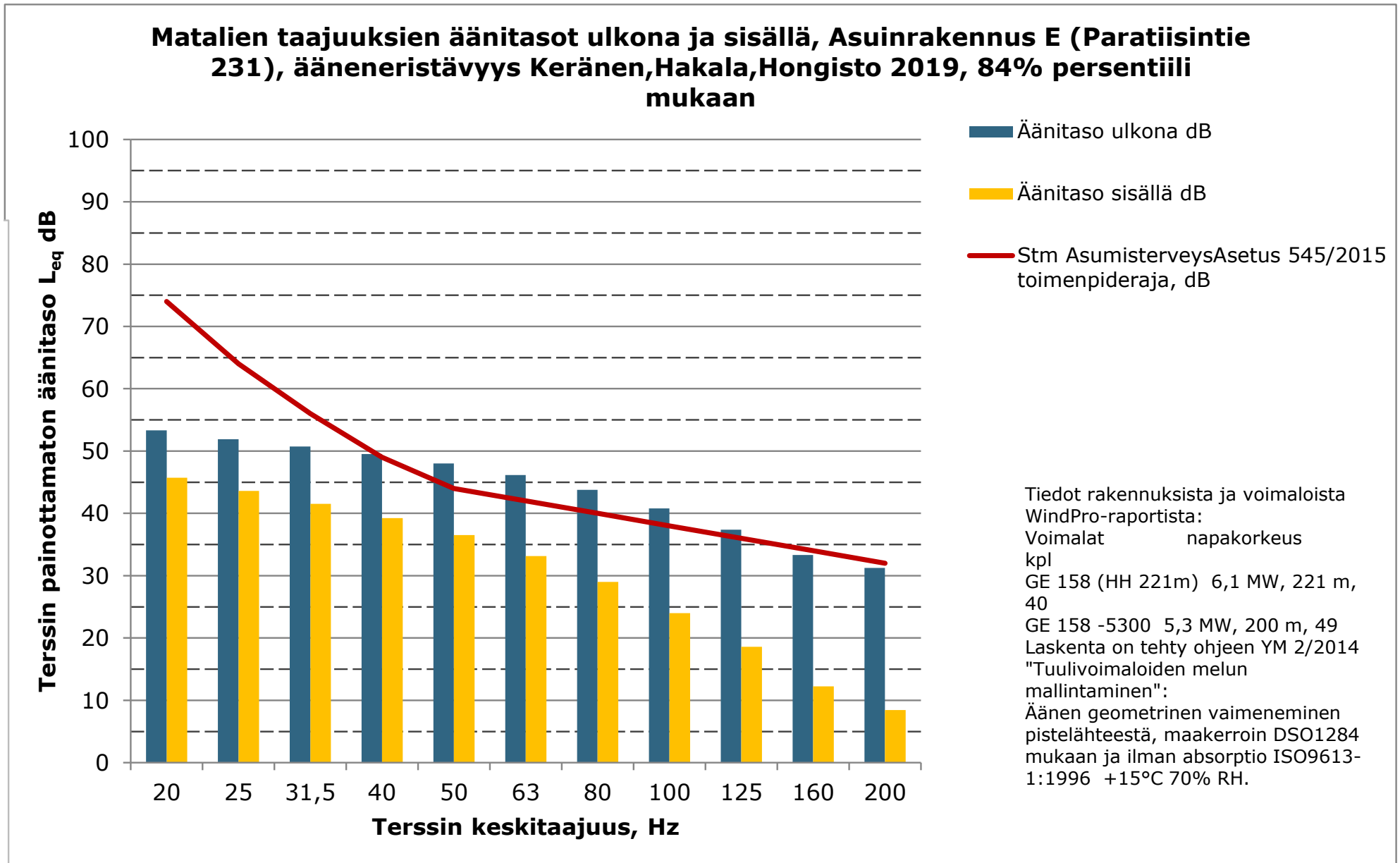
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus C  
(~Pökkyläntie 178), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%  
persentiili mukaan**



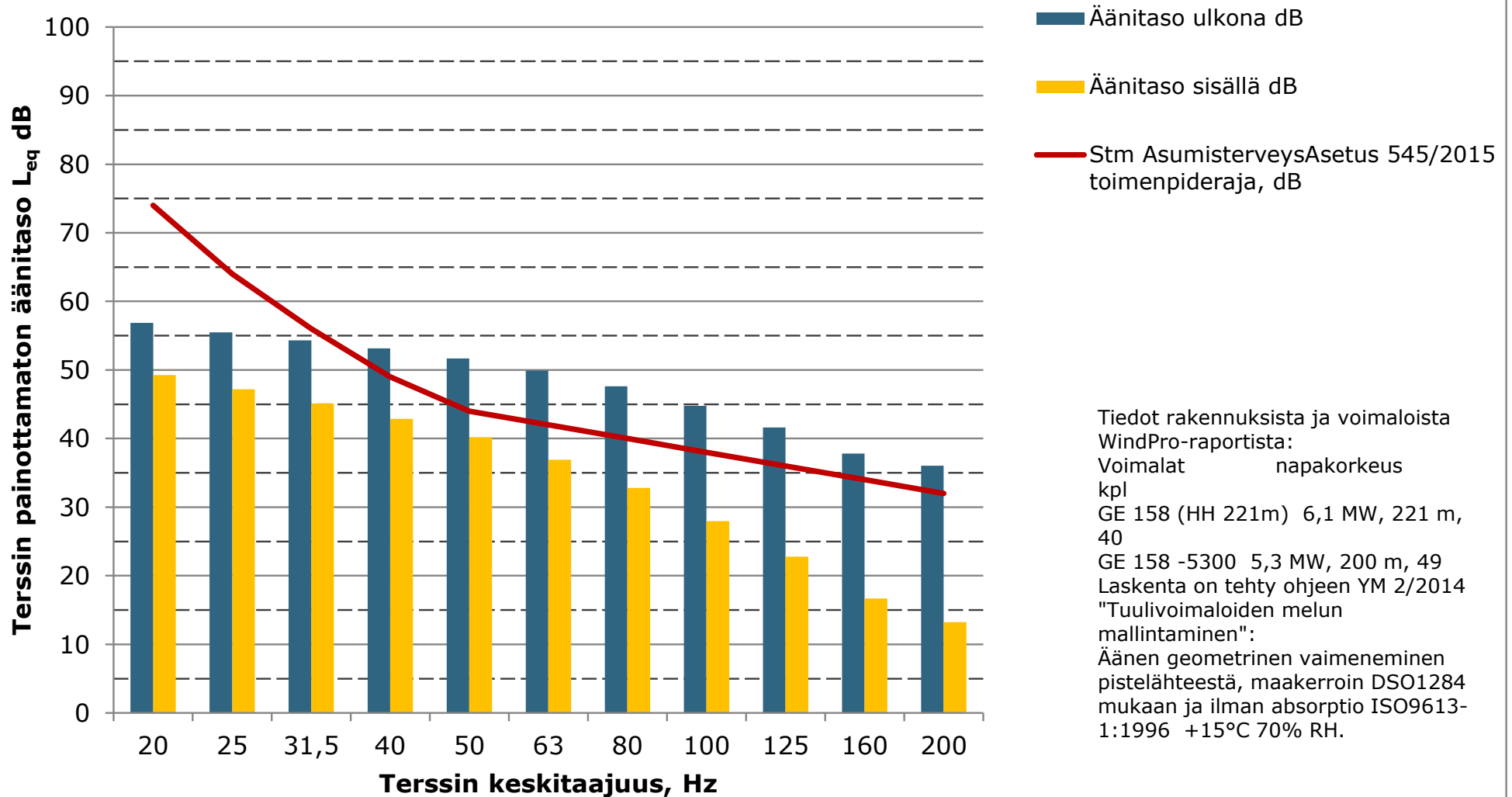
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus D  
(Luminevantie 162), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

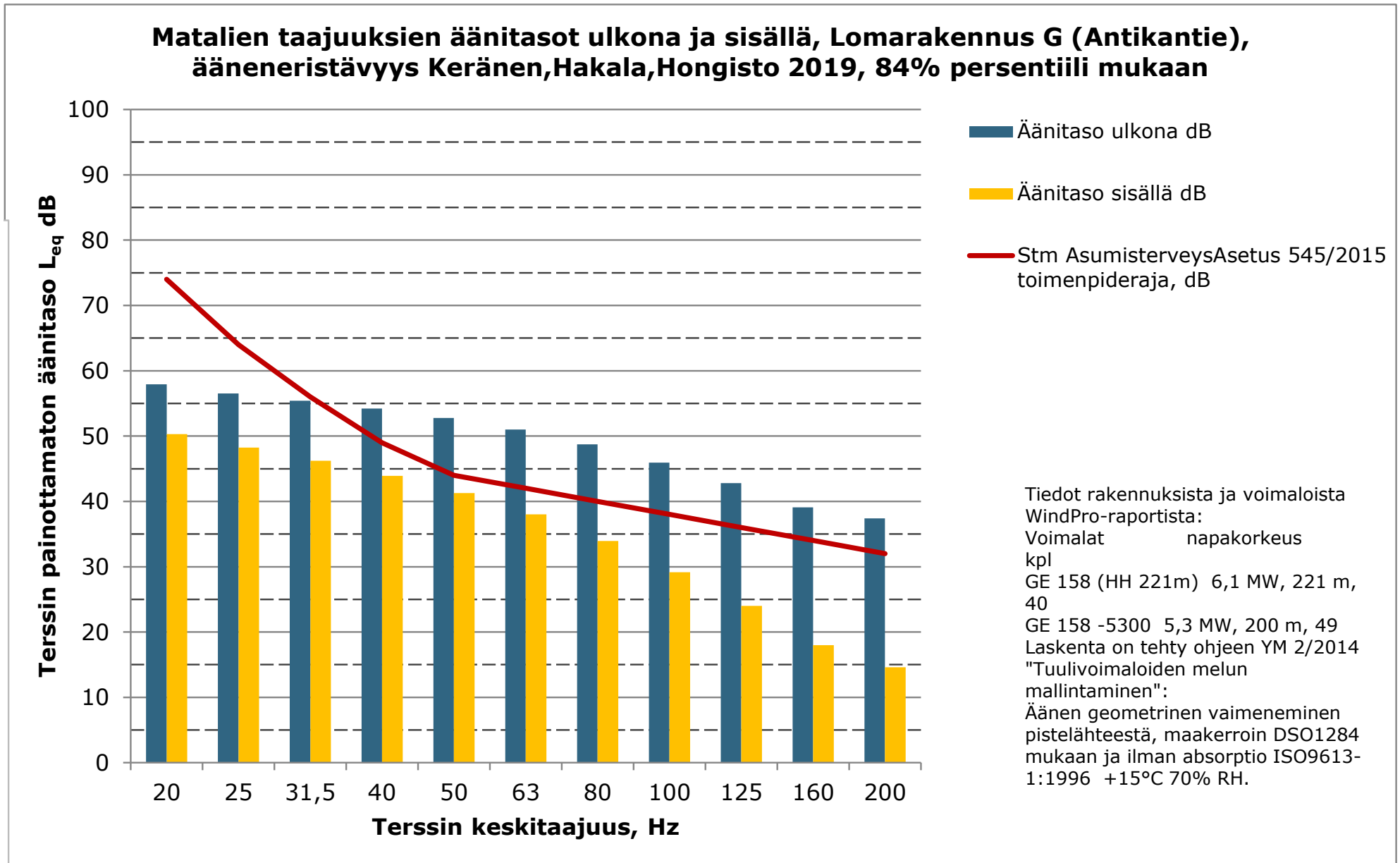


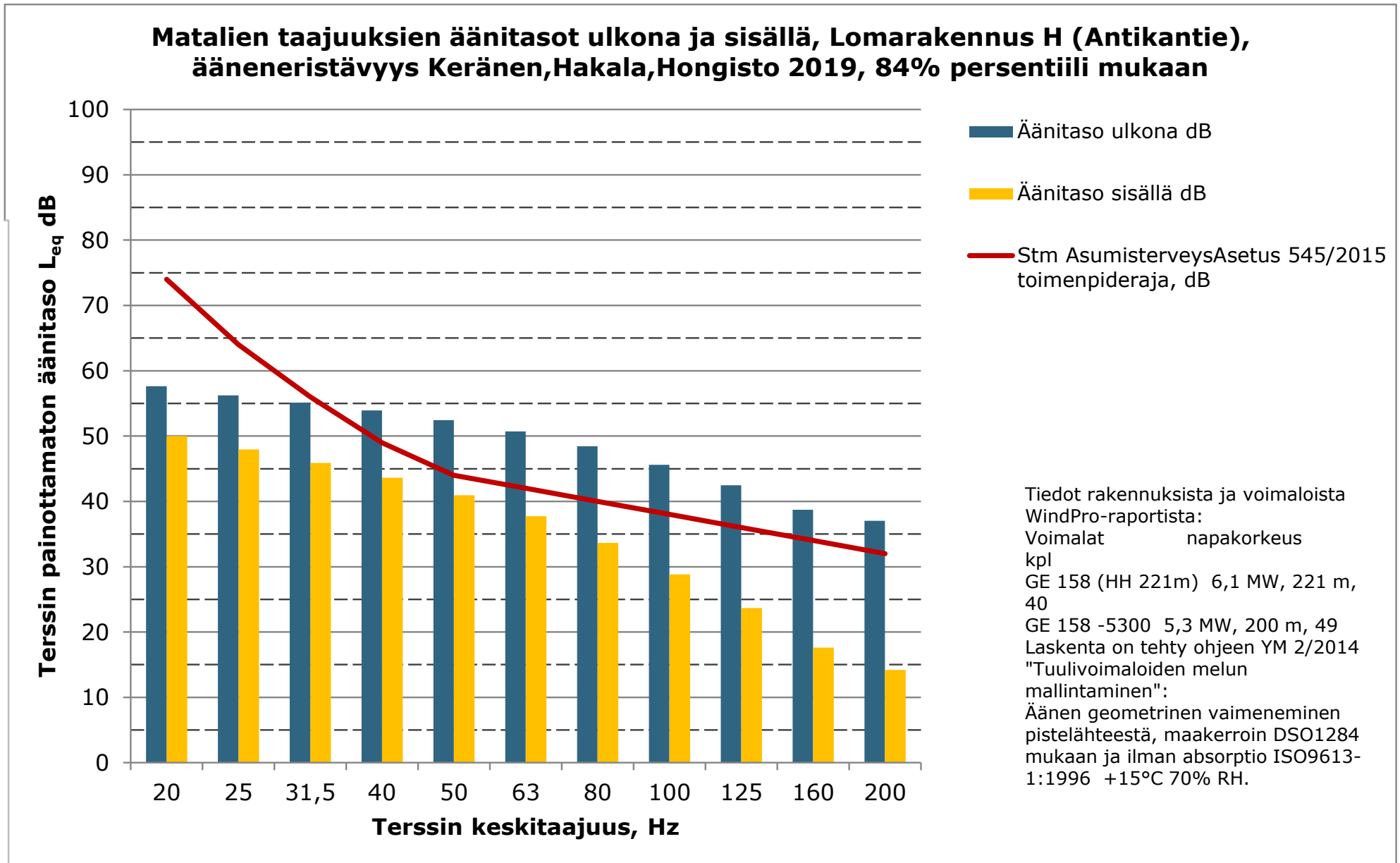




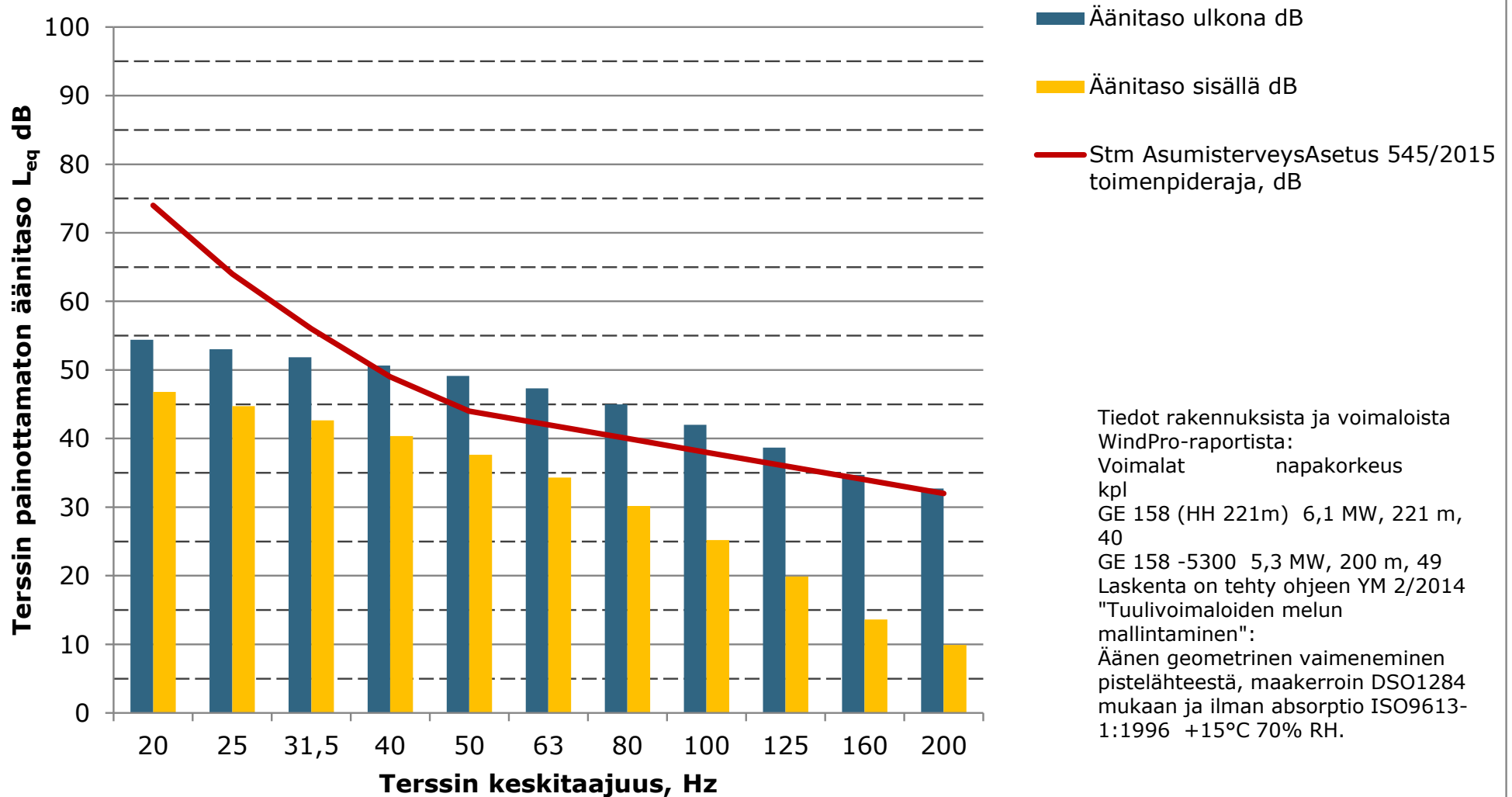
**Matalien taajuuksien äänitasot ulkona ja sisällä, Lomarakennus F  
(Isojärventie), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**





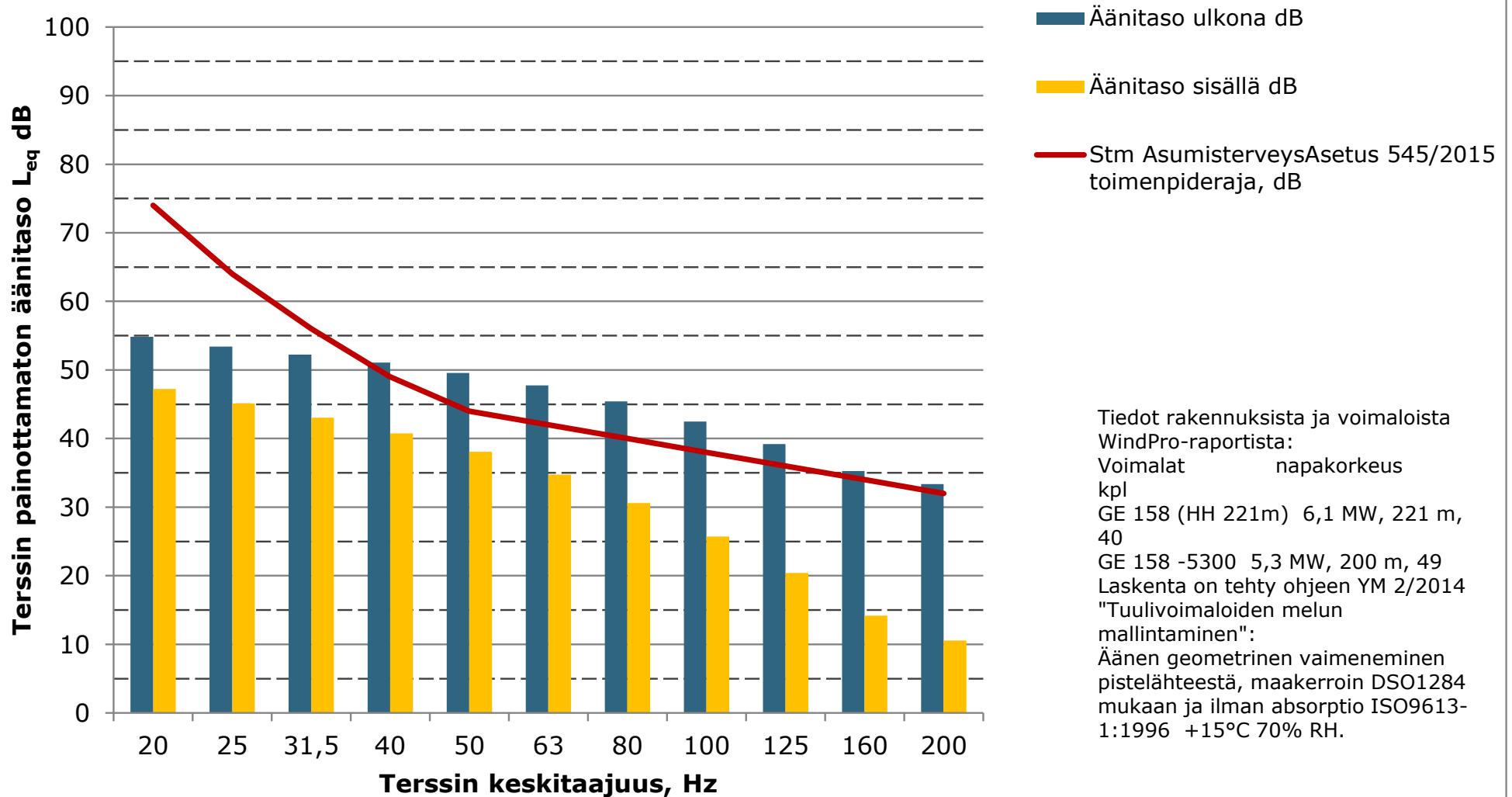


**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus I  
(Kalliokangas), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

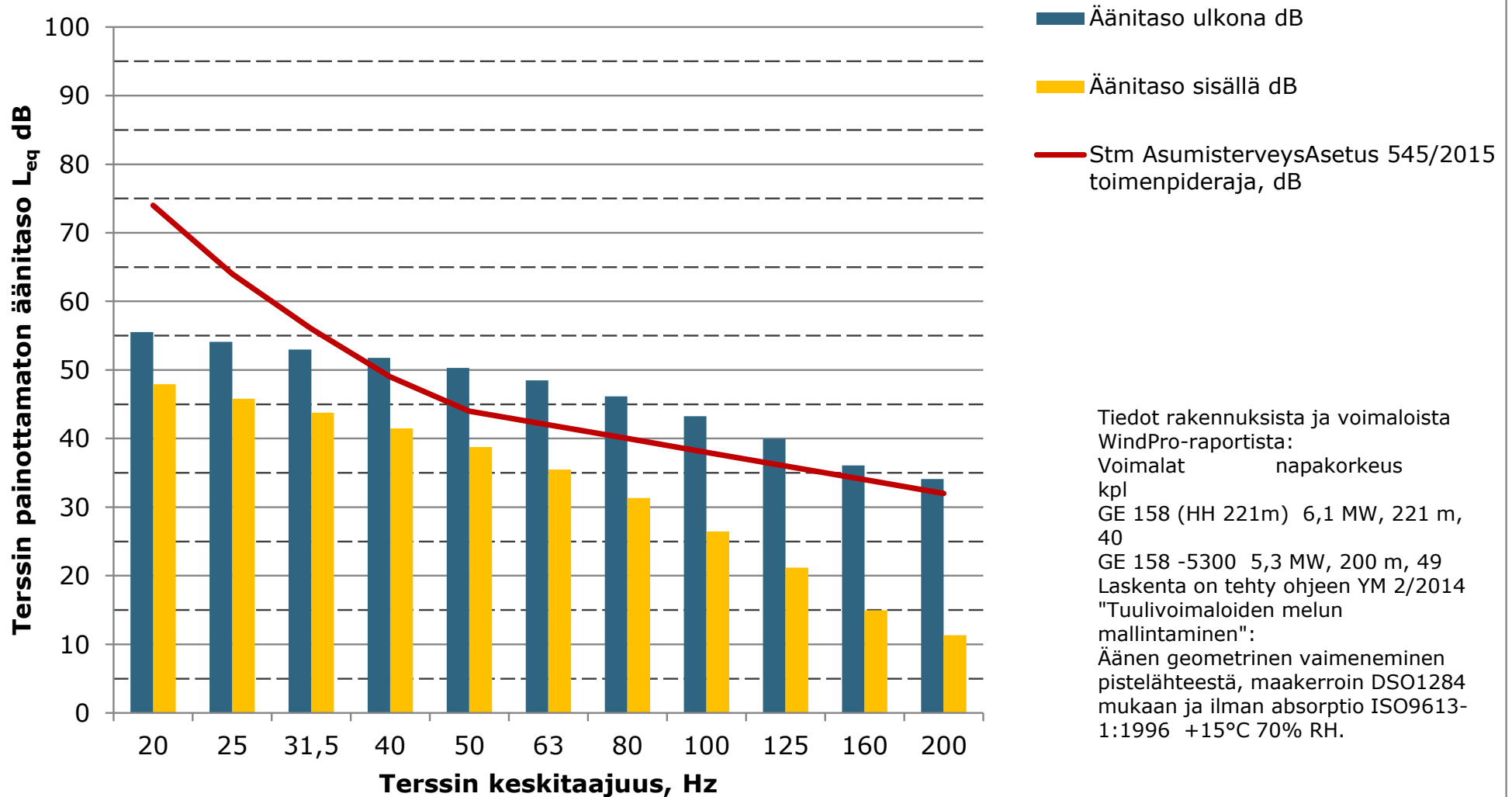




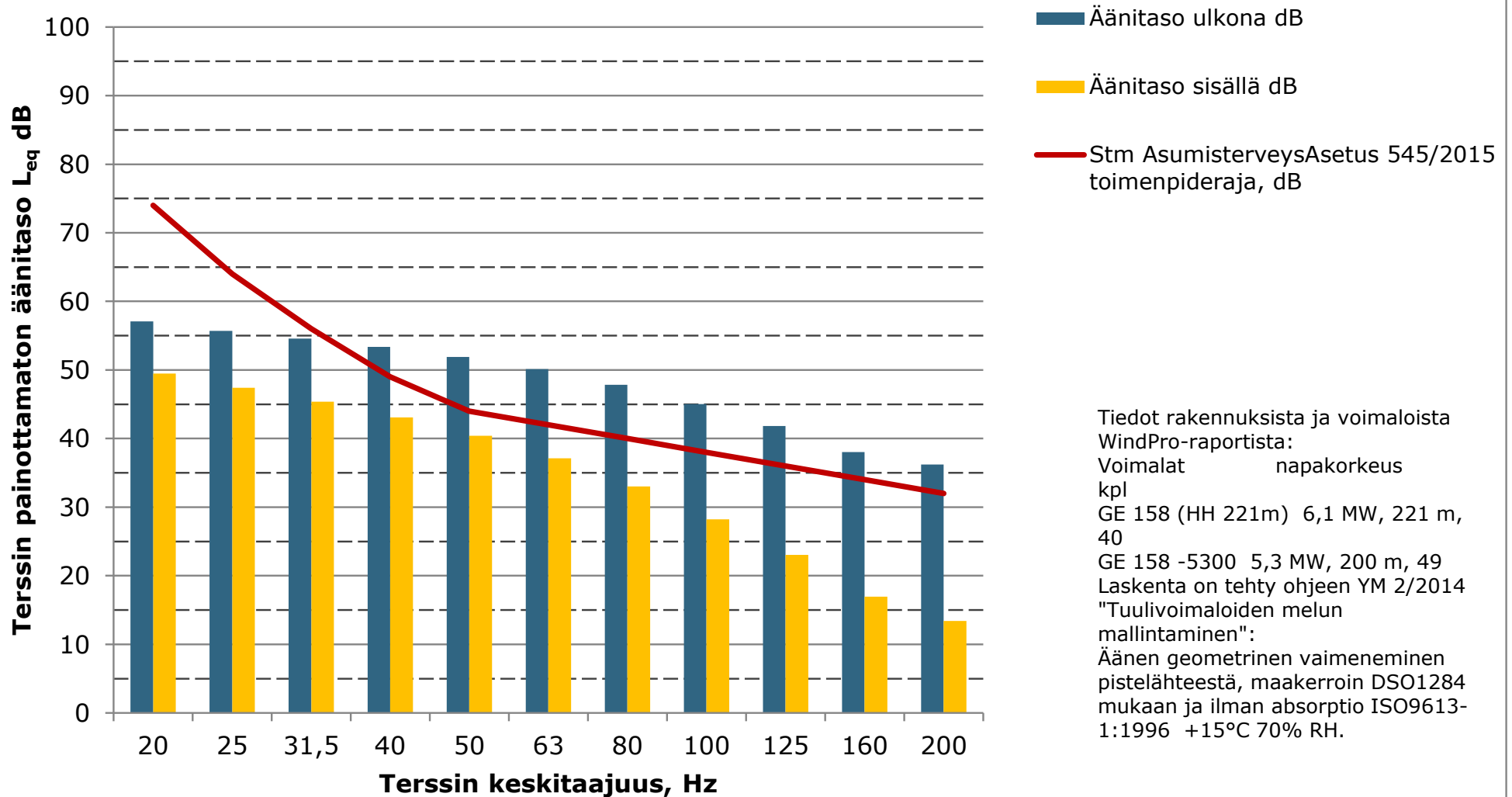
**Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus J  
(Ojantakasentie 88), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84%  
persentiili mukaan**

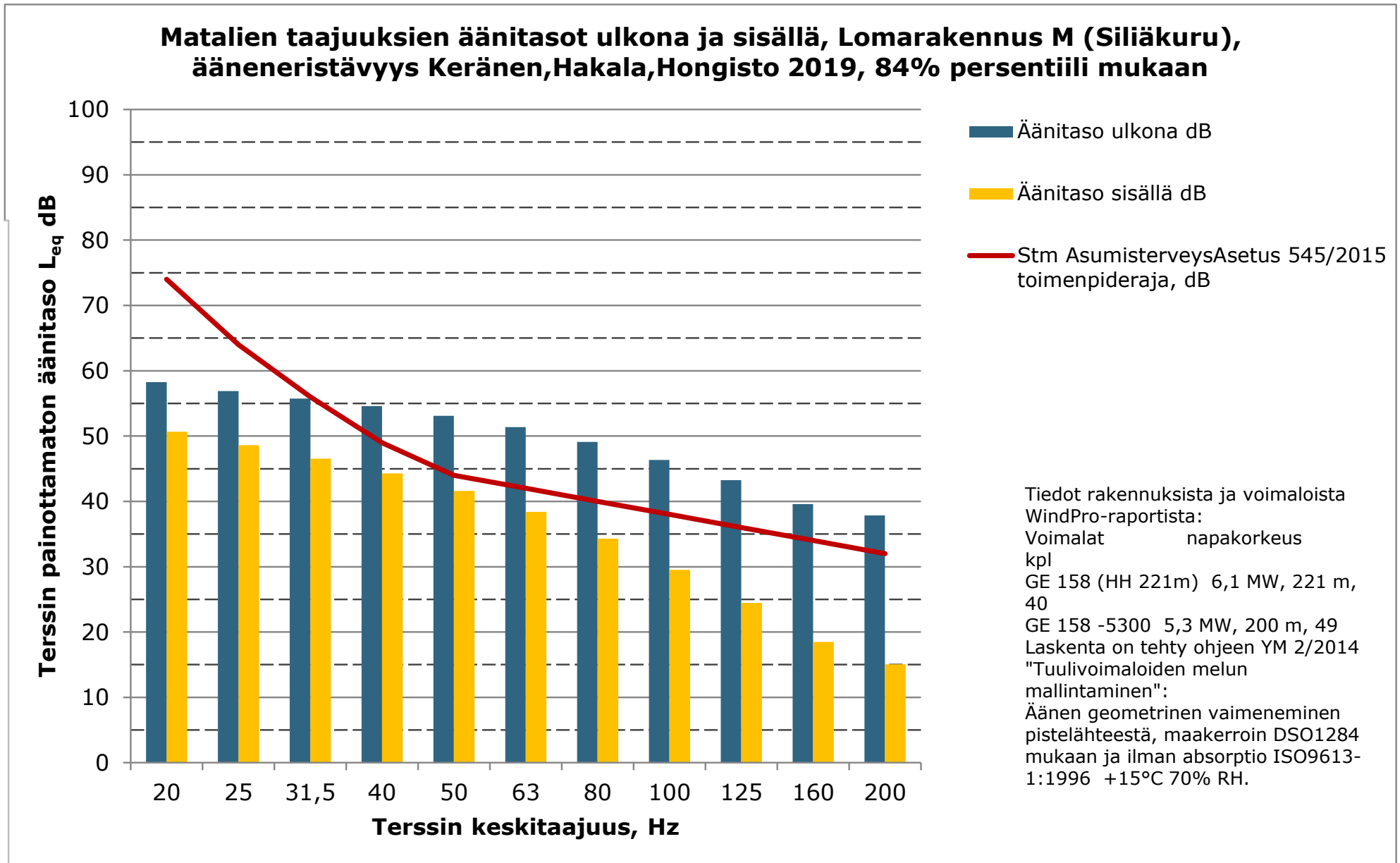


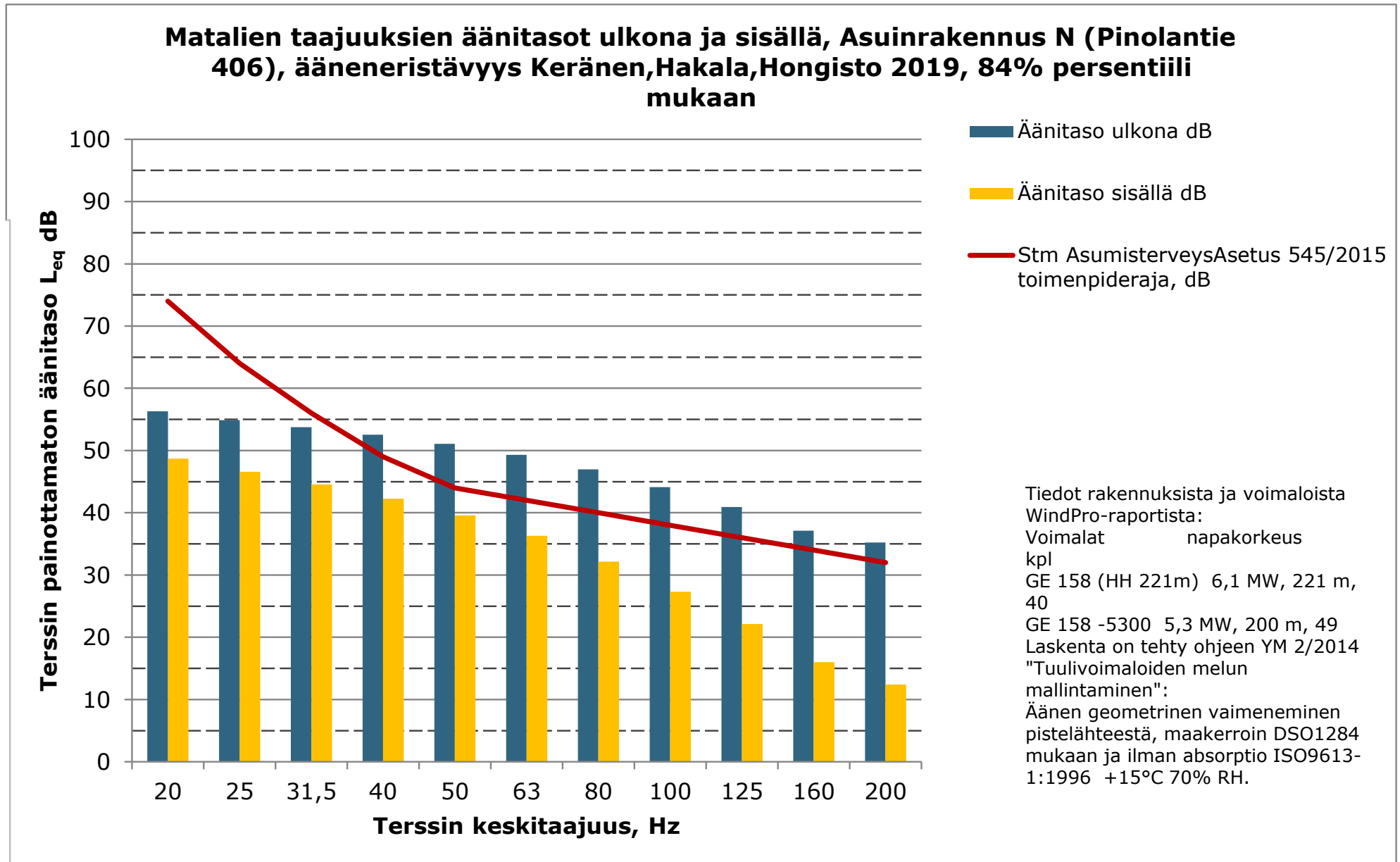
### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus K (Ollilantie 218), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan



### Matalien taajuuksien äänitasot ulkona ja sisällä, Asuinrakennus L (Uusi-Kaikola), ääneneristävyys Keränen, Hakala, Hongisto 2019, 84% persentiili mukaan









3.2.2023

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**Liite 16. Yhteisvaikutus varjostusmallinnuksen tulokset ”real case, no forest” - VE1**

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto1\_RealCase\_NoForest\_RD200m\_Puutionsaari

### Assumptions for shadow calculations

Maximum distance for influence

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

Please look in WTG table

Minimum sun height over horizon for influence 3 °

Day step for calculation 1 days

Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

MERRA2\_N64.000\_E025.000 (1)

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
536 402 373 411 605 882 1 053 1 105 978 762 634 656 8 397

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\_Rahkola-Hautakangas

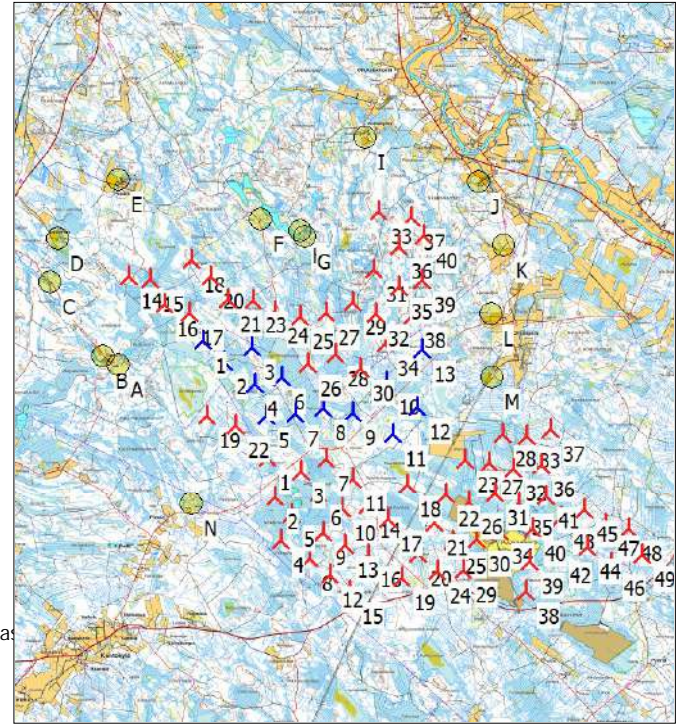
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

### WTGs



Scale 1:200 000  
New WTG Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
			[m]									
1	398 896	7 112 332	92,5	PUU01	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
1	397 208	7 115 412	87,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
2	399 097	7 111 286	95,0	PUU02	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
2	397 754	7 114 856	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
3	399 784	7 111 972	97,5	PUU03	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
3	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
4	399 264	7 110 151	96,9	PUU04	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
4	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
5	399 536	7 110 832	95,4	PUU05	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
5	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	400 239	7 111 382	96,6	PUU06	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	400 444	7 112 292	97,2	PUU07	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
8	400 019	7 109 649	100,0	PUU08	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
8	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
9	400 380	7 110 348	99,8	PUU09	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
9	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
10	400 876	7 110 966	99,4	PUU10	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
10	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
11	401 152	7 111 752	99,6	PUU11	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
11	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
12	400 549	7 109 232	102,5	PUU12	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
12	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
13	400 953	7 110 020	102,4	PUU13	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
13	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
14	401 537	7 111 046	104,5	PUU14	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
14	395 254	7 117 093	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
15	401 068	7 108 792	105,9	PUU15	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
15	395 819	7 117 022	82,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
16	401 564	7 109 758	104,2	PUU16	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4

To be continued on next page...

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto1\_RealCase\_NoForest\_RD200m\_Puutionsaari

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM
			[m]									
16	396 195	7 116 379	82,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
17	402 089	7 110 702	107,5	PUU17	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
17	396 858	7 116 145	84,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
18	402 589	7 111 603	106,9	PUU18	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
18	396 894	7 117 531	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
19	402 455	7 109 148	112,5	PUU19	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
19	397 303	7 113 442	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
20	402 889	7 109 778	110,0	PUU20	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
20	397 417	7 117 093	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
21	403 318	7 110 593	107,6	PUU21	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
21	397 854	7 116 507	90,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
22	398 058	7 113 189	92,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
22	403 622	7 111 352	107,4	PUU22	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
23	404 117	7 112 276	103,6	PUU23	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
23	398 529	7 116 484	94,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
24	403 379	7 109 327	115,0	PUU24	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
24	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
25	403 790	7 110 129	108,4	PUU25	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
25	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
26	404 210	7 111 152	105,6	PUU26	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
26	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
27	404 739	7 112 199	105,0	PUU27	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
27	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
28	405 100	7 112 943	100,4	PUU28	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
28	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
29	404 061	7 109 351	110,0	PUU29	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
29	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
30	404 420	7 110 174	107,1	PUU30	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
30	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
31	404 900	7 111 381	105,4	PUU31	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
31	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
32	405 395	7 112 030	102,3	PUU32	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
32	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
33	405 740	7 112 891	100,3	PUU33	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
33	401 837	7 118 791	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
34	405 042	7 110 380	105,7	PUU34	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
34	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
35	405 532	7 111 130	103,6	PUU35	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
35	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
36	406 114	7 112 133	103,3	PUU36	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
36	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
37	406 380	7 113 067	107,2	PUU37	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
37	402 692	7 118 655	96,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
38	405 707	7 108 791	110,8	PUU38	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
38	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
39	405 822	7 109 587	108,2	PUU39	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
39	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
40	405 893	7 110 455	105,0	PUU40	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
40	403 021	7 118 167	96,4	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
41	406 257	7 111 298	104,0	PUU41	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
42	406 558	7 109 872	106,7	PUU42	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
43	406 638	7 110 744	105,9	PUU43	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
44	407 324	7 109 954	108,7	PUU44	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
45	407 269	7 110 957	112,5	PUU45	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
46	407 963	7 109 542	113,4	PUU46	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
47	407 809	7 110 582	116,1	PUU47	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
48	408 414	7 110 457	120,0	PUU48	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
49	408 786	7 109 772	117,5	PUU49	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto1\_RealCase\_NoForest\_RD200m\_Puutionsaari  
 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]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:46
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	1:41
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	1:11
G	Lomarakennus G (Antikantie)	5:35
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	1:18
J	Asuinrakennus J (Ojantakasentie 88)	2:32
K	Asuinrakennus K (Ollilantie 218)	1:27
L	Asuinrakennus L (Uusi-Kaikola)	5:38
M	Lomarakennus M (Siliäkuru)	11:49
N	Asuinrakennus N (Pinolantie 406)	4:50

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

No.	Name	Expected [h/year]
1	PUU01	2:58
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (121)	0:00
2	PUU02	1:51
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (122)	0:00
3	PUU03	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (123)	0:00
4	PUU04	0:00
4	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (124)	0:00
5	PUU05	0:00
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (125)	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (126)	0:00
6	PUU06	0:00
7	PUU07	0:00
7	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (127)	0:00
8	PUU08	0:00
8	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (128)	0:00
9	PUU09	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (129)	0:00
10	PUU10	0:00
10	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (130)	0:00
11	PUU11	0:00
11	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (131)	0:00
12	PUU12	0:00

To be continued on next page...

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto1\_RealCase\_NoForest\_RD200m\_Puutionsaari

...continued from previous page

No.	Name	Expected [h/year]
12	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (132)	0:00
13	PUU13	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (133)	4:40
14	PUU14	0:00
14	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (134)	1:41
15	PUU15	0:00
15	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (135)	0:00
16	PUU16	0:00
16	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (136)	0:46
17	PUU17	0:00
17	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (137)	0:00
18	PUU18	0:00
18	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (138)	0:00
19	PUU19	0:00
19	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (139)	0:00
20	PUU20	0:00
20	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (140)	1:11
21	PUU21	0:00
21	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (141)	0:00
22	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (142)	0:00
22	PUU22	0:00
23	PUU23	1:05
23	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (143)	0:00
24	PUU24	0:00
24	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (144)	0:59
25	PUU25	0:00
25	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (145)	0:00
26	PUU26	0:00
26	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (146)	0:00
27	PUU27	1:18
27	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (147)	1:05
28	PUU28	2:40
28	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (148)	0:00
29	PUU29	0:00
29	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (149)	0:00
30	PUU30	0:00
30	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (150)	0:00
31	PUU31	0:00
31	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (151)	1:20
32	PUU32	0:00
32	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (152)	0:00
33	PUU33	2:01
33	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (153)	3:21
34	PUU34	0:00
34	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (154)	0:00
35	PUU35	0:00
35	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (155)	0:00
36	PUU36	0:00
36	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (156)	0:00
37	PUU37	1:30
37	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (157)	1:17
38	PUU38	0:00
38	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (158)	1:32
39	PUU39	0:00
39	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (159)	2:33
40	PUU40	0:00
40	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (160)	2:42
41	PUU41	0:00
42	PUU42	0:00
43	PUU43	0:00
44	PUU44	0:00
45	PUU45	0:00
46	PUU46	0:00
47	PUU47	0:00
48	PUU48	0:00
49	PUU49	0:00

Project:

Rahkola\_Hautakangas

Licensed user:

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Osmontie 34, PO Box 950

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Calculated:

30.1.2023 13.14/3.5.584

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto1\_RealCase\_NoForest\_RD200m\_Puutionsaari

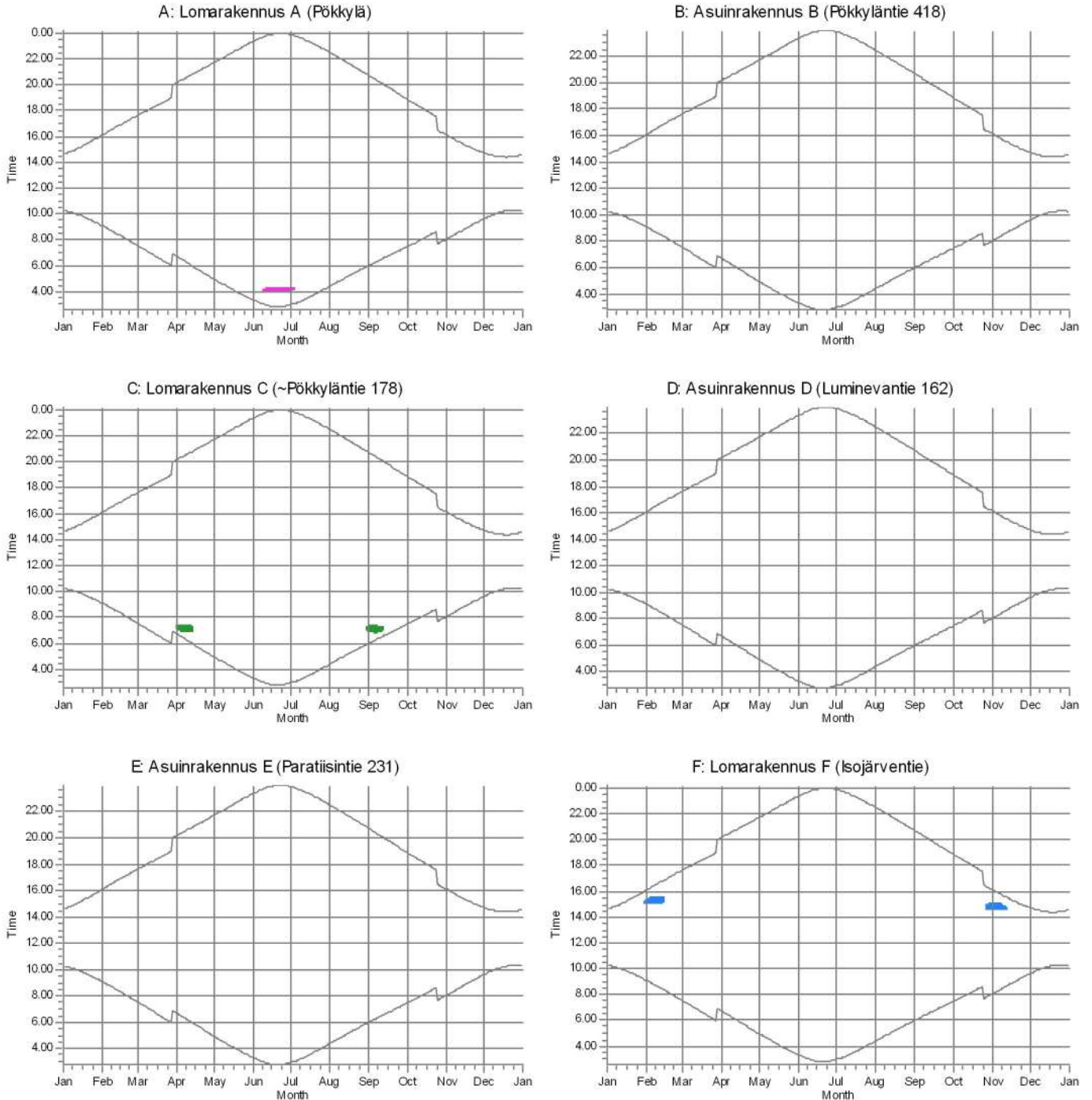
Total times in Receptor wise and WTG wise tables can differ, as a WTG can lead to flicker at 2 or more receptors simultaneously and/or receptors may receive flicker from 2 or more WTGs simultaneously.

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, graphical

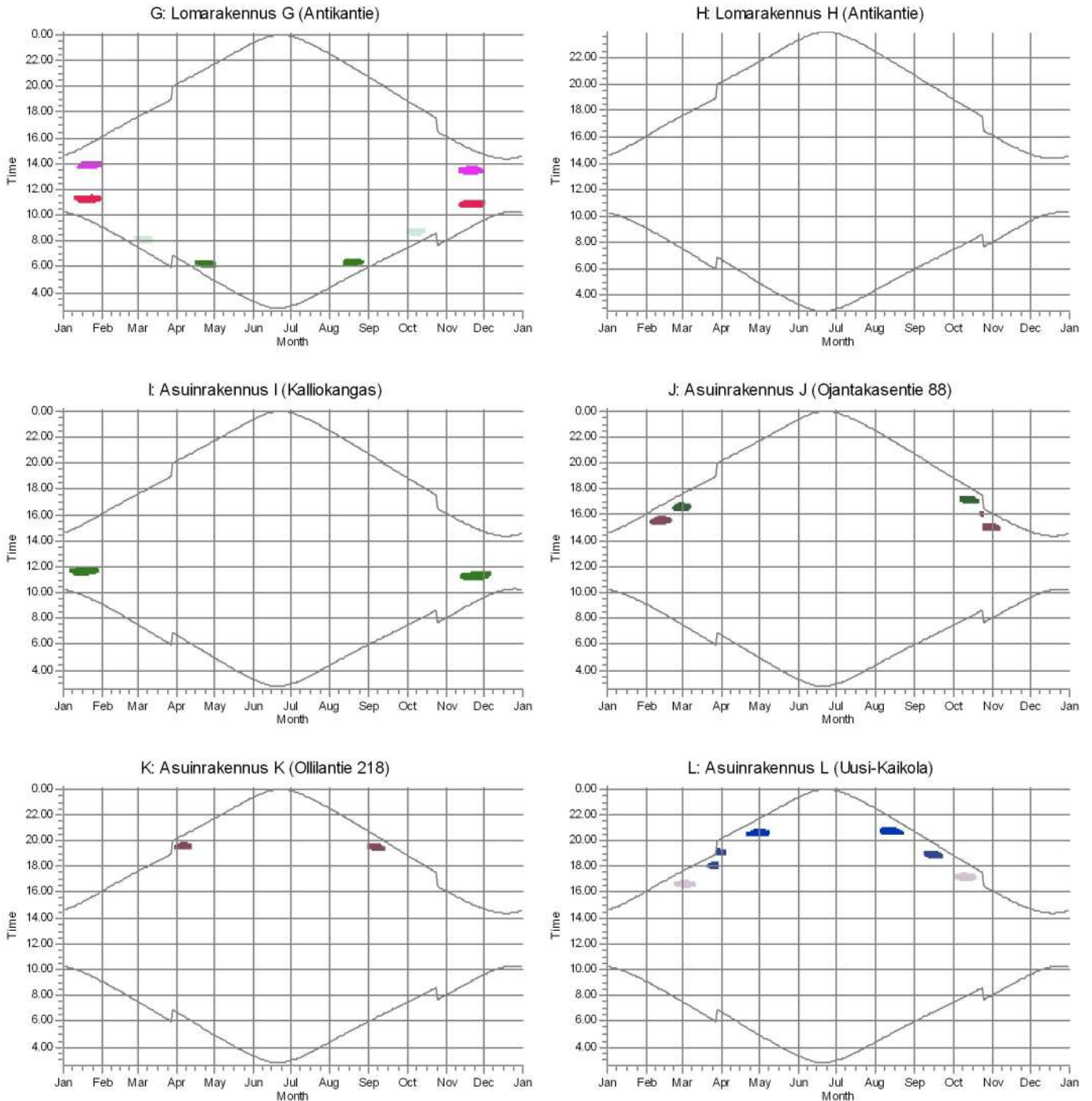
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoeto1\_RealCase\_NoForest\_RD200m\_Puutionsaari



WTG1  
■ 14. Generic Generic2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (134) ■ 16. Generic Generic2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (134) ■ 20. Generic Generic2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (140)

## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoeto1\_RealCase\_NoForest\_RD200m\_Puutionsaari

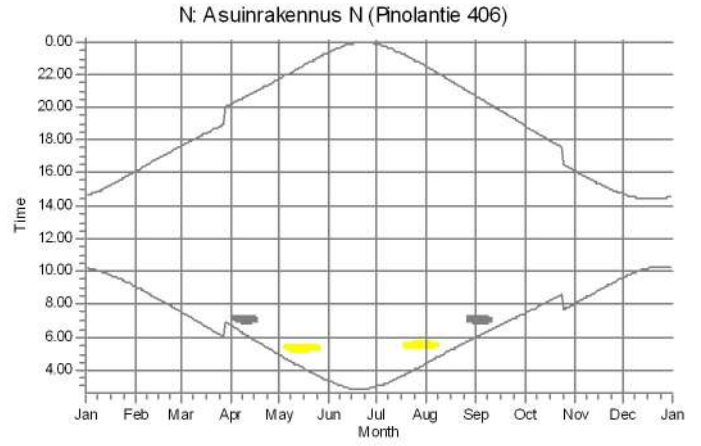
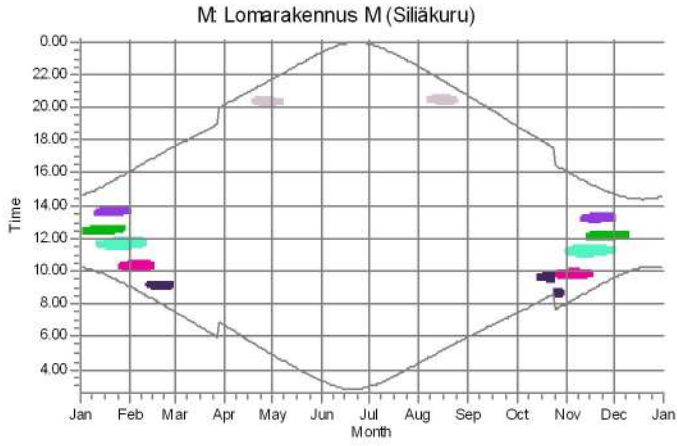


WTG:

13: Generic Generac2 7000.200.0 I0I hub: 200.0 m (TOT: 300.0 m) (133)	27: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (147)	33: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (153)	38: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (158)	40: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (160)
24: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (144)	31: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (151)	37: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (157)	39: Generic Generac2 7000.200.0 I0I hub: 150.0 m (TOT: 250.0 m) (159)	

## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto1\_RealCase\_NoForest\_RD200m\_Puutionsaari



WTG1  
1: PA101  
2: PA102

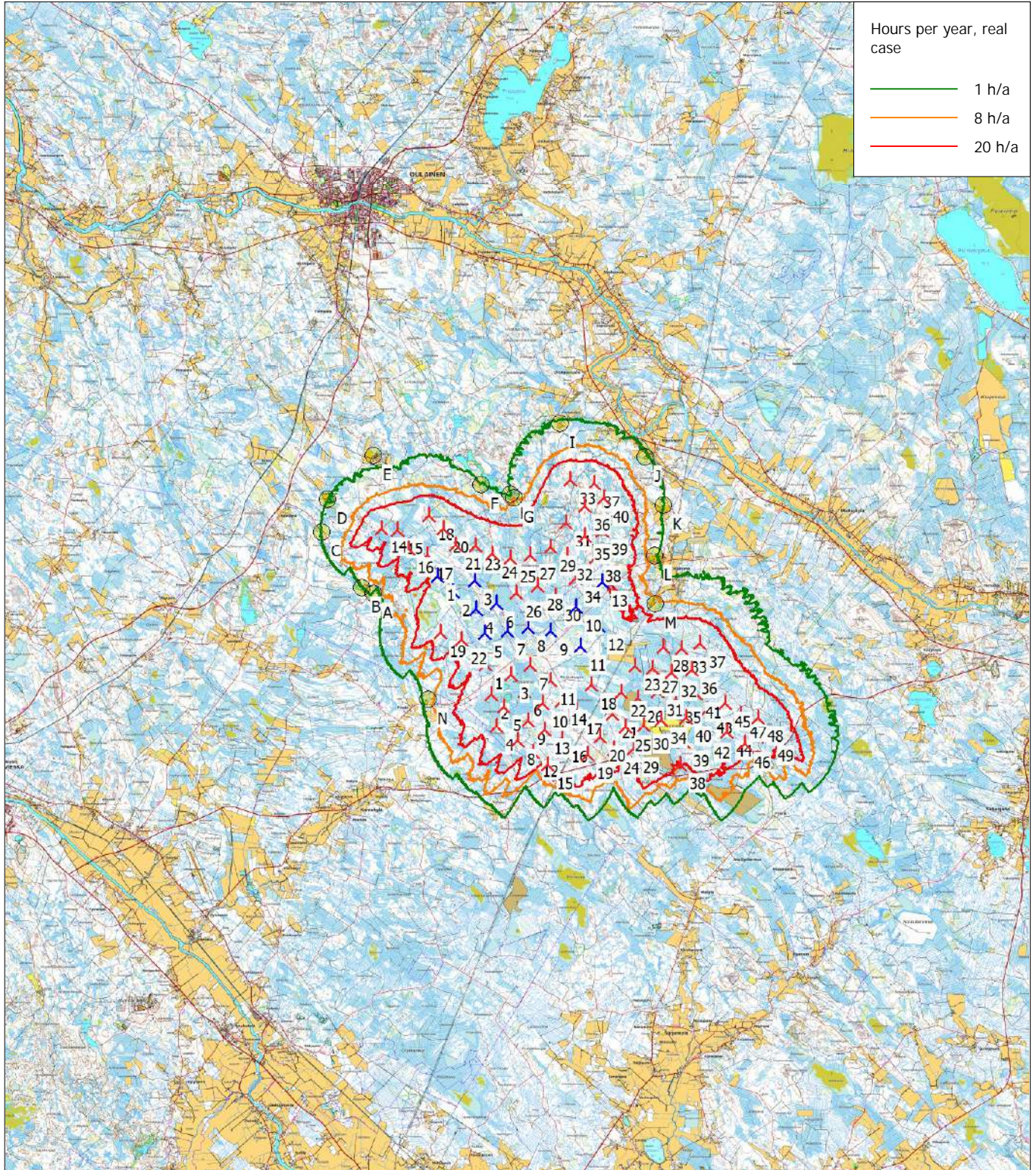
13: Generic\_GeneriQ\_7000\_200.0\_HOI\_hub\_200.0\_m\_(TOT: 300.0 m) (133)  
23: PA103  
27: PA107  
28: PA108

33: PA113  
37: PA117



## SHADOW - Map

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto1\_RealCase\_NoForest\_RD200m\_Puutionsaari



0 2,5 5 7,5 10km

Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 17. Yhteisvaikutus varjostusmallinnuksen tulokset ”real case, Luke forest” - VE1**

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

### Assumptions for shadow calculations

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

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

Sunshine probability S (Average daily sunshine hours) []  
 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

MERRA2\_N64.000\_E025.000 (1)

### Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
536	402	373	411	605	882	1053	1105	978	762	634	656	8397

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\_Rahkola-Hautakangas

Area object(s) used in calculation:

Area object (SE): (2)

Area object (SW): (3)

Area object (NE): (4)

Area object (NW): (5)

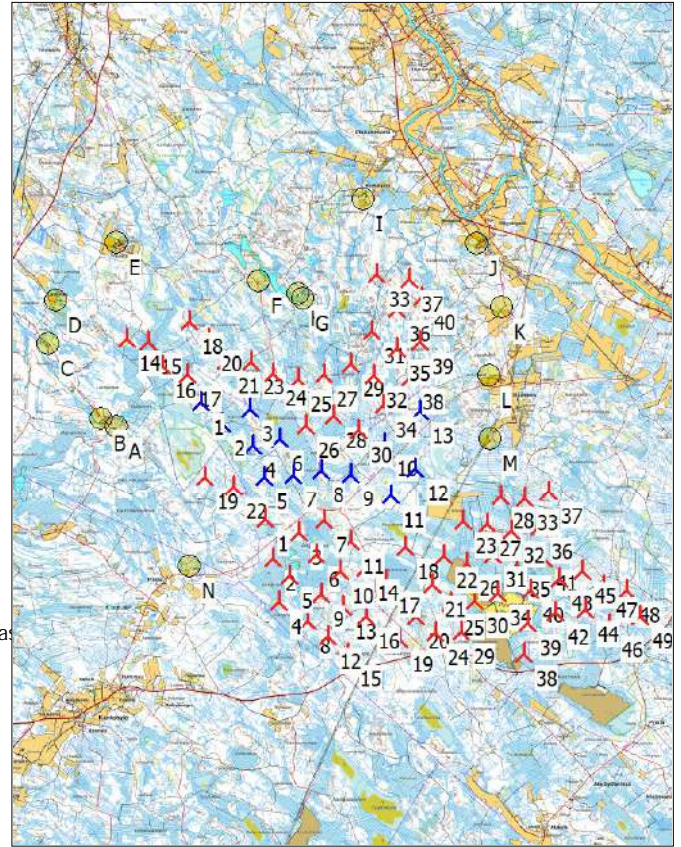
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

### WTGs



Scale 1:200 000  
 New WTG  
 Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
1	398 896	7 112 332	92,5	PUU01	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
1	397 208	7 115 412	87,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
2	399 097	7 111 286	95,0	PUU02	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
2	397 754	7 114 856	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
3	399 784	7 111 972	97,5	PUU03	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
3	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
4	399 264	7 110 151	96,9	PUU04	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
4	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
5	399 536	7 110 832	95,4	PUU05	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
5	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	400 239	7 111 382	96,6	PUU06	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	400 444	7 112 292	97,2	PUU07	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
8	400 019	7 109 649	100,0	PUU08	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
8	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
9	400 380	7 110 348	99,8	PUU09	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
9	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
10	400 876	7 110 966	99,4	PUU10	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
10	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
11	401 152	7 111 752	99,6	PUU11	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
11	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
12	400 549	7 109 232	102,5	PUU12	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
12	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
13	400 953	7 110 020	102,4	PUU13	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
13	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4

To be continued on next page...



## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data		
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM [RPM]	
14	401 537	7 111 046	104,5	PUU14	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
14	395 254	7 117 093	87,5	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
15	401 068	7 108 792	105,9	PUU15	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
15	395 819	7 117 022	82,9	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
16	401 564	7 109 758	104,2	PUU16	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
16	396 195	7 116 379	82,5	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
17	402 089	7 110 702	107,5	PUU17	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
17	396 858	7 116 145	84,9	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
18	402 589	7 111 603	106,9	PUU18	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
18	396 894	7 117 531	90,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
19	402 455	7 109 148	112,5	PUU19	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
19	397 303	7 113 442	87,5	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
20	402 889	7 109 778	110,0	PUU20	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
20	397 417	7 117 093	90,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
21	403 318	7 110 593	107,6	PUU21	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
21	397 854	7 116 507	90,9	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
22	398 058	7 113 189	92,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
22	403 622	7 111 352	107,4	PUU22	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
23	404 117	7 112 276	103,6	PUU23	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
23	398 529	7 116 484	94,2	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
24	403 379	7 109 327	115,0	PUU24	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
24	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
25	403 790	7 110 129	108,4	PUU25	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
25	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
26	404 210	7 111 152	105,6	PUU26	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
26	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
27	404 739	7 112 199	105,0	PUU27	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
27	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
28	405 100	7 112 943	100,4	PUU28	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
28	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
29	404 061	7 109 351	110,0	PUU29	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
29	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
30	404 420	7 110 174	107,1	PUU30	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
30	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
31	404 900	7 111 381	105,4	PUU31	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
31	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
32	405 395	7 112 030	102,3	PUU32	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
32	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
33	405 740	7 112 891	100,3	PUU33	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
33	401 837	7 118 791	95,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
34	405 042	7 110 380	105,7	PUU34	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
34	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
35	405 532	7 111 130	103,6	PUU35	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
35	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
36	406 114	7 112 133	103,3	PUU36	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
36	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
37	406 380	7 113 067	107,2	PUU37	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
37	402 692	7 118 655	96,2	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
38	405 707	7 108 791	110,8	PUU38	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
38	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
39	405 822	7 109 587	108,2	PUU39	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
39	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
40	405 893	7 110 455	105,0	PUU40	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
40	403 021	7 118 167	96,4	Generic Generic2 7000 200.0 !O!	...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
41	406 257	7 111 298	104,0	PUU41	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
42	406 558	7 109 872	106,7	PUU42	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
43	406 638	7 110 744	105,9	PUU43	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
44	407 324	7 109 954	108,7	PUU44	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
45	407 269	7 110 957	112,5	PUU45	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
46	407 963	7 109 542	113,4	PUU46	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
47	407 809	7 110 582	116,1	PUU47	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
48	408 414	7 110 457	120,0	PUU48	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	
49	408 786	7 109 772	117,5	PUU49	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4	

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoeto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari  
 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]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:00
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	0:00
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	0:00
G	Lomarakennus G (Antikantie)	2:05
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	1:18
J	Asuinrakennus J (Ojantakasentie 88)	0:00
K	Asuinrakennus K (Ollilantie 218)	0:00
L	Asuinrakennus L (Uusi-Kaikola)	3:05
M	Lomarakennus M (Siliäkuru)	3:06
N	Asuinrakennus N (Pinolantie 406)	0:00

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

No.	Name	Expected [h/year]
1	PUU01	0:00
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (121)	0:00
2	PUU02	0:00
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (122)	0:00
3	PUU03	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (123)	0:00
4	PUU04	0:00
4	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (124)	0:00
5	PUU05	0:00
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (125)	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (126)	0:00
6	PUU06	0:00
7	PUU07	0:00
7	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (127)	0:00
8	PUU08	0:00
8	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (128)	0:00
9	PUU09	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (129)	0:00
10	PUU10	0:00
10	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (130)	0:00
11	PUU11	0:00
11	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (131)	0:00
12	PUU12	0:00

To be continued on next page...

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoeto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

...continued from previous page

No.	Name	Expected [h/year]
12	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (132)	0:00
13	PUU13	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (133)	4:40
14	PUU14	0:00
14	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (134)	0:00
15	PUU15	0:00
15	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (135)	0:00
16	PUU16	0:00
16	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (136)	0:00
17	PUU17	0:00
17	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (137)	0:00
18	PUU18	0:00
18	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (138)	0:00
19	PUU19	0:00
19	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (139)	0:00
20	PUU20	0:00
20	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (140)	0:00
21	PUU21	0:00
21	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (141)	0:00
22	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (142)	0:00
22	PUU22	0:00
23	PUU23	0:00
23	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (143)	0:00
24	PUU24	0:00
24	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (144)	0:59
25	PUU25	0:00
25	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (145)	0:00
26	PUU26	0:00
26	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (146)	0:00
27	PUU27	0:00
27	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (147)	1:05
28	PUU28	0:00
28	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (148)	0:00
29	PUU29	0:00
29	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (149)	0:00
30	PUU30	0:00
30	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (150)	0:00
31	PUU31	0:00
31	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (151)	0:00
32	PUU32	0:00
32	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (152)	0:00
33	PUU33	0:00
33	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (153)	1:18
34	PUU34	0:00
34	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (154)	0:00
35	PUU35	0:00
35	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (155)	0:00
36	PUU36	0:00
36	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (156)	0:00
37	PUU37	0:00
37	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (157)	0:00
38	PUU38	0:00
38	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (158)	1:32
39	PUU39	0:00
39	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (159)	0:00
40	PUU40	0:00
40	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (160)	0:00
41	PUU41	0:00
42	PUU42	0:00
43	PUU43	0:00
44	PUU44	0:00
45	PUU45	0:00
46	PUU46	0:00
47	PUU47	0:00
48	PUU48	0:00
49	PUU49	0:00

Project:

Rahkola\_Hautakangas

Licensed user:

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Calculated:

30.1.2023 16.30/3.5.584

## SHADOW - Main Result

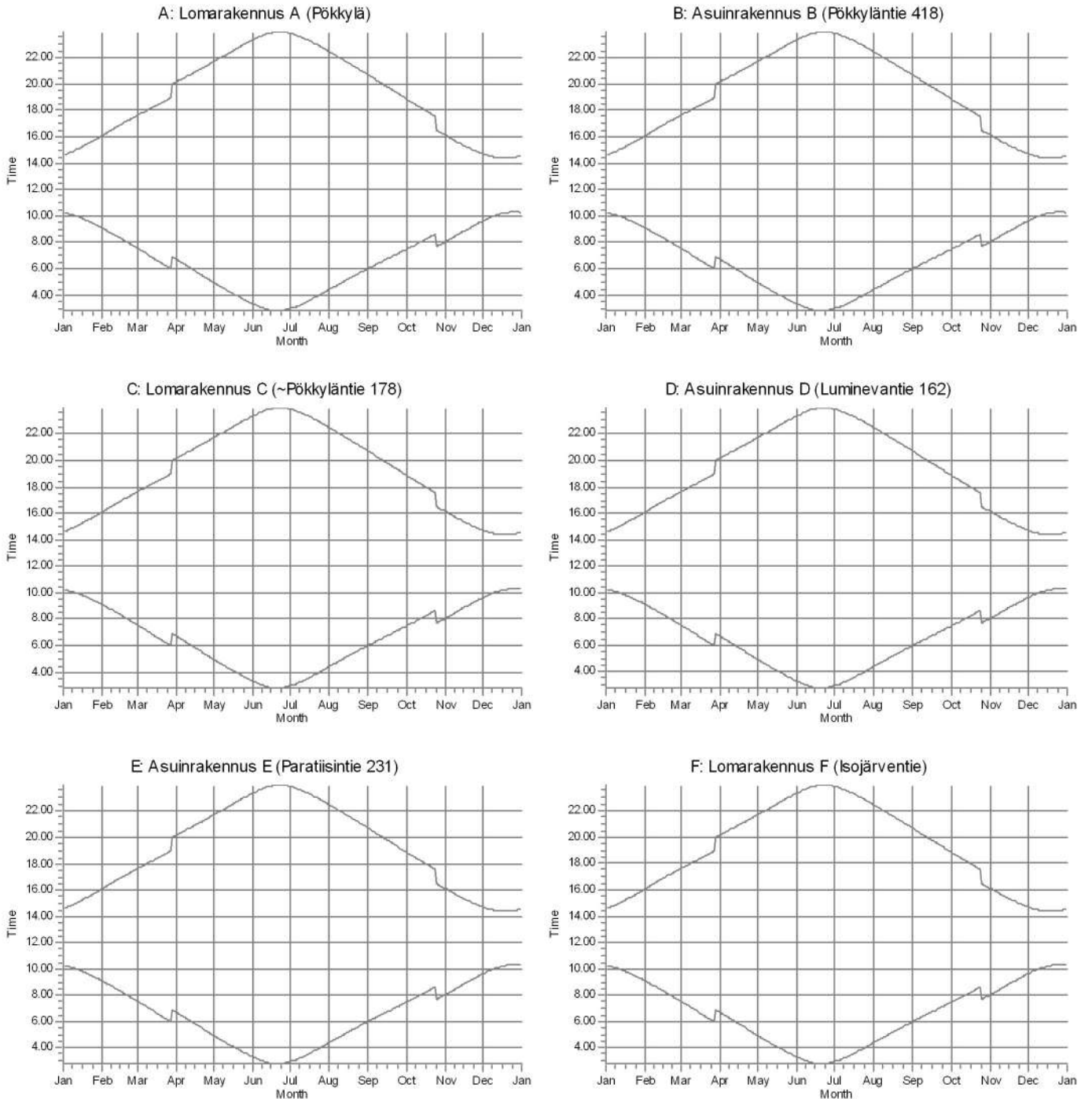
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoeto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

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, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoeto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

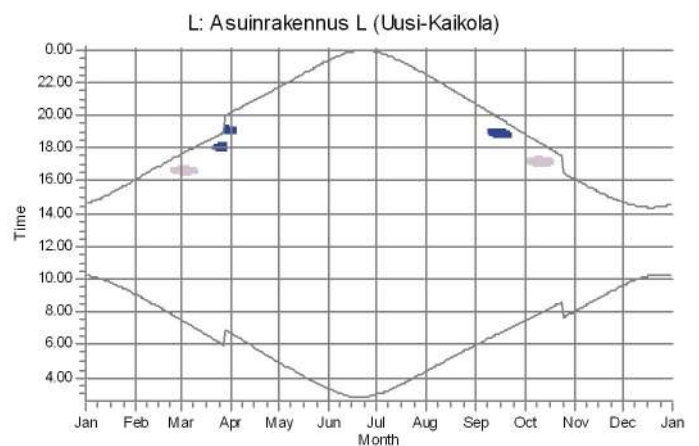
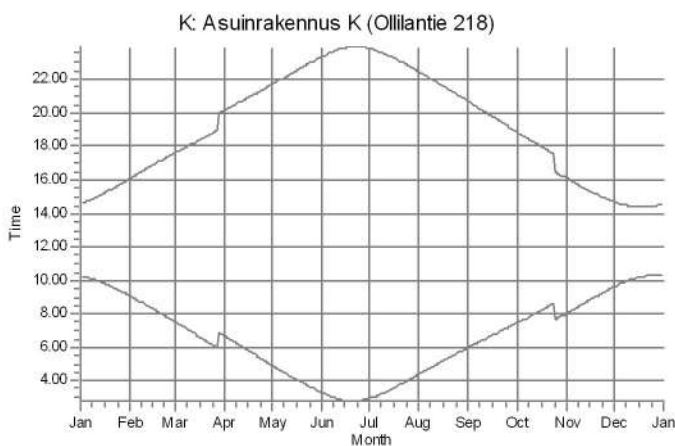
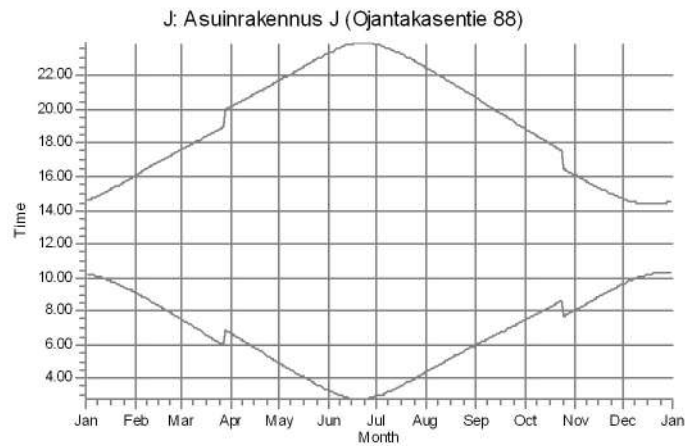
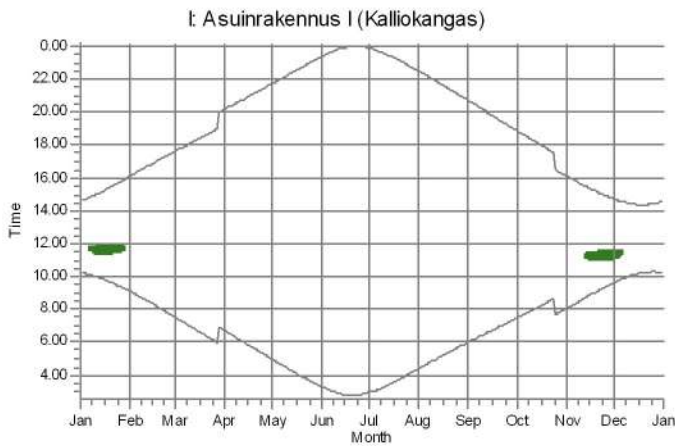
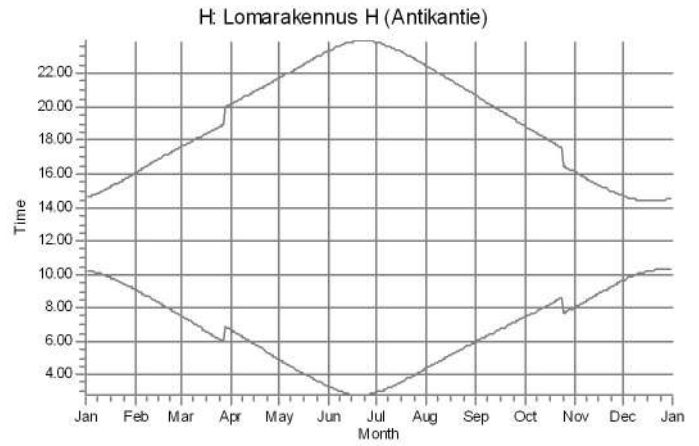
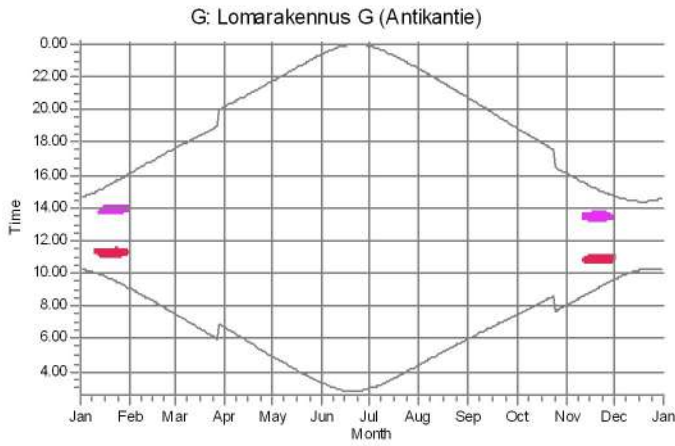


WTG



## SHADOW - Calendar, graphical

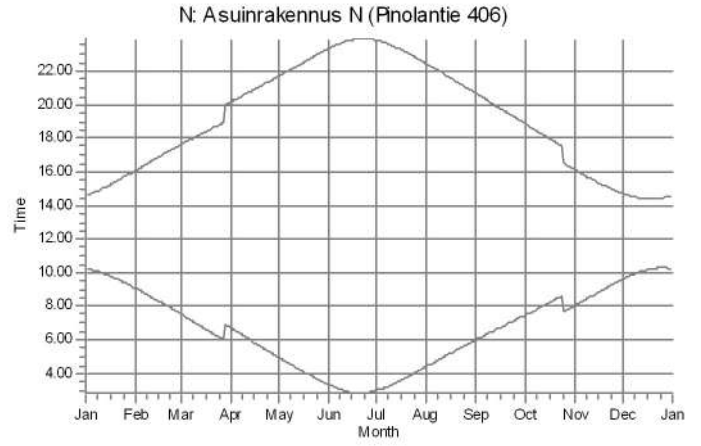
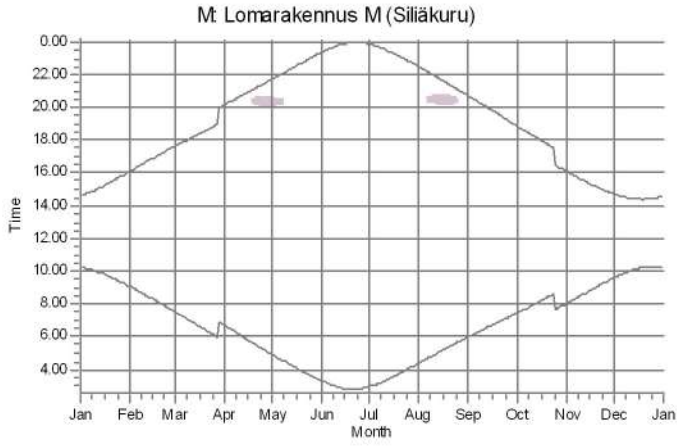
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoeto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari



WTG: 13: Generic Geniec2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (133) 24: Generic Geniec2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (144) 27: Generic Geniec2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (147) 33: Generic Geniec2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (153) 38: Generic Geniec2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (158)

## SHADOW - Calendar, graphical

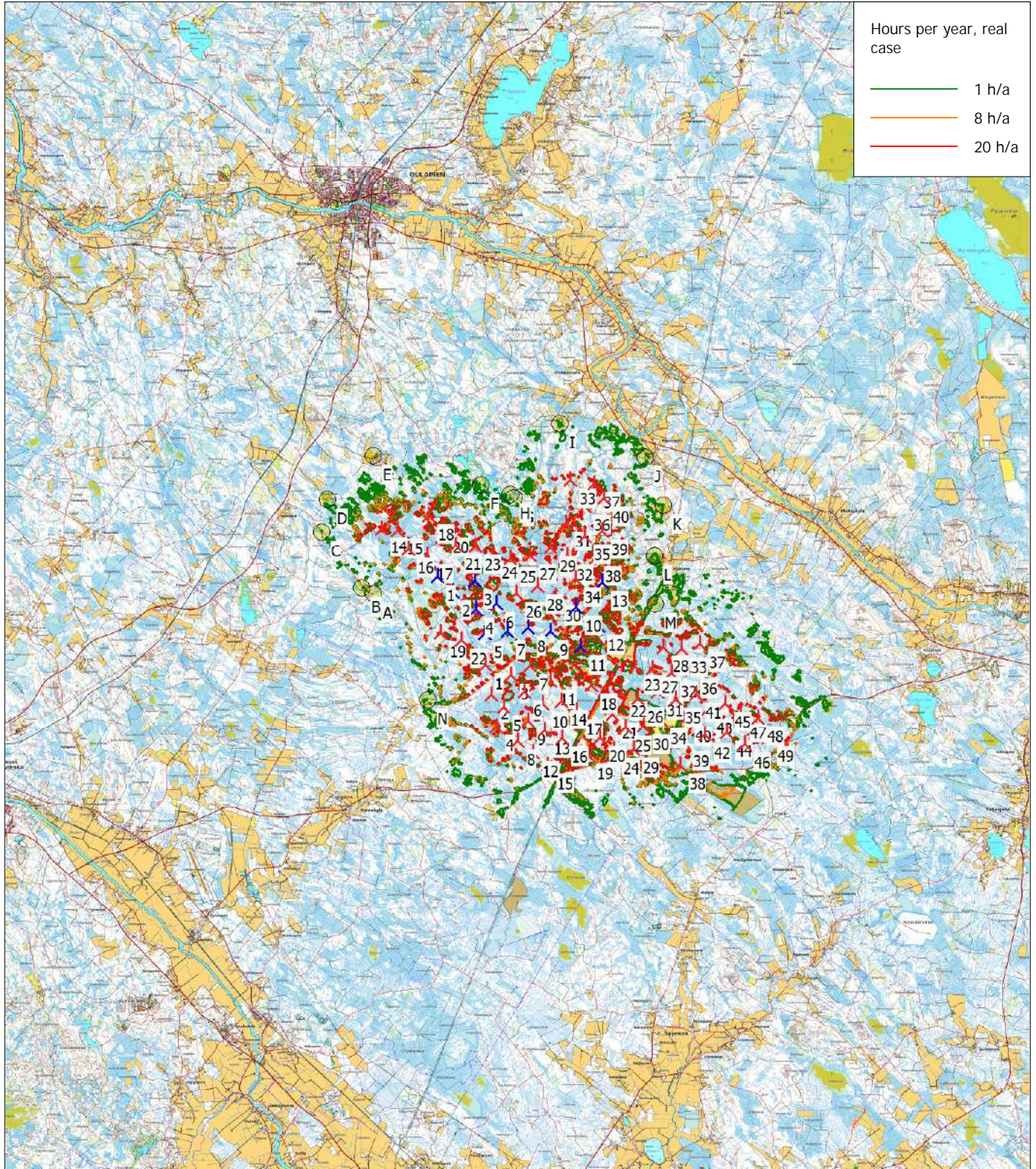
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari





## SHADOW - Map

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto1\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari



Hours per year, real case

- 1 h/a
- 8 h/a
- 20 h/a

0 2,5 5 7,5 10km

Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 18. Yhteisvaikutus varjostusmallinnuksen tulokset ”real case, no forest” - VE2**

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto2\_RealCase\_NoForest\_RD200m\_Puutionsaari  
Assumptions for shadow calculations

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

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

Sunshine probability S (Average daily sunshine hours) []  
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

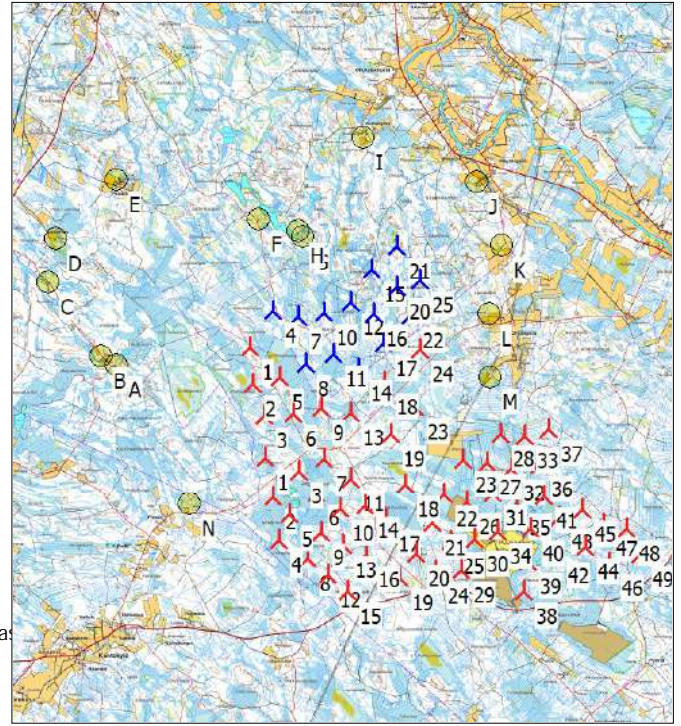
MERRA2\_N64.000\_E025.000 (1)

Operational time  
N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
537 403 374 412 607 885 1 057 1 109 981 765 636 658 8 425  
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\_Rahkola\_Hautakangas  
Obstacles used in calculation  
Receptor grid resolution: 1,0 m

All coordinates are in  
Finish TM ETRS-TM35FIN-ETRS89

### WTGs



Scale 1:200 000  
New WTG Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
			[m]									
1	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
1	398 896	7 112 332	92,5	PUU01	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
2	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
2	399 097	7 111 286	95,0	PUU02	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
3	399 784	7 111 972	97,5	PUU03	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
3	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
4	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
4	399 264	7 110 151	96,9	PUU04	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
5	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
5	399 536	7 110 832	95,4	PUU05	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
6	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	400 239	7 111 382	96,6	PUU06	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	400 444	7 112 292	97,2	PUU07	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
8	400 019	7 109 649	100,0	PUU08	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
8	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
9	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
9	400 380	7 110 348	99,8	PUU09	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
10	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
10	400 876	7 110 966	99,4	PUU10	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
11	401 152	7 111 752	99,6	PUU11	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
11	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
12	400 549	7 109 232	102,5	PUU12	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
12	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
13	400 953	7 110 020	102,4	PUU13	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
13	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
14	401 537	7 111 046	104,5	PUU14	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
14	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
15	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
15	401 068	7 108 792	105,9	PUU15	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
16	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4

To be continued on next page...



## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto2\_RealCase\_NoForest\_RD200m\_Puutionsaari

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM
			[m]									
16	401 564	7 109 758	104,2	PUU16	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
17	402 089	7 110 702	107,5	PUU17	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
17	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
18	402 589	7 111 603	106,9	PUU18	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
18	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
19	402 455	7 109 148	112,5	PUU19	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
19	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
20	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
20	402 889	7 109 778	110,0	PUU20	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
21	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
21	403 318	7 110 593	107,6	PUU21	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
22	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
22	403 622	7 111 352	107,4	PUU22	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
23	404 117	7 112 276	103,6	PUU23	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
23	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
24	403 379	7 109 327	115,0	PUU24	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
24	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
25	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
25	403 790	7 110 129	108,4	PUU25	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
26	404 210	7 111 152	105,6	PUU26	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
27	404 739	7 112 199	105,0	PUU27	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
28	405 100	7 112 943	100,4	PUU28	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
29	404 061	7 109 351	110,0	PUU29	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
30	404 420	7 110 174	107,1	PUU30	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
31	404 900	7 111 381	105,4	PUU31	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
32	405 395	7 112 030	102,3	PUU32	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
33	405 740	7 112 891	100,3	PUU33	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
34	405 042	7 110 380	105,7	PUU34	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
35	405 532	7 111 130	103,6	PUU35	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
36	406 114	7 112 133	103,3	PUU36	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
37	406 380	7 113 067	107,2	PUU37	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
38	405 707	7 108 791	110,8	PUU38	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
39	405 822	7 109 587	108,2	PUU39	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
40	405 893	7 110 455	105,0	PUU40	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
41	406 257	7 111 298	104,0	PUU41	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
42	406 558	7 109 872	106,7	PUU42	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
43	406 638	7 110 744	105,9	PUU43	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
44	407 324	7 109 954	108,7	PUU44	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
45	407 269	7 110 957	112,5	PUU45	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
46	407 963	7 109 542	113,4	PUU46	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
47	407 809	7 110 582	116,1	PUU47	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
48	408 414	7 110 457	120,0	PUU48	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
49	408 786	7 109 772	117,5	PUU49	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4

## Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
				[m]	[m]	[m]	[m]	[°]		[m]
A	Lomarakenus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakenus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakenus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakenus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakenus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Olliantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakenus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto2\_RealCase\_NoForest\_RD200m\_Puutionsaari

### Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:00
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	0:00
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	0:00
G	Lomarakennus G (Antikantie)	3:27
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	0:00
J	Asuinrakennus J (Ojantakasentie 88)	0:00
K	Asuinrakennus K (Ollilantie 218)	0:00
L	Asuinrakennus L (Uusi-Kaikola)	5:39
M	Lomarakennus M (Siliäkuru)	11:52
N	Asuinrakennus N (Pinolantie 406)	4:51

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

No.	Name	Expected [h/year]
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (267)	0:00
1	PUU01	2:59
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (268)	0:00
2	PUU02	1:52
3	PUU03	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (269)	0:00
4	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (270)	0:59
4	PUU04	0:00
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (271)	0:00
5	PUU05	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (272)	0:00
6	PUU06	0:00
7	PUU07	0:00
7	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (273)	0:00
8	PUU08	0:00
8	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (274)	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (275)	0:00
9	PUU09	0:00
10	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (276)	1:06
10	PUU10	0:00
11	PUU11	0:00
11	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (277)	0:00
12	PUU12	0:00
12	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (278)	0:00
13	PUU13	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (279)	0:00
14	PUU14	0:00
14	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (280)	0:00
15	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (281)	1:20
15	PUU15	0:00
16	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (282)	0:00
16	PUU16	0:00
17	PUU17	0:00
17	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (283)	0:00
18	PUU18	0:00
18	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (284)	0:00
19	PUU19	0:00
19	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (285)	0:00
20	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (286)	0:00
20	PUU20	0:00
21	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (287)	0:00
21	PUU21	0:00
22	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (288)	1:32

To be continued on next page...

Project:

Rahkola\_Hautakangas

Licensed user:

FCG Finnish Consulting Group Oy

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FI-00601 Helsinki

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Miikka Saranpää / miikka.saranpaa@fcg.fi

Calculated:

30.1.2023 13.22/3.5.584

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_NoForest\_RD200m\_Puutionsaari

...continued from previous page

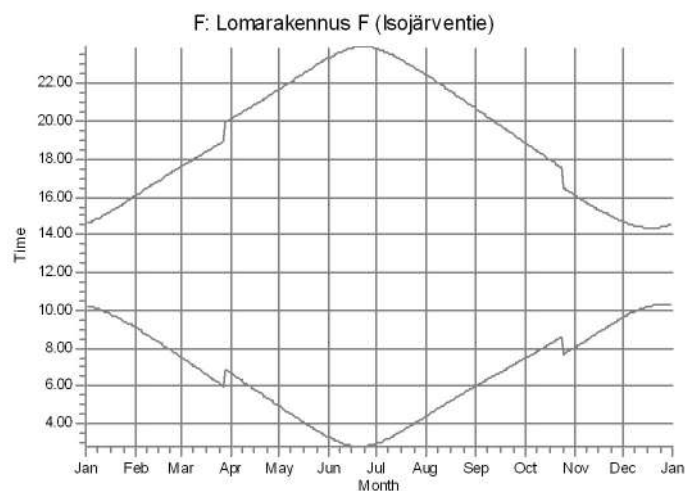
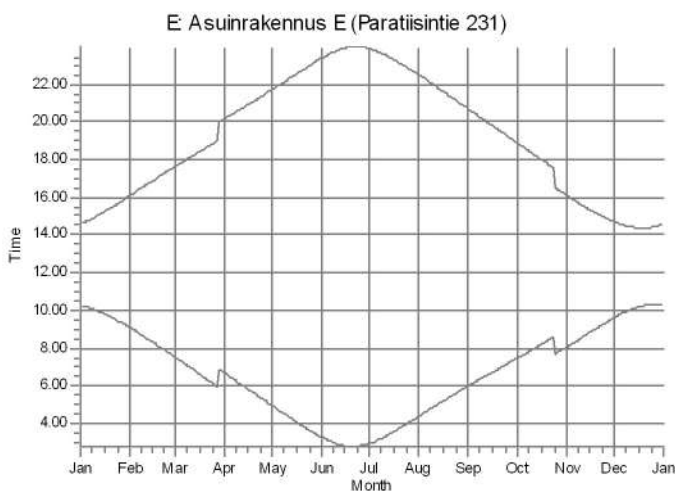
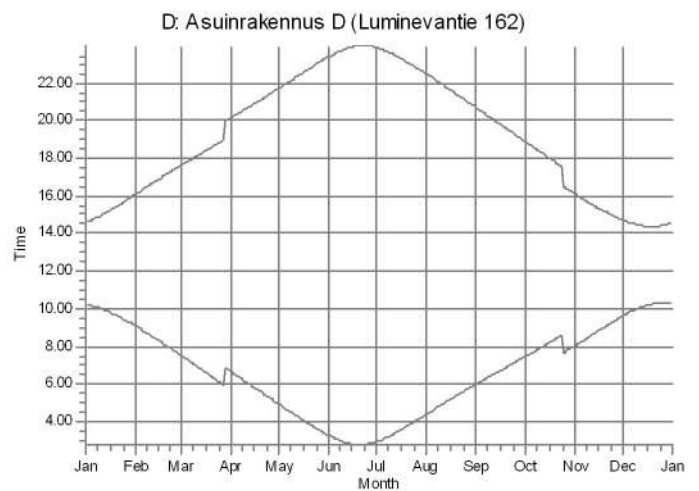
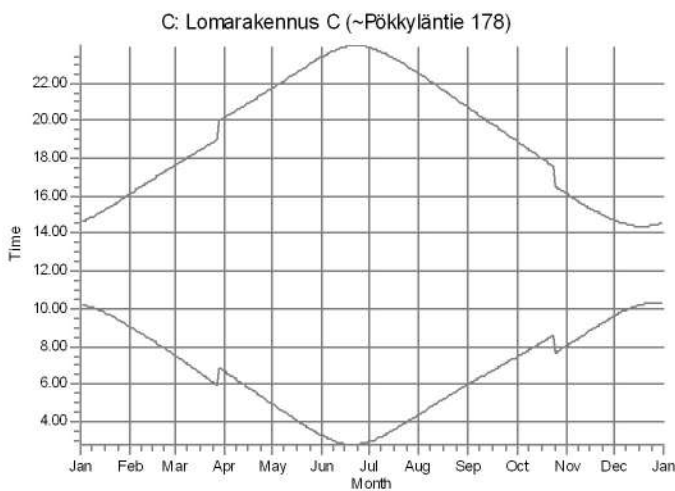
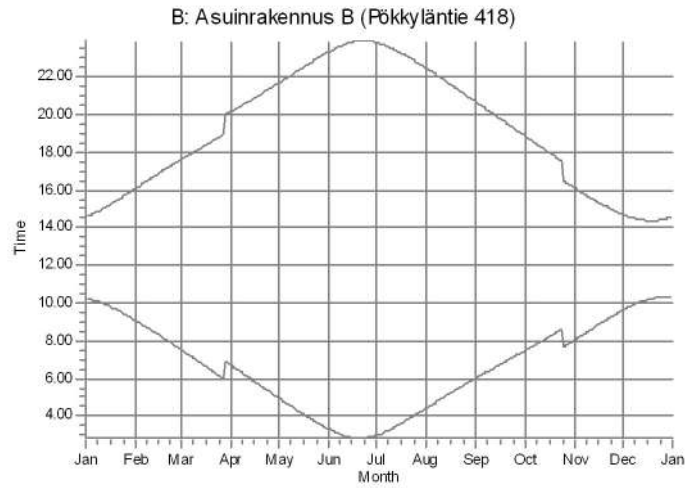
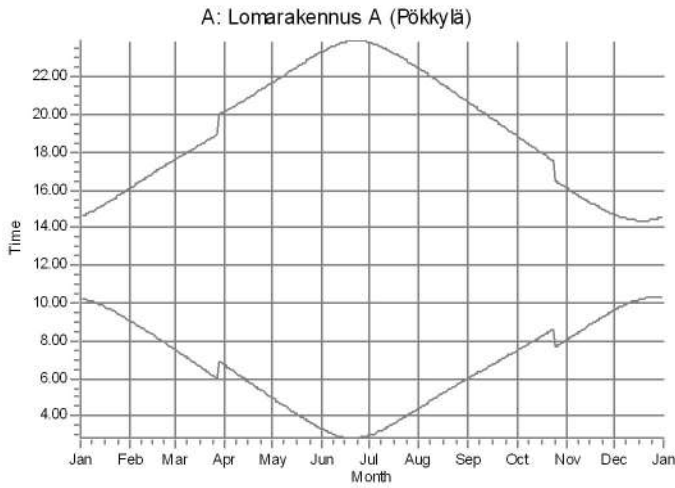
No.	Name	Expected [h/year]
22	PUU22	0:00
23	PUU23	1:05
23	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (289)	0:00
24	PUU24	0:00
24	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (290)	4:41
25	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (291)	2:33
25	PUU25	0:00
26	PUU26	0:00
27	PUU27	1:19
28	PUU28	2:40
29	PUU29	0:00
30	PUU30	0:00
31	PUU31	0:00
32	PUU32	0:00
33	PUU33	2:02
34	PUU34	0:00
35	PUU35	0:00
36	PUU36	0:00
37	PUU37	1:30
38	PUU38	0:00
39	PUU39	0:00
40	PUU40	0:00
41	PUU41	0:00
42	PUU42	0:00
43	PUU43	0:00
44	PUU44	0:00
45	PUU45	0:00
46	PUU46	0:00
47	PUU47	0:00
48	PUU48	0:00
49	PUU49	0:00

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

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, graphical

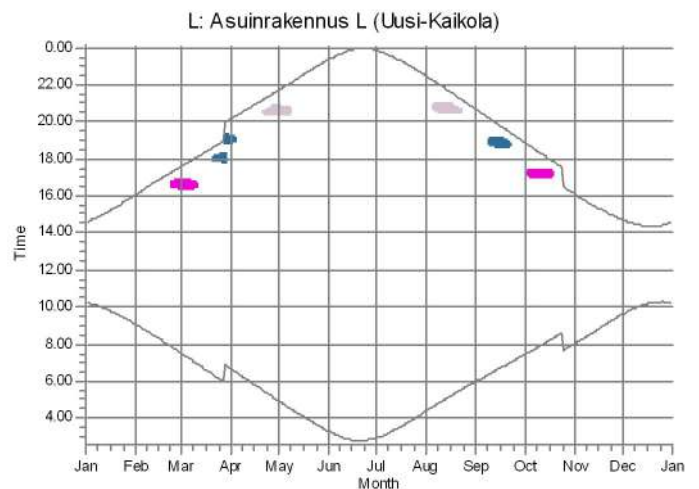
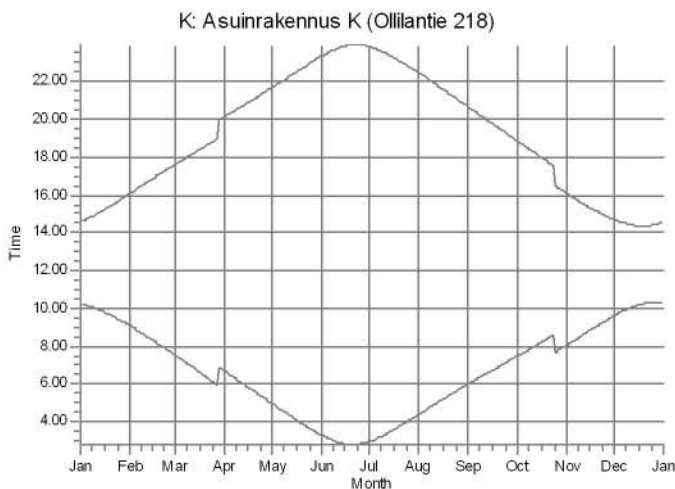
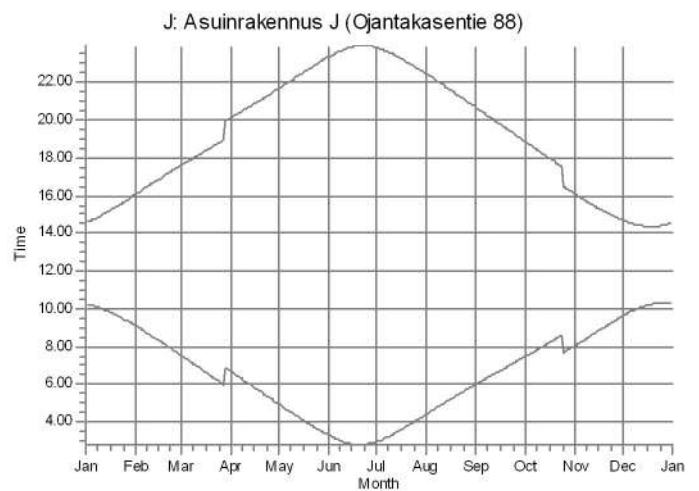
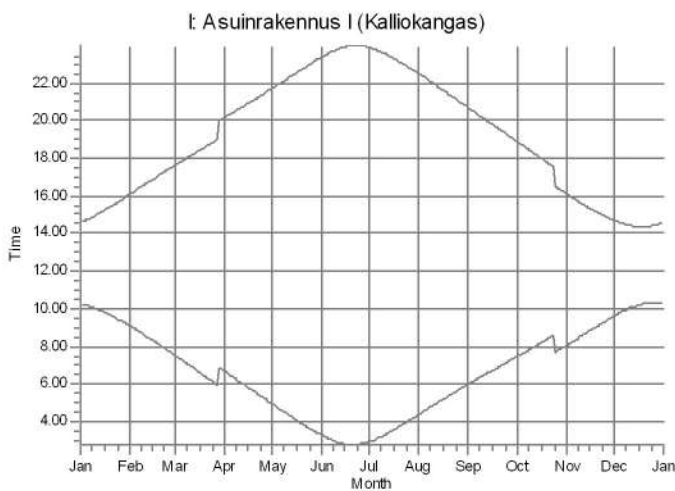
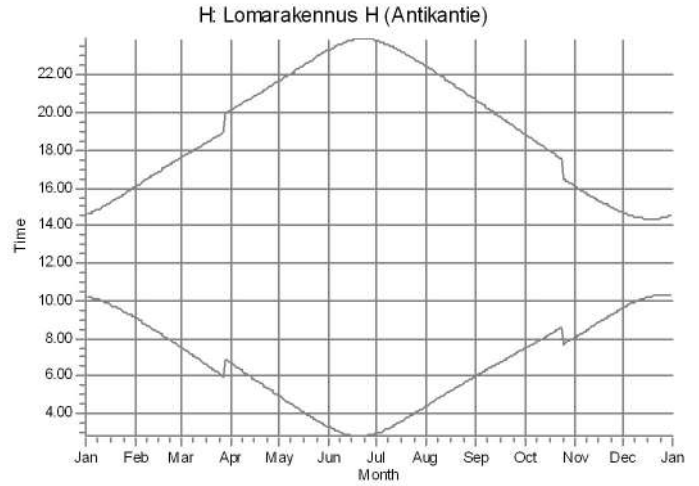
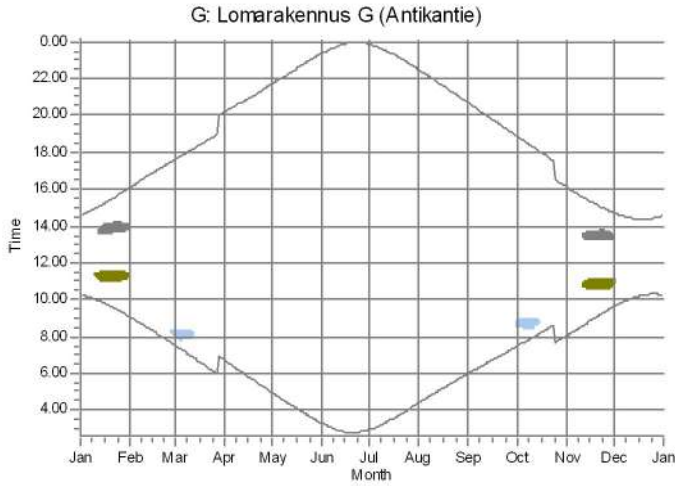
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_NoForest\_RD200m\_Puutionsaari



WTCs

## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_NoForest\_RD200m\_Puutionsaari



WTCs

4: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (270)  
10: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (276)

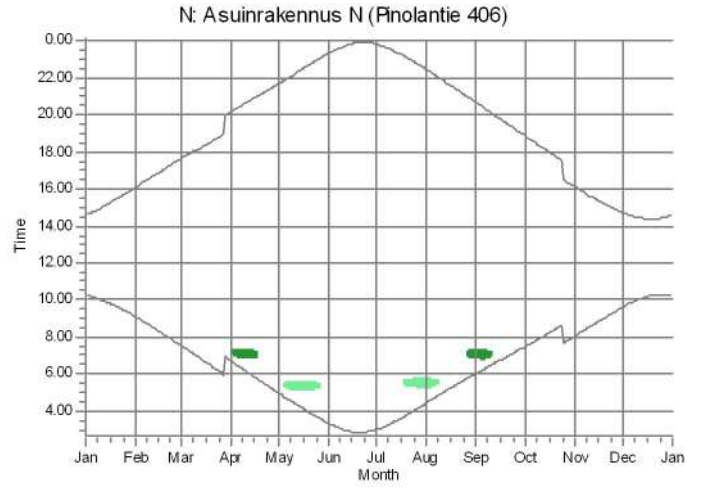
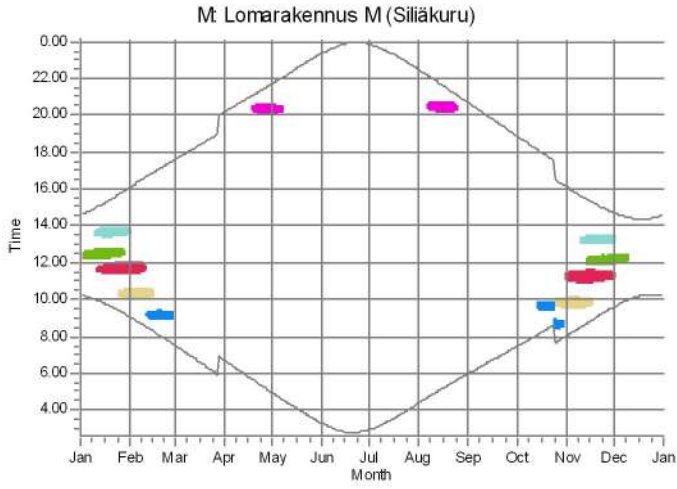
15: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (281)  
22: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (288)

24: Generic Generac2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (290)  
25: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (291)



## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_NoForest\_RD200m\_Puutionsaari



WTGs

24: Generic Generic2 7000 2000.0 101 hub: 200.0 m (TOT: 300.0 m) (290)

1: PU001

2: PU002

23: PU023

27: PU027

28: PU028

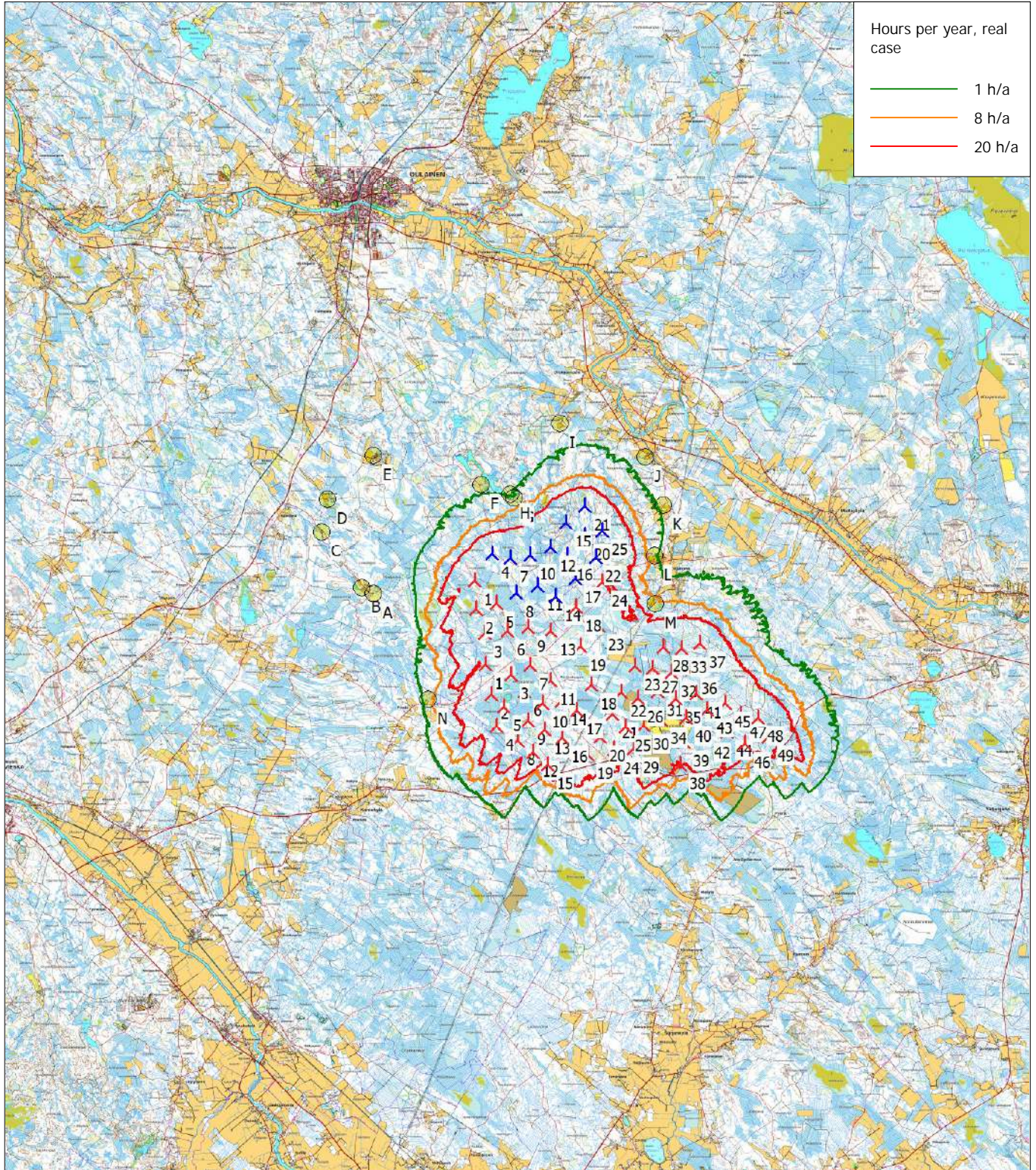
33: PU033

37: PU037



## SHADOW - Map

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoeto2\_RealCase\_NoForest\_RD200m\_Puutionsaari



Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

▲ New WTG

● Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 19. Yhteisvaikutus varjostusmallinnuksen tulokset ”real case, Luke forest” - VE2**

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

### Assumptions for shadow calculations

Maximum distance for influence

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

Please look in WTG table

Minimum sun height over horizon for influence 3 °

Day step for calculation 1 days

Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

MERRA2\_N64.000\_E025.000 (1)

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
537 403 374 412 607 885 1 057 1 109 981 765 636 658 8 425

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\_Rahkola-Hautakangas

Area object(s) used in calculation:

Area object (SE): (2)

Area object (SW): (3)

Area object (NE): (4)

Area object (NW): (5)

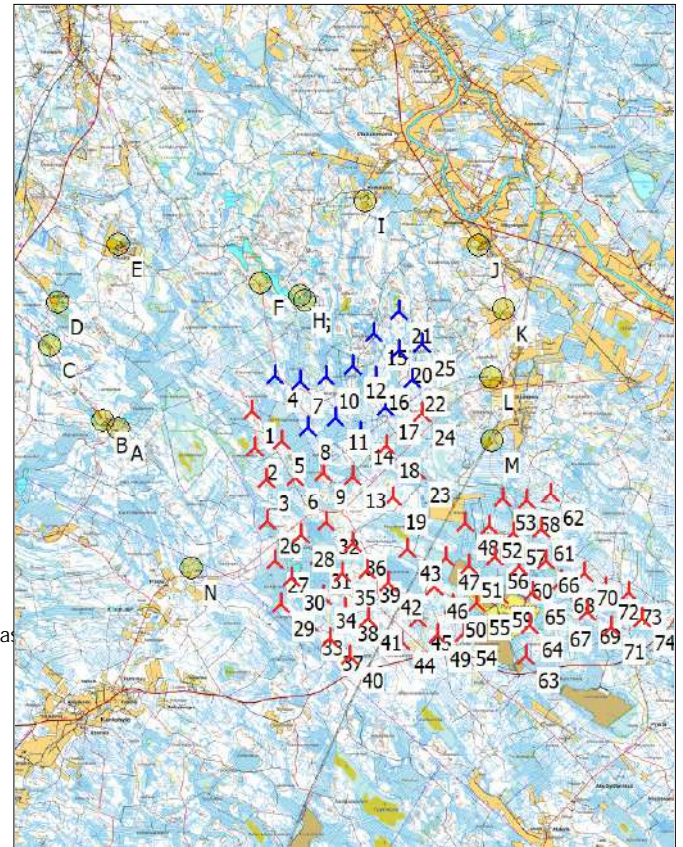
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

### WTGs



Scale 1:200 000  
New WTG Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
1	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
2	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
3	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
4	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
5	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
7	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
8	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
9	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
10	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
11	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
12	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
13	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
14	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
15	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
16	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
17	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
18	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
19	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
20	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
21	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
22	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
23	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
24	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
25	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	150,0	2 124	10,4
26	398 896	7 112 332	92,5	PUU01	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4

To be continued on next page...

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM
			[m]									
27	399 097	7 111 286	95,0	PUU02	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
28	399 784	7 111 972	97,5	PUU03	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
29	399 264	7 110 151	96,9	PUU04	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
30	399 536	7 110 832	95,4	PUU05	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
31	400 239	7 111 382	96,6	PUU06	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
32	400 444	7 112 292	97,2	PUU07	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
33	400 019	7 109 649	100,0	PUU08	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
34	400 380	7 110 348	99,8	PUU09	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
35	400 876	7 110 966	99,4	PUU10	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
36	401 152	7 111 752	99,6	PUU11	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
37	400 549	7 109 232	102,5	PUU12	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
38	400 953	7 110 020	102,6	PUU13	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
39	401 537	7 111 046	104,5	PUU14	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
40	401 068	7 108 792	105,9	PUU15	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
41	401 564	7 109 758	104,2	PUU16	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
42	402 089	7 110 702	107,5	PUU17	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
43	402 589	7 111 603	106,9	PUU18	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
44	402 455	7 109 148	112,5	PUU19	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
45	402 889	7 109 778	110,0	PUU20	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
46	403 318	7 110 593	107,6	PUU21	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
47	403 622	7 111 352	107,4	PUU22	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
48	404 117	7 112 276	103,6	PUU23	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
49	403 379	7 109 327	115,0	PUU24	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
50	403 790	7 110 129	108,4	PUU25	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
51	404 210	7 111 152	105,6	PUU26	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
52	404 739	7 112 199	105,0	PUU27	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
53	405 100	7 112 943	100,4	PUU28	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
54	404 061	7 109 351	110,0	PUU29	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
55	404 420	7 110 174	107,1	PUU30	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
56	404 900	7 111 381	105,4	PUU31	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
57	405 395	7 112 030	102,3	PUU32	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
58	405 740	7 112 891	100,3	PUU33	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
59	405 042	7 110 380	105,7	PUU34	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
60	405 532	7 111 130	103,6	PUU35	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
61	406 114	7 112 133	103,3	PUU36	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
62	406 380	7 113 067	107,2	PUU37	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
63	405 707	7 108 791	110,8	PUU38	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
64	405 822	7 109 587	108,2	PUU39	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
65	405 893	7 110 455	105,0	PUU40	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
66	406 257	7 111 298	104,0	PUU41	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
67	406 558	7 109 872	106,7	PUU42	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
68	406 638	7 110 744	105,9	PUU43	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
69	407 324	7 109 954	108,7	PUU44	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
70	407 269	7 110 957	112,5	PUU45	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
71	407 963	7 109 542	113,4	PUU46	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
72	407 809	7 110 582	116,1	PUU47	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
73	408 414	7 110 457	120,0	PUU48	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
74	408 786	7 109 772	117,5	PUU49	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4

## Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
				[m]	[m]	[m]	a.g.l.	window		(ZVI) a.g.l.
							[m]	[°]		[m]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0

To be continued on next page...



## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

...continued from previous page

No.	Name	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
				[m]	[m]	[m]	a.g.l. [m]	window [°]		(ZVI) a.g.l. [m]
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:00
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	0:00
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	0:00
G	Lomarakennus G (Antikantie)	2:05
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	0:00
J	Asuinrakennus J (Ojantakasentie 88)	0:00
K	Asuinrakennus K (Ollilantie 218)	0:00
L	Asuinrakennus L (Uusi-Kaikola)	3:06
M	Lomarakennus M (Siliäkuru)	3:06
N	Asuinrakennus N (Pinolantie 406)	0:00

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

No.	Name	Expected [h/year]
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (267)	0:00
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (268)	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (269)	0:00
4	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (270)	0:59
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (271)	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (272)	0:00
7	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (273)	0:00
8	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (274)	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (275)	0:00
10	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (276)	1:06
11	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (277)	0:00
12	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (278)	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (279)	0:00
14	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (280)	0:00
15	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (281)	0:00
16	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (282)	0:00
17	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (283)	0:00
18	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (284)	0:00
19	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (285)	0:00
20	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (286)	0:00
21	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (287)	0:00
22	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (288)	1:32
23	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (289)	0:00
24	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (290)	4:41
25	Generic Generic2 7000 200.0 !O! hub: 150,0 m (TOT: 250,0 m) (291)	0:00
26	PUU01	0:00
27	PUU02	0:00
28	PUU03	0:00
29	PUU04	0:00
30	PUU05	0:00
31	PUU06	0:00
32	PUU07	0:00

To be continued on next page...

Project:

Rahkola\_Hautakangas

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Mikka Saranpää / mikka.saranpaa@fcg.fi

Calculated:

30.1.2023 16.44/3.5.584

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

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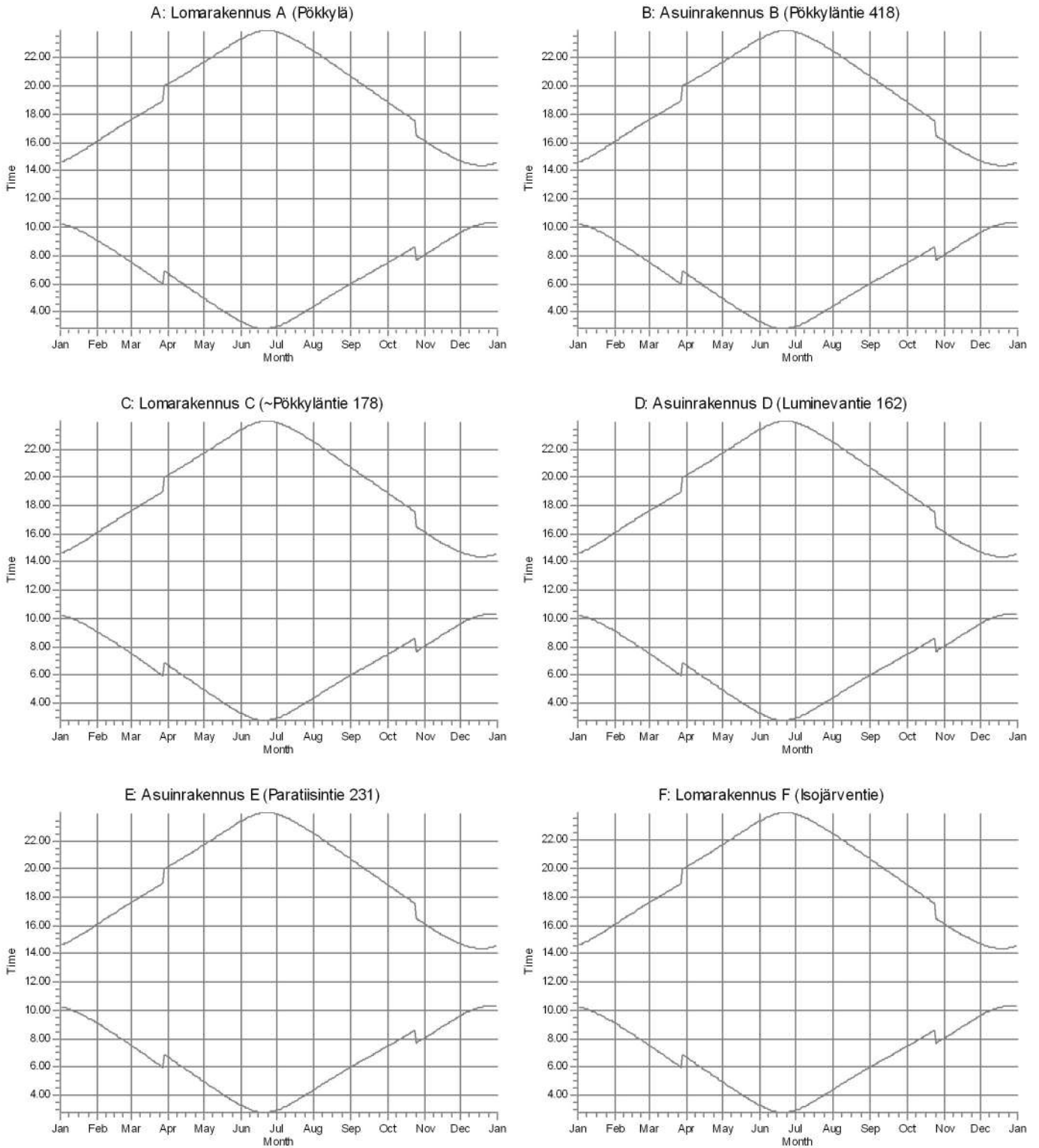
No.	Name	Expected [h/year]
33	PUU08	0:00
34	PUU09	0:00
35	PUU10	0:00
36	PUU11	0:00
37	PUU12	0:00
38	PUU13	0:00
39	PUU14	0:00
40	PUU15	0:00
41	PUU16	0:00
42	PUU17	0:00
43	PUU18	0:00
44	PUU19	0:00
45	PUU20	0:00
46	PUU21	0:00
47	PUU22	0:00
48	PUU23	0:00
49	PUU24	0:00
50	PUU25	0:00
51	PUU26	0:00
52	PUU27	0:00
53	PUU28	0:00
54	PUU29	0:00
55	PUU30	0:00
56	PUU31	0:00
57	PUU32	0:00
58	PUU33	0:00
59	PUU34	0:00
60	PUU35	0:00
61	PUU36	0:00
62	PUU37	0:00
63	PUU38	0:00
64	PUU39	0:00
65	PUU40	0:00
66	PUU41	0:00
67	PUU42	0:00
68	PUU43	0:00
69	PUU44	0:00
70	PUU45	0:00
71	PUU46	0:00
72	PUU47	0:00
73	PUU48	0:00
74	PUU49	0:00

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

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, graphical

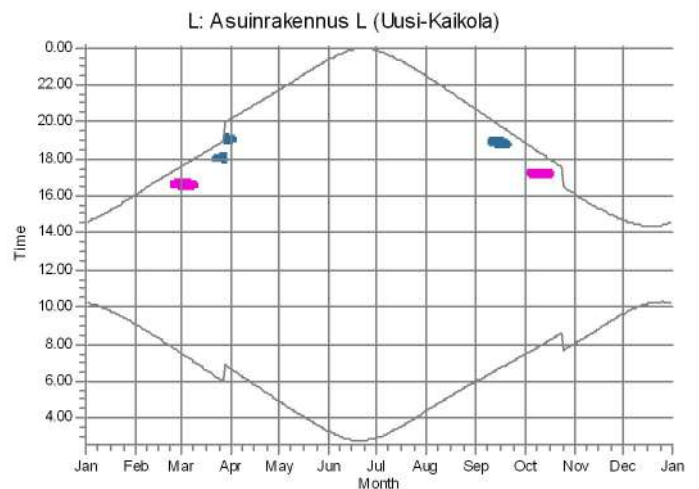
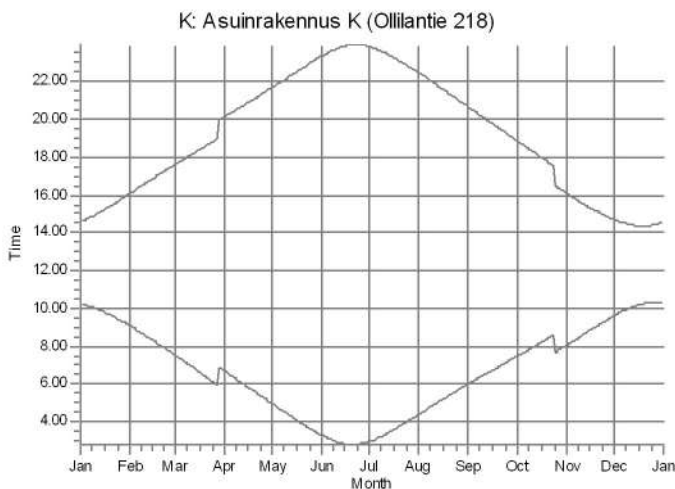
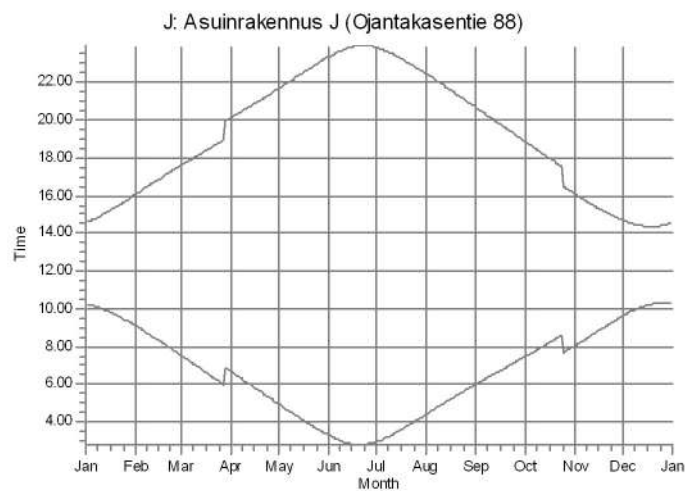
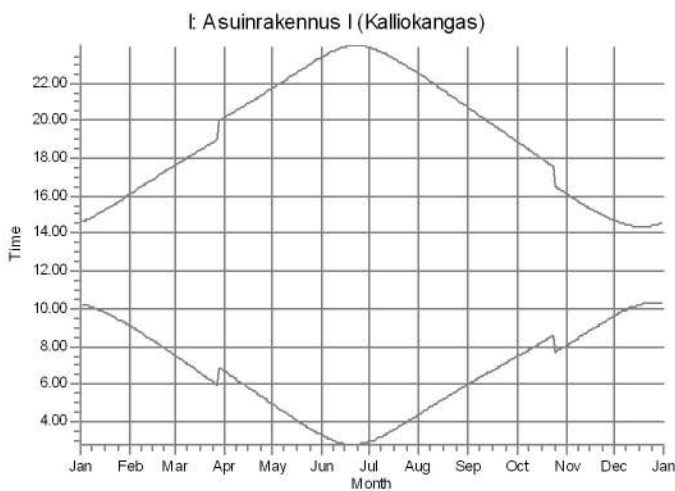
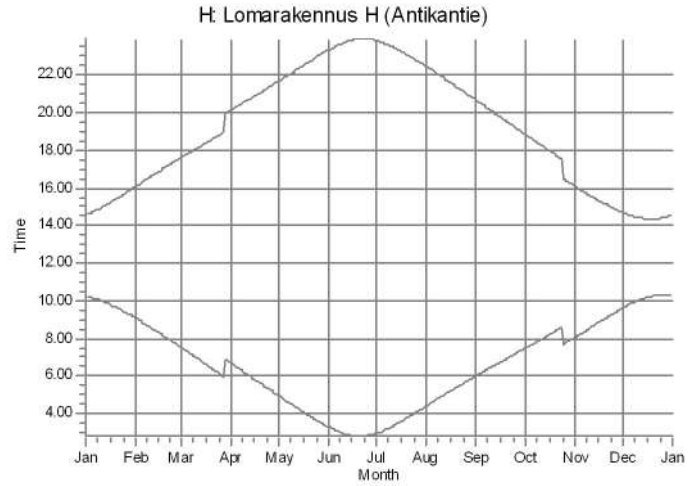
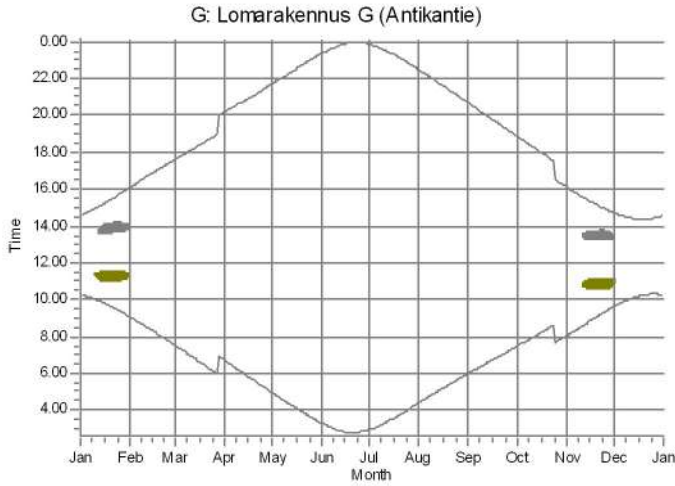
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari



WTG:

## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari



WTCs

4: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (270)

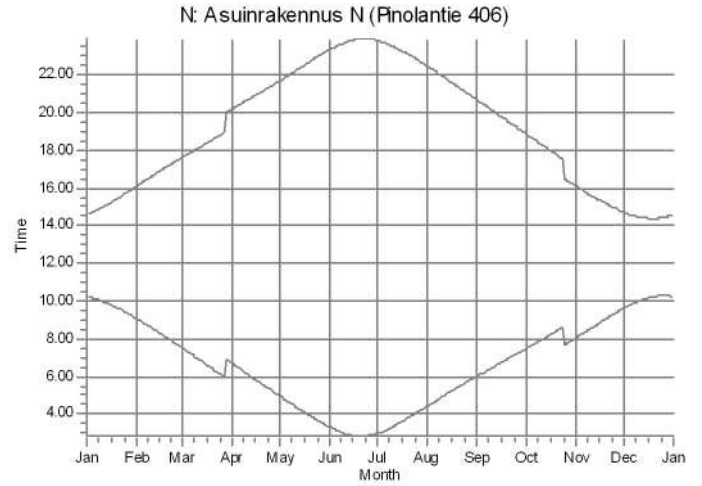
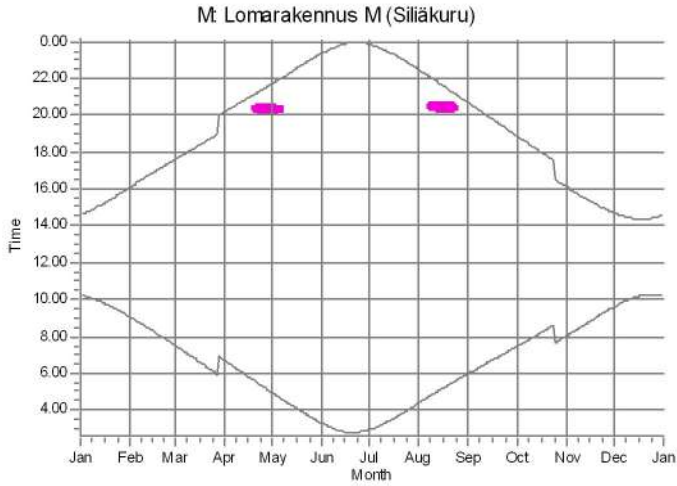
10: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (276)

22: Generic Generac2 7000 200.0 I0I hub: 150.0 m (TOT: 250.0 m) (288)

24: Generic Generac2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (290)

## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari

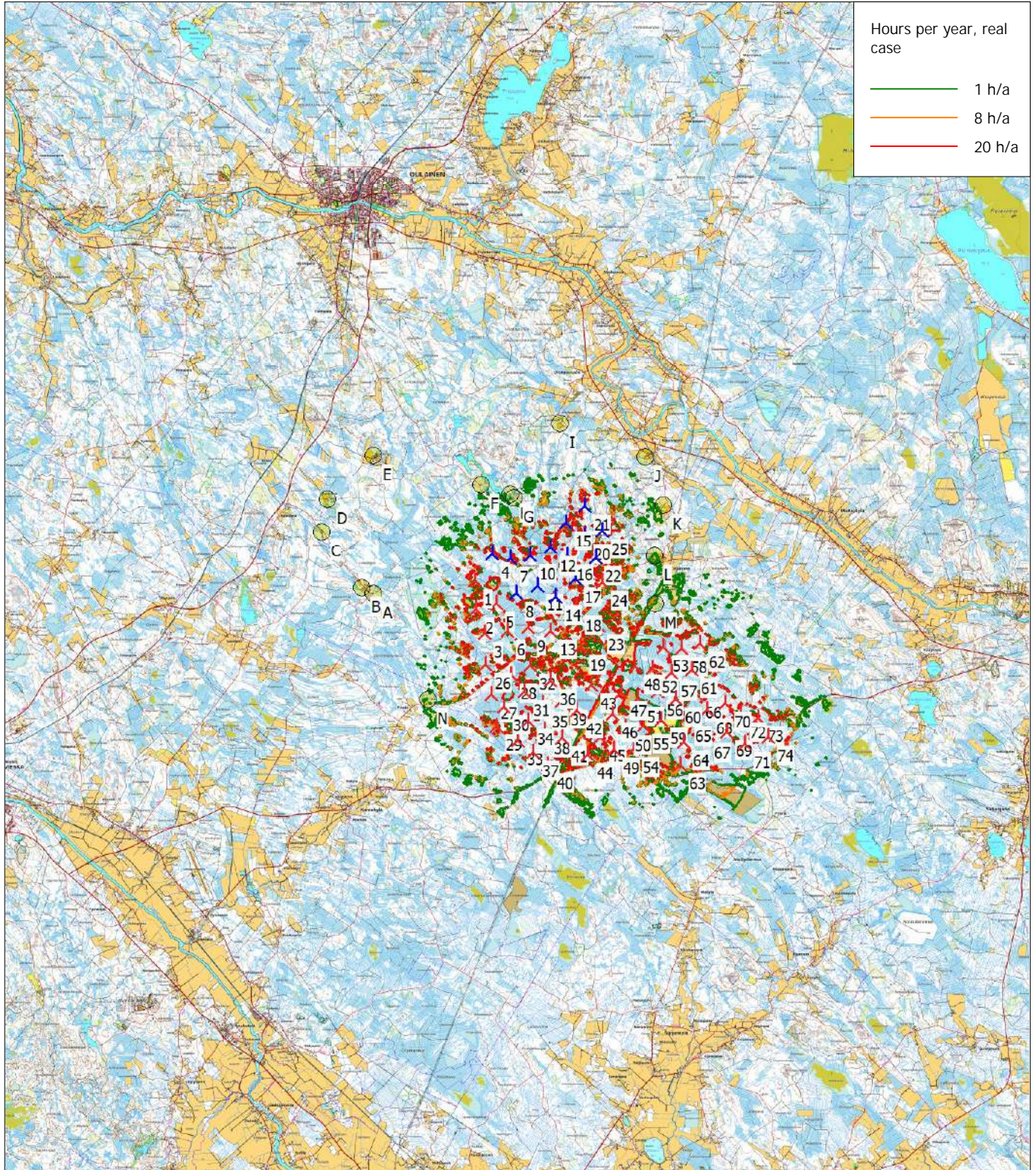


WTCs  
24: Generic Generic2 7000 200.0 IOI hub: 200.0 m (TOT: 300.0 m) (290)



## SHADOW - Map

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto2\_RealCase\_Luke\_Forest\_RD200m\_Puutionsaari



Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

New WTG

Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 20. Yhteisvaikutus varjostusmallinnuksen tulokset ”real case, no forest” - VE3**

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_NoForest\_RD200m\_Puutionsaari

### Assumptions for shadow calculations

Maximum distance for influence

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

Please look in WTG table

Minimum sun height over horizon for influence 3 °

Day step for calculation 1 days

Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

MERRA2\_N64.000\_E025.000 (1)

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
540 405 376 415 610 890 1 063 1 115 986 769 639 662 8 472

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\_Rahkola\_Hautakangas

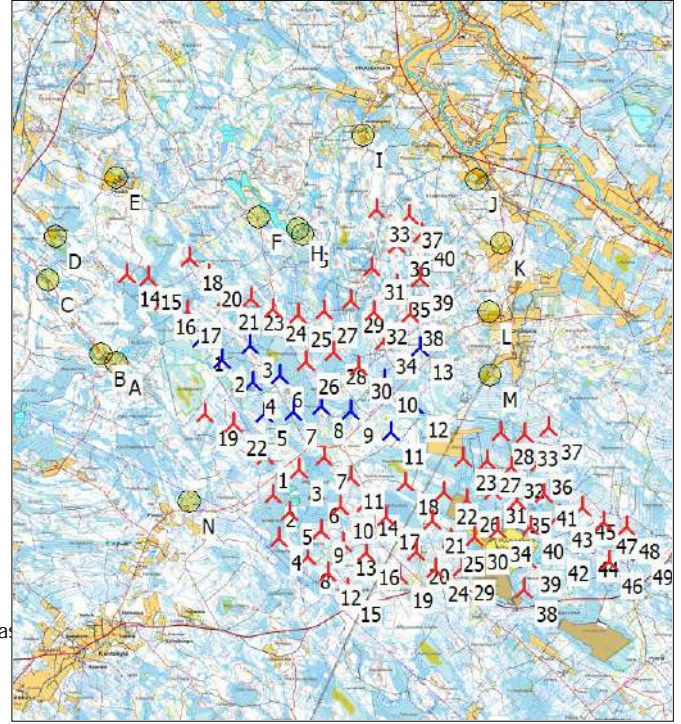
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

### WTGs



Scale 1:200 000  
New WTG Shadow receptor

	East	North	Z	Row data/Description	WTG type			Shadow data				
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM
			[m]									
1	398 896	7 112 332	92,5	PUU01	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
1	397 208	7 115 412	87,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
2	399 097	7 111 286	95,0	PUU02	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
2	397 754	7 114 856	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
3	399 784	7 111 972	97,5	PUU03	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
3	398 503	7 115 243	85,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
4	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
4	399 264	7 110 151	96,9	PUU04	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
5	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
5	399 536	7 110 832	95,4	PUU05	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
6	400 239	7 111 382	96,6	PUU06	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
6	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
7	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
7	400 444	7 112 292	97,2	PUU07	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
8	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
8	400 019	7 109 649	100,0	PUU08	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
9	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
9	400 380	7 110 348	99,8	PUU09	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
10	400 876	7 110 966	99,6	PUU10	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
10	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
11	401 152	7 111 752	99,6	PUU11	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
11	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
12	400 549	7 109 232	102,5	PUU12	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
12	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
13	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
13	400 953	7 110 020	102,4	PUU13	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
14	395 254	7 117 093	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
14	401 537	7 111 046	104,5	PUU14	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
15	401 068	7 108 792	105,9	PUU15	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
15	395 819	7 117 022	82,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
16	396 195	7 116 379	82,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4

To be continued on next page...

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto3\_RealCase\_NoForest\_RD200m\_Puutionsaari

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM
			[m]									
16	401 564	7 109 758	104,2	PUU16	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
17	402 089	7 110 702	107,5	PUU17	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
17	396 858	7 116 145	84,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
18	402 589	7 111 603	106,9	PUU18	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
18	396 894	7 117 531	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
19	402 455	7 109 148	112,5	PUU19	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
19	397 303	7 113 442	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
20	402 889	7 109 778	110,0	PUU20	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
20	397 417	7 117 093	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
21	397 854	7 116 507	90,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
21	403 318	7 110 593	107,6	PUU21	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
22	403 622	7 111 352	107,4	PUU22	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
22	398 058	7 113 189	92,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
23	404 117	7 112 276	103,6	PUU23	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
23	398 529	7 116 484	94,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
24	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
24	403 379	7 109 327	115,0	PUU24	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
25	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
25	403 790	7 110 129	108,4	PUU25	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
26	404 210	7 111 152	105,6	PUU26	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
26	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
27	404 739	7 112 199	105,0	PUU27	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
27	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
28	405 100	7 112 943	100,4	PUU28	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
28	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
29	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
29	404 061	7 109 351	110,0	PUU29	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
30	404 420	7 110 174	107,1	PUU30	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
30	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
31	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
31	404 900	7 111 381	105,4	PUU31	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
32	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
32	405 395	7 112 030	102,3	PUU32	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
33	401 837	7 118 791	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
33	405 740	7 112 891	100,3	PUU33	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
34	405 042	7 110 380	105,7	PUU34	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
34	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
35	405 532	7 111 130	103,6	PUU35	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
35	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
36	406 114	7 112 133	103,3	PUU36	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
36	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
37	402 692	7 118 655	96,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
37	406 380	7 113 067	107,2	PUU37	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
38	405 707	7 108 791	110,8	PUU38	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
38	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
39	405 822	7 109 587	108,2	PUU39	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
39	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
40	405 893	7 110 455	105,0	PUU40	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
40	403 021	7 118 167	96,4	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
41	406 257	7 111 298	104,0	PUU41	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
42	406 558	7 109 872	106,7	PUU42	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
43	406 638	7 110 744	105,9	PUU43	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
44	407 324	7 109 954	108,7	PUU44	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
45	407 269	7 110 957	112,5	PUU45	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
46	407 963	7 109 542	113,4	PUU46	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
47	407 809	7 110 582	116,1	PUU47	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
48	408 414	7 110 457	120,0	PUU48	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
49	408 786	7 109 772	117,5	PUU49	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_NoForest\_RD200m\_Puutionsaari  
 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]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:10
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	2:13
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	1:35
G	Lomarakennus G (Antikantie)	7:20
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	1:33
J	Asuinrakennus J (Ojantakasentie 88)	3:10
K	Asuinrakennus K (Ollilantie 218)	2:02
L	Asuinrakennus L (Uusi-Kaikola)	6:56
M	Lomarakennus M (Siliäkuru)	11:56
N	Asuinrakennus N (Pinolantie 406)	4:53

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

No.	Name	Expected [h/year]
1	PUU01	3:00
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (490)	0:00
2	PUU02	1:52
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (491)	0:00
3	PUU03	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (492)	0:00
4	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (493)	0:00
4	PUU04	0:00
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (494)	0:00
5	PUU05	0:00
6	PUU06	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (495)	0:00
7	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (496)	0:00
7	PUU07	0:00
8	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (497)	0:00
8	PUU08	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (498)	0:00
9	PUU09	0:00
10	PUU10	0:00
10	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (499)	0:00
11	PUU11	0:00
11	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (500)	0:00
12	PUU12	0:00

To be continued on next page...



## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_NoForest\_RD200m\_Puutionsaari

...continued from previous page

No.	Name	Expected [h/year]
12	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (501)	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (502)	4:42
13	PUU13	0:00
14	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (503)	2:13
14	PUU14	0:00
15	PUU15	0:00
15	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (504)	0:00
16	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (505)	0:10
16	PUU16	0:00
17	PUU17	0:00
17	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (506)	0:00
18	PUU18	0:00
18	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (507)	0:00
19	PUU19	0:00
19	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (508)	0:00
20	PUU20	0:00
20	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (509)	1:35
21	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (510)	0:00
21	PUU21	0:00
22	PUU22	0:00
22	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (511)	0:00
23	PUU23	1:05
23	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (512)	0:00
24	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (513)	1:18
24	PUU24	0:00
25	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (514)	0:00
25	PUU25	0:00
26	PUU26	0:00
26	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (515)	0:00
27	PUU27	1:19
27	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (516)	1:22
28	PUU28	2:41
28	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (517)	0:00
29	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (518)	0:00
29	PUU29	0:00
30	PUU30	0:00
30	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (519)	0:00
31	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (520)	1:44
31	PUU31	0:00
32	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (521)	0:00
32	PUU32	0:00
33	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (522)	4:20
33	PUU33	2:03
34	PUU34	0:00
34	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (523)	0:00
35	PUU35	0:00
35	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (524)	0:00
36	PUU36	0:00
36	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (525)	0:00
37	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (526)	1:37
37	PUU37	1:31
38	PUU38	0:00
38	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (527)	1:57
39	PUU39	0:00
39	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (528)	3:25
40	PUU40	0:00
40	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (529)	3:35
41	PUU41	0:00
42	PUU42	0:00
43	PUU43	0:00
44	PUU44	0:00
45	PUU45	0:00
46	PUU46	0:00
47	PUU47	0:00
48	PUU48	0:00
49	PUU49	0:00

Project:

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Calculated:

30.1.2023 13.42/3.5.584

## SHADOW - Main Result

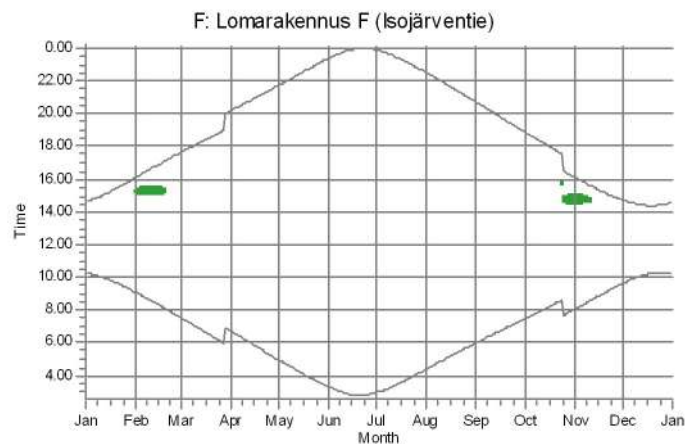
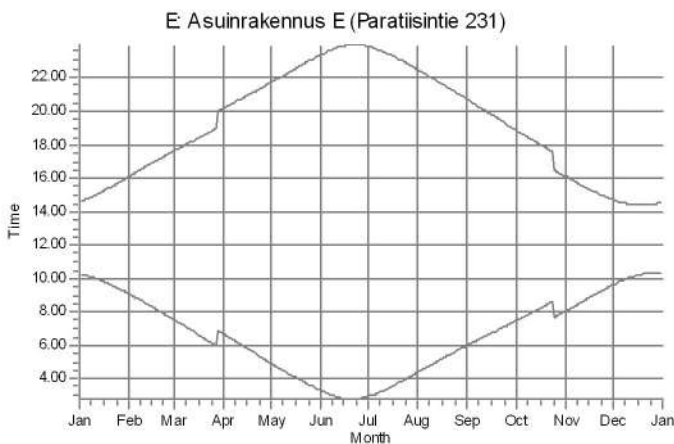
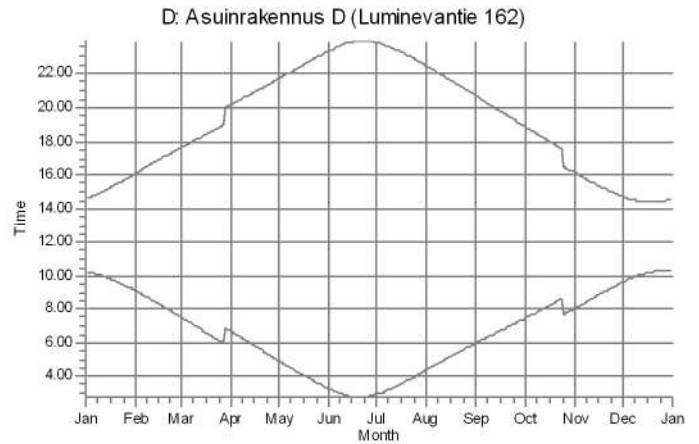
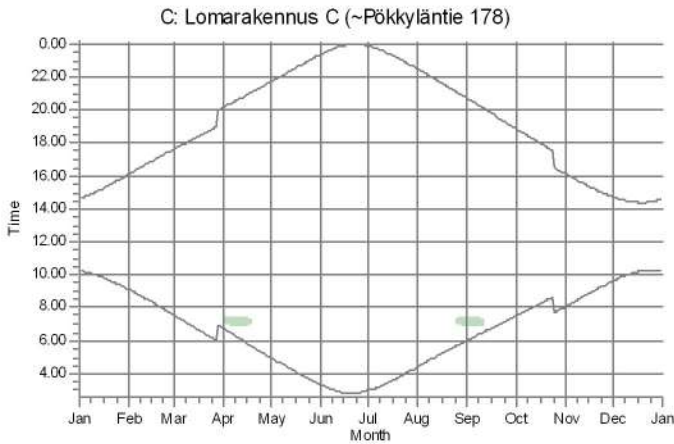
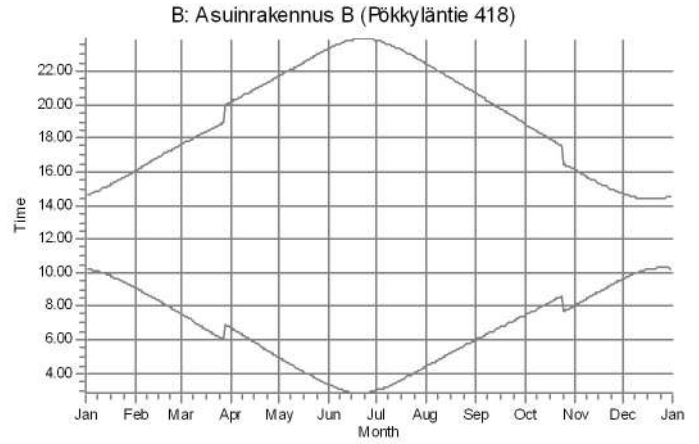
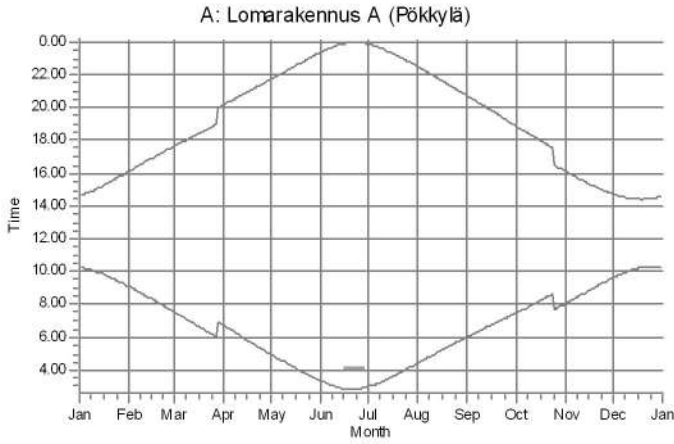
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto3\_RealCase\_NoForest\_RD200m\_Puutionsaari

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, graphical

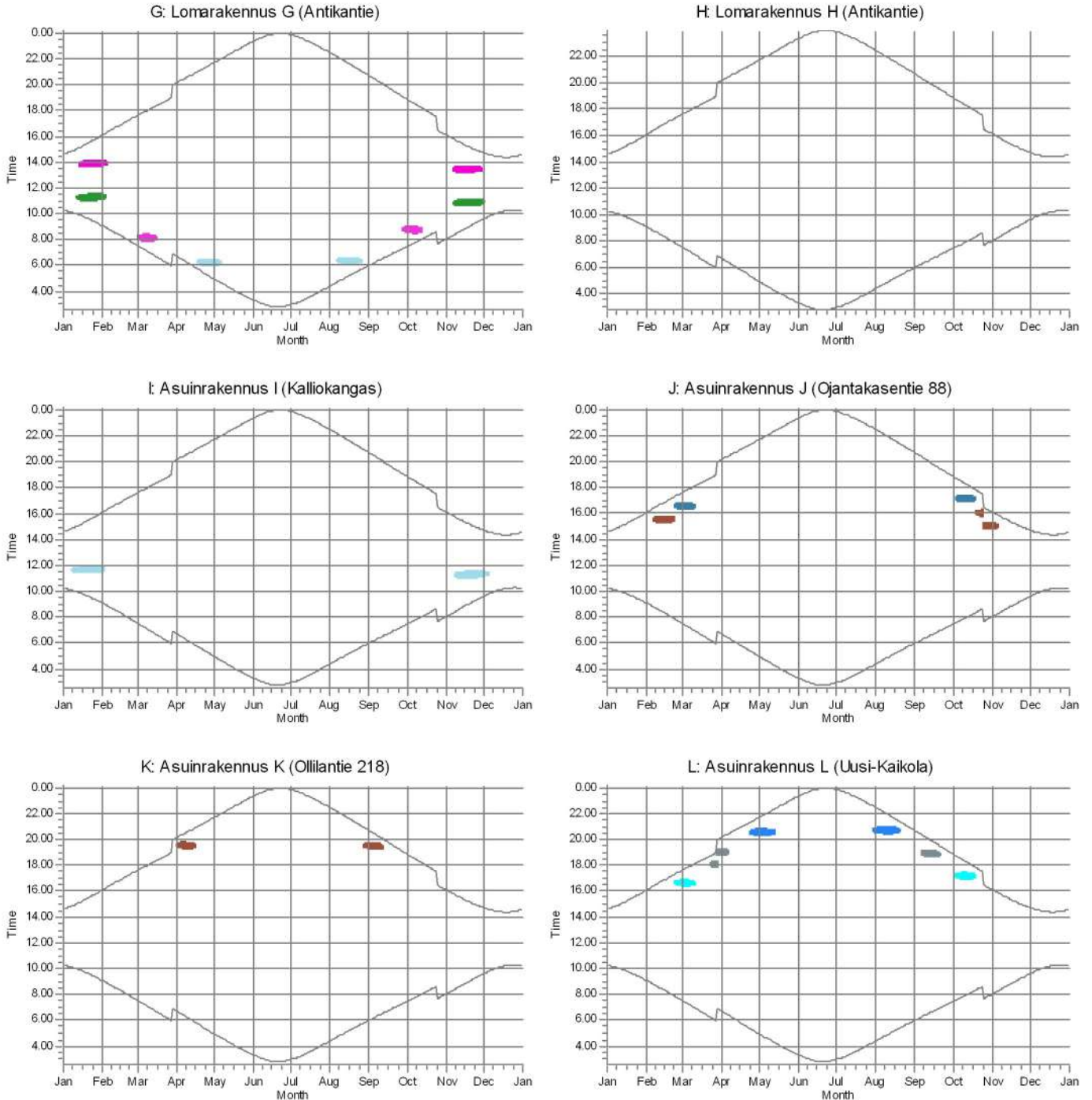
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoeto3\_RealCase\_NoForest\_RD200m\_Puutionsaari



WTGL  
 14. Generic Generic2 7000 200.0 f0I hub: 200.0 m (TOT: 300.0 m) (50%)  
 16. Generic Generic2 7000 200.0 f0I hub: 200.0 m (TOT: 300.0 m) (50%)  
 20. Generic Generic2 7000 200.0 f0I hub: 200.0 m (TOT: 300.0 m) (50%)

## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_NoForest\_RD200m\_Puutionsaari

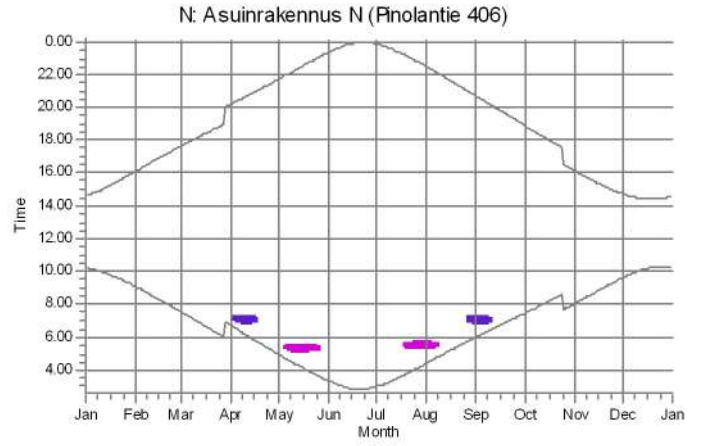
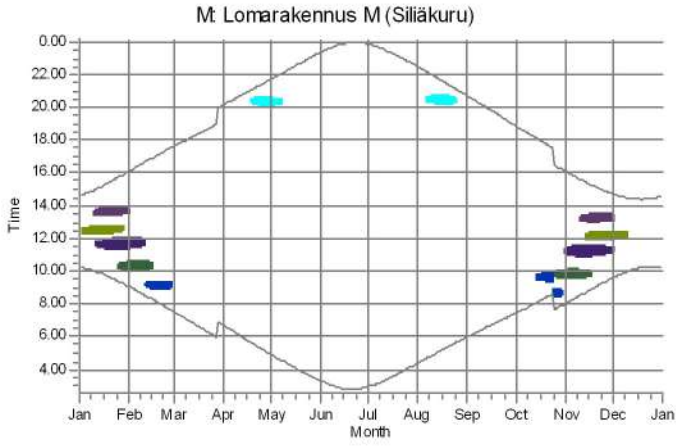


WTG:

13: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (502)	27: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (514)	33: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (522)	38: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (527)	40: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (529)
24: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (513)	31: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (520)	37: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (524)	39: Generic GeneriC2 7000 200.0 lOI hub: 200.0 m (TOT: 300.0 m) (528)	

## SHADOW - Calendar, graphical

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto3\_RealCase\_NoForest\_RD200m\_Puutionsaari



WTGs

13: Generic Concrete2 7000.200.0 101 (101, 300.0 m) (502)

1: PUA01

2: PUA02

23: PUA23

27: PUA27

28: PUA28

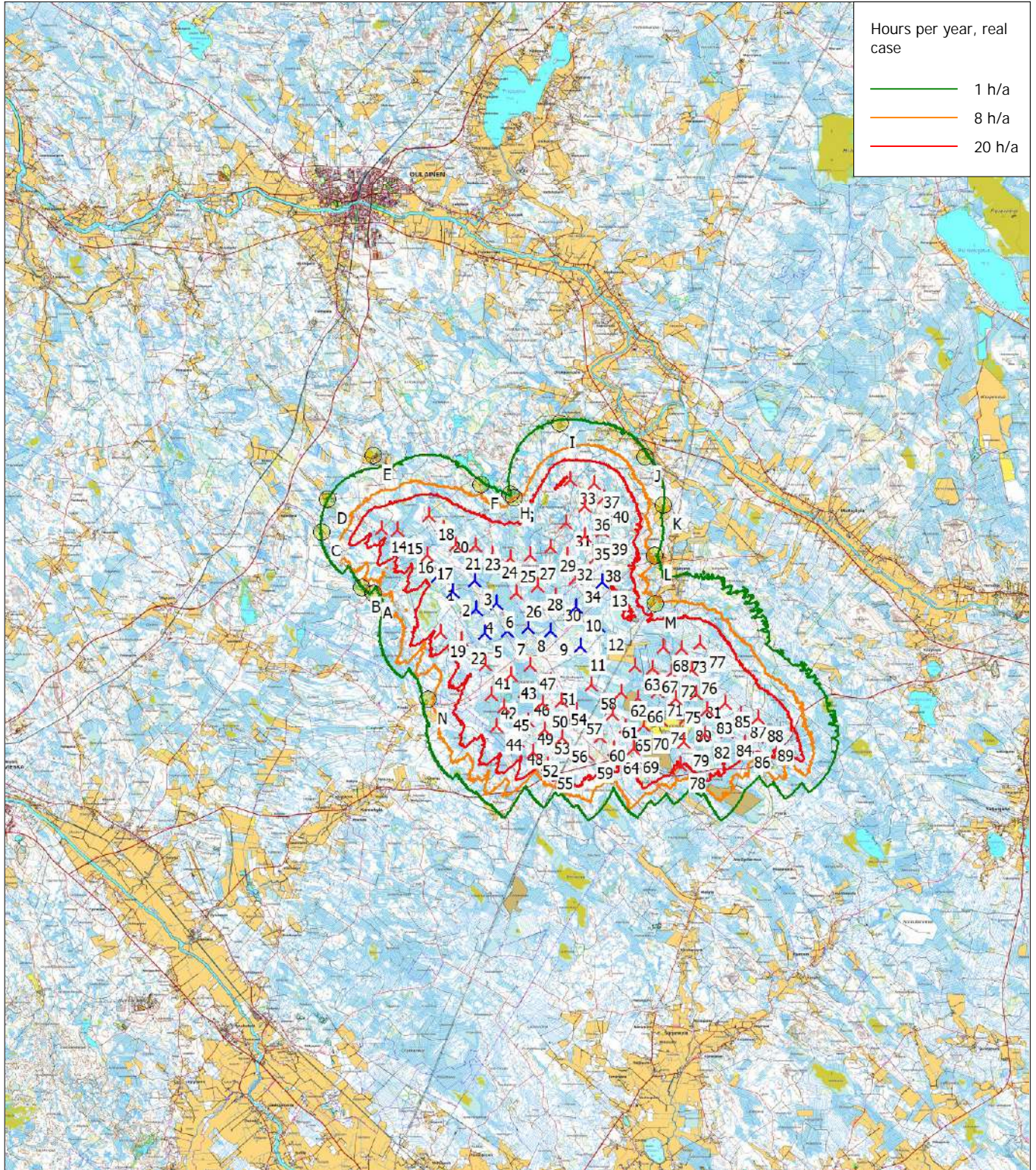
33: PUA33

37: PUA37



## SHADOW - Map

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_NoForest\_RD200m\_Puutionsaari



Hours per year, real case

- 1 h/a
- 8 h/a
- 20 h/a

0 2,5 5 7,5 10km

Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

New WTG

Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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



3.2.2023

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**Liite 21. Yhteisvaikutus varjostusmallinnuksen tulokset ”real case, Luke forest” - VE3**

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtohto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari

### Assumptions for shadow calculations

Maximum distance for influence

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

Please look in WTG table

Minimum sun height over horizon for influence 3 °

Day step for calculation 1 days

Time step for calculation 1 minutes

Sunshine probability S (Average daily sunshine hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0,77 2,46 4,42 6,93 8,81 9,87 9,13 6,84 4,43 2,23 0,93 0,26

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

MERRA2\_N64.000\_E025.000 (1)

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
540 405 376 415 610 890 1 063 1 115 986 769 639 662 8 472

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\_Rahkola-Hautakangas

Area object(s) used in calculation:

Area object (SE): (2)

Area object (SW): (3)

Area object (NE): (4)

Area object (NW): (5)

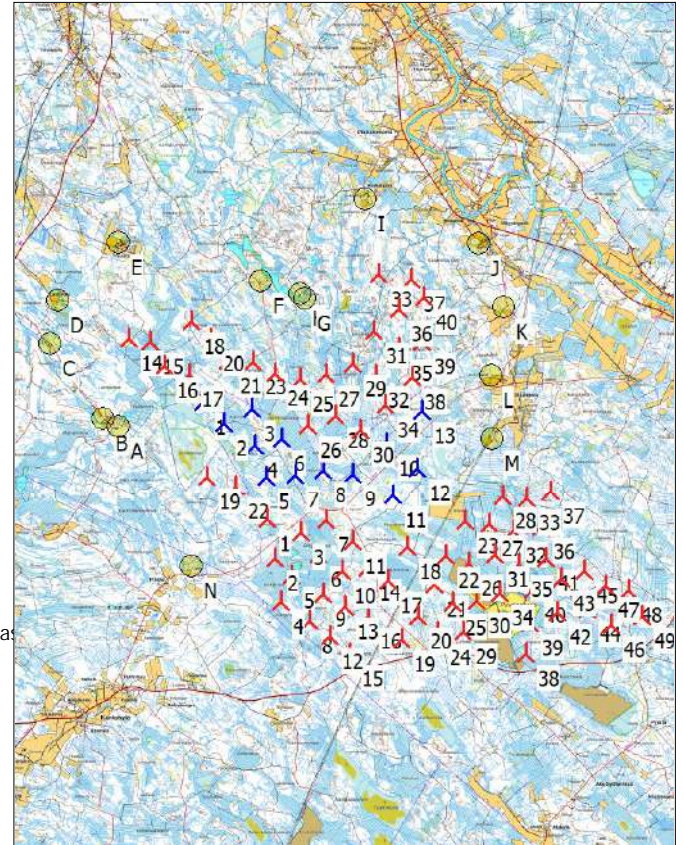
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

### WTGs



New WTG

Scale 1:200 000

Shadow receptor

	East	North	Z	Row data/Description	WTG type		Shadow data					
					Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Calculation distance [m]	RPM [RPM]
			[m]									
1	398 896	7 112 332	92,5	PUU01	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
1	397 208	7 115 412	87,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
2	399 097	7 111 286	95,0	PUU02	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
2	397 754	7 114 856	87,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
3	399 784	7 111 972	97,5	PUU03	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
3	398 503	7 115 243	95,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
4	399 264	7 110 151	96,9	PUU04	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
4	398 570	7 114 265	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
5	399 536	7 110 832	95,4	PUU05	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
5	398 871	7 113 427	90,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	399 272	7 114 459	97,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
6	400 239	7 111 382	96,6	PUU06	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	400 444	7 112 292	97,2	PUU07	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
7	399 647	7 113 488	95,9	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
8	400 019	7 109 649	100,0	PUU08	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
8	400 360	7 113 628	101,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
9	400 380	7 110 348	99,8	PUU09	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
9	401 168	7 113 504	105,0	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
10	400 876	7 110 966	99,4	PUU10	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
10	402 041	7 114 329	106,2	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
11	401 152	7 111 752	99,6	PUU11	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
11	402 216	7 112 963	108,5	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
12	400 549	7 109 232	102,5	PUU12	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
12	402 852	7 113 666	105,7	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
13	400 953	7 110 020	102,4	PUU13	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
13	402 975	7 115 189	106,6	Generic Generic2 7000 200.0 !O! ...	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4

To be continued on next page...

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari

...continued from previous page

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.	Type-generator				Calculation distance [m]	RPM [RPM]
14	401 537	7 111 046	104,5	PUU14	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
14	395 254	7 117 093	87,5	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
15	401 068	7 108 792	105,9	PUU15	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
15	395 819	7 117 022	82,9	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
16	401 564	7 109 758	104,2	PUU16	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
16	396 195	7 116 379	82,5	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
17	402 089	7 110 702	107,5	PUU17	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
17	396 858	7 116 145	84,9	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
18	402 589	7 111 603	106,9	PUU18	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
18	396 894	7 117 531	90,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
19	402 455	7 109 148	112,5	PUU19	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
19	397 303	7 113 442	87,5	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
20	402 889	7 109 778	110,0	PUU20	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
20	397 417	7 117 093	90,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
21	403 318	7 110 593	107,6	PUU21	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
21	397 854	7 116 507	90,9	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
22	398 058	7 113 189	92,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
22	403 622	7 111 352	107,4	PUU22	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
23	404 117	7 112 276	103,6	PUU23	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
23	398 529	7 116 484	94,2	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
24	403 379	7 109 327	115,0	PUU24	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
24	399 116	7 116 184	97,2	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
25	403 790	7 110 129	108,4	PUU25	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
25	399 762	7 116 032	97,5	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
26	404 210	7 111 152	105,6	PUU26	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
26	399 974	7 114 812	98,5	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
27	404 739	7 112 199	105,0	PUU27	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
27	400 456	7 116 139	99,7	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
28	405 100	7 112 943	100,4	PUU28	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
28	400 698	7 115 062	103,2	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
29	404 061	7 109 351	110,0	PUU29	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
29	401 155	7 116 430	99,5	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
30	404 420	7 110 174	107,1	PUU30	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
30	401 348	7 114 680	105,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
31	404 900	7 111 381	105,4	PUU31	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
31	401 706	7 117 283	100,1	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
32	405 395	7 112 030	102,3	PUU32	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
32	401 754	7 116 113	102,5	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
33	405 740	7 112 891	100,3	PUU33	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
33	401 837	7 118 791	95,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
34	405 042	7 110 380	105,7	PUU34	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
34	402 023	7 115 337	105,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
35	405 532	7 111 130	103,6	PUU35	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
35	402 362	7 116 825	105,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
36	406 114	7 112 133	103,3	PUU36	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
36	402 365	7 117 878	100,0	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
37	406 380	7 113 067	107,2	PUU37	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
37	402 692	7 118 655	96,2	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
38	405 707	7 108 791	110,8	PUU38	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
38	402 733	7 116 070	109,9	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
39	405 822	7 109 587	108,2	PUU39	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
39	402 975	7 117 005	103,9	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
40	405 893	7 110 455	105,0	PUU40	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
40	403 021	7 118 167	96,4	Generic Generic2 7000 200.0 !O!	Yes	Generic	Generic2-7 000	7 000	200,0	200,0	2 120	10,4
41	406 257	7 111 298	104,0	PUU41	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
42	406 558	7 109 872	106,7	PUU42	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
43	406 638	7 110 744	105,9	PUU43	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
44	407 324	7 109 954	108,7	PUU44	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
45	407 269	7 110 957	112,5	PUU45	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
46	407 963	7 109 542	113,4	PUU46	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
47	407 809	7 110 582	116,1	PUU47	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
48	408 414	7 110 457	120,0	PUU48	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4
49	408 786	7 109 772	117,5	PUU49	Yes	Generic	Generic2-5 600	5 600	200,0	200,0	2 448	10,4

## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari  
 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]
A	Lomarakennus A (Pökkylä)	394 971	7 114 786	80,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Asuinrakennus B (Pökkyläntie 418)	394 575	7 114 996	77,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Lomarakennus C (~Pökkyläntie 178)	393 172	7 116 951	75,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Asuinrakennus D (Luminevantie 162)	393 376	7 118 095	75,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Asuinrakennus E (Paratiisintie 231)	394 975	7 119 629	79,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Lomarakennus F (Isojärventie)	398 737	7 118 604	90,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Lomarakennus G (Antikantie)	399 889	7 118 156	91,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Lomarakennus H (Antikantie)	399 756	7 118 284	92,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Asuinrakennus I (Kalliokangas)	401 495	7 120 763	87,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Asuinrakennus J (Ojantakasentie 88)	404 469	7 119 588	83,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Asuinrakennus K (Ollilantie 218)	405 119	7 117 909	94,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Asuinrakennus L (Uusi-Kaikola)	404 793	7 116 122	94,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Lomarakennus M (Siliäkuru)	404 833	7 114 443	100,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Asuinrakennus N (Pinolantie 406)	396 890	7 111 092	88,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

## Calculation Results

Shadow receptor

No.	Name	Shadow, expected values Shadow hours per year [h/year]
A	Lomarakennus A (Pökkylä)	0:00
B	Asuinrakennus B (Pökkyläntie 418)	0:00
C	Lomarakennus C (~Pökkyläntie 178)	0:00
D	Asuinrakennus D (Luminevantie 162)	0:00
E	Asuinrakennus E (Paratiisintie 231)	0:00
F	Lomarakennus F (Isojärventie)	0:00
G	Lomarakennus G (Antikantie)	2:40
H	Lomarakennus H (Antikantie)	0:00
I	Asuinrakennus I (Kalliokangas)	1:33
J	Asuinrakennus J (Ojantakasentie 88)	0:00
K	Asuinrakennus K (Ollilantie 218)	0:00
L	Asuinrakennus L (Uusi-Kaikola)	3:31
M	Lomarakennus M (Siliäkuru)	3:07
N	Asuinrakennus N (Pinolantie 406)	0:00

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

No.	Name	Expected [h/year]
1	PUU01	0:00
1	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (490)	0:00
2	PUU02	0:00
2	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (491)	0:00
3	PUU03	0:00
3	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (492)	0:00
4	PUU04	0:00
4	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (493)	0:00
5	PUU05	0:00
5	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (494)	0:00
6	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (495)	0:00
6	PUU06	0:00
7	PUU07	0:00
7	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (496)	0:00
8	PUU08	0:00
8	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (497)	0:00
9	PUU09	0:00
9	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (498)	0:00
10	PUU10	0:00
10	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (499)	0:00
11	PUU11	0:00
11	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (500)	0:00
12	PUU12	0:00

To be continued on next page...



## SHADOW - Main Result

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari

...continued from previous page

No.	Name	Expected [h/year]
12	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (501)	0:00
13	PUU13	0:00
13	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (502)	4:42
14	PUU14	0:00
14	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (503)	0:00
15	PUU15	0:00
15	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (504)	0:00
16	PUU16	0:00
16	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (505)	0:00
17	PUU17	0:00
17	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (506)	0:00
18	PUU18	0:00
18	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (507)	0:00
19	PUU19	0:00
19	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (508)	0:00
20	PUU20	0:00
20	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (509)	0:00
21	PUU21	0:00
21	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (510)	0:00
22	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (511)	0:00
22	PUU22	0:00
23	PUU23	0:00
23	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (512)	0:00
24	PUU24	0:00
24	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (513)	1:18
25	PUU25	0:00
25	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (514)	0:00
26	PUU26	0:00
26	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (515)	0:00
27	PUU27	0:00
27	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (516)	1:22
28	PUU28	0:00
28	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (517)	0:00
29	PUU29	0:00
29	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (518)	0:00
30	PUU30	0:00
30	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (519)	0:00
31	PUU31	0:00
31	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (520)	0:00
32	PUU32	0:00
32	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (521)	0:00
33	PUU33	0:00
33	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (522)	1:33
34	PUU34	0:00
34	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (523)	0:00
35	PUU35	0:00
35	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (524)	0:00
36	PUU36	0:00
36	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (525)	0:00
37	PUU37	0:00
37	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (526)	0:00
38	PUU38	0:00
38	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (527)	1:57
39	PUU39	0:00
39	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (528)	0:00
40	PUU40	0:00
40	Generic Generic2 7000 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (529)	0:00
41	PUU41	0:00
42	PUU42	0:00
43	PUU43	0:00
44	PUU44	0:00
45	PUU45	0:00
46	PUU46	0:00
47	PUU47	0:00
48	PUU48	0:00
49	PUU49	0:00

Project:

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Licensed user:

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Calculated:

30.1.2023 15.43/3.5.584

## SHADOW - Main Result

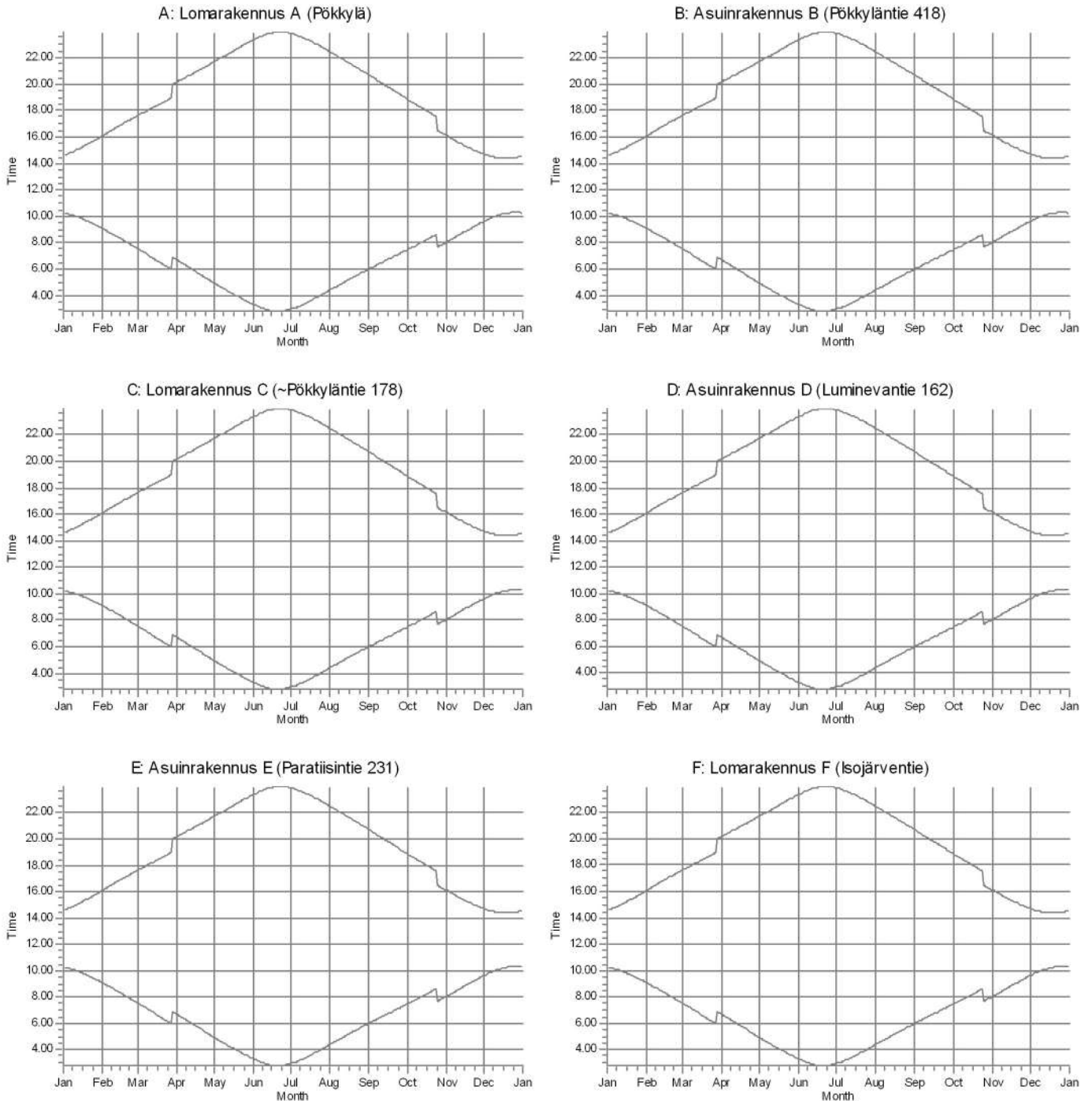
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoehto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari

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, graphical

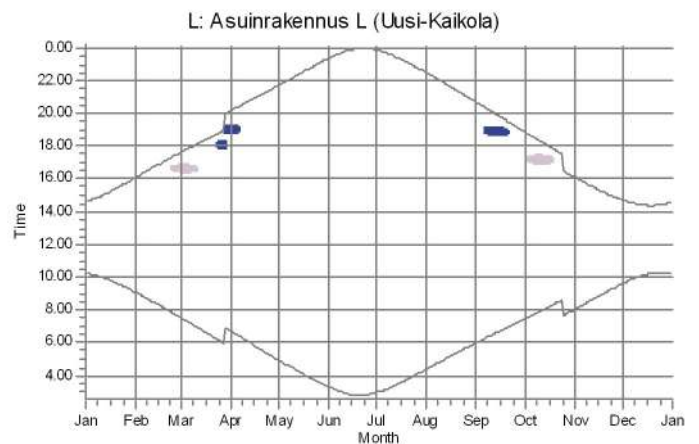
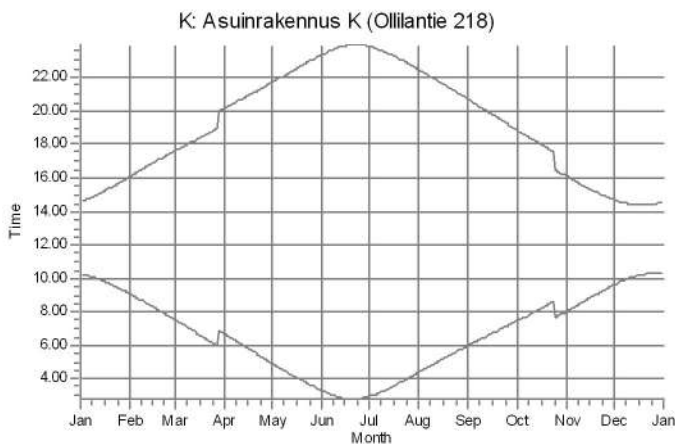
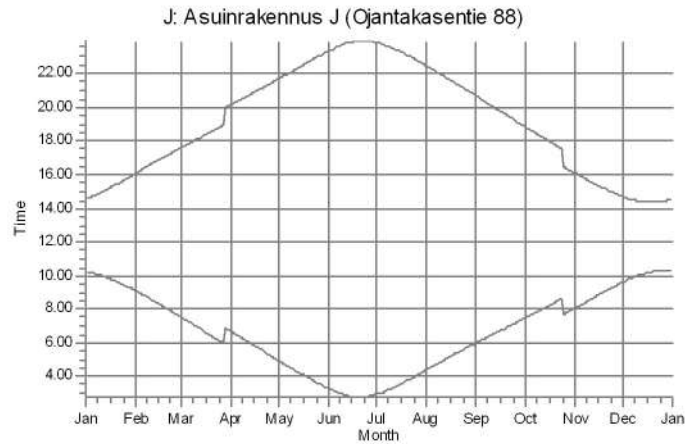
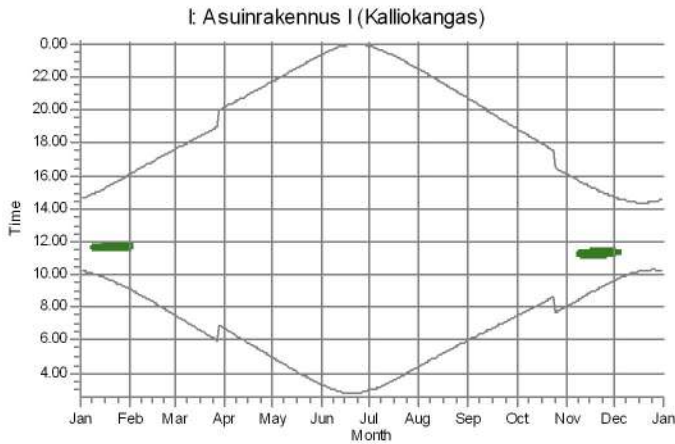
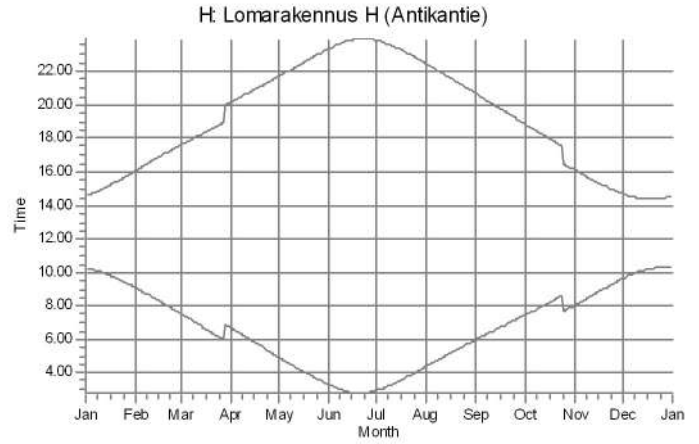
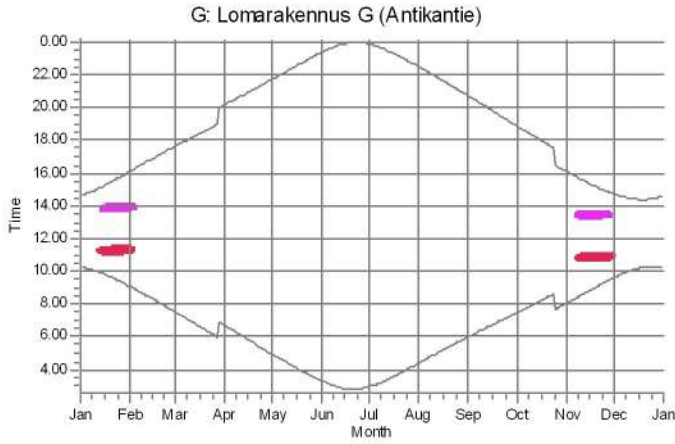
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihtoeto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari



WTG

## SHADOW - Calendar, graphical

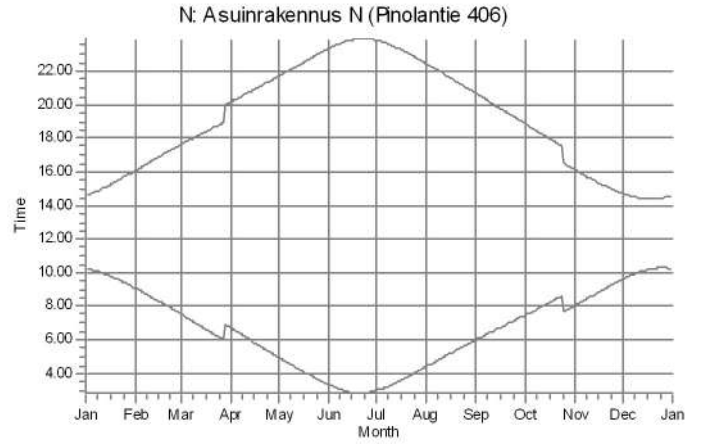
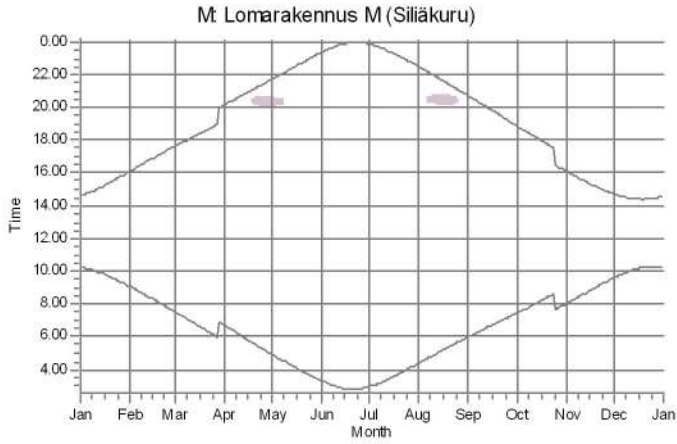
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoeto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari



WTGL  
 13: Generic Generic2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (502)   
 24: Generic Generic2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (513)   
 27: Generic Generic2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (514)   
 33: Generic Generic2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (522)   
 38: Generic Generic2 7000 200.0 I0I hub: 200.0 m (TOT: 300.0 m) (527)

## SHADOW - Calendar, graphical

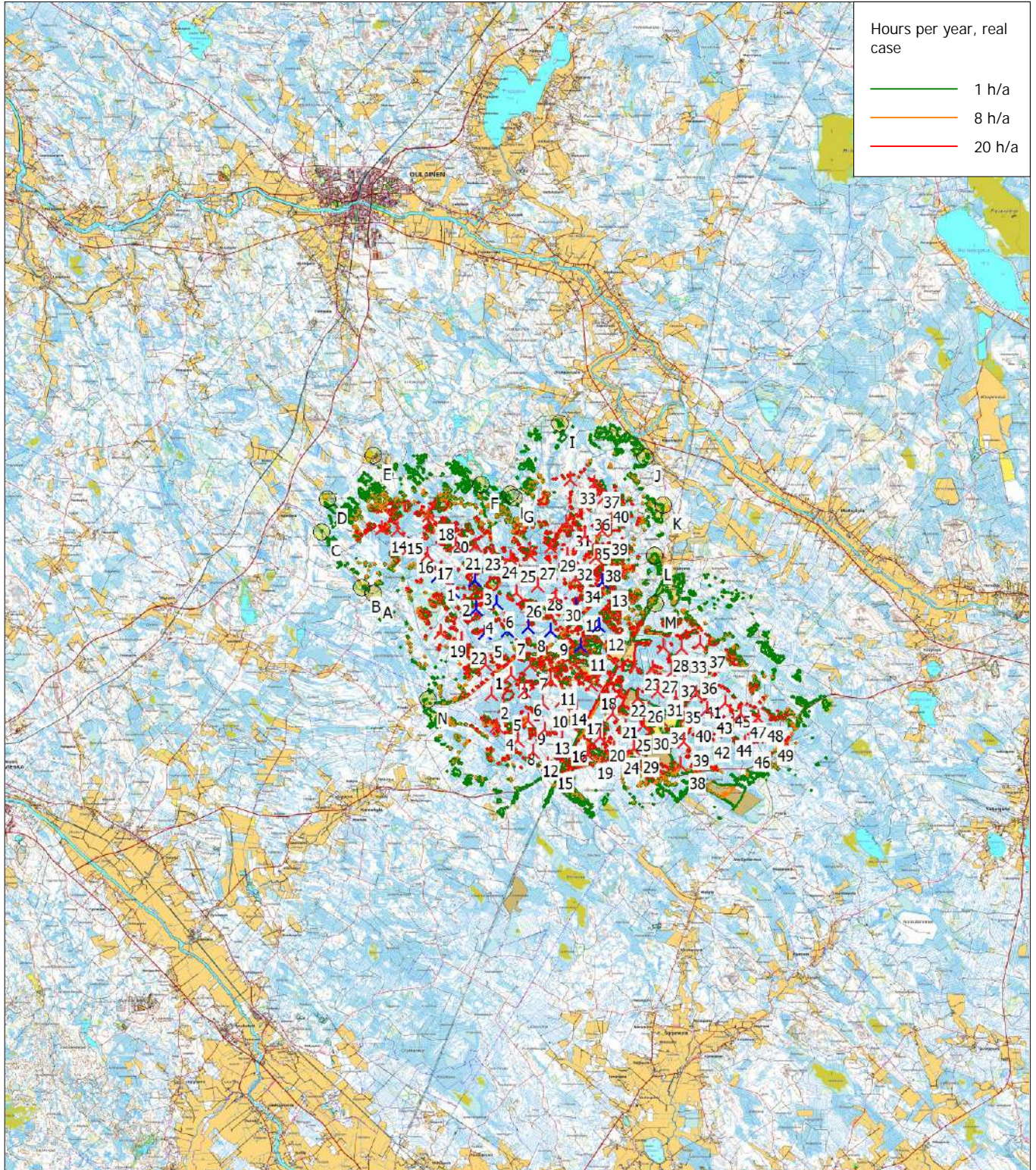
Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari





## SHADOW - Map

Calculation: Yhteisvaikutus\_Rahkola-Hautakangas Hankevaihhtoehto3\_RealCase\_Luke Forest\_RD200m\_Puutionsaari



Map: Maastokarttarasteri50K , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 399 960 North: 7 115 070

New WTG

Shadow receptor

Flicker map level: Height Contours: CONTOURLINE\_Rahkola\_Hautakangas\_1.wpo (1)

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