

WINDA ENERGY OY

Verkasalon tuulivoimahanke

Melu- ja varjostusmallinnusraportti

11.10.2023

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Verkasalon tuulivoimahanke

MELU- JA VARJOSTUSMALLINNUKSEN TAVOITTEET

Verkasalon tuulivoimahankkeen hankeomistaja Winda Energy Oy suunnittelee vaihtoehdossa 1 (VE1) 28 voimalan rakentamista ja vaihtoehdossa 2 (VE2) 33 voimalan rakentamista Ylivieskan, Alavieskan ja Kalajoen kuntien alueelle. Tämä melu- ja varjostusmallinnusraportti on laadittu Verkasalon hankkeen YVA-menettelyvaiheen sijoitussuunnitelmien perusteella.

Tuulivoimaloiden aiheuttamia meluvaikutuksia on arvioitu WindPRO-ohjelman DECIBEL-moduulilla. Tuulivoimaloiden aiheuttamat varjostusvaikutukset on mallinnettu WindPro-ohjelman SHADOW-moduulilla. Melu- ja varjostusmallinnukset on laatinut Aarni Nikkola ja laaduntarkastuksen on tehnyt Johanna Harju FCG Finnish Consulting Group Oy:stä.

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.

Verkasalon tuulivoimaloiden äänenpainetasot on mallinnettu molemmissa vaihtoehdoissa voimalaitostyyppillä Nordex N175-6.8MW 232,5 metriä korkealla tornilla ja 175 metrin roottorihalkaisijalla. Voimaloiden kokonaiskorkeus on näin ollen 320 metriä.

Voimalaitoksen N175-6.8 MW lähtömelutaso on 106,9 dB(A). Voimalaitosvalmistajan mukaan N175-6.8MW melutaso vastaa ylempää luottamusväliä 95 % ja on valmistajan mukaan melun takuuarvo, kun siihen lisätään 1,5 dB(A).

Tuulivoimahankkeiden yhteisvaikutuksia tarkasteltaessa on huomioitu Verkasalon hankkeen läheisyydessä sijaitsevan Hangaskurunkankaan tuulivoimahankkeen voimalat. Hangaskurunkankaan tuulivoimaloiden äänenpainetasot on Hangaskurunkankaan melumallinnusraportin (AFRY 2023) mallinnettu geneerisellä voimalaitostyyppillä, jonka roottorin halkaisija on 200 m. Lähtömelunatasona käytettiin Vestas V150 4/4.2 mukaista äänipäästötasoa 107,8 dB, johon lisättiin +2 dB:n varmuusarvo.

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

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Taulukko 1. Verkasalon tuulivoimahankkeen mallinnusohjelma ja tuulivoimaloiden äänitehotasot voimalaitoksella N175-6,8 MW sekä melun erityispiirteet.

MALLINNUSOHJELMAN TIEDOT							
Mallinnusohjelma ja versio: WindPRO version 3.6.355				Mallinnusmenetelmä: ISO 9613-2			
TUULIVOIMALAN (TUULIVOIMALOIDEN TIEDOT)							
Tuulivoimalan valmistaja: Nordex				Tyyppi: N175		Sarjanumero/t:-	
Nimellisteho: 6,8 MW		Napakorkeus: 232,5 m		Roottorin halkaisija: 175 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, STE			
Ei		Ei		Noise mode, lähtömelutaso			106, 9 dB
AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT							
Third octave sound power levels F008_278_A17_EN Revision 01, 2022-05-08							
Valmistajan ilmoittama tuulivoimalan tuottama äänitehotaso vastaa keskiäänitasoa ja lisäämällä epävarmuus 1,5 dB(A) saadaan äänitehotaso vastaamaan takuuarvoa.							
Nordexin mukaan:							
The warranted sound power levels are calculated expected mean values. This is common practise in the industry and also other OEMs are following the same approach. Within the Noise Emission Warranty Nordex warrants that a single measurement will be within the confidence interval according to IEC 61400-14.							
Please further be advised, that we limit the Confidence Interval according to the Noise Emission Warranty to a maximum value of 1.5dB(A).							
Oktaaveittain [Hz],dB(A)		1/3-oktaaveittain [Hz] LWA dB					
		20	20	73,3	200	96	102,4
63	91,2	25	76,7	250	96,5	2000	100,3
125	98	31,5	78,6	315	97,3	2500	96,8
250	101,4	40	79,8	400	97,2	3150	92,4
500	101,9	50	81,8	500	97	4000	86,8
1000	102,8	63	86,1	630	97,3	5000	81,2
2000	100,7	80	88,8	800	98	6300	74,1
4000	91,4	100	90,4	1000	98	8000	66,4
8000	74,9	125	93	1250	98,2	10000	57
108,4 dB(A)		160	95				
Melun erityispiirteiden mittausta 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. Hangaskurunkankaan tuulivoimahankkeen mallinnusohjelma ja tuulivoimaloiden äänitehotasot voimalaitoksella Vestas V150 – 4/4.2 MW sekä melun erityispiirteet.

MALLINNUSOHJELMAN TIEDOT							
Mallinnusohjelma ja versio: WindPRO version 3.6.355				Mallinnusmenetelmä: ISO 9613-2			
TUULIVOIMALAN (TUULIVOIMALOIDEN TIEDOT)							
Tuulivoimalan valmistaja: Vestas				Tyyppi: V150-4.0/4.2		Sarjanumero/t: -	
Nimellisteho: 4.2 MW		Napakorkeus: 200,0 m		Roottorin halkaisija: 200 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			
Ei		Ei		Noise mode, lähtömelutaso			
AKUSTISET TIEDOT/LASKENNAN LÄHTÖTIEDOT							
Document nro: DMS 0067-4767 V03, Date 2017-11-13							
Voimalaitosvalmistajan mukaan melutaso 107,8 dB(A) on IEC-standardin 61400-11 mukainen takuuarvo.							
Lisätty varmuusarvo K (+ 2 dB)							
Oktaaveittain [Hz],dB(A)		1/3-oktaaveittain [Hz] LWA dB					
		20	63,6	200	89,1	1600	98,8
63	83,5	25	66,8	250	90,7	2000	99
125	90,3	31,5	69,9	315	92,3	2500	99,2
250	95,7	40	72,9	400	93,7	3150	99,2
500	99,7	50	75,6	500	94,9	4000	99
1000	102,5	63	78,3	630	96	5000	98,7
2000	103,8	80	80,8	800	97	6300	98,2
4000	103,7	100	83,1	1000	97,7	8000	97,5
8000	102,3	125	85,2	1250	98,3	10000	96,7
109,8 dB(A)		160	87,3				
Melun erityispiirteiden mittaustulos ja havainnot:							
Kapeakaistaisuus / Tonaalisuus		Impulssimaisuus		Merkityksellinen sykintä (amplitudi-modulaatio)		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, Hakala

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

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
DLo [dB]	7.6	8.3	9.2	10.3	11.5	13.0	14.8	16.8	18.8	21.1	22.8

Matalataajuuden 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 sekä melulle altistuvat kohteet.

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 absorption ja heijastuksen huomioiminen, käytetyt kertoimet			
ISO 9613-2	0,4		HUOM
Ilmakehän stabiilius laskennassa/meteorologinen korjaus			
Neutraali, (0): Neutraali		Muu, mikä ja miksi:	
Säätöolosuhteiden 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

Taulukko 5. Verkasalon tuulivoimahankkeen mallinnusohjelma ja tuulivoimaloiden koko varjostusmallinnuksissa.

MALLINNUSOHJELMAN TIEDOT			
Mallinnusohjelma ja versio: WindPRO version 3.6.355		Mallinnusmenetelmä: ISO 9613-2	
TUULIVOIMALAN TIEDOT			
Tuulivoimalan valmistaja: Generic		Tyyppi: RD200	Sarjanu- mero/t:-
Nimellisteho: 7,2 MW	Napakorkeus: 220 m	Roottorin halkaisija: 200 m	Tornin tyyppi: teräs/hybridi

Verkasalon tuulivoimaloiden varjostusvaikutukset on mallinnettu käyttäen roottorinhalkaisijaltaan 200 metristä voimalaitosta 220 metriä korkealla tornilla. Kokonaiskorkeudeltaan voimala on mallinuksissa 320 metriä. Hangaskurunkankaan yhteisvaikutushankkeen voimaloina on käytetty roottorinhalkaisijaltaan ja napakorkeudeltaan 200 metrisiä voimaloita, voimaloiden kokonaiskorkeutena näin ollen 300 metriä.

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.

Varjostusmallinnuksessa huomioidaan siiven lavan maksimileveys sekä siiven kärjen leveys 90 % etäisyydellä turbiinista. Mallinnuksessa siiven oletetaan kapenevan lineaarisesti kohti kärjen leveysarvoa.

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 voimaloita kohti ns. "greenhouse mode".

Auringon keskimääräiset paistetunnit perustuvat Oulunsalon Oulun lentoaseman sääaseman mitattuihin säätietoihin vuosilta 1981 - 2010. Laskentojen tuulen suunta ja nopeusjakauma käytettiin NASA:n MERRA-dataa (Modern Era Retrospective-analysis for Research and Applications) hankealueen läheisyydeltä.

Puuston huomioivassa varjostusmallinnuksissa (Luke forest) on huomioitu puuston peittävyys käytämällä Luonnonvarakeskuksen vuoden 2021 puuston keskipituus aineistoa.

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 tyypillisen 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 _{Zeq} ,1h, dB	74	64	56	49	44	42	40	38	36	34	32
Edellisestä laskettu keski-äänitaso A-painotettuna L _{Aeq} ,1h, dB	24	19	17	14	14	16	18	19	20	21	21

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

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2.3.2 Varjostus

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

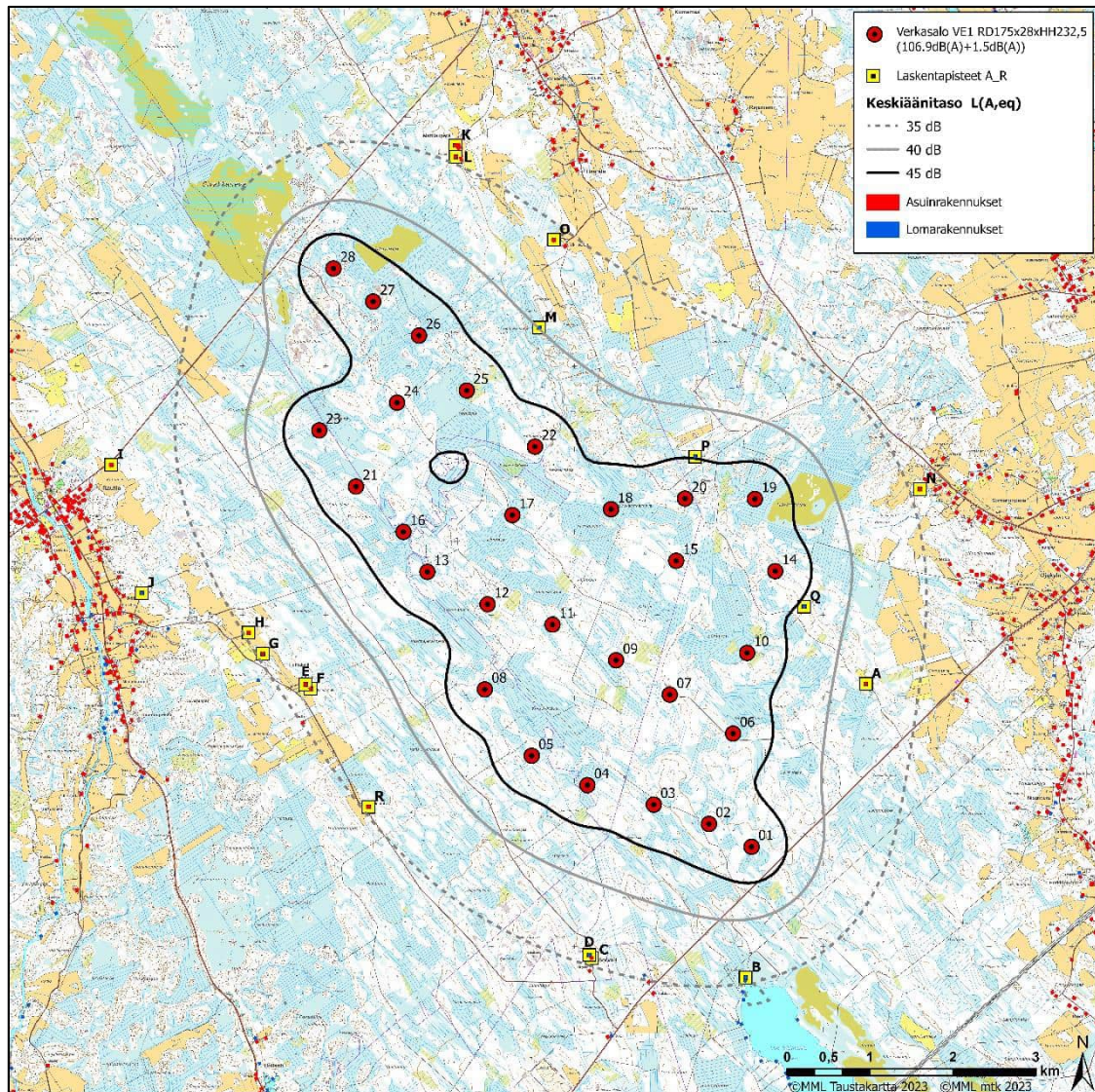
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MELU- JA VARJOSTUSMALLINNUSTEN TULOKSET

3.1 Melumallinnus

3.1.1 Melun laskentatulokset ISO 9613-2 voimalaitoksella Nordex N175 - 6.8MW (106,9 dB(A) + 1,5 dB(A))

Vaihtoehtoon 1 (VE1) melumallinnuksen mukaan melutaso 40 dB(A) ylittyy lähimmillä lomarakennuksilla laskentapisteissä Lomarakenus P (44,7 dB(A)) ja Lomarakenus Q (44,2 dB(A)), (Kuva 1 ja Taulukko 8). Katso tarkemmat laskentatulokset liitteestä 1.

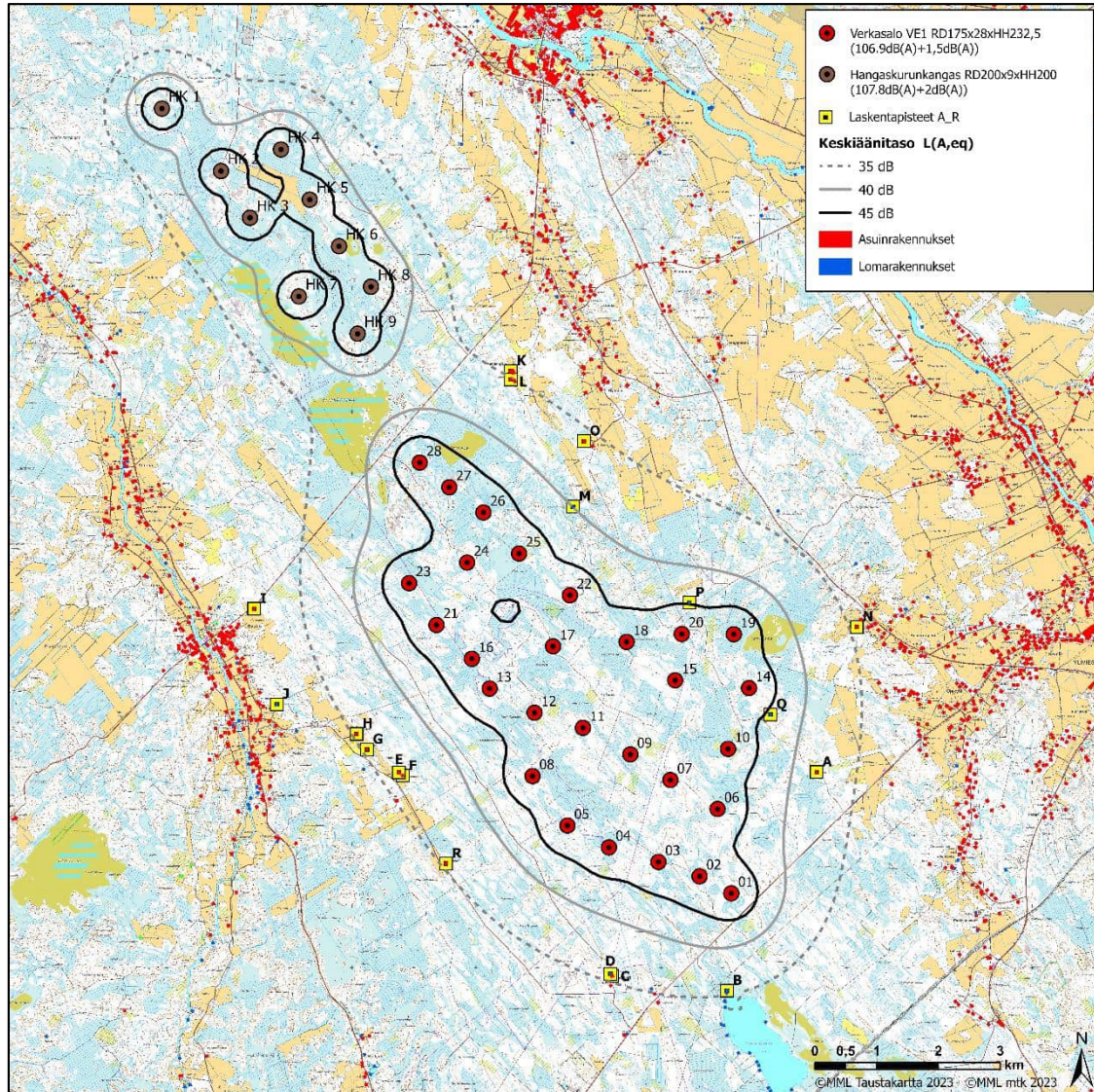


Kuva 1. Melumallinnuksen tulos VE1.

Vaihtoehtoon 1 (VE1) melun yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa on esitetty kuvassa 2 ja taulukossa 9. Melumallinnuksen tulosten mukaan melutaso 40 dB(A) ylittyy samoissa laskentapisteissä kuin huomioitaessa ainoastaan Verkasalon vaihtoehtoon 1 voimalat. Myös melutasot

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kyseisissä laskentapisteissä ovat samat, joten Hangaskurunkankaan hankkeen huomiointi ei aiheuta lisämelua näissä laskentapisteissä. Katso tarkemmat laskentatulokset liitteestä 2.



Kuva 2. Melumallinnuksen tulos Verkasalo VE1 yhdessä Hangaskurunkankaan hankkeen kanssa.

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Taulukko 8. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 1 (VE1).

Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	37,8
Lomarakennus B	372 065	7 102 626	82,5	4,0	35,4
Asuinrakennus C	370 211	7 102 863	82,5	4,0	35,4
Lomarakennus D	370 180	7 102 899	82,5	4,0	35,5
Asuinrakennus E	366 759	7 106 162	67,5	4,0	36,1
Asuinrakennus F	366 819	7 106 110	67,5	4,0	36,2
Asuinrakennus G	366 243	7 106 530	65,0	4,0	35,3
Asuinrakennus H	366 073	7 106 785	64,5	4,0	35,2
Asuinrakennus I	364 417	7 108 809	61,2	4,0	31,9
Lomarakennus J	364 785	7 107 263	61,9	4,0	31,9
Asuinrakennus K	368 566	7 112 661	59,4	4,0	34,1
Asuinrakennus L	368 569	7 112 523	60,1	4,0	34,6
Lomarakennus M	369 574	7 110 463	60,0	4,0	39,9
Asuinrakennus N	374 166	7 108 516	60,2	4,0	34,4
Asuinrakennus O	369 753	7 111 523	57,6	4,0	35,7
Lomarakennus P	371 457	7 108 909	60,7	4,0	44,7
Lomarakennus Q	372 769	7 107 100	70,9	4,0	44,2
Asuinrakennus R	367 519	7 104 685	70,6	4,0	35,3

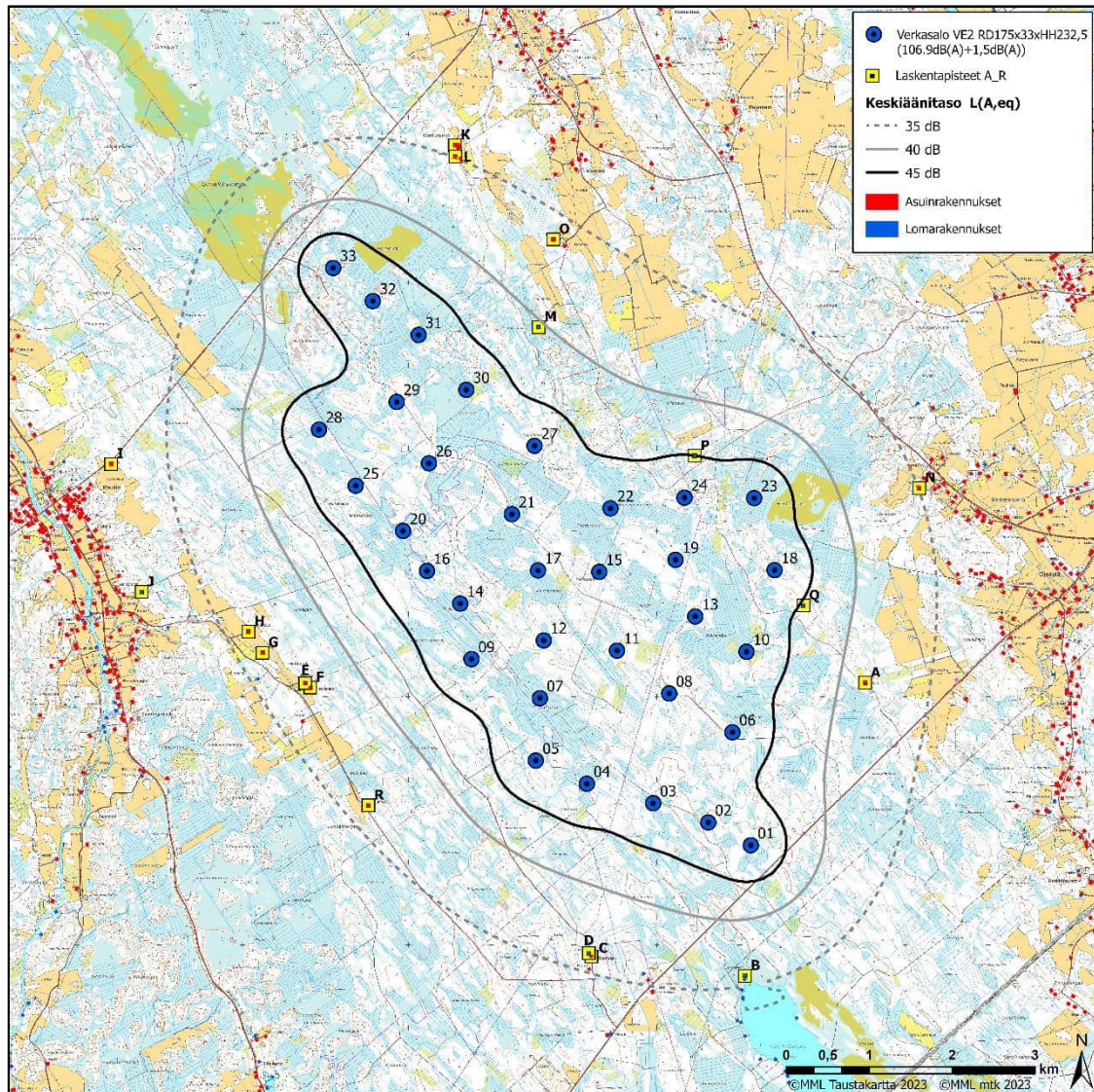
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Taulukko 9. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 1 (VE1). Yhteisvaikutukset Hangaskurunkankaan (Vestas V150 – 4/4.2MW) hankkeen kanssa.

Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta- korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	37,8
Lomarakennus B	372 065	7 102 626	82,5	4,0	35,4
Asuinrakennus C	370 211	7 102 863	82,5	4,0	35,4
Lomarakennus D	370 180	7 102 899	82,5	4,0	35,5
Asuinrakennus E	366 759	7 106 162	67,5	4,0	36,2
Asuinrakennus F	366 819	7 106 110	67,5	4,0	36,2
Asuinrakennus G	366 243	7 106 530	65,0	4,0	35,3
Asuinrakennus H	366 073	7 106 785	64,5	4,0	35,3
Asuinrakennus I	364 417	7 108 809	61,2	4,0	32,1
Lomarakennus J	364 785	7 107 263	61,9	4,0	32,0
Asuinrakennus K	368 566	7 112 661	59,4	4,0	34,6
Asuinrakennus L	368 569	7 112 523	60,1	4,0	35,1
Lomarakennus M	369 574	7 110 463	60,0	4,0	40,0
Asuinrakennus N	374 166	7 108 516	60,2	4,0	34,4
Asuinrakennus O	369 753	7 111 523	57,6	4,0	35,8
Lomarakennus P	371 457	7 108 909	60,7	4,0	44,7
Lomarakennus Q	372 769	7 107 100	70,9	4,0	44,2
Asuinrakennus R	367 519	7 104 685	70,6	4,0	35,3

Vaihtoehtoon 2 (VE2) melumallinnuksen tulosten mukaan melutaso 40 dB(A) ylittyy laskentapisteissä Lomarakennus M (40,4 dB(A)), Lomarakennus P (45,0 dB(A)) ja Lomarakennus Q (44,6 dB(A)) (Kuva 3, Taulukko 10). Katso tarkemmat laskentatulokset liitteestä 3.

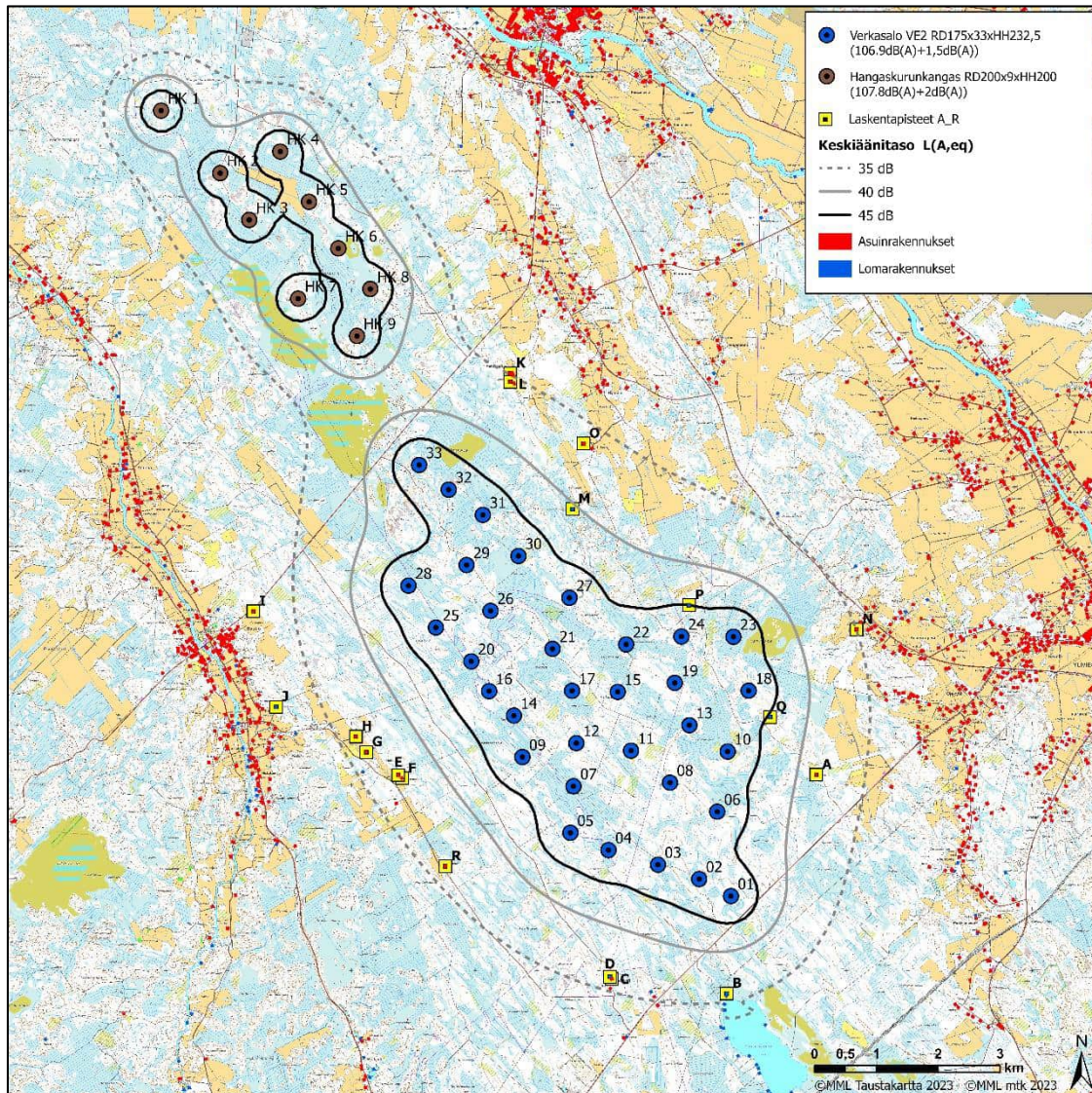
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Kuva 3. Melumallinnuksen tulos VE2.

Vaihtoehdon 2 (VE2) melun yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa on esitetty kuvassa 4 ja taulukossa 11. Melumallinnuksen tulosten mukaan melutaso 40 dB(A) ylittyy samoissa laskentapisteissä kuin huomioitaessa ainoastaan Verkasalon vaihtoehdon 2 voimat. Myös melutasot kyseisissä laskentapisteissä ovat samat, joten Hangaskurunkankaan hankkeen huomiointi ei aiheuta lisämelua näissä laskentapisteissä. Katso tarkemmat laskentatulokset liitteestä 4.

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Kuva 4. Melumallinnuksen tulos Verkasalo VE2 yhdessä Hangaskurunkankaan hankkeen kanssa.

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Taulukko 10. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 2 (VE2).

Laskentapiste	ETRS89- TM35 Itä	ETRS89- TM35 Pohjoinen	Z (m)	Laskenta- korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	38,3
Lomarakennus B	372 065	7 102 626	82,5	4,0	35,6
Asuinrakennus C	370 211	7 102 863	82,5	4,0	35,8
Lomarakennus D	370 180	7 102 899	82,5	4,0	35,9
Asuinrakennus E	366 759	7 106 162	67,5	4,0	37,1
Asuinrakennus F	366 819	7 106 110	67,5	4,0	37,2
Asuinrakennus G	366 243	7 106 530	65,0	4,0	36,1
Asuinrakennus H	366 073	7 106 785	64,5	4,0	36,0
Asuinrakennus I	364 417	7 108 809	61,2	4,0	32,5
Lomarakennus J	364 785	7 107 263	61,9	4,0	32,6
Asuinrakennus K	368 566	7 112 661	59,4	4,0	34,4
Asuinrakennus L	368 569	7 112 523	60,1	4,0	34,9
Lomarakennus M	369 574	7 110 463	60,0	4,0	40,4
Asuinrakennus N	374 166	7 108 516	60,2	4,0	35,0
Asuinrakennus O	369 753	7 111 523	57,6	4,0	36,1
Lomarakennus P	371 457	7 108 909	60,7	4,0	45,0
Lomarakennus Q	372 769	7 107 100	70,9	4,0	44,6
Asuinrakennus R	367 519	7 104 685	70,6	4,0	36,0

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Taulukko 11. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 2 (VE2). Yhteisvaikutukset Hangaskurunkankaan (Vestas V150 – 4/4.2MW) hankkeen kanssa.

Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	38,3
Lomarakennus B	372 065	7 102 626	82,5	4,0	35,6
Asuinrakennus C	370 211	7 102 863	82,5	4,0	35,8
Lomarakennus D	370 180	7 102 899	82,5	4,0	36,0
Asuinrakennus E	366 759	7 106 162	67,5	4,0	37,1
Asuinrakennus F	366 819	7 106 110	67,5	4,0	37,2
Asuinrakennus G	366 243	7 106 530	65,0	4,0	36,1
Asuinrakennus H	366 073	7 106 785	64,5	4,0	36,0
Asuinrakennus I	364 417	7 108 809	61,2	4,0	32,6
Lomarakennus J	364 785	7 107 263	61,9	4,0	32,7
Asuinrakennus K	368 566	7 112 661	59,4	4,0	34,9
Asuinrakennus L	368 569	7 112 523	60,1	4,0	35,4
Lomarakennus M	369 574	7 110 463	60,0	4,0	40,4
Asuinrakennus N	374 166	7 108 516	60,2	4,0	35,0
Asuinrakennus O	369 753	7 111 523	57,6	4,0	36,2
Lomarakennus P	371 457	7 108 909	60,7	4,0	45,0
Lomarakennus Q	372 769	7 107 100	70,9	4,0	44,6
Asuinrakennus R	367 519	7 104 685	70,6	4,0	36,0

3.1.2 Matalataajuiset melutasot voimalaitoksella Nordex N175 - 6.8MW STE (106,9 dB(A) + 1,5 dB(A))

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

Mallinnettaessa Verkasalon tuulivoimahankkeen matalataajuisia melutasoja voimalaitostyyppillä Nordex N175 - 6.8MW vaihtoehdoissa VE 1 ja VE 2, ei matalataajuinen melu ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteissä A – R. Taulukossa 12 on esitetty matalataajuisen melun laskentatulokset vaihtoehdossa VE 1 ja taulukossa 13 matalataajuisen melun laskentatulokset vaihtoehdossa VE 2. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on hankevaihtoehdossa VE 1 enimmillään 0,5 dB alle toimenpiderajan taajuudella 63 Hz ja hankevaihtoehdossa VE 2 enimmillään 0,01 dB alle toimenpiderajan taajuudella 63 Hz (lomarakennus P). Katso tarkemmat laskentatulokset liitteistä 5 ja 7.

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Taulukko 12. Matalataajuisen melun laskentatulokset VE1.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	8,1	80	-5,1	63
Lomarakennus B	6,1	80	-7,2	63
Asuinrakennus C	6,4	80	-6,8	63
Lomarakennus D	6,5	80	-6,7	63
Asuinrakennus E	7,2	80	-6,0	63
Asuinrakennus F	7,3	80	-6,0	63
Asuinrakennus G	6,6	80	-6,7	63
Asuinrakennus H	6,5	80	-6,7	63
Asuinrakennus I	4,1	80	-9,1	63
Lomarakennus J	4,2	80	-9,0	63
Asuinrakennus K	5,4	80	-7,9	63
Asuinrakennus L	5,7	80	-7,5	63
Lomarakennus M	9,7	80	-3,6	63
Asuinrakennus N	5,7	80	-7,5	63
Asuinrakennus O	6,8	80	-6,5	63
Lomarakennus P	12,8	80	-0,5	63
Lomarakennus Q	12,3	80	-1,0	63
Asuinrakennus R	6,6	80	-6,7	63

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Taulukko 13. Matalataajuisen melun laskentatulokset VE2.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	8,7	80	-4,5	63
Lomarakennus B	6,5	80	-6,7	63
Asuinrakennus C	6,9	80	-6,3	63
Lomarakennus D	7,0	80	-6,2	63
Asuinrakennus E	8,1	80	-5,2	63
Asuinrakennus F	8,2	80	-5,1	63
Asuinrakennus G	7,4	80	-5,8	63
Asuinrakennus H	7,3	80	-5,9	63
Asuinrakennus I	4,7	80	-8,5	63
Lomarakennus J	4,9	80	-8,2	63
Asuinrakennus K	5,8	80	-7,4	63
Asuinrakennus L	6,2	80	-7,0	63
Lomarakennus M	10,2	80	-3,0	63
Asuinrakennus N	6,4	80	-6,8	63
Asuinrakennus O	7,3	80	-5,9	63
Lomarakennus P	13,3	80	-0,01	63
Lomarakennus Q	12,9	80	-0,5	63
Asuinrakennus R	7,3	80	-5,9	63

Mallinnettaessa Hangaskurunkankaan tuulivoimahankkeen kanssa muodostuvia matalataajuisen melun yhteisvaikutuksia Verkasalon vaihtoehdoissa VE 1 ja VE 2, ei matalataajuinen melu ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteissä A – R. Taulukossa 14 on esitetty matalataajuisen yhteismelun laskentatulokset vaihtoehdossa VE 1 ja taulukossa 15 matalataajuisen yhteismelun laskentatulokset vaihtoehdossa VE 2. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on hankevaihtoehdossa VE 1 enimmillään 0,5 dB alle toimenpiderajan taajuudella 63 Hz ja hankevaihtoehdossa VE 2 enimmillään 0,01 dB alle toimenpiderajan taajuudella 63 Hz (lomarakennus P). Katso tarkemmat laskentatulokset liitteistä 6 ja 8.

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Taulukko 14. Matalataajuisen melun laskentatulokset VE1. Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L eq,1h – Asumis-terveys ohje sisällä	Hz	L eq,1h – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	8,2	80	-5,1	63
Lomarakennus B	6,1	80	-7,1	63
Asuinrakennus C	6,4	80	-6,8	63
Lomarakennus D	6,5	80	-6,7	63
Asuinrakennus E	7,2	80	-6,0	63
Asuinrakennus F	7,3	80	-6,0	63
Asuinrakennus G	6,6	80	-6,6	63
Asuinrakennus H	6,6	80	-6,7	63
Asuinrakennus I	4,2	80	-9,0	63
Lomarakennus J	4,3	80	-8,9	63
Asuinrakennus K	5,6	80	-7,6	63
Asuinrakennus L	6,0	80	-7,2	63
Lomarakennus M	9,7	80	-3,6	63
Asuinrakennus N	5,8	80	-7,4	63
Asuinrakennus O	6,9	80	-6,4	63
Lomarakennus P	12,8	80	-0,5	63
Lomarakennus Q	12,3	80	-1,0	63
Asuinrakennus R	6,6	80	-6,6	63

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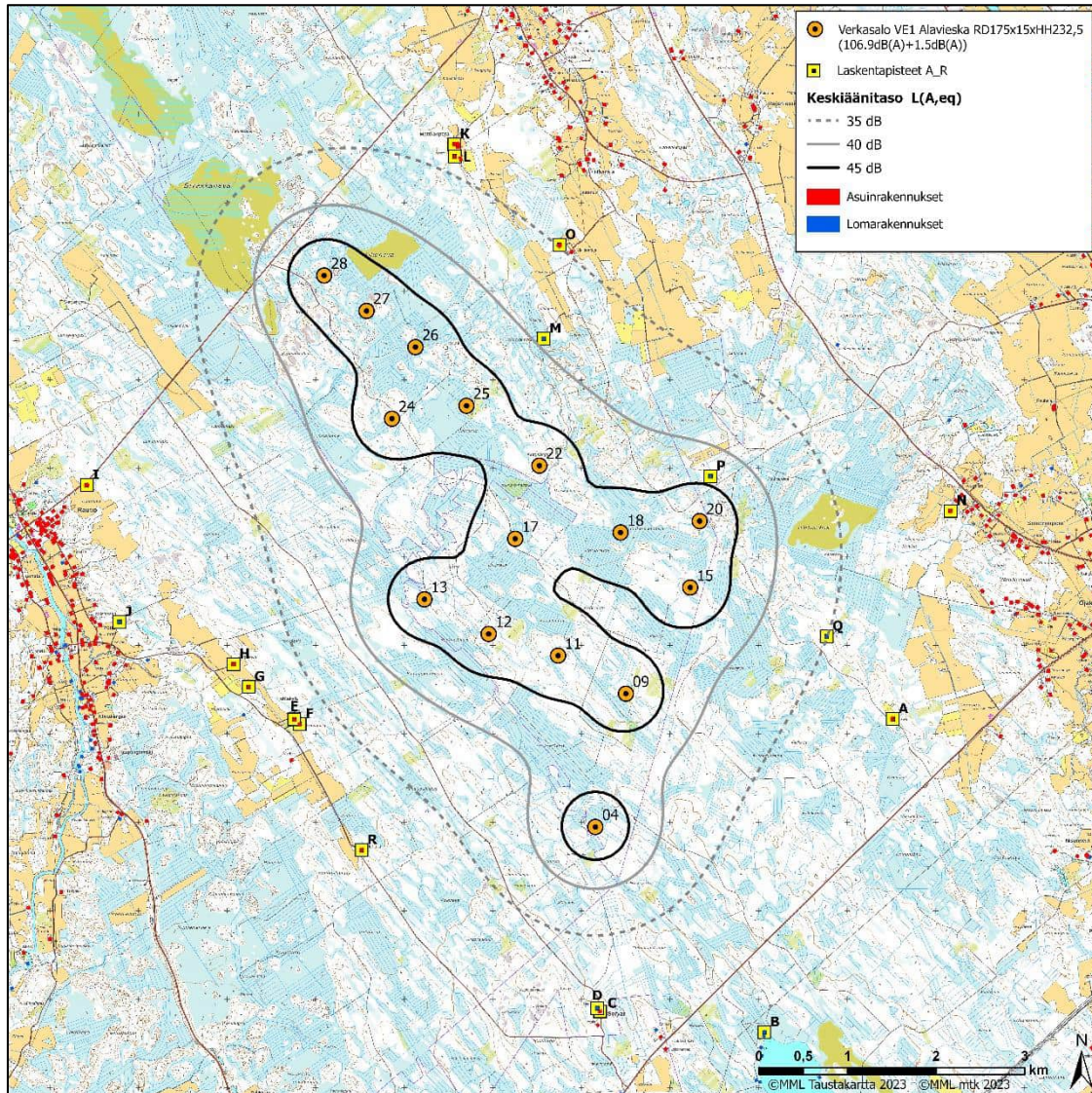
Taulukko 15. Matalataajuisen melun laskentatulokset VE2. Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L eq,1h – Asumis-terveys ohje sisällä	Hz	L eq,1h – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	8,7	80	-4,5	63
Lomarakennus B	6,5	80	-6,7	63
Asuinrakennus C	7,0	80	-6,3	63
Lomarakennus D	7,0	80	-6,2	63
Asuinrakennus E	8,1	80	-5,1	63
Asuinrakennus F	8,2	80	-5,1	63
Asuinrakennus G	7,4	80	-5,8	63
Asuinrakennus H	7,3	80	-5,9	63
Asuinrakennus I	4,8	80	-8,3	63
Lomarakennus J	5,0	80	-8,2	63
Asuinrakennus K	6,1	80	-7,1	63
Asuinrakennus L	6,4	80	-6,8	63
Lomarakennus M	10,3	80	-3,0	63
Asuinrakennus N	6,4	80	-6,8	63
Asuinrakennus O	7,4	80	-5,8	63
Lomarakennus P	13,3	80	-0,01	63
Lomarakennus Q	12,9	80	-0,5	63
Asuinrakennus R	7,4	80	-5,9	63

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3.1.3 Kuntakohtaiset melun laskentatulokset ISO 9613-2 voimalaitoksella Nordex N175 - 6.8MW (106,9 dB(A) + 1,5 dB(A))

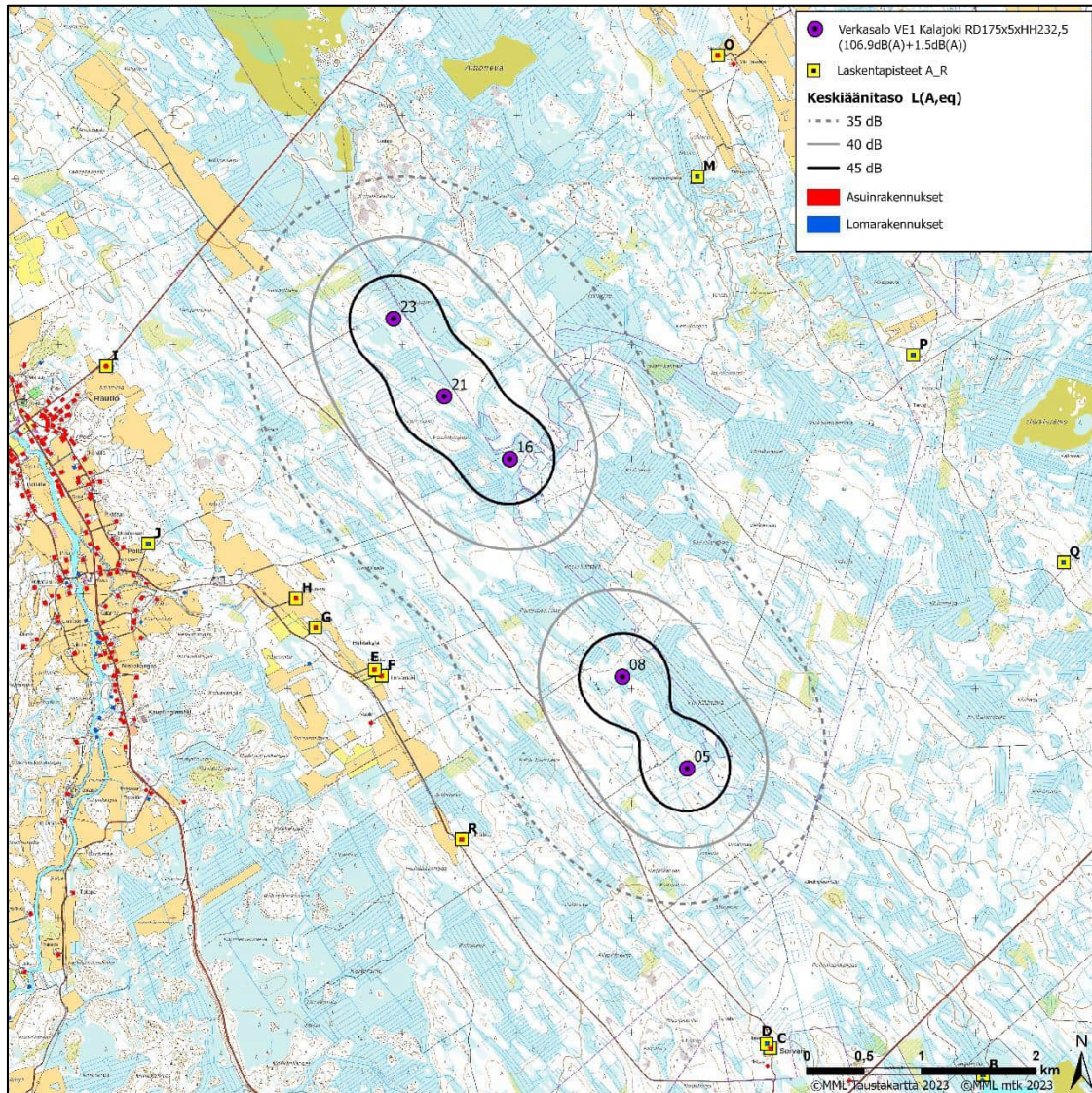
Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), ylittyy melutaso 40 dB(A) laskentapisteessä Lomarakennus P (43,5 dB(A)). (Kuva 5, Taulukko 16). Katso tarkemmat laskentatulokset liitteestä 9.



Kuva 5. Melumallinnuksen tulos VE1 voimalat Alavieskan kunnan alueella.

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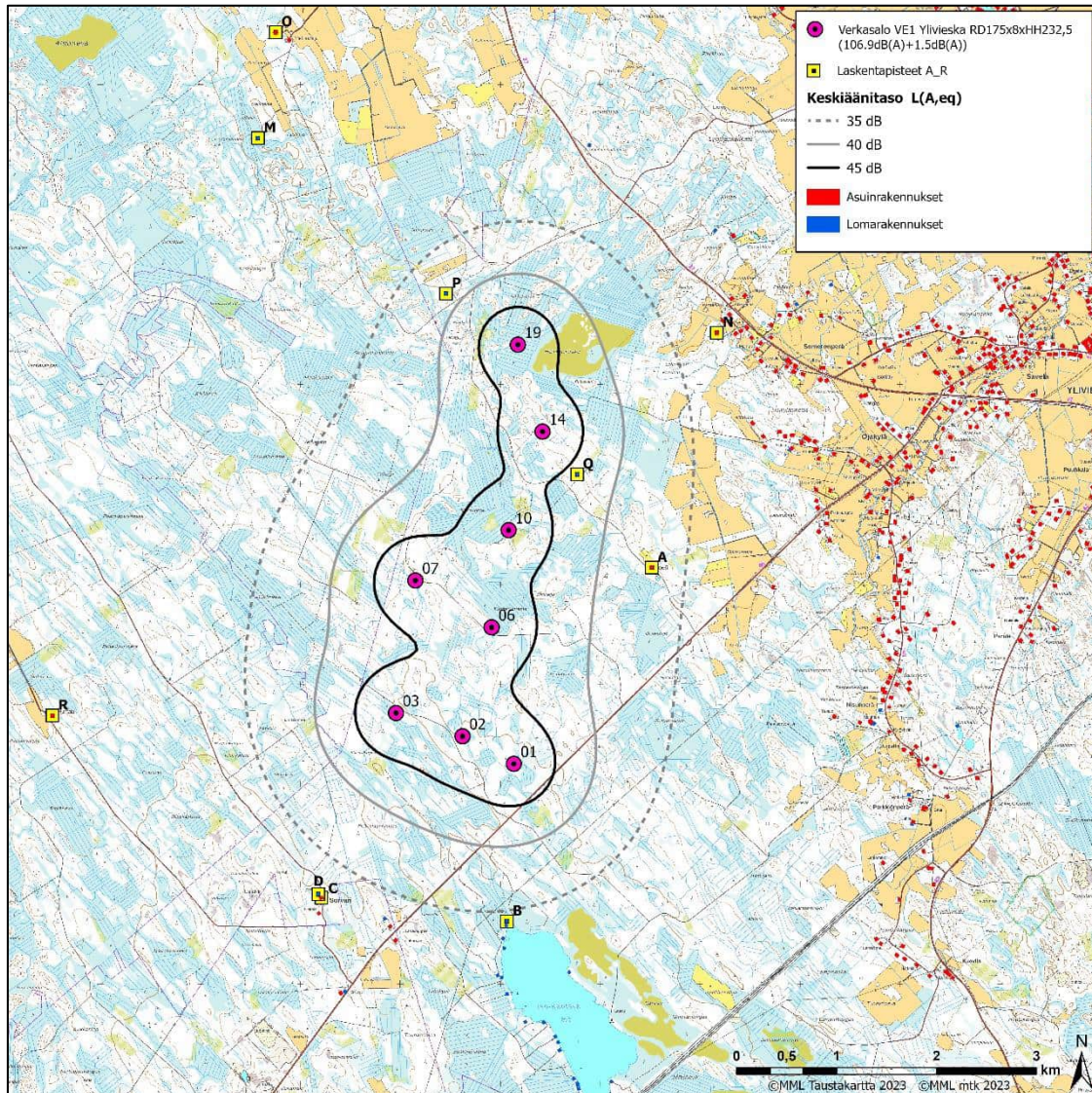
Huomioitaessa ainoastaan Kalajoen kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), melutaso 40 dB(A) ei ylitä lähimmillä asuin- tai lomarakennuksilla. (Kuva 6, Taulukko 17). Katso tarkemmat laskentatulokset liitteestä 9.



Kuva 6. Melumallinnuksen tulos VE1 voimalat Kalajoen kunnan alueella.

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Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), ylittyy melutaso 40 dB(A) laskentapisteessä Lomarakenus Q (43,6 dB(A)), (Kuva 7, Taulukko 18). Katso tarkemmat laskentatulokset liitteestä 9.



Kuva 7. Melumallinnuksen tulos VE1 voimalat Ylivieskan kunnan alueella.

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Taulukko 16. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 1 (VE1) voimalat Alavieskan kunnan alueella.

Laskentapiste	ETRS89- TM35 Itä	ETRS89- TM35 Pohjoinen	Z (m)	Laskenta- korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	30,7
Lomarakennus B	372 065	7 102 626	82,5	4,0	27,3
Asuinrakennus C	370 211	7 102 863	82,5	4,0	30,2
Lomarakennus D	370 180	7 102 899	82,5	4,0	30,4
Asuinrakennus E	366 759	7 106 162	67,5	4,0	33,2
Asuinrakennus F	366 819	7 106 110	67,5	4,0	33,3
Asuinrakennus G	366 243	7 106 530	65,0	4,0	32,2
Asuinrakennus H	366 073	7 106 785	64,5	4,0	32,1
Asuinrakennus I	364 417	7 108 809	61,2	4,0	29,1
Lomarakennus J	364 785	7 107 263	61,9	4,0	28,9
Asuinrakennus K	368 566	7 112 661	59,4	4,0	33,4
Asuinrakennus L	368 569	7 112 523	60,1	4,0	34,0
Lomarakennus M	369 574	7 110 463	60,0	4,0	39,4
Asuinrakennus N	374 166	7 108 516	60,2	4,0	29,6
Asuinrakennus O	369 753	7 111 523	57,6	4,0	34,9
Lomarakennus P	371 457	7 108 909	60,7	4,0	43,5
Lomarakennus Q	372 769	7 107 100	70,9	4,0	35,0
Asuinrakennus R	367 519	7 104 685	70,6	4,0	31,5

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Taulukko 17. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 1 (VE1) voimalat Kalajoen kunnan alueella.

Laskentapiste	ETRS89- TM35 Itä	ETRS89- TM35 Pohjoinen	Z (m)	Laskenta- korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	22,7
Lomarakennus B	372 065	7 102 626	82,5	4,0	22,8
Asuinrakennus C	370 211	7 102 863	82,5	4,0	26,9
Lomarakennus D	370 180	7 102 899	82,5	4,0	27,1
Asuinrakennus E	366 759	7 106 162	67,5	4,0	32,3
Asuinrakennus F	366 819	7 106 110	67,5	4,0	32,4
Asuinrakennus G	366 243	7 106 530	65,0	4,0	31,7
Asuinrakennus H	366 073	7 106 785	64,5	4,0	31,8
Asuinrakennus I	364 417	7 108 809	61,2	4,0	28,3
Lomarakennus J	364 785	7 107 263	61,9	4,0	28,4
Asuinrakennus K	368 566	7 112 661	59,4	4,0	23,8
Asuinrakennus L	368 569	7 112 523	60,1	4,0	24,2
Lomarakennus M	369 574	7 110 463	60,0	4,0	28,5
Asuinrakennus N	374 166	7 108 516	60,2	4,0	20,3
Asuinrakennus O	369 753	7 111 523	57,6	4,0	25,3
Lomarakennus P	371 457	7 108 909	60,7	4,0	26,2
Lomarakennus Q	372 769	7 107 100	70,9	4,0	24,4
Asuinrakennus R	367 519	7 104 685	70,6	4,0	31,6

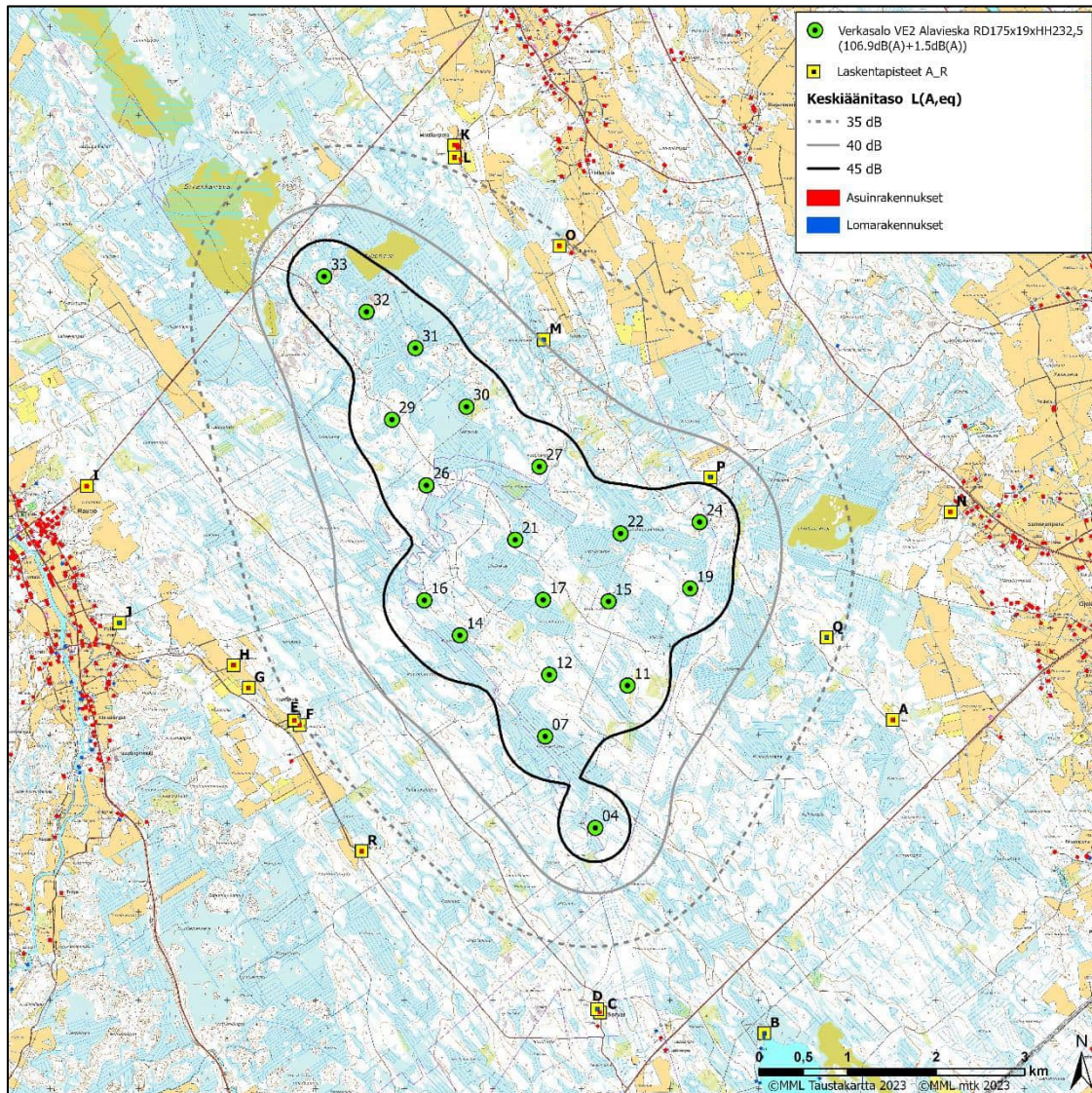
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Taulukko 18. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 1 (VE1) voimalat Ylivieskan kunnan alueella.

Laskentapiste	ETRS89- TM35 Itä	ETRS89- TM35 Pohjoinen	Z (m)	Laskenta- korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	36,7
Lomarakennus B	372 065	7 102 626	82,5	4,0	34,3
Asuinrakennus C	370 211	7 102 863	82,5	4,0	32,9
Lomarakennus D	370 180	7 102 899	82,5	4,0	32,9
Asuinrakennus E	366 759	7 106 162	67,5	4,0	24,9
Asuinrakennus F	366 819	7 106 110	67,5	4,0	25,1
Asuinrakennus G	366 243	7 106 530	65,0	4,0	23,6
Asuinrakennus H	366 073	7 106 785	64,5	4,0	23,1
Asuinrakennus I	364 417	7 108 809	61,2	4,0	19,2
Lomarakennus J	364 785	7 107 263	61,9	4,0	20,4
Asuinrakennus K	368 566	7 112 661	59,4	4,0	20,6
Asuinrakennus L	368 569	7 112 523	60,1	4,0	20,8
Lomarakennus M	369 574	7 110 463	60,0	4,0	26,2
Asuinrakennus N	374 166	7 108 516	60,2	4,0	32,5
Asuinrakennus O	369 753	7 111 523	57,6	4,0	24,0
Lomarakennus P	371 457	7 108 909	60,7	4,0	38,3
Lomarakennus Q	372 769	7 107 100	70,9	4,0	43,6
Asuinrakennus R	367 519	7 104 685	70,6	4,0	27,0

Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), melutaso 40 dB(A) ylittyy lähimmällä lomarakennuksella laskentapisteessä Lomarakennus P (43,8 dB(A)), (Kuva 8, Taulukko 19). Katso tarkemmat laskentatulokset liitteestä 10.

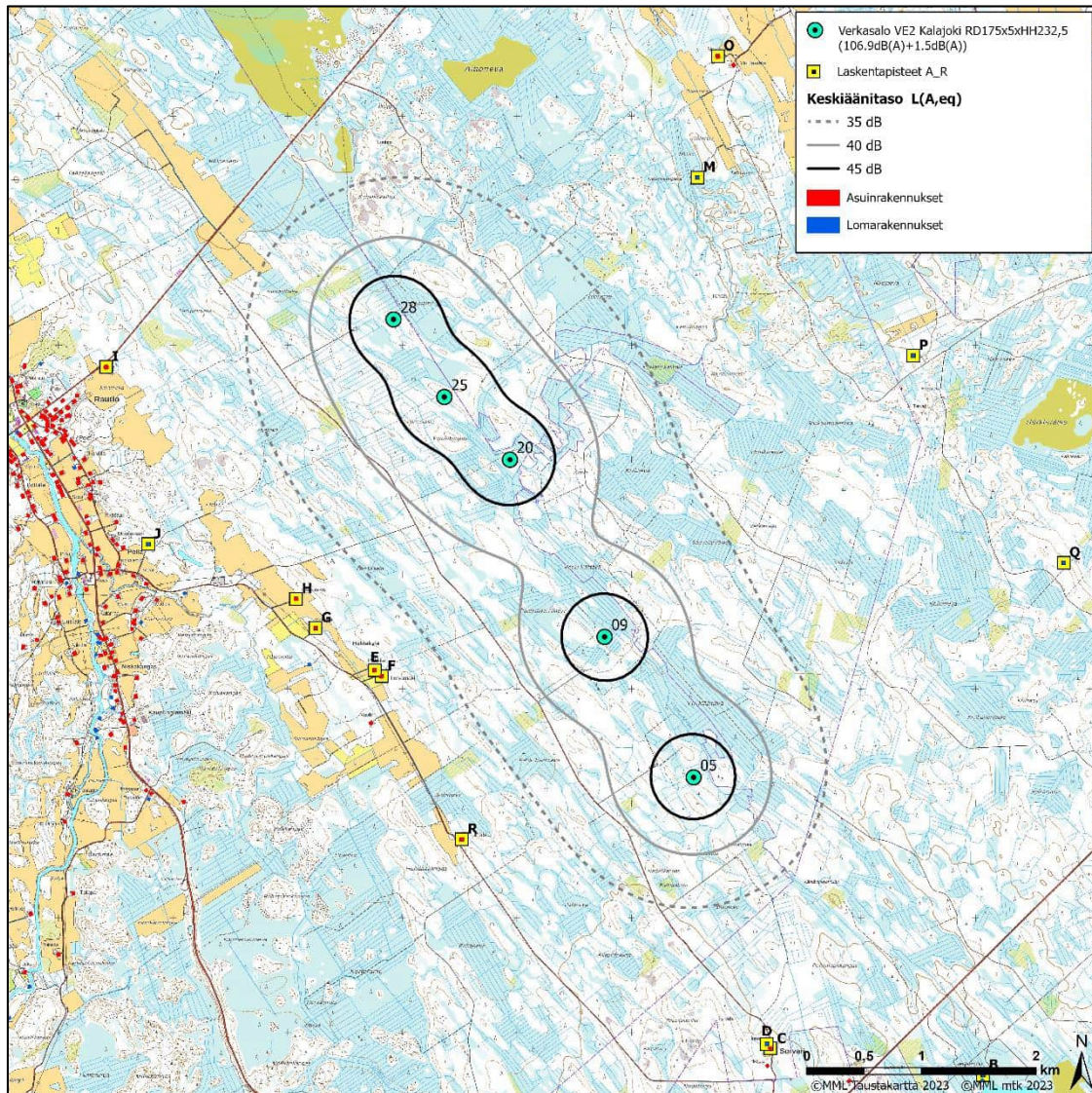
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Kuva 8. Melumallinnuksen tulos VE2 voimalat Alavieskan kunnan alueella.

Huomioitaessa ainoastaan Kalajoen kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), melutaso 40 dB(A) ei ylitä lähimmillä asuin- tai lomarakennuksilla. (Kuva 9, Taulukko 20). Katso tarkemmat laskentatulokset liitteestä 10.

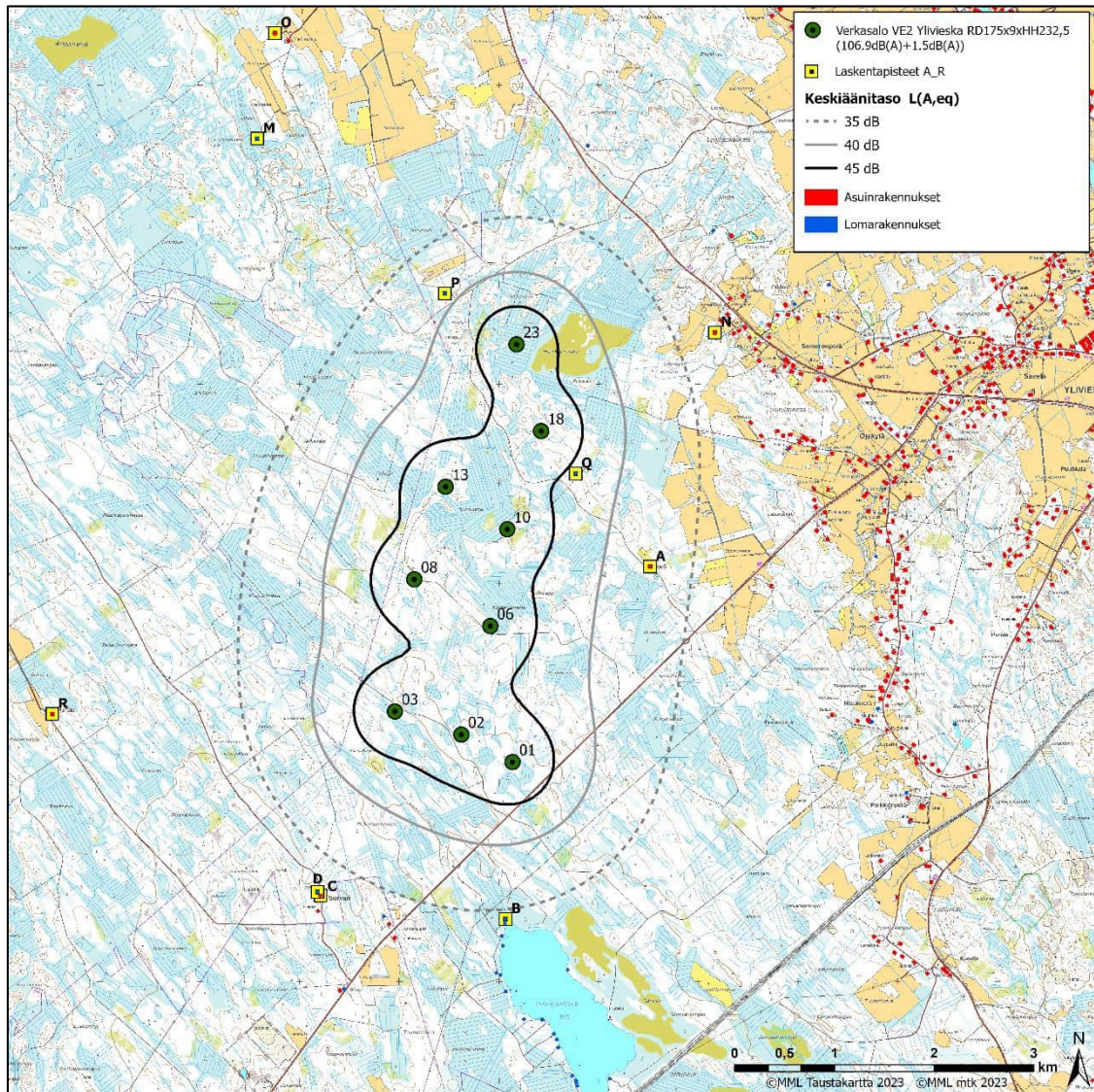
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Kuva 9. Melumallinnuksen tulos VE2 voimalat Kalajoen kunnan alueella.

Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), ylittyy melutaso 40 dB(A) laskentapisteessä Lomarakennus Q (43,9 dB(A)), (Kuva 10, Taulukko 21). Katso tarkemmat laskentatulokset liitteestä 10.

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Kuva 10. Melumallinnuksen tulos VE2 voimalat Ylivieskan kunnan alueella.

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Taulukko 19. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 2 (VE2) voimalat Alavieskan kunnan alueella.

Laskentapiste	ETRS89- TM35 Itä	ETRS89- TM35 Pohjoinen	Z (m)	Laskenta- korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	31,7
Lomarakennus B	372 065	7 102 626	82,5	4,0	28,4
Asuinrakennus C	370 211	7 102 863	82,5	4,0	31,3
Lomarakennus D	370 180	7 102 899	82,5	4,0	31,4
Asuinrakennus E	366 759	7 106 162	67,5	4,0	34,7
Asuinrakennus F	366 819	7 106 110	67,5	4,0	34,8
Asuinrakennus G	366 243	7 106 530	65,0	4,0	33,6
Asuinrakennus H	366 073	7 106 785	64,5	4,0	33,4
Asuinrakennus I	364 417	7 108 809	61,2	4,0	30,0
Lomarakennus J	364 785	7 107 263	61,9	4,0	30,0
Asuinrakennus K	368 566	7 112 661	59,4	4,0	33,8
Asuinrakennus L	368 569	7 112 523	60,1	4,0	34,3
Lomarakennus M	369 574	7 110 463	60,0	4,0	39,9
Asuinrakennus N	374 166	7 108 516	60,2	4,0	30,4
Asuinrakennus O	369 753	7 111 523	57,6	4,0	35,4
Lomarakennus P	371 457	7 108 909	60,7	4,0	43,8
Lomarakennus Q	372 769	7 107 100	70,9	4,0	35,8
Asuinrakennus R	367 519	7 104 685	70,6	4,0	33,3

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Taulukko 20. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 2 (VE2) voimalat Kalajoen kunnan alueella.

Laskentapiste	ETRS89- TM35 Itä	ETRS89- TM35 Pohjoinen	Z (m)	Laskenta- korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	22,6
Lomarakennus B	372 065	7 102 626	82,5	4,0	22,7
Asuinrakennus C	370 211	7 102 863	82,5	4,0	26,9
Lomarakennus D	370 180	7 102 899	82,5	4,0	27,1
Asuinrakennus E	366 759	7 106 162	67,5	4,0	32,5
Asuinrakennus F	366 819	7 106 110	67,5	4,0	32,6
Asuinrakennus G	366 243	7 106 530	65,0	4,0	31,8
Asuinrakennus H	366 073	7 106 785	64,5	4,0	32,0
Asuinrakennus I	364 417	7 108 809	61,2	4,0	28,3
Lomarakennus J	364 785	7 107 263	61,9	4,0	28,4
Asuinrakennus K	368 566	7 112 661	59,4	4,0	23,9
Asuinrakennus L	368 569	7 112 523	60,1	4,0	24,3
Lomarakennus M	369 574	7 110 463	60,0	4,0	28,6
Asuinrakennus N	374 166	7 108 516	60,2	4,0	20,2
Asuinrakennus O	369 753	7 111 523	57,6	4,0	25,4
Lomarakennus P	371 457	7 108 909	60,7	4,0	26,2
Lomarakennus Q	372 769	7 107 100	70,9	4,0	24,4
Asuinrakennus R	367 519	7 104 685	70,6	4,0	31,2

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Taulukko 21. Laskennalliset melutasot Verkasalon tuulivoimahankkeen ympäristössä voimalaitoksella N175 - 6,8 MW vaihtoehdossa 2 (VE2) voimalat Ylivieskan kunnan alueella.

Laskentapiste	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Laskenta-korkeus (m)	Melutaso dB(A)
Asuinrakennus A	373 516	7 106 167	70,0	4,0	37,1
Lomarakennus B	372 065	7 102 626	82,5	4,0	34,4
Asuinrakennus C	370 211	7 102 863	82,5	4,0	33,0
Lomarakennus D	370 180	7 102 899	82,5	4,0	33,1
Asuinrakennus E	366 759	7 106 162	67,5	4,0	25,5
Asuinrakennus F	366 819	7 106 110	67,5	4,0	25,7
Asuinrakennus G	366 243	7 106 530	65,0	4,0	24,2
Asuinrakennus H	366 073	7 106 785	64,5	4,0	23,7
Asuinrakennus I	364 417	7 108 809	61,2	4,0	19,9
Lomarakennus J	364 785	7 107 263	61,9	4,0	21,0
Asuinrakennus K	368 566	7 112 661	59,4	4,0	21,3
Asuinrakennus L	368 569	7 112 523	60,1	4,0	21,5
Lomarakennus M	369 574	7 110 463	60,0	4,0	27,0
Asuinrakennus N	374 166	7 108 516	60,2	4,0	32,9
Asuinrakennus O	369 753	7 111 523	57,6	4,0	24,7
Lomarakennus P	371 457	7 108 909	60,7	4,0	38,7
Lomarakennus Q	372 769	7 107 100	70,9	4,0	43,9
Asuinrakennus R	367 519	7 104 685	70,6	4,0	27,5

3.1.4 Kuntakohtaiset matalataajuiset melutasot voimalaitoksella Nordex N175 - 6.8MW STE (106,9 dB(A) + 1,5 dB(A))

Verkasalon tuulivoimahankkeen Alavieskan kunnan alueella sijaitsevien voimaloiden aiheuttamat matalataajuiset melutasot vaihtoehdossa 1 (VE 1) on esitetty taulukossa 22. Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat voimalat, ei melu ylitä Sosiaali- ja terveysministeriön asuimisterveysohjearvoa laskentapisteissä A – R. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on enimmillään 2 dB alle toimenpiderajan taajuudella 63 Hz (Lomarakennus P).

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Taulukko 22. Matalataajuisen melun laskentatulokset VE1 vain Alavieskan kunnan alueella olevilla voimaloilla laskettuna.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L eq,1h – Asumis-terveys ohje sisällä	Hz	L eq,1h – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	2,6	80	-10,6	63
Lomarakennus B	0,0	80	-13,2	63
Asuinrakennus C	1,8	80	-11,4	63
Lomarakennus D	1,9	80	-11,3	63
Asuinrakennus E	4,4	80	-8,8	63
Asuinrakennus F	4,5	80	-8,8	63
Asuinrakennus G	3,8	80	-9,5	63
Asuinrakennus H	3,7	80	-9,6	63
Asuinrakennus I	1,5	80	-11,6	63
Lomarakennus J	1,5	80	-11,7	63
Asuinrakennus K	4,3	80	-8,9	63
Asuinrakennus L	4,7	80	-8,5	63
Lomarakennus M	8,8	80	-4,5	63
Asuinrakennus N	1,8	80	-11,4	63
Asuinrakennus O	5,6	80	-7,6	63
Lomarakennus P	11,3	80	-2,0	63
Lomarakennus Q	5,5	80	-7,8	63
Asuinrakennus R	3,2	80	-10,0	63

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Verkasalon tuulivoimahankkeen Alavieskan kunnan alueella sijaitsevien voimaloiden aiheuttamat matalataajuiset melutasot vaihtoehdossa 2 (VE 2) on esitetty taulukossa 23. Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat voimalat, ei melu ylitä Sosiaali- ja terveysministeriön asuimisterveysohjearvoa laskentapisteissä A – R. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on enimmillään 1,6 dB alle toimenpiderajan taajuudella 63 Hz (Lomarakenus P).

Taulukko 23. Matalataajuisen melun laskentatulokset VE2 vain Alavieskan kunnan alueella olevilla voimaloilla laskettuna.

Rakenus	Äänitaso ulkona		Äänitaso sisällä	
	L _{eq,1h} – Asuimisterveys ohje sisällä	Hz	L _{eq,1h} – Asuimisterveys ohje sisällä	Hz
Asuinrakenus A	3,6	80	-9,6	63
Lomarakenus B	1,1	80	-12,0	63
Asuinrakenus C	3,0	80	-10,2	63
Lomarakenus D	3,1	80	-10,1	63
Asuinrakenus E	5,8	80	-7,4	63
Asuinrakenus F	5,9	80	-7,4	63
Asuinrakenus G	5,1	80	-8,2	63
Asuinrakenus H	4,9	80	-8,3	63
Asuinrakenus I	2,5	80	-10,7	63
Lomarakenus J	2,6	80	-10,6	63
Asuinrakenus K	4,8	80	-8,4	63
Asuinrakenus L	5,2	80	-8,0	63
Lomarakenus M	9,4	80	-3,9	63
Asuinrakenus N	2,7	80	-10,5	63
Asuinrakenus O	6,2	80	-7,0	63
Lomarakenus P	11,8	80	-1,6	63
Lomarakenus Q	6,4	80	-6,9	63
Asuinrakenus R	4,7	80	-8,5	63

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Verkasalon tuulivoimahankkeen Kalajoen kunnan alueella sijaitsevien voimaloiden aiheuttamat matalataajuiset melutasot vaihtoehdossa 1 (VE 1) on esitetty taulukossa 24. Huomioitaessa ainoastaan Kalajoen kunnan alueella sijaitsevat voimalat, ei melu ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteissä A – R. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on enimmillään 10,5 dB alle toimenpiderajan taajuudella 63 Hz (Asuinrakennus F).

Taulukko 24. Matalataajuisen melun laskentatulokset VE1 vain Kalajoen kunnan alueella olevilla voimaloilla laskettuna.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	-4,4	80	-17,5	63
Lomarakennus B	-4,5	80	-17,6	63
Asuinrakennus C	-1,7	80	-14,9	63
Lomarakennus D	-1,5	80	-14,8	63
Asuinrakennus E	2,7	80	-10,6	63
Asuinrakennus F	2,7	80	-10,5	63
Asuinrakennus G	2,2	80	-11,1	63
Asuinrakennus H	2,3	80	-11,0	63
Asuinrakennus I	-0,5	80	-13,7	63
Lomarakennus J	-0,3	80	-13,5	63
Asuinrakennus K	-3,5	80	-16,7	63
Asuinrakennus L	-3,3	80	-16,4	63
Lomarakennus M	-0,1	80	-13,4	63
Asuinrakennus N	-6,0	80	-19,1	63
Asuinrakennus O	-2,4	80	-15,6	63
Lomarakennus P	-1,7	80	-14,9	63
Lomarakennus Q	-3,0	80	-16,2	63
Asuinrakennus R	1,9	80	-11,3	63

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Verkasalon tuulivoimahankkeen Kalajoen kunnan alueella sijaitsevien voimaloiden aiheuttamat matalataajuiset melutasot vaihtoehdossa 2 (VE 2) on esitetty taulukossa 25. Huomioitaessa ainoastaan Kalajoen kunnan alueella sijaitsevat voimalat, ei melu ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteissä A – R. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on enimmillään 10,4 dB alle toimenpiderajan taajuudella 63 Hz (Asuinrakennus F).

Taulukko 25. Matalataajuisen melun laskentatulokset VE2 vain Kalajoen kunnan alueella olevilla voimaloilla laskettuna.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	-4,4	80	-17,6	63
Lomarakennus B	-4,6	80	-17,7	63
Asuinrakennus C	-1,7	80	-14,9	63
Lomarakennus D	-1,6	80	-14,8	63
Asuinrakennus E	2,8	80	-10,5	63
Asuinrakennus F	2,9	80	-10,4	63
Asuinrakennus G	2,3	80	-11,0	63
Asuinrakennus H	2,4	80	-10,9	63
Asuinrakennus I	-0,4	80	-13,6	63
Lomarakennus J	-0,2	80	-13,4	63
Asuinrakennus K	-3,5	80	-16,7	63
Asuinrakennus L	-3,2	80	-16,4	63
Lomarakennus M	-0,1	80	-13,3	63
Asuinrakennus N	-6,0	80	-19,1	63
Asuinrakennus O	-2,4	80	-15,6	63
Lomarakennus P	-1,6	80	-14,8	63
Lomarakennus Q	-3,1	80	-16,3	63
Asuinrakennus R	1,6	80	-11,6	63

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Verkasalon tuulivoimahankkeen Ylivieskan kunnan alueella sijaitsevien voimaloiden aiheuttamat matalataajuiset melutasot vaihtoehdossa 1 (VE 1) on esitetty taulukossa 26. Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat voimat, ei melu ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteissä A – R. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on enimmillään 2,2 dB alle toimenpiderajan taajuudella 63 Hz (Lomarakenus Q).

Taulukko 26. Matalataajuisen melun laskentatulokset VE1 vain Ylivieskan kunnan alueella olevilla voimaloilla laskettuna.

Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	6,4	80	-6,9	63
Lomarakenus B	4,3	80	-9,0	63
Asuinrakennus C	3,4	80	-9,9	63
Lomarakenus D	3,4	80	-9,9	63
Asuinrakennus E	-2,0	80	-15,2	63
Asuinrakennus F	-1,9	80	-15,1	63
Asuinrakennus G	-3,0	80	-16,1	63
Asuinrakennus H	-3,3	80	-16,4	63
Asuinrakennus I	-6,3	80	-19,3	63
Lomarakenus J	-5,3	80	-18,4	63
Asuinrakennus K	-5,3	80	-18,4	63
Asuinrakennus L	-5,2	80	-18,2	63
Lomarakenus M	-1,3	80	-14,5	63
Asuinrakennus N	3,0	80	-10,3	63
Asuinrakennus O	-2,9	80	-16,0	63
Lomarakenus P	6,9	80	-6,4	63
Lomarakenus Q	11,2	80	-2,2	63
Asuinrakennus R	-0,6	80	-13,8	63

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Verkasalon tuulivoimahankkeen Ylivieskan kunnan alueella sijaitsevien voimaloiden aiheuttamat matalataajuiset melutasot vaihtoehdossa 2 (VE 2) on esitetty taulukossa 27. Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat voimat, ei melu ylitä Sosiaali- ja terveysministeriön asumisterveysohjearvoa laskentapisteissä A – R. Taulukoissa näkyy toimenpiderajan alitus (negatiivinen arvo) tai ylitys (positiivinen arvo). Rakennusten sisätiloissa melu on enimmillään 1,8 dB alle toimenpiderajan taajuudella 63 Hz (Lomarakenus Q).

Taulukko 27. Matalataajuisen melun laskentatulokset VE2 vain Ylivieskan kunnan alueella olevilla voimaloilla laskettuna.

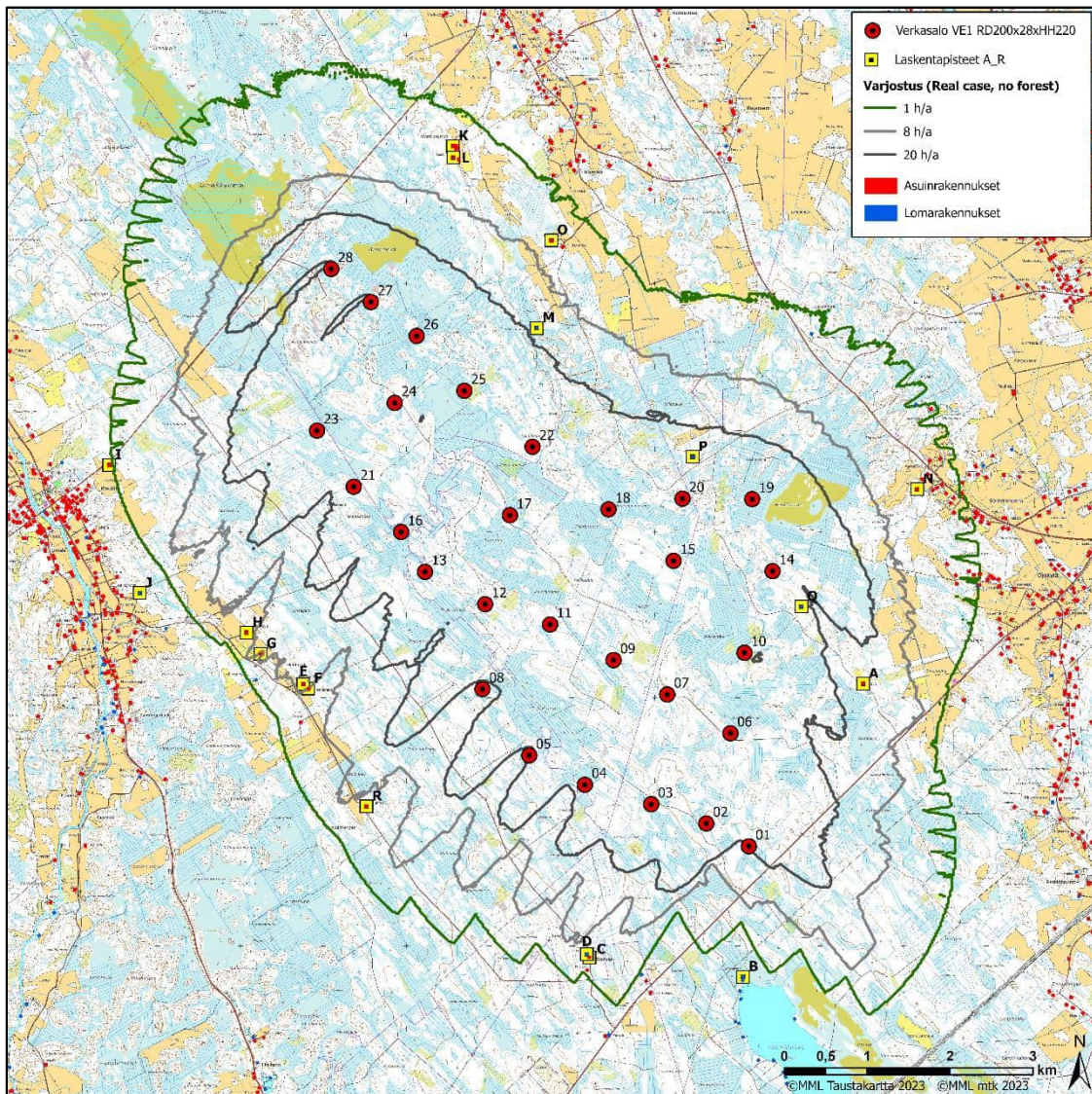
Rakennus	Äänitaso ulkona		Äänitaso sisällä	
	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz	L _{eq,1h} – Asumis-terveys ohje sisällä	Hz
Asuinrakennus A	6,8	80	-6,5	63
Lomarakenus B	4,5	80	-8,8	63
Asuinrakennus C	3,6	80	-9,7	63
Lomarakenus D	3,6	80	-9,6	63
Asuinrakennus E	-1,4	80	-14,6	63
Asuinrakennus F	-1,3	80	-14,5	63
Asuinrakennus G	-2,4	80	-15,5	63
Asuinrakennus H	-2,7	80	-15,8	63
Asuinrakennus I	-5,7	80	-18,7	63
Lomarakenus J	-4,7	80	-17,8	63
Asuinrakennus K	-4,7	80	-17,7	63
Asuinrakennus L	-4,5	80	-17,5	63
Lomarakenus M	-0,6	80	-13,7	63
Asuinrakennus N	3,5	80	-9,8	63
Asuinrakennus O	-2,2	80	-15,3	63
Lomarakenus P	7,4	80	-5,9	63
Lomarakenus Q	11,6	80	-1,8	63
Asuinrakennus R	-0,1	80	-13,3	63

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3.2 Varjostusmallinnus

3.2.1 Varjostusmallinnuksen tulokset VE1 ja VE2 voimalaitoksella Generic RD200 HH220

Vaihtoehdossa 1 (VE1) lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä asuinrakennus A (12 h 3 min/vuosi), asuinrakennus E (9 h 11 min/vuosi, asuinrakennus F (8 h 15 min/vuosi), asuinrakennus G (8h 49 min/vuosi), lomarakennus M (17 h 51 min/vuosi), lomarakennus P (45 h 44 min /vuosi) ja lomarakennus Q (25 h 4 min/vuosi), kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 11, Taulukko 28) Katso tarkemmat laskentatulokset liitteestä 17.

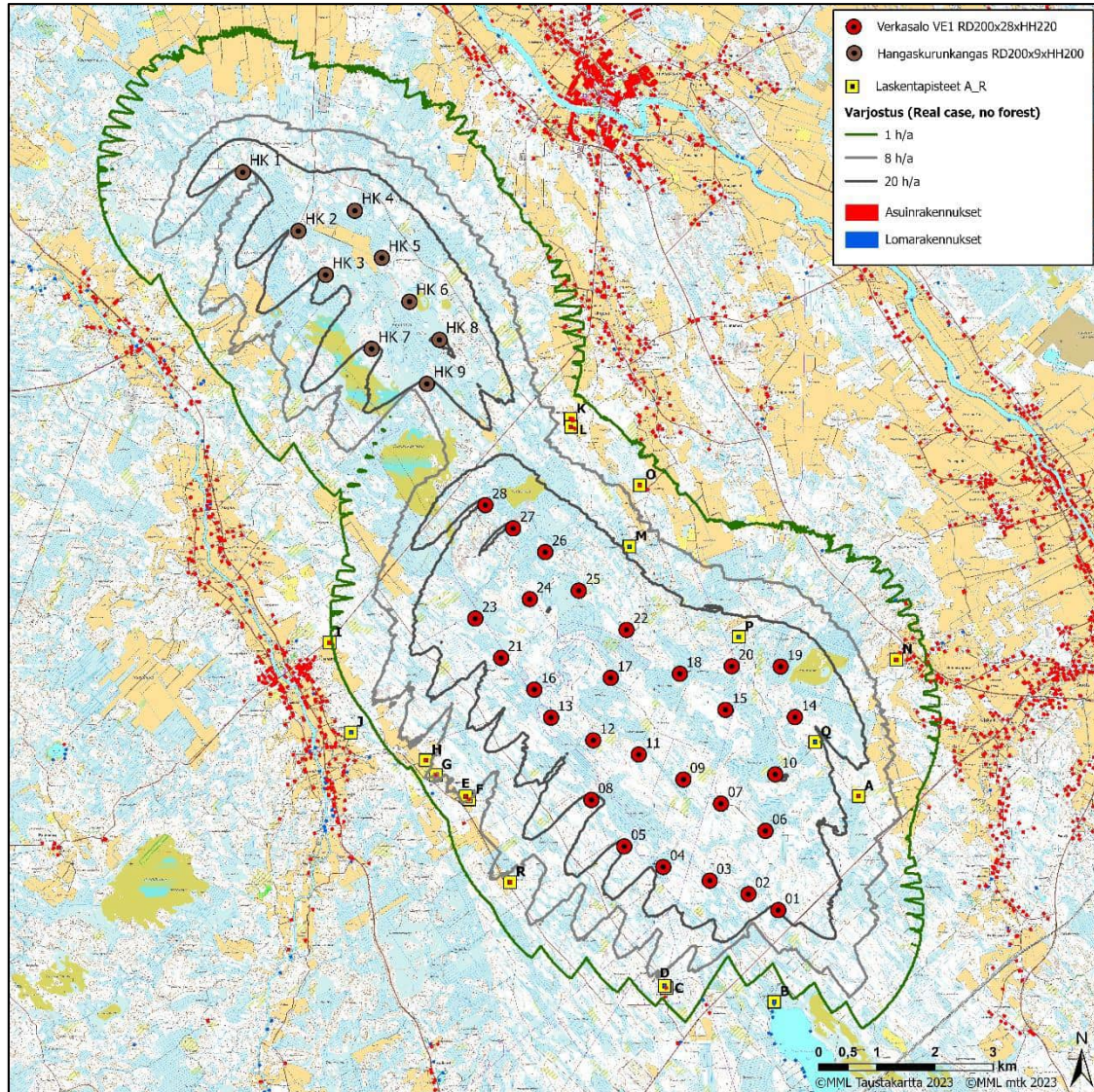


Kuva 11. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE1.

Vaihtoehdossa 1 (VE1) Hangaskurunkankaan hankkeen kanssa muodostuva varjostuksen yhteisvaikutus on lähimpien asuin- ja lomarakennusten pihapiirissä yli 8 h/a asuinrakennuksen A (12 h 2 min/vuosi), asuinrakennuksen E (9 h 11 min/vuosi, asuinrakennuksen F (8 h 14 min/vuosi), asuinrakennuksen G (8h 48 min/vuosi), lomarakennuksen M (17 h 49 min/vuosi), lomarakennuksen P (45 h

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40 min/vuosi) ja lomarakennuksen Q (25 h 1 min/vuosi) alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 12, Taulukko 29) Katso tarkemmat laskentatulokset liitteestä 18.



Kuva 12. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu, VE1 yhdessä Hangaskurunkankaan hankkeen kanssa.

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Taulukko 28. Varjostusmallinnuksen tulos VE1, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	12:03
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	5:50
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	6:16
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	9:11
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	8:15
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	8:49
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	17:51
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	3:26
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	4:06
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	45:44
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	25:04
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	6:17

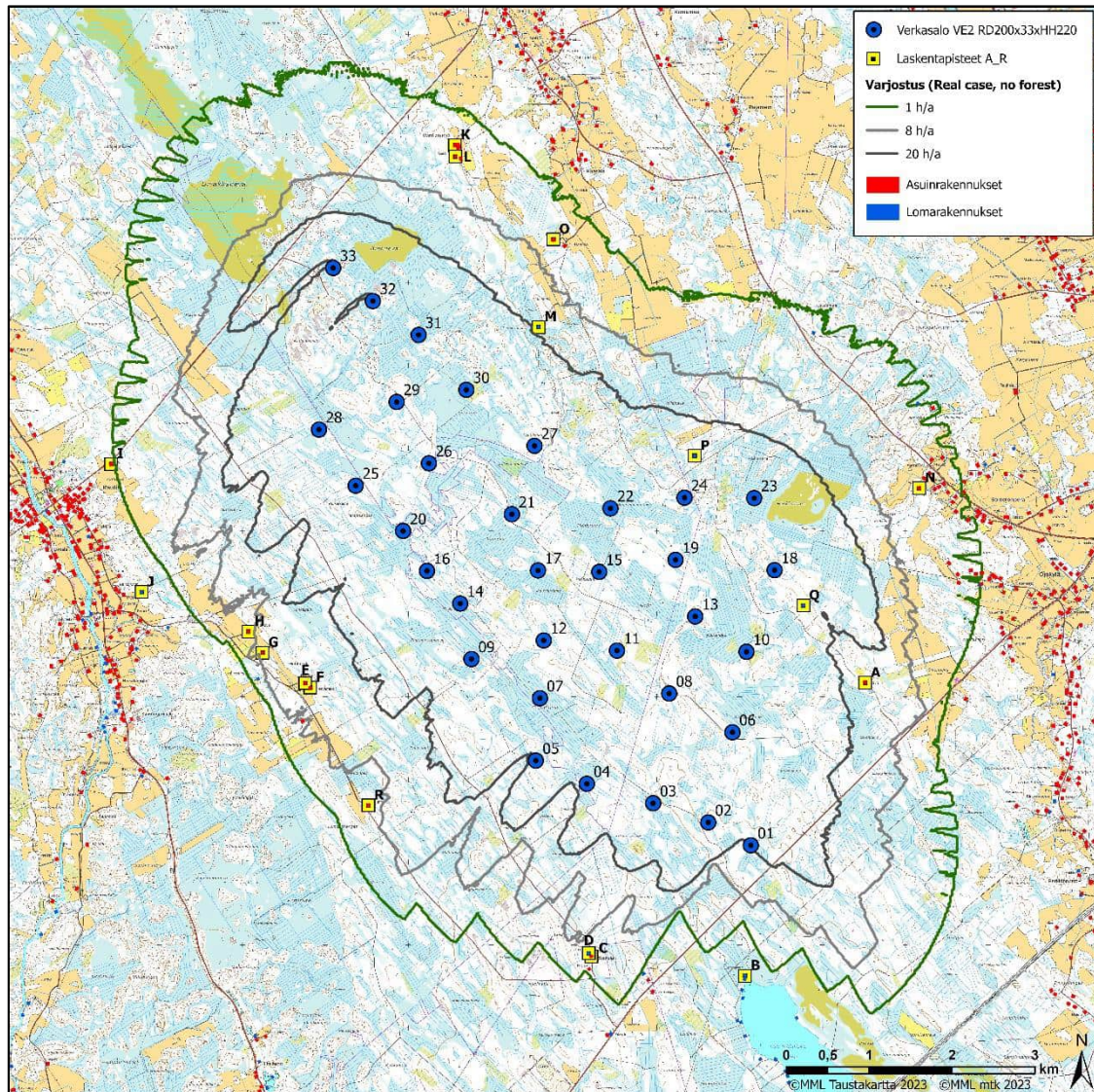
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Taulukko 29. Varjostusmallinnuksen tulos VE1 yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	12:02
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	5:49
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	6:16
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	9:11
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	8:14
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	8:48
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	17:49
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	3:26
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	4:06
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	45:40
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	25:01
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	6:17

Vaihtoehdossa 2 (VE2) lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä asuinrakennus A (14 h 23 min/vuosi), asuinrakennus E (11 h 9 min/vuosi, asuinrakennus F (10 h 32 min/vuosi), asuinrakennus G (10h 28 min/vuosi), lomarakennus M (19 h 16 min/vuosi), lomarakennus P (50 h 23 min /vuosi) ja lomarakennus Q (31 h 4 min/vuosi), kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 13, Taulukko 30) Katso tarkemmat laskentatulokset liitteestä 19.

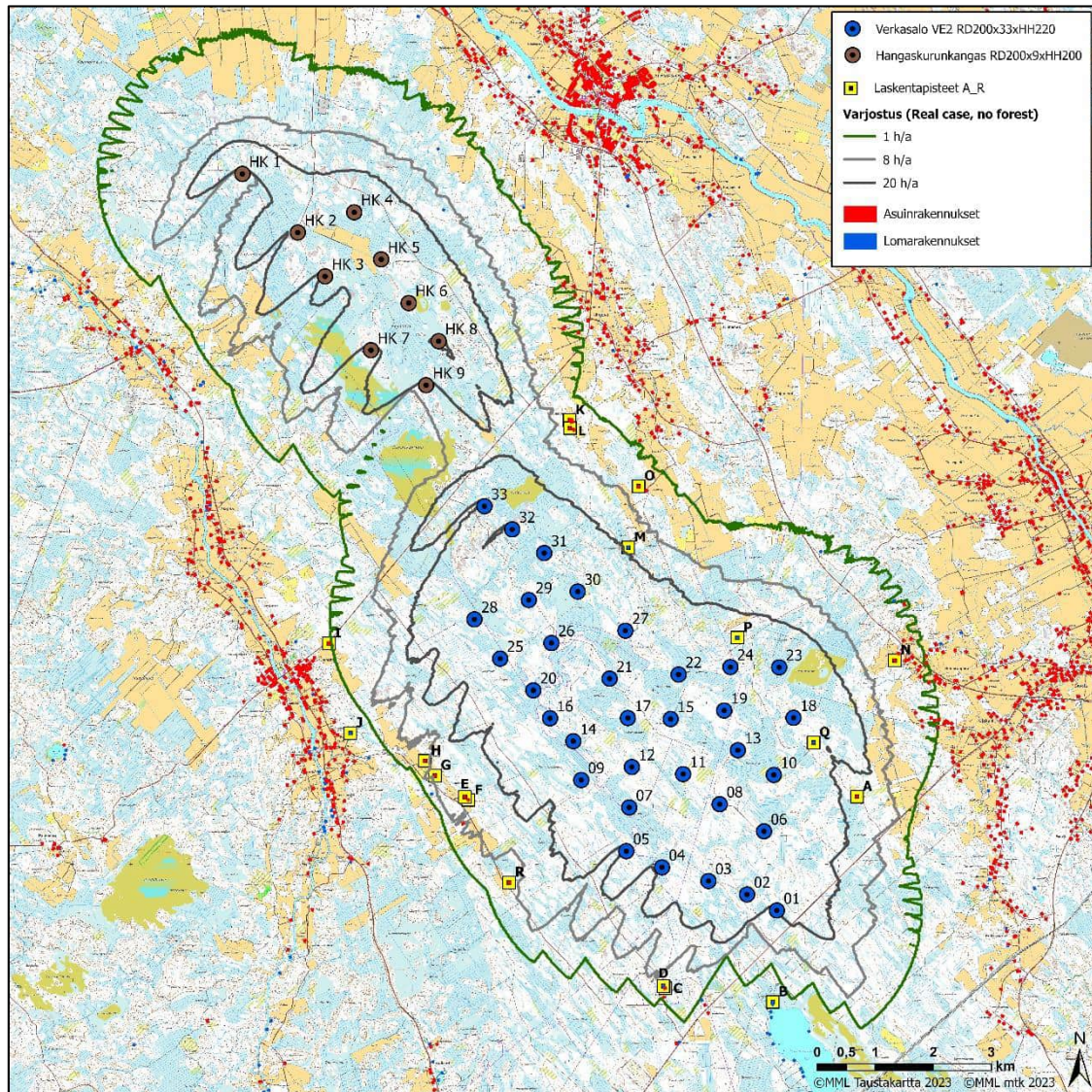
11.10.2023



Kuva 13. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE2.

Vaihtoehdossa 2 (VE2) Hangaskurunkankaan hankkeen kanssa muodostuva varjostuksen yhteisvaikutus ylittää 8 h/a asuinrakennuksen A (14 h 22 min/vuosi), asuinrakennus E (11 h 8 min/vuosi, asuinrakennus F (10 h 31 min/vuosi), asuinrakennus G (10h 28 min/vuosi), lomarakennus M (19 h 15 min/vuosi), lomarakennus P (50 h 19 min /vuosi) ja lomarakennus Q (31 h 2 min/vuosi) alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 14, Taulukko 31) Katso tarkemmat laskentatulokset liitteestä 20.

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Kuva 14. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu, VE2 yhdessä Hangaskurunkankaan hankkeen kanssa.

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Taulukko 30. Varjostusmallinnuksen tulos VE2, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	14:23
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	5:50
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	6:16
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	11:09
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	10:32
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	10:28
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	19:16
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	3:26
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	4:06
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	50:23
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	31:04
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	5:24

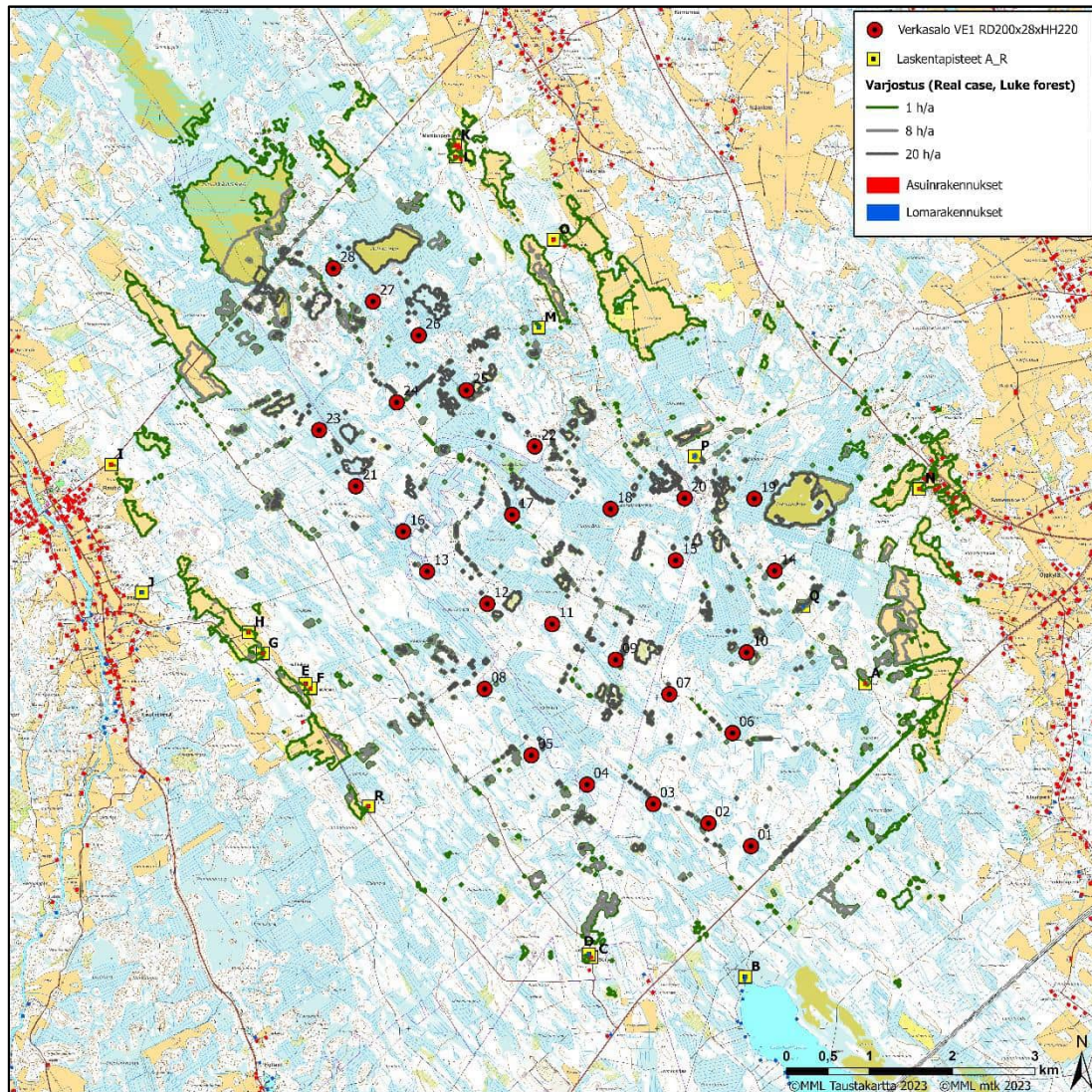
11.10.2023

Taulukko 31. Varjostusmallinnuksen tulos VE2 yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	14:22
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	5:49
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	6:16
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	11:08
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	10:31
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	10:28
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	19:15
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	3:26
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	4:06
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	50:19
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	31:02
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	5:24

Huomioitaessa puuston suojaava vaikutus (Luonnonvarakeskuksen puuston keskipituusaineisto 2021) vaihtoehdossa 1 (VE1), ylittää varjostusvaikutus 8 h/a laskentapisteissä asuinrakennus G (8h 49 min/vuosi), lomarakennus M (9 h 59 min/vuosi), lomarakennus P (21 h 58 min/vuosi) ja lomarakennus Q (25 h 4 min/vuosi). (Kuva 15, Taulukko 32) Katso tarkemmat laskentatulokset liitteestä 21.

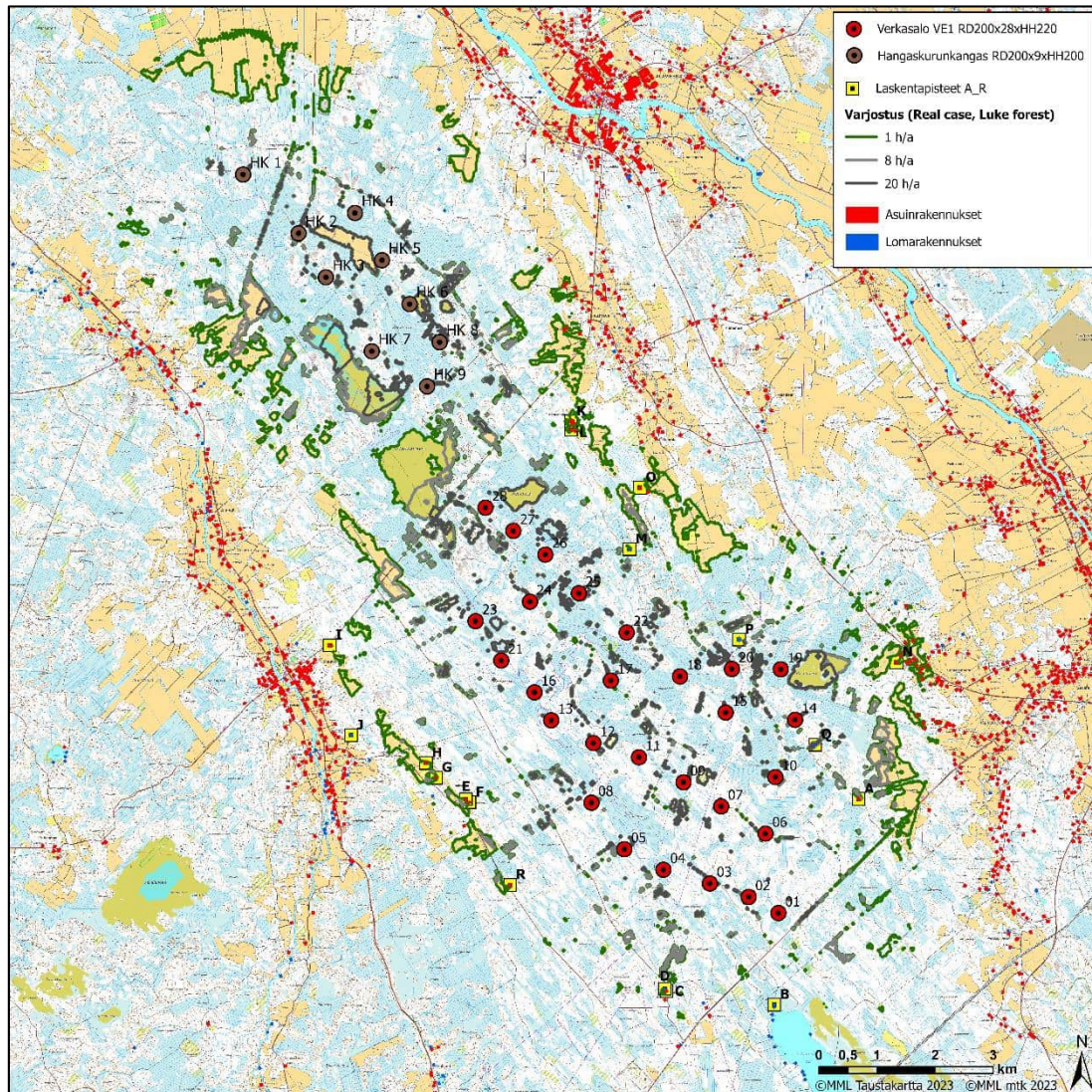
11.10.2023



Kuva 15. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu VE1.

Huomioitaessa puuston suojaava vaikutus vaihtoehdossa 1 (VE1), ylittää Hangaskurunkankaan hankkeen kanssa muodostuva varjostuksen yhteisvaikutus 8 h/a laskentapisteissä asuinrakennus G (8h 48 min/vuosi), lomarakennus M (9 h 58 min/vuosi), lomarakennus P (21 h 56 min/vuosi) ja lomarakennus Q (25 h 1 min/vuosi). (Kuva 16, Taulukko 33) Katso tarkemmat laskentatulokset liitteestä 22.

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Kuva 16. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu, VE1 yhdessä Hangaskurunkankaan hankkeen kanssa.

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Taulukko 32. Varjostusmallinnuksen tulos VE1, kun puuston suojaava vaikutus on huomioitu ”real case, Luke forest”.

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	2:30
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	2:39
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	5:10
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	8:49
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	9:59
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	21:58
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	25:04
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

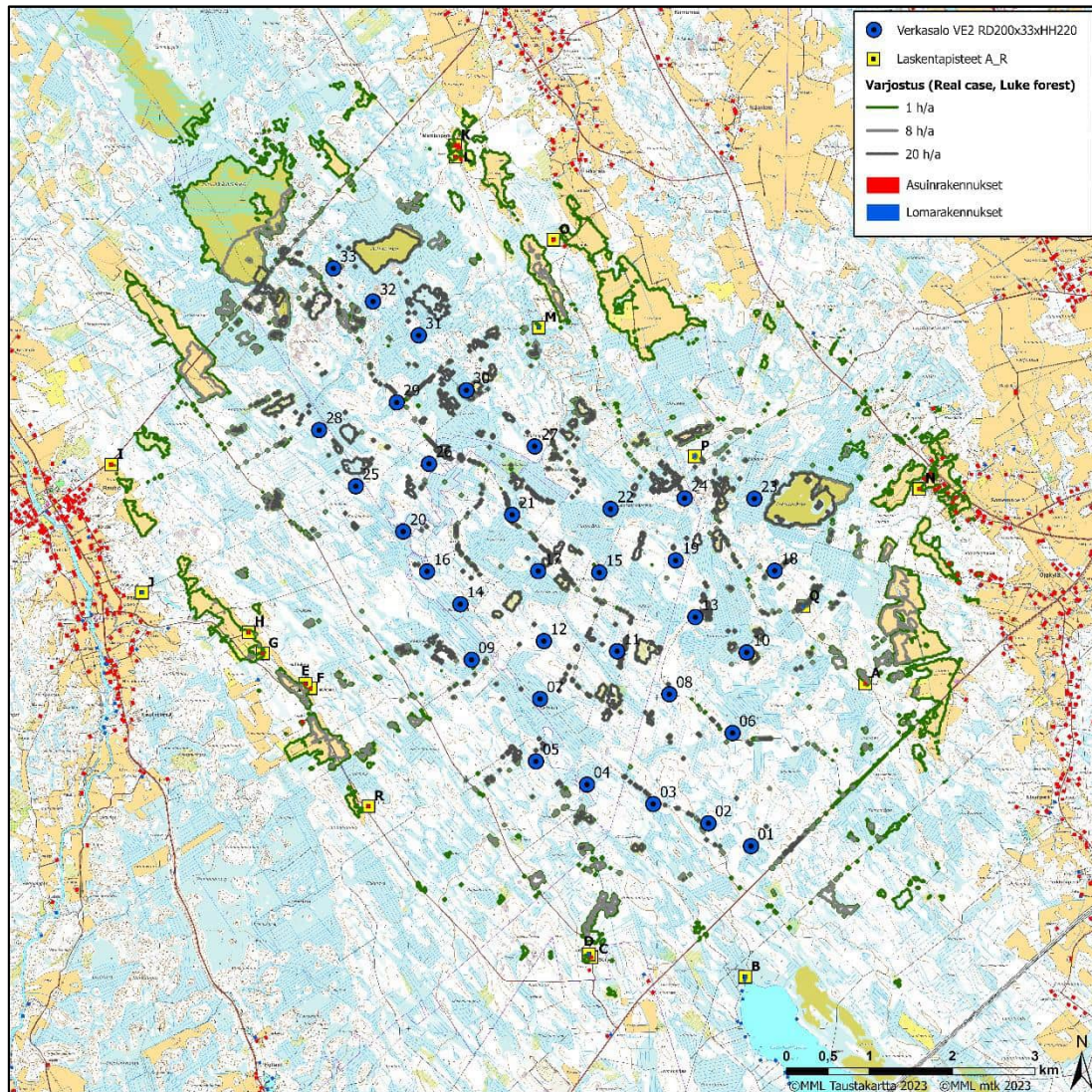
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Taulukko 33. Varjostusmallinnuksen tulos VE1 yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa, kun puuston suojaava vaikutus on huomioitu "real case, Luke forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	2:30
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	2:39
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	5:10
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	8:48
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	9:58
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	21:56
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	25:01
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

Huomioitaessa puuston suojaava vaikutus (Luonnonvarakeskuksen puuston keskipituusaineisto 2021) vaihtoehdossa 2 (VE2), ylittää varjostusvaikutus 8 h/a laskentapisteissä asuinrakennus E (8h 46 min/vuosi), asuinrakennus G (10h 28 min/vuosi), lomarakennus M (9 h 59 min/vuosi), lomarakennus P (21 h 58 min /vuosi) ja lomarakennus Q (31 h 4 min/vuosi). (Kuva 17, Taulukko 34) Katso tarkemmat laskentatulokset liitteestä 23.

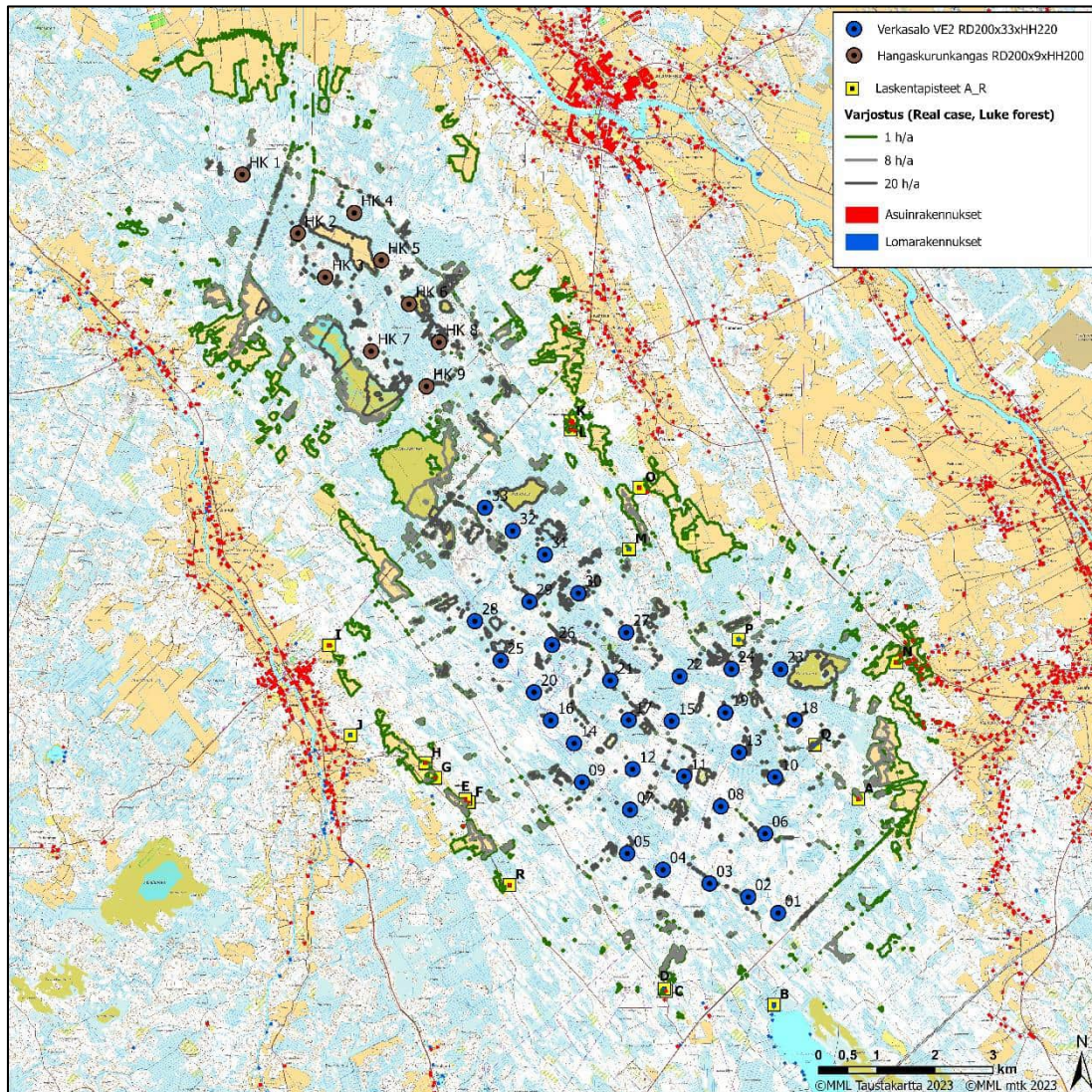
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Kuva 17. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu VE2.

Huomioitaessa puuston suojaava vaikutus vaihtoehdossa 2 (VE2), ylittää Hangaskurunkankaan hankkeen kanssa muodostuva varjostuksen yhteisvaikutus 8 h/a laskentapisteissä asuinrakennus E (8h 45 min/vuosi), asuinrakennus G (10h 28 min/vuosi), lomarakennus M (9 h 58 min/vuosi), lomarakennus P (21 h 56 min /vuosi) ja lomarakennus Q (31 h 2 min/vuosi). (Kuva 18, Taulukko 35) Katso tarkemmat laskentatulokset liitteestä 24.

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Kuva 18. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu, VE2 yhdessä Hangaskurunkankaan hankkeen kanssa.

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Taulukko 34. Varjostusmallinnuksen tulos VE2, kun puuston suojaava vaikutus on huomioitu ”real case, Luke forest”.

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	2:30
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	2:39
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	8:46
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	10:28
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	9:59
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	21:58
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	31:04
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

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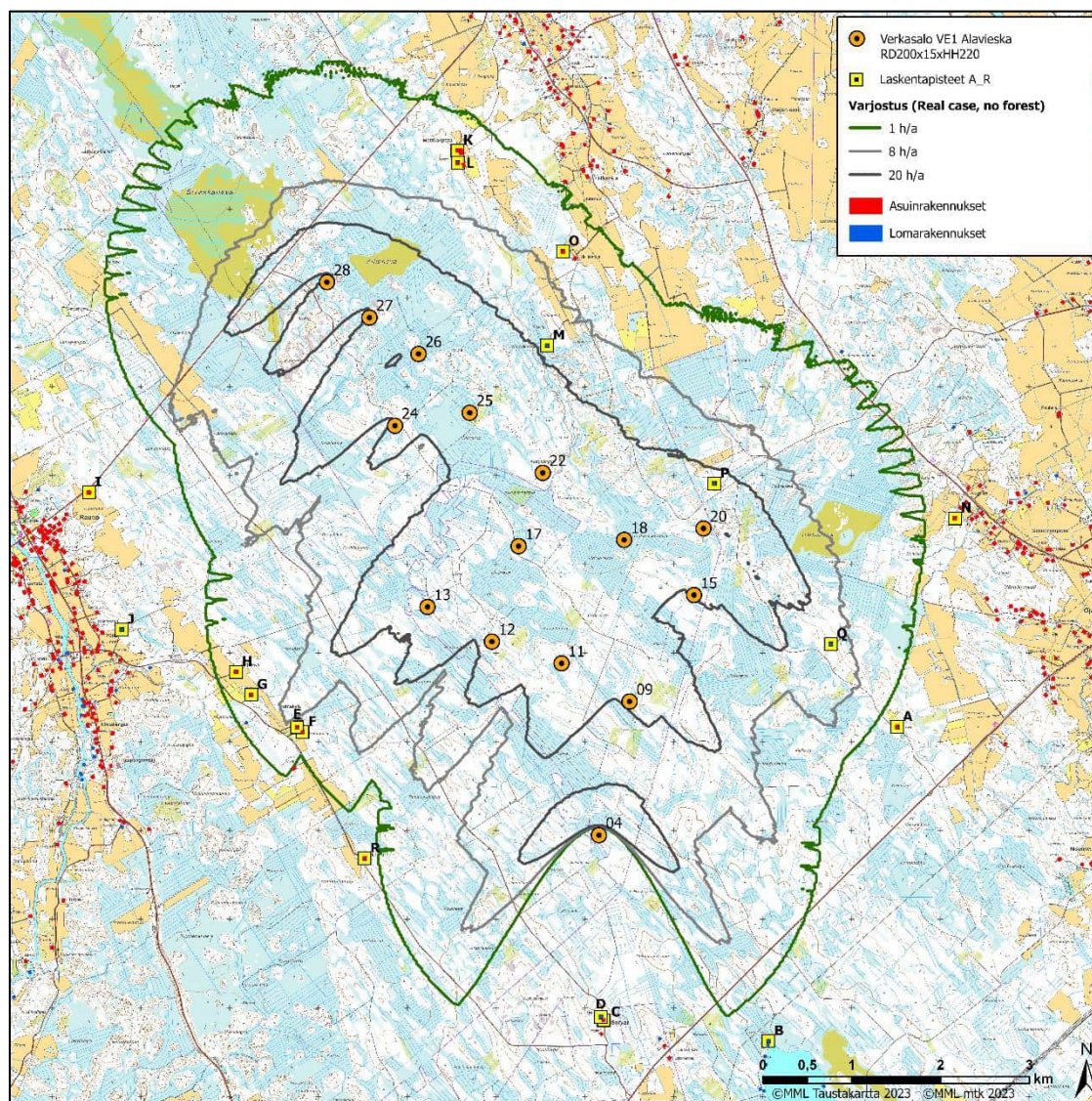
Taulukko 35. Varjostusmallinnuksen tulos VE2 yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa, kun puuston suojaava vaikutus on huomioitu "real case, Luke forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	2:30
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	2:39
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	8:45
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	10:28
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	6:26
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	9:58
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	21:56
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	31:02
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

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3.2.2 Varjostuksen kuntakohtaiset tulokset VE1 ja VE2 voimalaitoksella Generic RD200 HH220

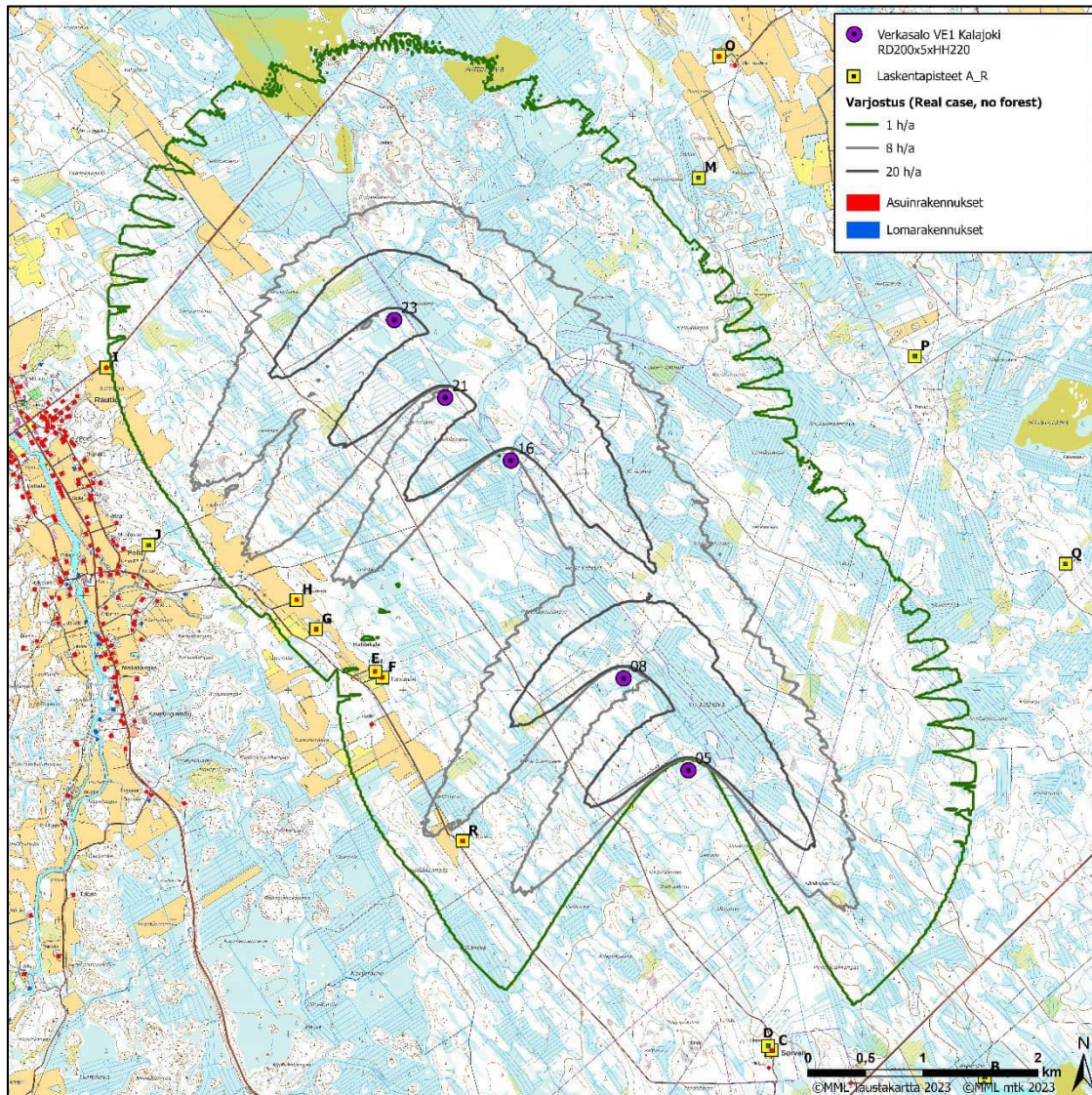
Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä lomarakennus M (15 h 51 min/vuosi), lomarakennus P (33 h 31 min/vuosi), lomarakennus Q (13 h 16 min/vuosi), kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 19, Taulukko 36) Katso tarkemmat laskentatulokset liitteestä 25.



Kuva 19. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE1 voimalat Alavieskan kunnan alueella.

Huomioitaessa ainoastaan Kalajoen kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), varjostusvaikutus ei ylitä 8 h/a missään asuin- tai lomarakennuksen pihapiirissä tuulivoimahankkeen lähistöllä, kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 20, Taulukko 37) Katso tarkemmat laskentatulokset liitteestä 25.

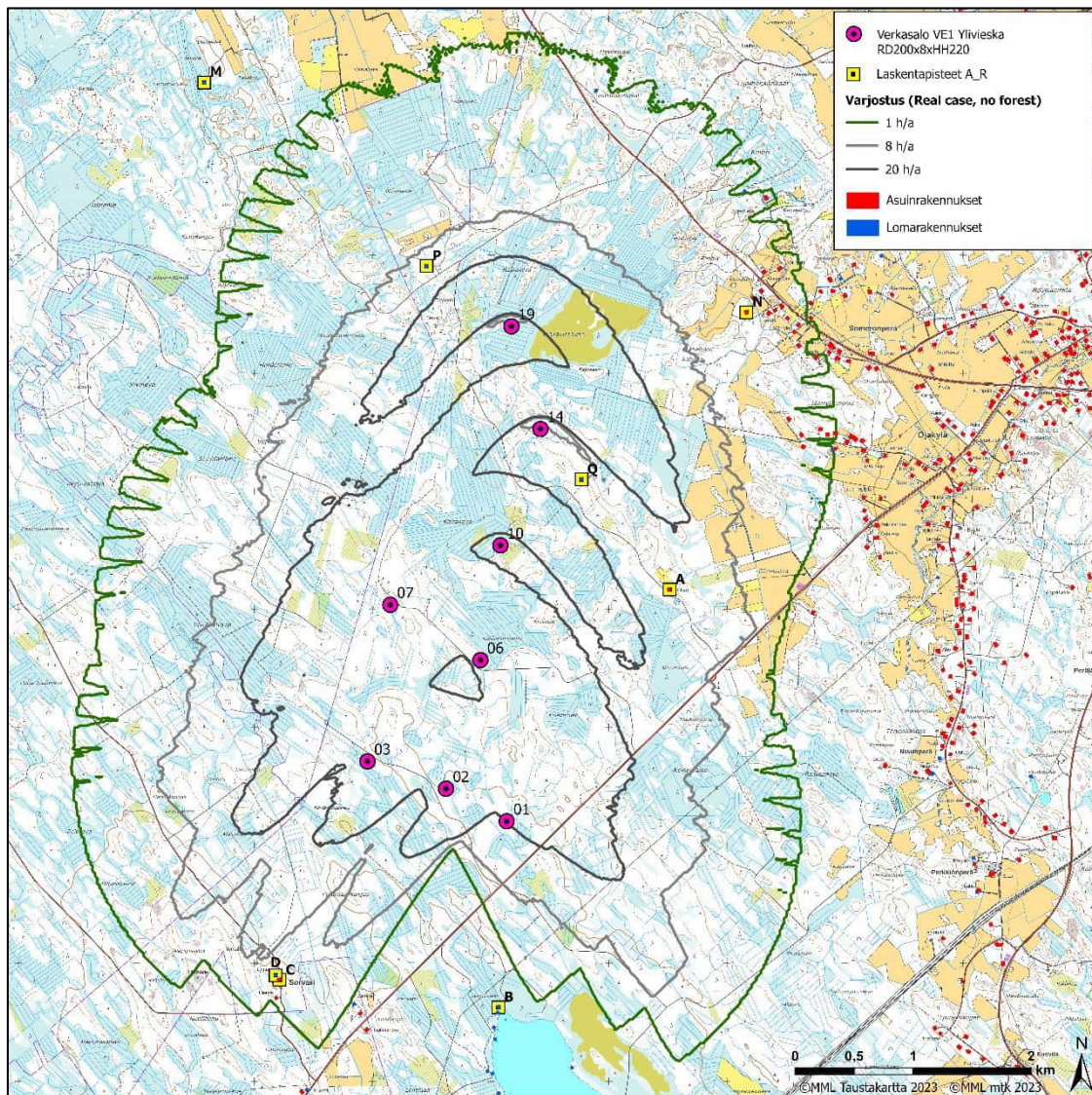
11.10.2023



Kuva 20. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE1 voimalat Kalajoen kunnan alueella.

Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteeissä asuinrakennus A (12 h 3 min/vuosi), asuinrakennus P (12 h 13 min/vuosi, asuinrakennus Q (11 h 44 min/vuosi), kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 21, Taulukko 38) Katso tarkemmat laskentatulokset liitteestä 25.

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Kuva 21. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE1 voimalat Ylivieskan kunnan alueella.

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Taulukko 36. Varjostusmallinnuksen tulos VE1 voimalat Alavieskan kunnan alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	0:00
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	0:00
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	7:25
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	6:18
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	3:02
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	2:12
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	17:51
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	4:06
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	33:31
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	13:16
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

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Taulukko 37. Varjostusmallinnuksen tulos VE1 voimalat Kalajoen kunnan alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	0:00
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	0:00
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	1:46
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	1:56
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	5:46
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	4:14
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	0:00
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	0:00
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	0:00
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	0:00
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	0:00
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	6:17

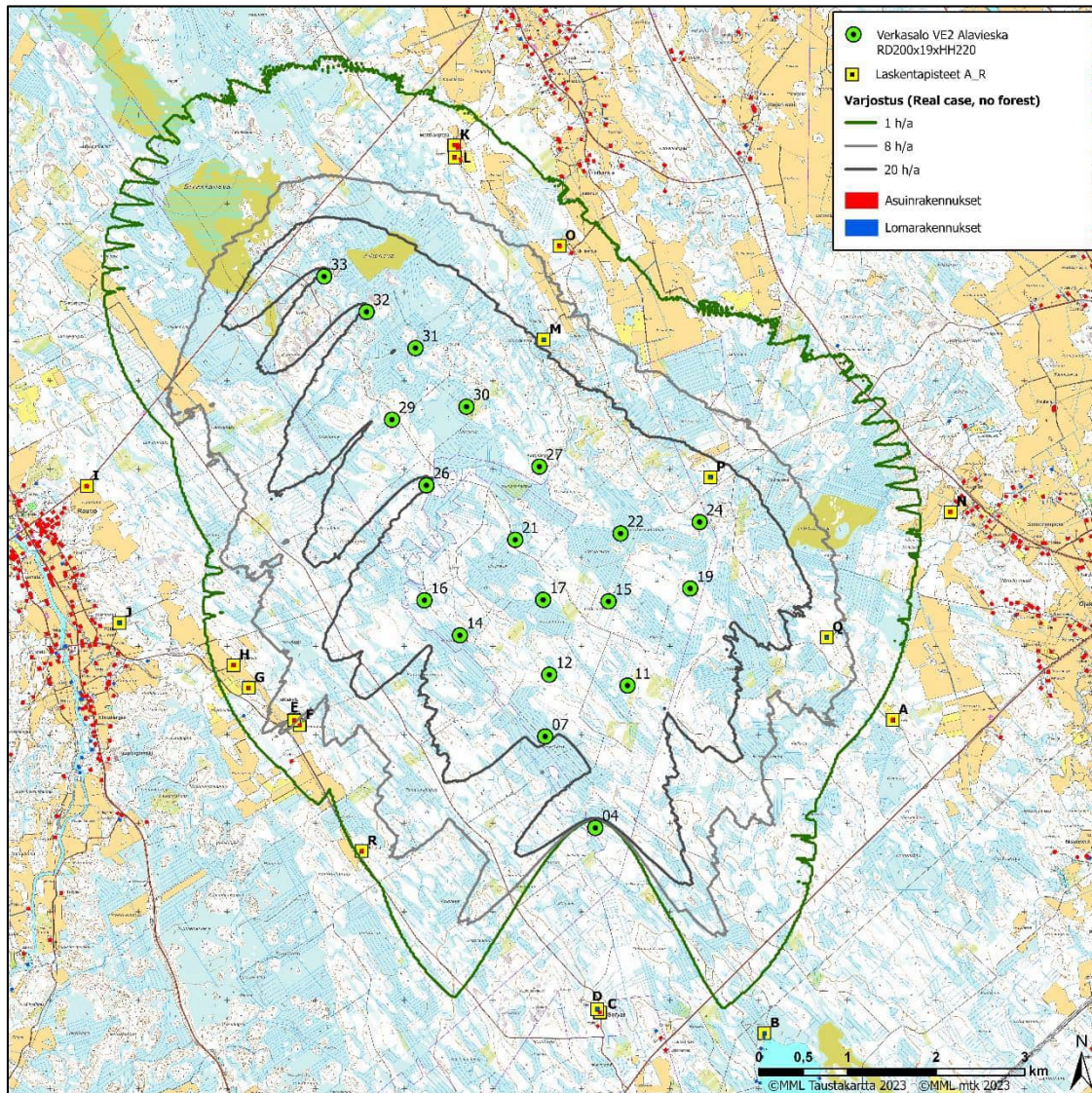
11.10.2023

Taulukko 38. Varjostusmallinnuksen tulos VE1 voimalat Ylivieskan kunnan alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	12:03
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	5:50
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	6:16
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	0:00
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	0:00
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	0:00
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	0:00
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	0:00
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	0:00
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	3:26
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	12:13
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	11:44
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä asuinrakennus E (8 h 46 min/vuosi), asuinrakennus M (19 h 16 min/vuosi, asuinrakennus P (36 h 26 min/vuosi), asuinrakennus Q (14h 41 min/vuosi), kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 22, Taulukko 39) Katso tarkemmat laskentatulokset liitteestä 26.

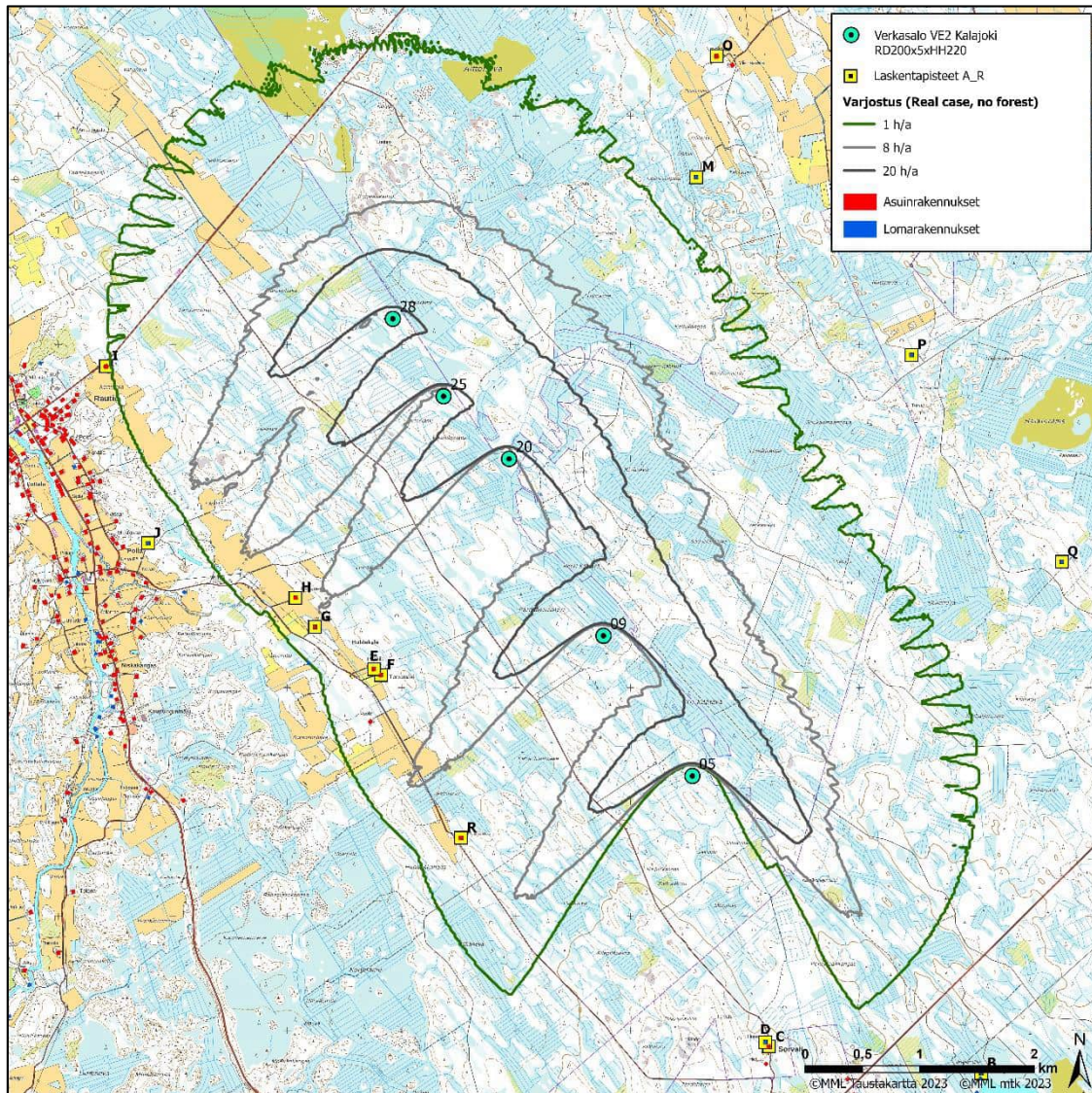
11.10.2023



Kuva 22. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE2 voimalat Alavieskan kunnan alueella.

Huomioitaessa ainoastaan Kalajoen kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), varjostusvaikutus ei ylitä 8 h/a missään asuin- tai lomarakennuksen pihapiirissä tuulivoimahankkeen lähistöllä, kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 23, Taulukko 40) Katso tarkemmat laskentatulokset liitteestä 26.

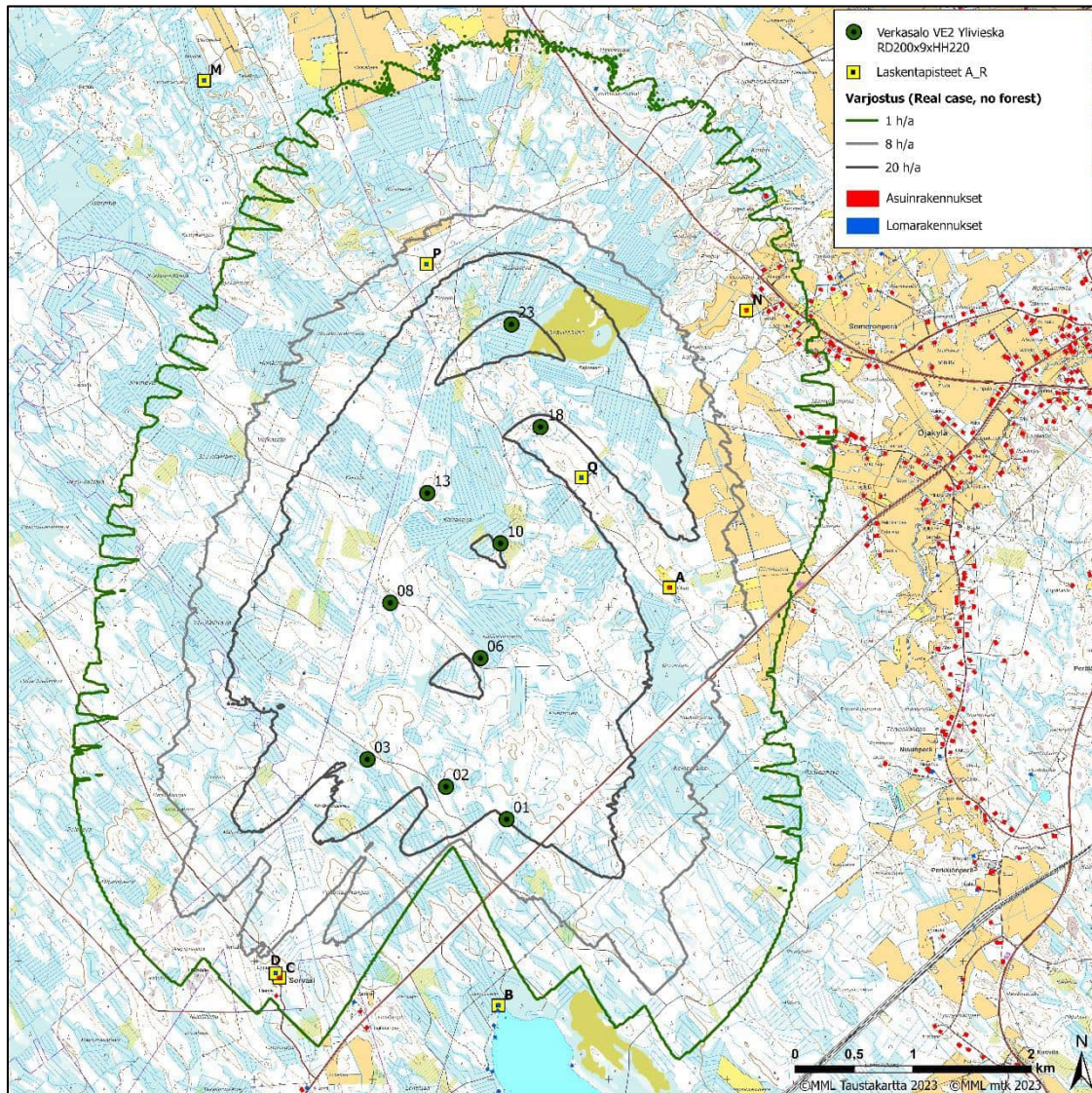
11.10.2023



Kuva 23. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE2 voimalat Kalajoen kunnan alueella.

Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä asuinrakennus A (14 h 23 min/vuosi), lomarakennus P (13 h 56 min/vuosi), lomarakennus Q (16 h 20 min/vuosi), kun puuston suojaavaa vaikutusta ei ole huomioitu. (Kuva 24, Taulukko 41) Katso tarkemmat laskentatulokset liitteestä 26.

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Kuva 24. Varjostusmallinnuksen tulos, kun puuston suojaavaa vaikutusta ei ole huomioitu VE2 voimalat Ylivieskan kunnan alueella.

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Taulukko 39. Varjostusmallinnuksen tulos VE2 voimalat Alavieskan kunnan alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	0:00
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	0:00
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	8:46
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	7:56
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	4:42
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	2:12
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	19:16
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	4:06
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	36:26
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	14:41
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	2:58

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Taulukko 40. Varjostusmallinnuksen tulos VE2 voimalat Kalajoen kunnan alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	0:00
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	0:00
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	2:23
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	2:35
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	5:46
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	4:14
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	0:00
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	0:00
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	0:00
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	0:00
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	0:00
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	2:26

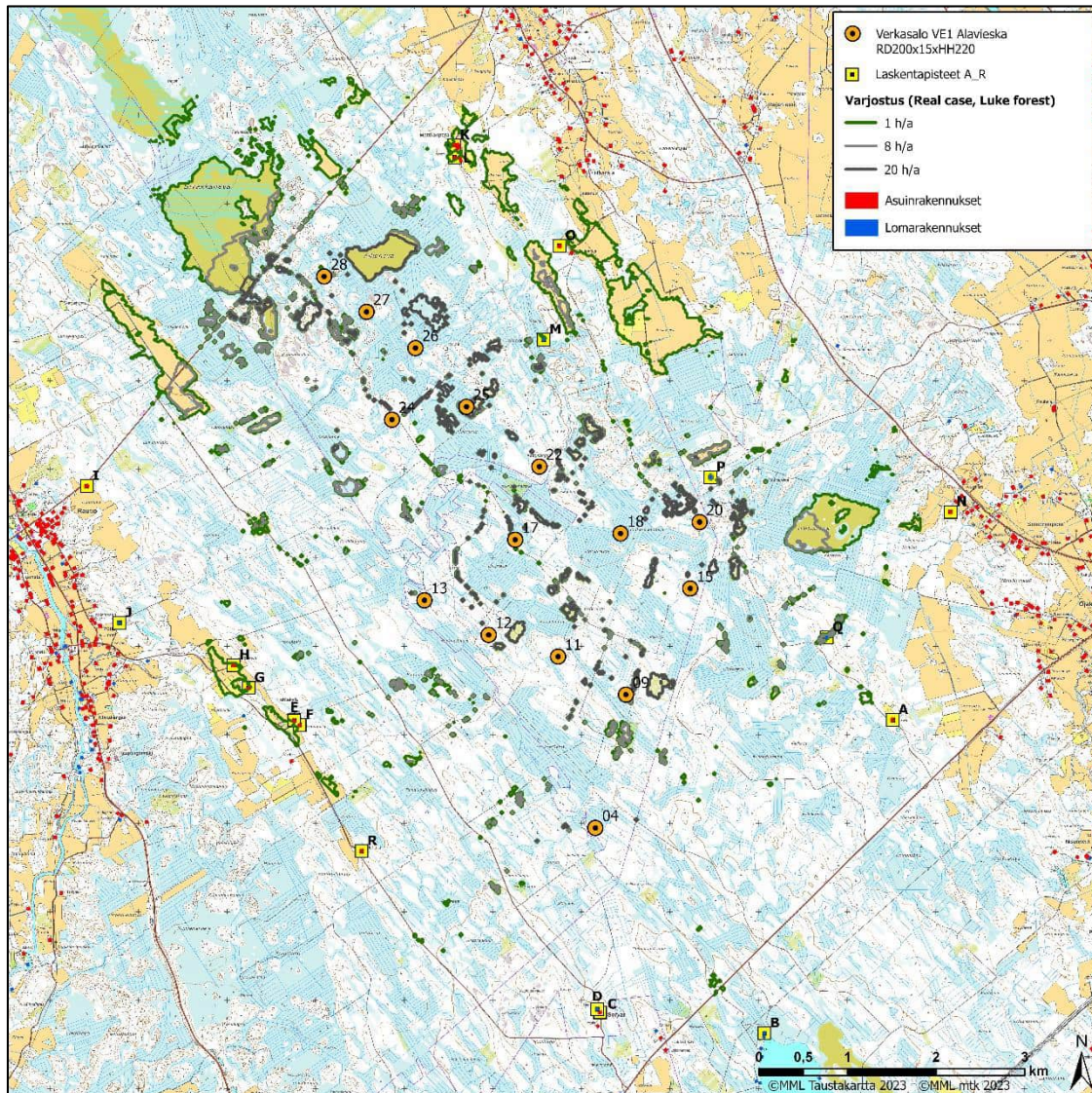
11.10.2023

Taulukko 41. Varjostusmallinnuksen tulos VE2 voimalat Ylivieskan kunnan alueella, kun puuston suojaavaa vaikutusta ei ole huomioitu "real case, no forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	14:23
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	5:50
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	6:16
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	0:00
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	0:00
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	0:00
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	0:00
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	0:00
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	0:00
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	3:26
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	13:56
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	16:20
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä lomarakennus M (9 h 59 min/vuosi), lomarakennus P (21 h 58 min /vuosi) ja lomarakennus Q (13 h 16 min/vuosi), kun puuston suojaava vaikutus on huomioitu (Luonnonvarakeskuksen puuston keskipituusaineisto 2021). (Kuva 25, Taulukko 42) Katso tarkemmat laskentatulokset liitteestä 27.

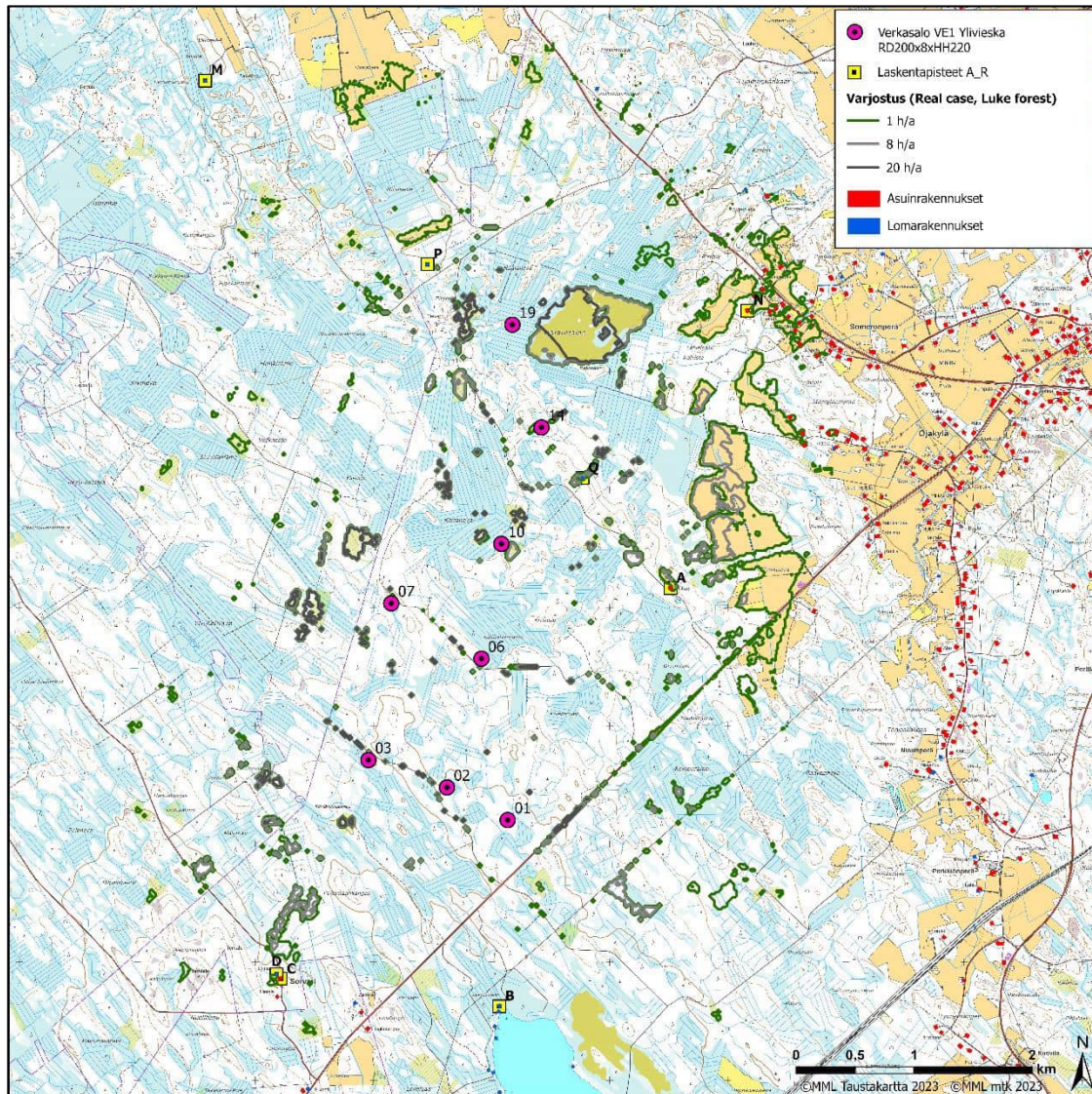
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Kuva 25. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu VE1 voimalat Alavieskan alueella.

Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 1 (VE1), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä lomarakennus Q (11 h, 44 min/vuosi), kun puuston suojaava vaikutus on huomioitu (Luonnonvarakeskuksen puuston keskipituusaineisto 2021). (Kuva 26, Taulukko 43) Katso tarkemmat laskentatulokset liitteestä 27.

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Kuva 26. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu VE1 voimalat Ylivieskan alueella.

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Taulukko 42. Varjostusmallinnuksen tulos VE1 voimalat Alavieskan kunnan alueella, kun puuston suojaava vaikutus on huomioitu "real case, Luke forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	0:00
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	0:00
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	5:10
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	3:02
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	2:12
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	9:59
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	21:58
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	13:16
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

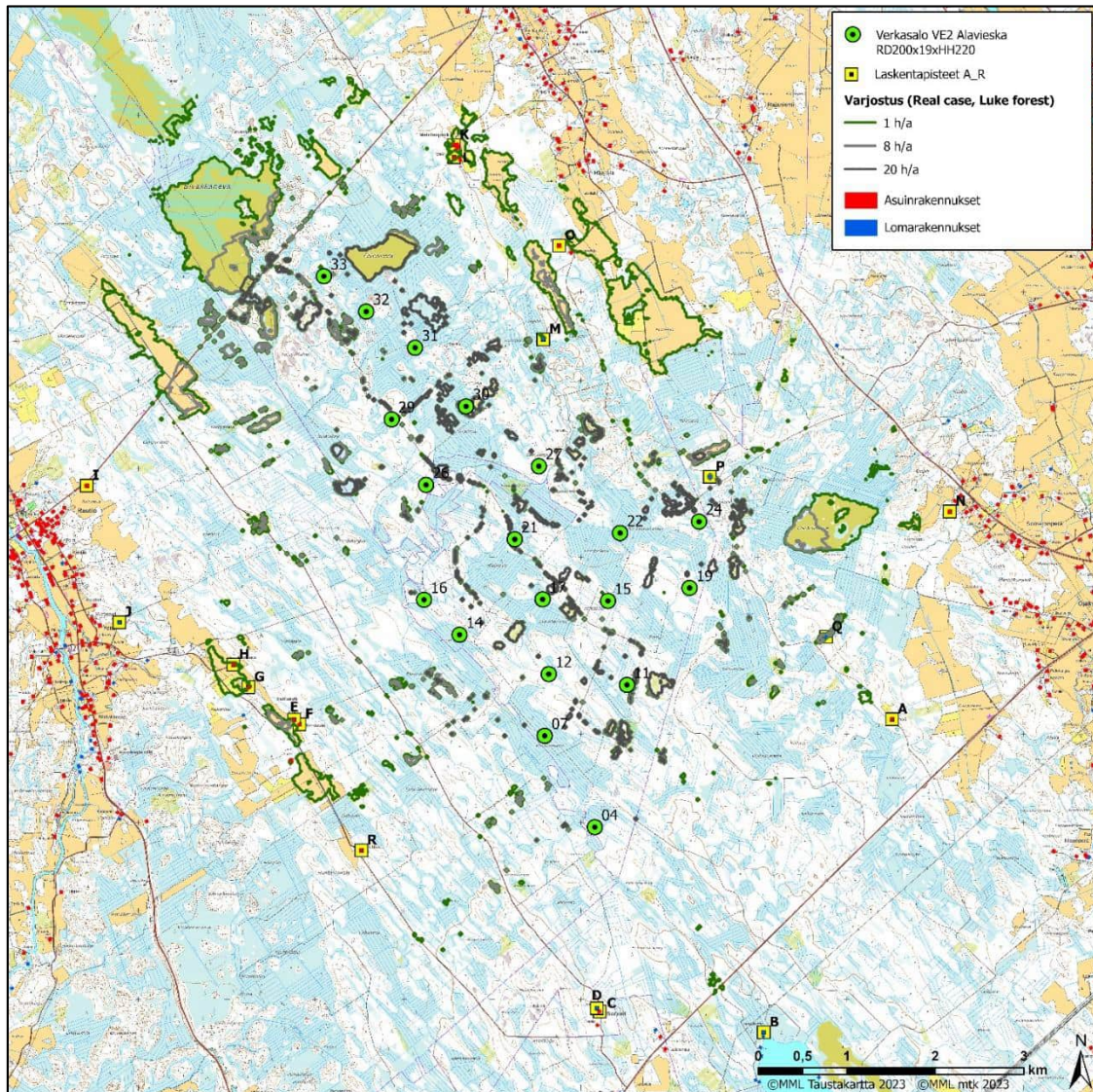
11.10.2023

Taulukko 43. Varjostusmallinnuksen tulos VE1 voimalat Ylivieskan kunnan alueella, kun puuston suojaava vaikutus on huomioitu "real case, Luke forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	2:30
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	2:39
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	0:00
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	0:00
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	0:00
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	0:00
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	0:00
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	0:00
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	0:00
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	11:44
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

Huomioitaessa ainoastaan Alavieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteissä asuinrakennus E (8h 46 min/vuosi), lomarakennus M (9 h 59 min/vuosi), lomarakennus P (21 h 58 min /vuosi) ja lomarakennus Q (14 h 41 min/vuosi), kun puuston suojaava vaikutus on huomioitu (Luonnonvarakeskuksen puuston keskipituusaineisto 2021). (Kuva 27, Taulukko 44) Katso tarkemmat laskentatulokset liitteestä 28.

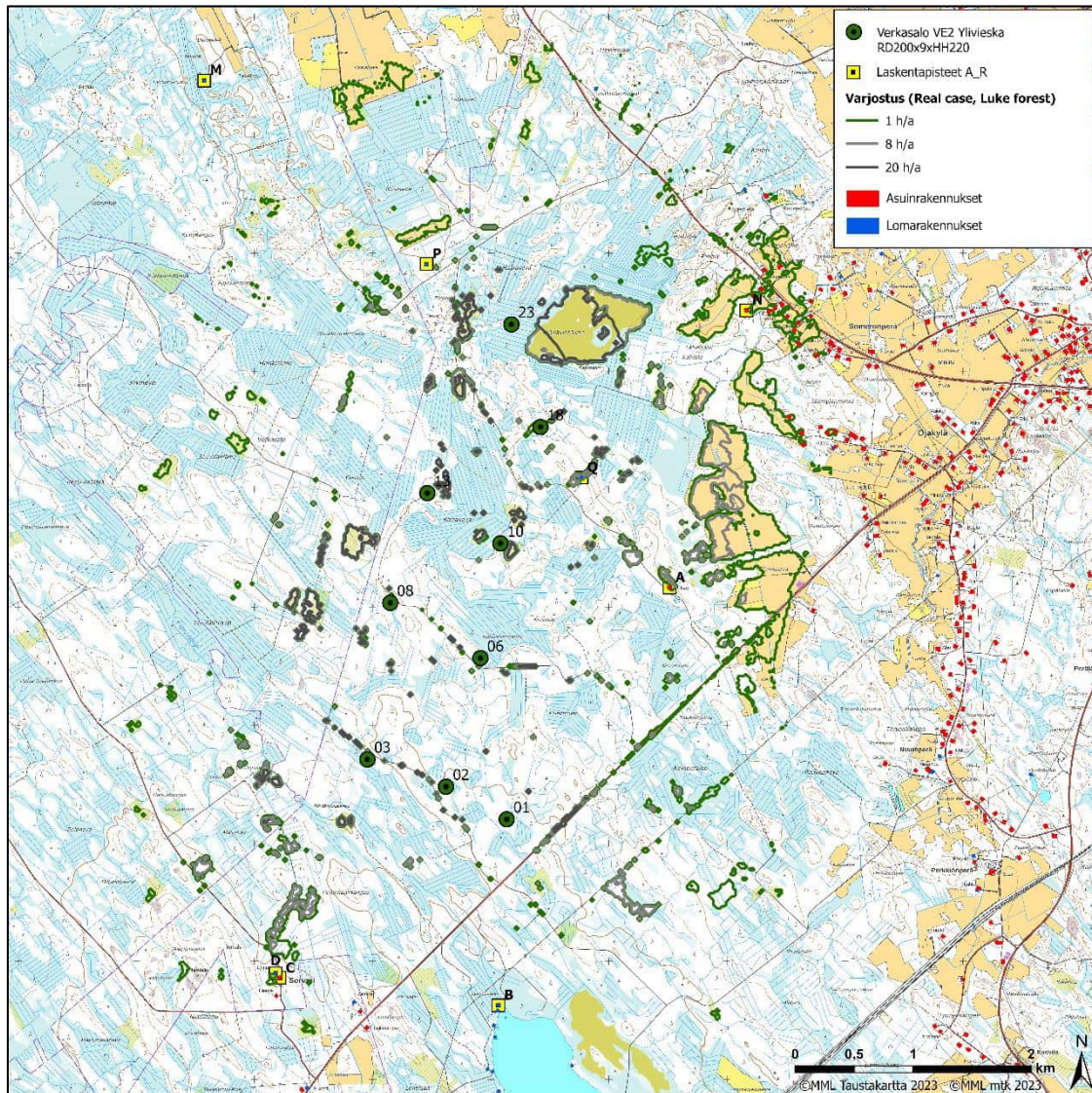
11.10.2023



Kuva 27. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu VE2 voimalat Alavieskan alueella.

Huomioitaessa ainoastaan Ylivieskan kunnan alueella sijaitsevat tuulivoimalat vaihtoehdossa 2 (VE2), lähimpien asuin- ja lomarakennusten pihapiirissä varjostusvaikutus on yli 8 h/a laskentapisteeissä lomarakennus Q (16 h 20 min/vuosi), kun puuston suojaava vaikutus on huomioitu (Luonnonvarakeskuksen puuston keskipituusaineisto 2021). (Kuva 28, Taulukko 45) Katso tarkemmat laskentatulokset liitteestä 28.

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Kuva 28. Varjostusmallinnuksen tulos, kun puuston suojaava vaikutus on huomioitu VE2 voimat Ylivieskan alueella.

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Taulukko 44. Varjostusmallinnuksen tulos VE2 voimalat Alavieskan kunnan alueella, kun puuston suojaava vaikutus on huomioitu "real case, Luke forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	0:00
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	0:00
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	8:46
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	4:42
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	2:12
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	3:52
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	4:17
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	9:59
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	21:58
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	14:41
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

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Taulukko 45. Varjostusmallinnuksen tulos VE2 voimalat Ylivieskan kunnan alueella, kun puuston suojaava vaikutus on huomioitu "real case, Luke forest".

	ETRS89-TM35 Itä	ETRS89-TM35 Pohjoinen	Z (m)	Lasken- taikkuna (m)	Varjostus (h/a)
Asuinrakennus A	373 516	7 106 167	70,0	5,0 x 5,0	2:30
Lomarakennus B	372 065	7 102 626	82,5	5,0 x 5,0	0:00
Asuinrakennus C	370 211	7 102 863	82,5	5,0 x 5,0	0:00
Lomarakennus D	370 180	7 102 899	82,5	5,0 x 5,0	2:39
Asuinrakennus E	366 759	7 106 162	67,5	5,0 x 5,0	0:00
Asuinrakennus F	366 819	7 106 110	67,5	5,0 x 5,0	0:00
Asuinrakennus G	366 243	7 106 530	65,0	5,0 x 5,0	0:00
Asuinrakennus H	366 073	7 106 785	64,5	5,0 x 5,0	0:00
Asuinrakennus I	364 417	7 108 809	61,2	5,0 x 5,0	0:00
Lomarakennus J	364 785	7 107 263	61,9	5,0 x 5,0	0:00
Asuinrakennus K	368 566	7 112 661	59,4	5,0 x 5,0	0:00
Asuinrakennus L	368 569	7 112 523	60,1	5,0 x 5,0	0:00
Lomarakennus M	369 574	7 110 463	60,0	5,0 x 5,0	0:00
Asuinrakennus N	374 166	7 108 516	60,2	5,0 x 5,0	0:00
Asuinrakennus O	369 753	7 111 523	57,6	5,0 x 5,0	0:00
Lomarakennus P	371 457	7 108 909	60,7	5,0 x 5,0	0:00
Lomarakennus Q	372 769	7 107 100	70,9	5,0 x 5,0	16:20
Asuinrakennus R	367 519	7 104 685	70,6	5,0 x 5,0	0:00

11.10.2023

FCG Finnish Consulting Group Oy

Aarni Nikkola, ins. AMK

Laatija

Johanna Harju, ins. AMK

Tarkastaja

11.10.2023

Liite 1. Verkasalon tuulivoimahanke - Melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 (VE1) N175 – 6.8 MW

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 10.32/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

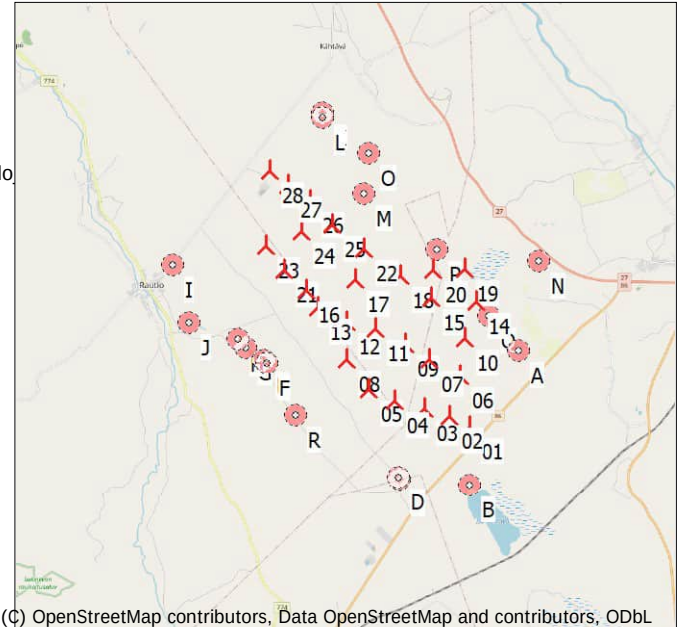
Uncertainty margin:

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)



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

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	Lwa,ref [dB(A)]
					Valid	Manufact.				Creator	Name		
01	372 136	7 104 203	80,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
02	371 622	7 104 479	80,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
03	370 957	7 104 711	79,4	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
04	370 157	7 104 947	72,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
05	369 485	7 105 301	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
06	371 914	7 105 569	73,3	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
07	371 150	7 106 037	77,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
08	368 920	7 106 101	71,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
09	370 503	7 106 453	74,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
10	372 083	7 106 541	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
11	369 736	7 106 883	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
12	368 953	7 107 128	72,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
13	368 227	7 107 519	68,6	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
14	372 422	7 107 527	67,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
15	371 227	7 107 652	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
16	367 939	7 108 000	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
17	369 253	7 108 202	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
18	370 442	7 108 273	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
19	372 176	7 108 397	63,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
20	371 335	7 108 402	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
21	367 367	7 108 547	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
22	369 525	7 109 029	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
23	366 924	7 109 225	67,2	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
24	367 862	7 109 559	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
25	368 702	7 109 705	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
26	368 126	7 110 369	63,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
27	367 574	7 110 777	62,8	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
28	367 096	7 111 177	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4

Calculation Results

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height	Noise	From WTGs	Distance to noise demand
				[m]	[m]	[dB(A)]	[dB(A)]	[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	37,8	396
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	35,4	695
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	35,4	865
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	35,5	842
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	36,1	824
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	36,2	810
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	35,3	1 005

To be continued on next page...

DECIBEL - Main Result

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB

...continued from previous page

Noise sensitive area

No.	Name	East	North	Z [m]	Immission height [m]	Demands		Sound level		Distance to noise demand [m]
						Noise [dB(A)]	From WTGs [dB(A)]			
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	35,2			994
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	31,9			1 641
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	31,9			1 815
K	Laskentapiste_K (Mattiilanperä)	368 566	7 112 661	59,4	4,0	40,0	34,1			1 061
L	Laskentapiste_L (Mattiilanperä)	368 569	7 112 523	60,1	4,0	40,0	34,6			943
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	39,9			10
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	34,4			990
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	35,7			885
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	44,7			-589
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	44,2			-520
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	35,3			941

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
01	2400	1578	2346	2351	5723	5648	6335	6590	8989	7962	9180	9052	6764	4767	7698	4754	2965	4642
02	2537	1905	2146	2140	5146	5073	5757	6010	8407	7382	8734	8604	6325	4772	7288	4433	2860	4109
03	2944	2361	1994	1972	4442	4368	5052	5306	7718	6679	8301	8168	5916	4978	6917	4227	2998	3438
04	3574	3004	2085	2048	3609	3535	4222	4479	6919	5850	7876	7741	5547	5368	6589	4170	3385	2651
05	4123	3716	2544	2500	2859	2786	3467	3722	6164	5094	7417	7280	5163	5679	6228	4111	3744	2061
06	1710	2946	3197	3184	5189	5123	5751	5966	8167	7327	7843	7717	5425	3710	6334	3371	1754	4483
07	2369	3532	3311	3285	4393	4332	4932	5133	7282	6482	7110	6980	4698	3904	5661	2888	1936	3875
08	4596	4687	3486	3441	2162	2101	2711	2929	5255	4295	6569	6431	4410	5775	5485	3784	3976	1993
09	3027	4133	3602	3568	3755	3700	4260	4443	6527	5775	6503	6371	4117	4205	5126	2635	2357	3468
10	1481	3915	4128	4110	5338	5282	5840	6016	7995	7334	7059	6938	4656	2870	5500	2449	884	4927
11	3847	4852	4048	4009	3064	3018	3511	3665	5658	4966	5895	5760	3584	4721	4640	2658	3040	3122
12	4663	5473	4447	4403	2397	2364	2775	2901	4838	4170	5547	5409	3393	5395	4468	3073	3817	2832
13	5459	6218	5061	5015	1999	1992	2216	2276	4023	3452	5153	5016	3238	6022	4285	3516	4561	2921
14	1745	4914	5162	5143	5826	5780	6259	6393	8108	7642	6421	6309	4090	2005	4806	1685	551	5668
15	2728	5095	4897	4868	4711	4670	5109	5227	6908	6454	5672	5549	3261	3063	4142	1277	1638	4750
16	5871	6775	5618	5572	2185	2197	2244	2227	3614	3239	4702	4566	2956	6249	3962	3633	4913	3342
17	4724	6245	5425	5384	3222	3209	3443	3482	4874	4565	4511	4374	2284	4924	3358	2315	3685	3921
18	3726	5876	5416	5381	4246	4220	4546	4616	6049	5746	4772	4644	2355	3732	3322	1197	2606	4628
19	2602	5772	5873	5849	5860	5825	6220	6313	7771	7478	5587	5480	3322	1994	3955	883	1427	5956
20	3123	5822	5652	5623	5095	5064	5425	5505	6930	6648	5080	4963	2710	2834	3499	521	1938	5327
21	6594	7559	6356	6310	2462	2498	2309	2186	2962	2884	4284	4154	2923	6799	3814	4106	5593	3865
22	4911	6888	6204	6165	3984	3980	4125	4118	5113	5058	3757	3623	1435	4669	2505	1936	3774	4785
23	7267	8365	7161	7115	3067	3117	2779	2584	2541	2902	3808	3686	2926	7277	3645	4544	6220	4579
24	6594	8107	7096	7052	3571	3603	3434	3301	3526	3839	3181	3048	1937	6390	2727	3654	5489	4886
25	5974	7837	7007	6965	4041	4059	4016	3930	4378	4616	2959	2821	1156	5592	2100	2867	4830	5158
26	6834	8687	7790	7747	4423	4455	4276	4130	4024	4561	2334	2200	1452	6318	1995	3637	5679	5716
27	7521	9307	8343	8298	4687	4728	4451	4265	3721	4486	2128	2009	2025	6969	2303	4309	6365	6093
28	8144	9890	8879	8834	5026	5075	4725	4510	3576	4545	2088	1996	2579	7554	2679	4916	6987	6506

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE1_RD175x28xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

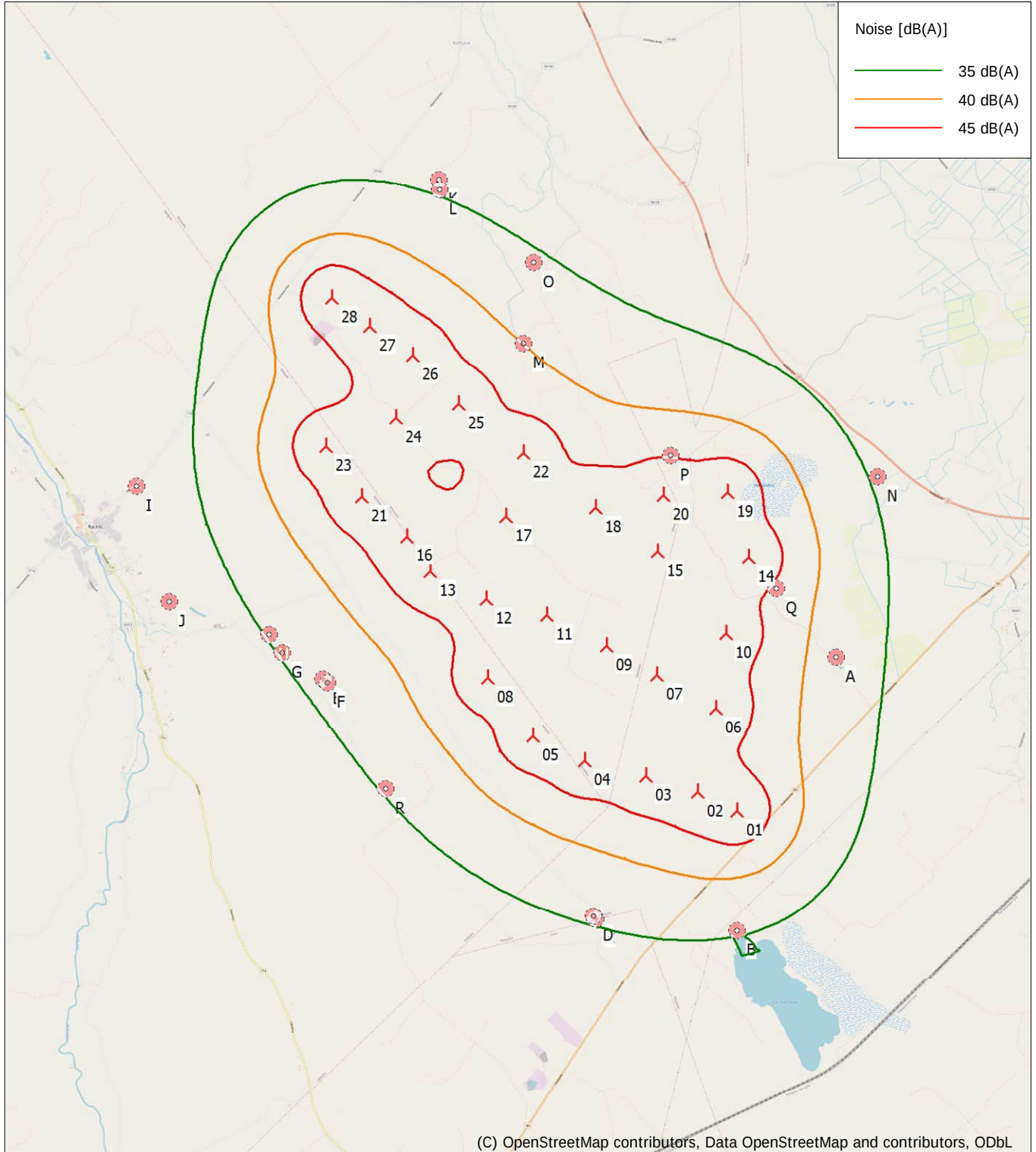
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB



0 1 2 3 4 km

Map: EMD OpenStreetMap , Print scale 1:75 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 369 673 North: 7 107 690
New WTG Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: 8,0 m/s
Height above sea level from active line object

11.10.2023

Liite 2. Verkasalon tuulivoimahanke - Melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 (VE1) N175 – 6.8 MW. Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

DECIBEL - Main Result

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200_107.8dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

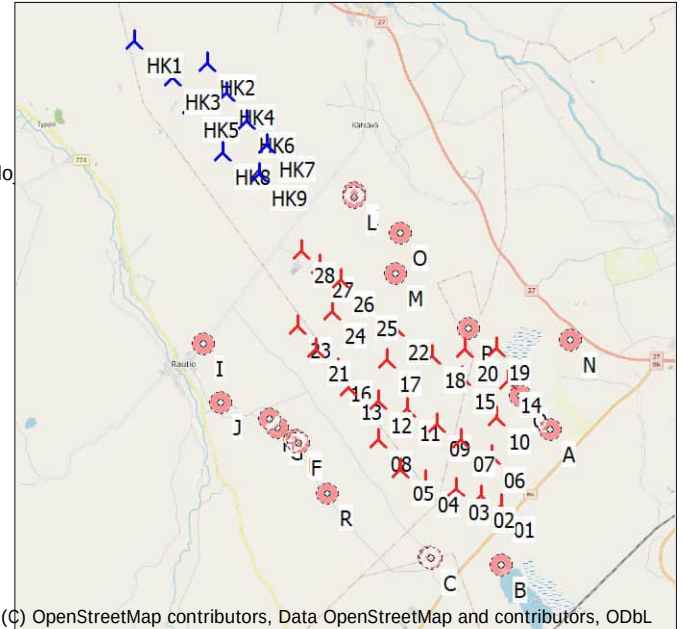
Uncertainty margin:

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)



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

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	Lwa_ref [dB(A)]
					Valid	Manufact.				Creator	Name		
01	372 136	7 104 203	80,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
02	371 622	7 104 479	80,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
03	370 957	7 104 711	79,4	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
04	370 157	7 104 947	72,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
05	369 485	7 105 301	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
06	371 914	7 105 569	73,3	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
07	371 150	7 106 037	77,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
08	368 920	7 106 101	71,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
09	370 503	7 106 453	74,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
10	372 083	7 106 541	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
11	369 736	7 106 883	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
12	368 953	7 107 128	72,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
13	368 227	7 107 519	68,6	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
14	372 422	7 107 527	67,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
15	371 227	7 107 652	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
16	367 939	7 108 000	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
17	369 253	7 108 202	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
18	370 442	7 108 273	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
19	372 176	7 108 397	63,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
20	371 335	7 108 402	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
21	367 367	7 108 547	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
22	369 525	7 109 029	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
23	366 924	7 109 225	67,2	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
24	367 862	7 109 559	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
25	368 702	7 109 705	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
26	368 126	7 110 369	63,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
27	367 574	7 110 777	62,8	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
28	367 096	7 111 177	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
HK1	362 925	7 116 909	50,0	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK2	364 851	7 116 247	55,0	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK3	363 880	7 115 898	53,1	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK4	365 316	7 115 435	55,6	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK5	364 350	7 115 141	55,0	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK6	365 790	7 114 681	57,5	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK7	366 307	7 114 024	57,5	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK8	365 140	7 113 868	57,5	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK9	366 091	7 113 264	57,5	VESTAS V150-4.0 8000 200....	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8

Calculation Results

DECIBEL - Main Result

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200_107.8dB

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height	Noise	Sound level	Distance to noise demand
				[m]	[m]	[dB(A)]	From WTGs [dB(A)]	[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	37,8	395
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	35,4	695
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	35,4	865
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	35,5	841
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	36,2	822
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	36,2	808
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	35,3	1 002
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	35,3	992
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	32,1	1 637
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	32,0	1 813
K	Laskentapiste_K (Mattiilanperä)	368 566	7 112 661	59,4	4,0	40,0	34,6	1 042
L	Laskentapiste_L (Mattiilanperä)	368 569	7 112 523	60,1	4,0	40,0	35,1	925
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	40,0	5
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	34,4	990
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	35,8	878
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	44,7	-589
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	44,2	-522
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	35,3	940

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
01	2400	1578	2346	2351	5723	5648	6335	6590	8989	7962	9180	9052	6764	4767	7698	4754	2965	4642
02	2537	1905	2146	2140	5146	5073	5757	6010	8407	7382	8734	8604	6325	4772	7288	4433	2860	4109
03	2944	2361	1994	1972	4442	4368	5052	5306	7718	6679	8301	8168	5916	4978	6917	4227	2998	3438
04	3574	3004	2085	2048	3609	3535	4222	4479	6919	5850	7876	7741	5547	5368	6589	4170	3385	2651
05	4123	3716	2544	2500	2859	2786	3467	3722	6164	5094	7417	7280	5163	5679	6228	4111	3744	2061
06	1710	2946	3197	3184	5189	5123	5751	5966	8167	7327	7843	7717	5425	3710	6334	3371	1754	4483
07	2369	3532	3311	3285	4393	4332	4932	5133	7282	6482	7110	6980	4698	3904	5661	2888	1936	3875
08	4596	4687	3486	3441	2162	2101	2711	2929	5255	4295	6569	6431	4410	5775	5485	3784	3976	1993
09	3027	4133	3602	3568	3755	3700	4260	4443	6527	5775	6503	6371	4117	4205	5126	2635	2357	3468
10	1481	3915	4128	4110	5338	5282	5840	6016	7995	7334	7059	6938	4656	2870	5500	2449	884	4927
11	3847	4852	4048	4009	3064	3018	3511	3665	5658	4966	5895	5760	3584	4721	4640	2658	3040	3122
12	4663	5473	4447	4403	2397	2364	2775	2901	4838	4170	5547	5409	3393	5395	4468	3073	3817	2832
13	5459	6218	5061	5015	1999	1992	2216	2276	4023	3452	5153	5016	3238	6022	4285	3516	4561	2921
14	1745	4914	5162	5143	5826	5780	6259	6393	8108	7642	6421	6309	4090	2005	4806	1685	551	5668
15	2728	5095	4897	4868	4711	4670	5109	5227	6908	6454	5672	5549	3261	3063	4142	1277	1638	4750
16	5871	6775	5618	5572	2185	2197	2244	2227	3614	3239	4702	4566	2956	6249	3962	3633	4913	3342
17	4724	6245	5425	5384	3222	3209	3443	3482	4874	4565	4511	4374	2284	4924	3358	2315	3685	3921
18	3726	5876	5416	5381	4246	4220	4546	4616	6049	5746	4772	4644	2355	3732	3322	1197	2606	4628
19	2602	5772	5873	5849	5860	5825	6220	6313	7771	7478	5587	5480	3322	1994	3955	883	1427	5956
20	3123	5822	5652	5623	5095	5064	5425	5505	6930	6648	5080	4963	2710	2834	3499	521	1938	5327
21	6594	7559	6356	6310	2462	2498	2309	2186	2962	2884	4284	4154	2923	6799	3814	4106	5593	3865
22	4911	6888	6204	6165	3984	3980	4125	4118	5113	5058	3757	3623	1435	4669	2505	1936	3774	4785
23	7267	8365	7161	7115	3067	3117	2779	2584	2541	2902	3808	3686	2926	7277	3645	4544	6220	4579
24	6594	8107	7096	7052	3571	3603	3434	3301	3526	3839	3181	3048	1937	6390	2727	3654	5489	4886
25	5974	7837	7007	6965	4041	4059	4016	3930	4378	4616	2959	2821	1156	5592	2100	2867	4830	5158
26	6834	8687	7790	7747	4423	4455	4276	4130	4024	4561	2334	2200	1452	6318	1995	3637	5679	5716
27	7521	9307	8343	8298	4687	4728	4451	4265	3721	4486	2128	2009	2025	6969	2303	4309	6365	6093
28	8144	9890	8879	8834	5026	5075	4725	4510	3576	4545	2088	1996	2579	7554	2679	4916	6987	6506
HK1	15085	16957	15824	15777	11410	11480	10897	10602	8236	9823	7061	7148	9261	14029	8696	11696	13897	13059
HK2	13292	15413	14418	14372	10264	10326	9816	9540	7451	8984	5163	5262	7468	12105	6808	9874	12099	11866
HK3	13695	15593	14491	14445	10153	10220	9662	9373	7109	8682	5695	5777	7872	12661	7323	10308	12507	11789
HK4	12375	14478	13492	13446	9385	9445	8953	8683	6687	8189	4273	4366	6546	11234	5915	8961	11182	10973
HK5	12828	14702	13605	13559	9297	9362	8817	8532	6332	7890	4891	4965	7013	11842	6502	9453	11643	10926
HK6	11497	13590	12618	12573	8574	8633	8164	7901	6030	7485	3433	3519	5667	10400	5067	8089	10305	10144
HK7	10663	12770	11824	11780	7875	7931	7494	7243	5547	6930	2638	2715	4833	9597	4258	7259	9471	9417
HK8	11378	13204	12117	12071	7874	7938	7421	7144	5110	6614	3632	3684	5591	10493	5175	8031	10199	9486
HK9	10271	12200	11188	11142	7133	7191	6736	6479	4759	6141	2547	2587	4470	9367	4055	6911	9088	8697

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200_107.8dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

WTG: VESTAS V150-4.0 8000 200.0 !O!

Noise: Vestas V150-4.0 RD200 HH200

Source Source/Date Creator Edited

Manufacturer 18.10.2017 USER 19.9.2023 10.42

Performance Specification 0067-7067 V05

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	109,8	No	83,5	90,3	95,7	99,7	102,5	103,8	103,7	102,3

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200_107.8dB

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

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: Verkasalo_VE1_RD175x28xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200_107.8dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

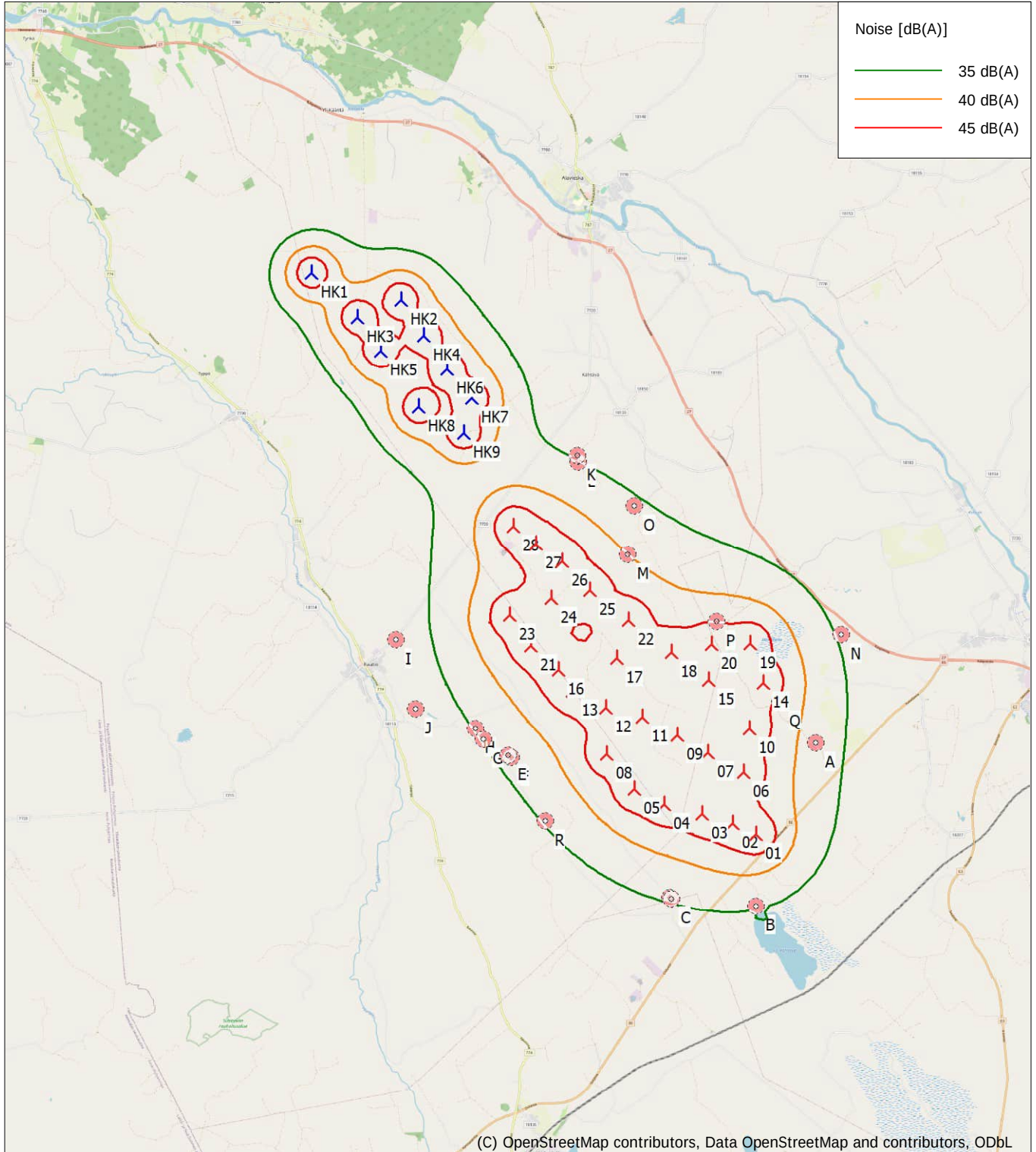
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE1_RD175x28xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200_107.8dB



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap, Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 367 674 North: 7 110 556
 New WTG Noise sensitive area
 Noise calculation model: ISO 9613-2 General. Wind speed: 8,0 m/s
 Height above sea level from active line object

11.10.2023

Liite 3. Verkasalon tuulivoimahanke - Melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 (VE2) N175 – 6.8 MW

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 10.52/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

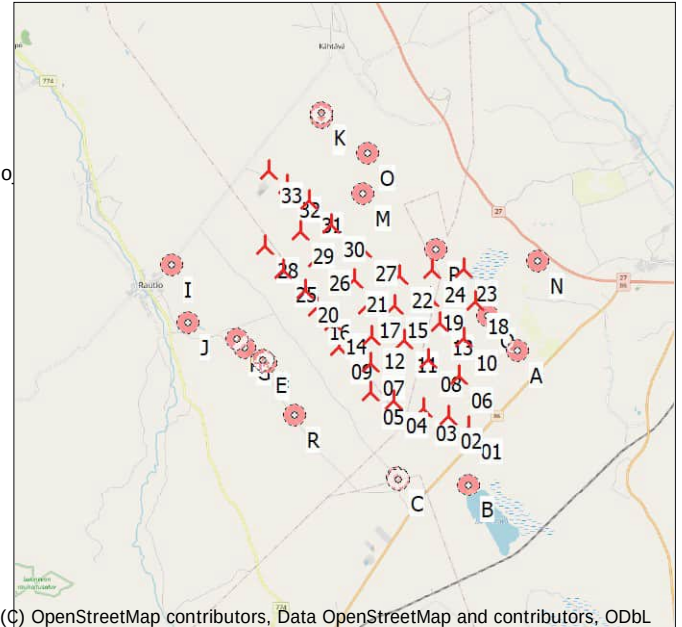
Uncertainty margin:

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)



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

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	Lwa,ref [dB(A)]
					Valid	Manufact.				Creator	Name		
01	372 136	7 104 203	80,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
02	371 622	7 104 479	80,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
03	370 957	7 104 711	79,4	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
04	370 157	7 104 947	72,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
05	369 541	7 105 227	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
06	371 914	7 105 569	73,3	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
07	369 591	7 105 980	71,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
08	371 150	7 106 037	77,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
09	368 764	7 106 453	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
10	372 083	7 106 541	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
11	370 521	7 106 556	73,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
12	369 636	7 106 678	75,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
13	371 464	7 106 967	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
14	368 628	7 107 123	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
15	370 306	7 107 506	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
16	368 227	7 107 519	68,6	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
17	369 568	7 107 523	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
18	372 422	7 107 527	67,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
19	371 227	7 107 652	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
20	367 939	7 108 000	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
21	369 253	7 108 202	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
22	370 442	7 108 273	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
23	372 176	7 108 397	63,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
24	371 335	7 108 402	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
25	367 367	7 108 547	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
26	368 250	7 108 818	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
27	369 525	7 109 029	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
28	366 924	7 109 225	67,2	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
29	367 862	7 109 559	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
30	368 702	7 109 705	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
31	368 126	7 110 369	63,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
32	367 574	7 110 777	62,8	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
33	367 096	7 111 177	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4

Calculation Results

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height	Noise	From WTGs	Distance to noise demand
				[m]	[m]	[dB(A)]	[dB(A)]	[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	38,3	313
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	35,6	678
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	35,8	818

To be continued on next page...

DECIBEL - Main Result

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB

...continued from previous page

Noise sensitive area

No.	Name	East	North	Z [m]	Immission height [m]	Demands		Sound level		Distance to noise demand [m]
						Noise [dB(A)]	From WTGs [dB(A)]			
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	35,9			794
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	37,1			624
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	37,2			602
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	36,1			859
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	36,0			870
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	32,5			1 602
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	32,6			1 742
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	4,0	40,0	34,4			1 040
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	4,0	40,0	34,9			921
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	40,4			-71
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	35,0			938
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	36,1			829
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	45,0			-668
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	44,6			-597
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	36,0			882

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
01	2400	1578	2346	2351	5723	5648	6335	6590	8989	7962	9180	9052	6764	4767	7698	4754	2965	4642
02	2537	1905	2146	2140	5146	5073	5757	6010	8407	7382	8734	8604	6325	4772	7288	4433	2860	4109
03	2944	2361	1994	1972	4442	4368	5052	5306	7718	6679	8301	8168	5916	4978	6917	4227	2998	3438
04	3574	3004	2085	2048	3609	3535	4222	4479	6919	5850	7876	7741	5547	5368	6589	4170	3385	2651
05	4085	3624	2457	2414	2935	2862	3546	3802	6253	5174	7498	7361	5237	5676	6300	4151	3732	2093
06	1710	2946	3197	3184	5189	5123	5751	5966	8167	7327	7843	7717	5425	3710	6334	3371	1754	4483
07	3930	4168	3178	3137	2838	2775	3392	3609	5897	4974	6759	6622	4483	5232	5545	3473	3370	2443
08	2369	3532	3311	3285	4393	4332	4932	5133	7282	6482	7110	6980	4698	3904	5661	2888	1936	3875
09	4760	5054	3871	3825	2027	1975	2522	2712	4945	4061	6211	6073	4091	5783	5166	3644	4057	2162
10	1481	3915	4128	4110	5338	5282	5840	6016	7995	7334	7059	6938	4656	2870	5500	2449	884	4927
11	3021	4222	3706	3673	3782	3728	4277	4454	6507	5779	6410	6278	4020	4140	5026	2533	2314	3537
12	3913	4724	3858	3818	2924	2874	3396	3566	5638	4887	6078	5942	3786	4889	4847	2880	3161	2908
13	2203	4382	4292	4266	4774	4723	5239	5395	7284	6686	6389	6265	3974	3115	4866	1941	1312	4558
14	4980	5660	4545	4500	2102	2074	2458	2578	4537	3846	5538	5400	3471	5710	4541	3345	4141	2679
15	3478	5187	4644	4609	3793	3756	4178	4294	6031	5526	5440	5309	3046	3991	4055	1815	2497	3965
16	5459	6218	5061	5015	1999	1992	2216	2276	4023	3452	5153	5016	3238	6022	4285	3516	4561	2921
17	4175	5497	4705	4665	3122	3091	3470	3572	5309	4790	5234	5098	2940	4704	4004	2343	3229	3501
18	1745	4914	5162	5143	5826	5780	6259	6393	8108	7642	6421	6309	4090	2005	4806	1685	551	5668
19	2728	5095	4897	4868	4711	4670	5109	5227	6908	6454	5672	5549	3261	3063	4142	1277	1638	4750
20	5871	6775	5618	5572	2185	2197	2244	2227	3614	3239	4702	4566	2956	6249	3962	3633	4913	3342
21	4724	6245	5425	5384	3222	3209	3443	3482	4874	4565	4511	4374	2284	4924	3358	2315	3685	3921
22	3726	5876	5416	5381	4246	4220	4546	4616	6049	5746	4772	4644	2355	3732	3322	1197	2606	4628
23	2602	5772	5873	5849	5860	5825	6220	6313	7771	7478	5587	5480	3322	1994	3955	883	1427	5956
24	3123	5822	5652	5623	5095	5064	5425	5505	6930	6648	5080	4963	2710	2834	3499	521	1938	5327
25	6594	7559	6356	6310	2462	2498	2309	2186	2962	2884	4284	4154	2923	6799	3814	4106	5593	3865
26	5895	7272	6269	6225	3046	3062	3043	2979	3834	3798	3856	3719	2112	5924	3095	3208	4835	4197
27	4911	6888	6204	6165	3984	3980	4125	4118	5113	5058	3757	3623	1435	4669	2505	1936	3774	4785
28	7267	8365	7161	7115	3067	3117	2779	2584	2541	2902	3808	3686	2926	7277	3645	4544	6220	4579
29	6594	8107	7096	7052	3571	3603	3434	3301	3526	3839	3181	3048	1937	6390	2727	3654	5489	4886
30	5974	7837	7007	6965	4041	4059	4016	3930	4378	4616	2959	2821	1156	5592	2100	2867	4830	5158
31	6834	8687	7790	7747	4423	4455	4276	4130	4024	4561	2334	2200	1452	6318	1995	3637	5679	5716
32	7521	9307	8343	8298	4687	4728	4451	4265	3721	4486	2128	2009	2025	6969	2303	4309	6365	6093
33	8144	9890	8879	8834	5026	5075	4725	4510	3576	4545	2088	1996	2579	7554	2679	4916	6987	6506

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE2_RD175x33xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

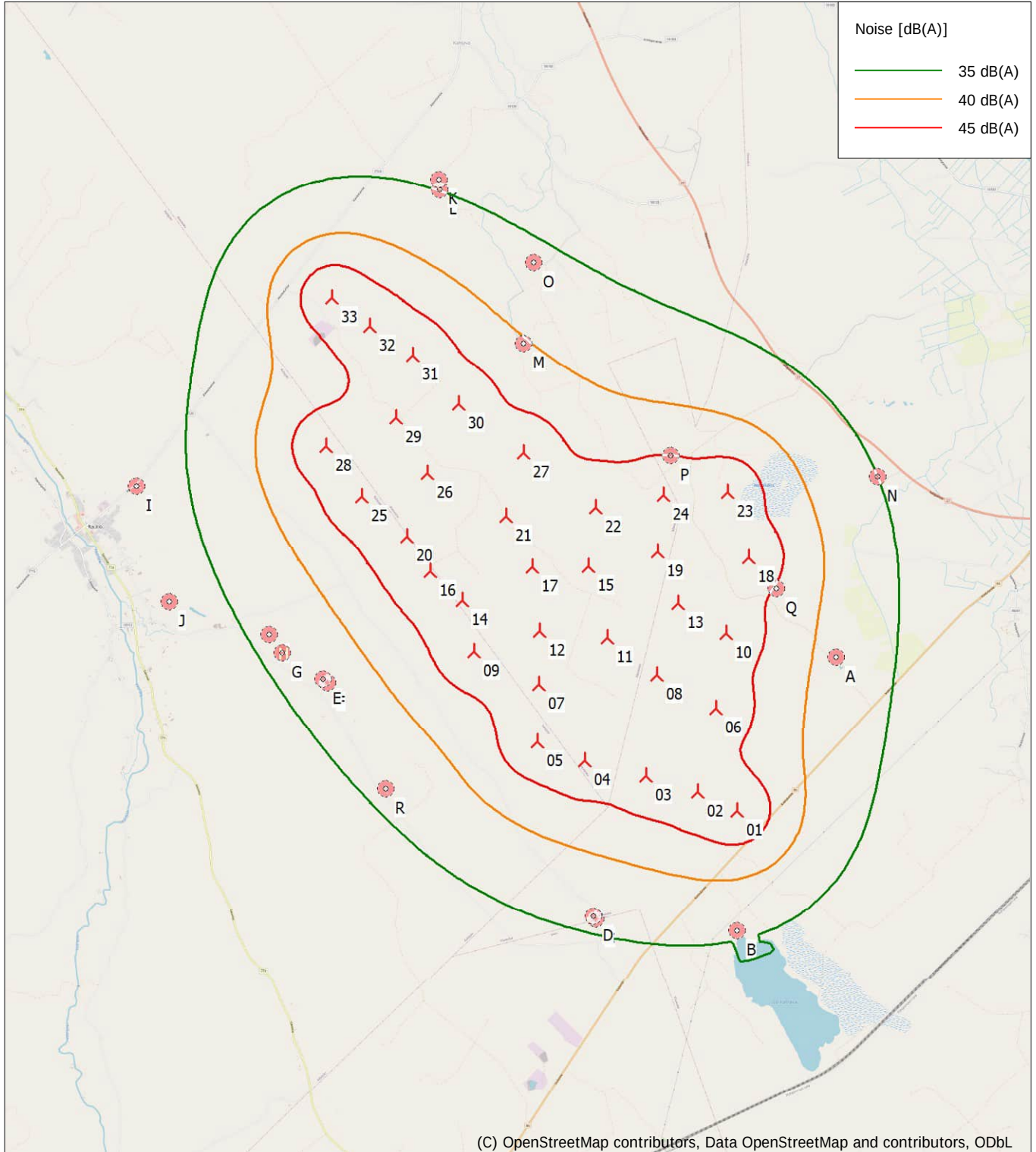
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB



0 1 2 3 4 km

Map: EMD OpenStreetMap , Print scale 1:75 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 369 673 North: 7 107 690
New WTG Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: 8,0 m/s
Height above sea level from active line object

11.10.2023

Liite 4. Verkasalon tuulivoimahanke - Melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 (VE2) N175 – 6.8 MW. Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 10.57/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

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

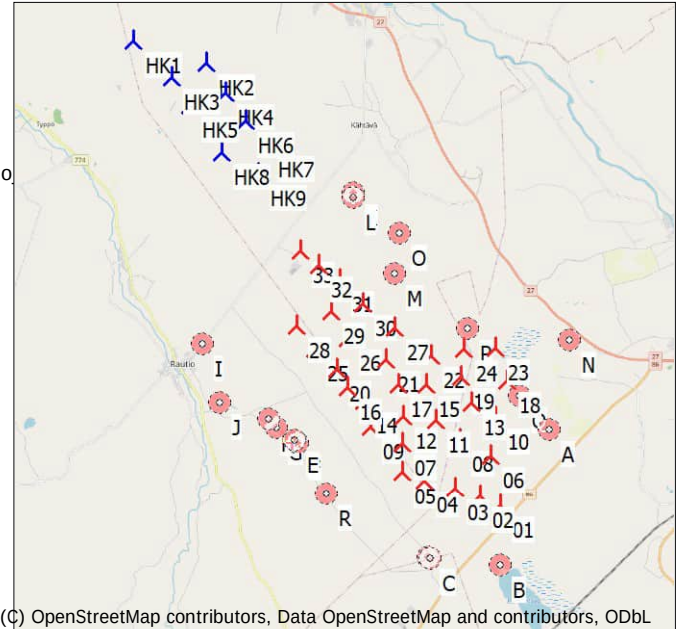
Uncertainty margin:

0,0 dB; Uncertainty margin in NSA has priority

Deviation from "official" noise demands. Negative is more

restrictive, positive is less restrictive.:

0,0 dB(A)



All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	Lwa_ref [dB(A)]
					Valid	Manufact.				Creator	Name		
01	372 136	7 104 203	80,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
02	371 622	7 104 479	80,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
03	370 957	7 104 711	79,4	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
04	370 157	7 104 947	72,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
05	369 541	7 105 227	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
06	371 914	7 105 569	73,3	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
07	369 591	7 105 980	71,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
08	371 150	7 106 037	77,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
09	368 764	7 106 453	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
10	372 083	7 106 541	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
11	370 521	7 106 556	73,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
12	369 636	7 106 678	75,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
13	371 464	7 106 967	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
14	368 628	7 107 123	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
15	370 306	7 107 506	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
16	368 227	7 107 519	68,6	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
17	369 568	7 107 523	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
18	372 422	7 107 527	67,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
19	371 227	7 107 652	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
20	367 939	7 108 000	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
21	369 253	7 108 202	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
22	370 442	7 108 273	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
23	372 176	7 108 397	63,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
24	371 335	7 108 402	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
25	367 367	7 108 547	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
26	368 250	7 108 818	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
27	369 525	7 109 029	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
28	366 924	7 109 225	67,2	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
29	367 862	7 109 559	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
30	368 702	7 109 705	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
31	368 126	7 110 369	63,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
32	367 574	7 110 777	62,8	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
33	367 096	7 111 177	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
HK1	362 925	7 116 909	50,0	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK2	364 851	7 116 247	55,0	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK3	363 880	7 115 898	53,1	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK4	365 316	7 115 435	55,6	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK5	364 350	7 115 141	55,0	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK6	365 790	7 114 681	57,5	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK7	366 307	7 114 024	57,5	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK8	365 140	7 113 868	57,5	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8
HK9	366 091	7 113 264	57,5	VESTAS V150-4.0 8000 200...	Yes	VESTAS	V150-4.0-8 000	8 000	200,0	200,0	USER Vestas V150-4.0 RD200 HH200	8,0	109,8

Calculation Results

DECIBEL - Main Result

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height	Noise	Sound level	Distance to noise demand
				[m]	[m]	[dB(A)]	From WTGs [dB(A)]	[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	38,3	312
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	35,6	678
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	35,8	818
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	36,0	793
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	37,1	622
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	37,2	600
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	36,1	857
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	36,0	867
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	32,6	1 596
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	32,7	1 739
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	4,0	40,0	34,9	1 020
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	4,0	40,0	35,4	901
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	40,4	-77
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	35,0	938
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	36,2	823
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	45,0	-672
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	44,6	-598
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	36,0	880

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
01	2400	1578	2346	2351	5723	5648	6335	6590	8989	7962	9180	9052	6764	4767	7698	4754	2965	4642
02	2537	1905	2146	2140	5146	5073	5757	6010	8407	7382	8734	8604	6325	4772	7288	4433	2860	4109
03	2944	2361	1994	1972	4442	4368	5052	5306	7718	6679	8301	8168	5916	4978	6917	4227	2998	3438
04	3574	3004	2085	2048	3609	3535	4222	4479	6919	5850	7876	7741	5547	5368	6589	4170	3385	2651
05	4085	3624	2457	2414	2935	2862	3546	3802	6253	5174	7498	7361	5237	5676	6300	4151	3732	2093
06	1710	2946	3197	3184	5189	5123	5751	5966	8167	7327	7843	7717	5425	3710	6334	3371	1754	4483
07	3930	4168	3178	3137	2838	2775	3392	3609	5897	4974	6759	6622	4483	5232	5545	3473	3370	2443
08	2369	3532	3311	3285	4393	4332	4932	5133	7282	6482	7110	6980	4698	3904	5661	2888	1936	3875
09	4760	5054	3871	3825	2027	1975	2522	2712	4945	4061	6211	6073	4091	5783	5166	3644	4057	2162
10	1481	3915	4128	4110	5338	5282	5840	6016	7995	7334	7059	6938	4656	2870	5500	2449	884	4927
11	3021	4222	3706	3673	3782	3728	4277	4454	6507	5779	6410	6278	4020	4140	5026	2533	2314	3537
12	3913	4724	3858	3818	2924	2874	3396	3566	5638	4887	6078	5942	3786	4889	4847	2880	3161	2908
13	2203	4382	4292	4266	4774	4723	5239	5395	7284	6686	6389	6265	3974	3115	4866	1941	1312	4558
14	4980	5660	4545	4500	2102	2074	2458	2578	4537	3846	5538	5400	3471	5710	4541	3345	4141	2679
15	3478	5187	4644	4609	3793	3756	4178	4294	6031	5526	5440	5309	3046	3991	4055	1815	2497	3965
16	5459	6218	5061	5015	1999	1992	2216	2276	4023	3452	5153	5016	3238	6022	4285	3516	4561	2921
17	4175	5497	4705	4665	3122	3091	3470	3572	5309	4790	5234	5098	2940	4704	4004	2343	3229	3501
18	1745	4914	5162	5143	5826	5780	6259	6393	8108	7642	6421	6309	4090	2005	4806	1685	551	5668
19	2728	5095	4897	4868	4711	4670	5109	5227	6908	6454	5672	5549	3261	3063	4142	1277	1638	4750
20	5871	6775	5618	5572	2185	2197	2244	2227	3614	3239	4702	4566	2956	6249	3962	3633	4913	3342
21	4724	6245	5425	5384	3222	3209	3443	3482	4874	4565	4511	4374	2284	4924	3358	2315	3685	3921
22	3726	5876	5416	5381	4246	4220	4546	4616	6049	5746	4772	4644	2355	3732	3322	1197	2606	4628
23	2602	5772	5873	5849	5860	5825	6220	6313	7771	7478	5587	5480	3322	1994	3955	883	1427	5956
24	3123	5822	5652	5623	5095	5064	5425	5505	6930	6648	5080	4963	2710	2834	3499	521	1938	5327
25	6594	7559	6356	6310	2462	2498	2309	2186	2962	2884	4284	4154	2923	6799	3814	4106	5593	3865
26	5895	7272	6269	6225	3046	3062	3043	2979	3834	3798	3856	3719	2112	5924	3095	3208	4835	4197
27	4911	6888	6204	6165	3984	3980	4125	4118	5113	5058	3757	3623	1435	4669	2505	1936	3774	4785
28	7267	8365	7161	7115	3067	3117	2779	2584	2541	2902	3808	3686	2926	7277	3645	4544	6220	4579
29	6594	8107	7096	7052	3571	3603	3434	3301	3526	3839	3181	3048	1937	6390	2727	3654	5489	4886
30	5974	7837	7007	6965	4041	4059	4016	3930	4378	4616	2959	2821	1156	5592	2100	2867	4830	5158
31	6834	8687	7790	7747	4423	4455	4276	4130	4024	4561	2334	2200	1452	6318	1995	3637	5679	5716
32	7521	9307	8343	8298	4687	4728	4451	4265	3721	4486	2128	2009	2025	6969	2303	4309	6365	6093
33	8144	9890	8879	8834	5026	5075	4725	4510	3576	4545	2088	1996	2579	7554	2679	4916	6987	6506
HK1	15085	16957	15824	15777	11410	11480	10897	10602	8236	9823	7061	7148	9261	14029	8696	11696	13897	13059
HK2	13292	15413	14418	14372	10264	10326	9816	9540	7451	9984	5163	5262	7468	12105	6808	9874	12099	11866
HK3	13695	15593	14491	14445	10153	10220	9662	9373	7109	8682	5695	5777	7872	12661	7323	10308	12507	11789
HK4	12375	14478	13492	13446	9385	9445	8953	8683	6687	8189	4273	4366	6546	11234	5915	8961	11182	10973
HK5	12828	14702	13605	13559	9297	9362	8817	8532	6332	7890	4891	4965	7013	11842	6502	9453	11643	10926
HK6	11497	13590	12618	12573	8574	8633	8164	7901	6030	7485	3433	3519	5667	10400	5067	8089	10305	10144
HK7	10663	12770	11824	11780	7875	7931	7494	7243	5547	6930	2638	2715	4833	9597	4258	7259	9471	9417
HK8	11378	13204	12117	12071	7874	7938	7421	7144	5110	6614	3632	3684	5591	10493	5175	8031	10199	9486
HK9	10271	12200	11188	11142	7133	7191	6736	6479	4759	6141	2547	2587	4470	9367	4055	6911	9088	8697

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

WTG: VESTAS V150-4.0 8000 200.0 !O!

Noise: Vestas V150-4.0 RD200 HH200

Source Source/Date Creator Edited

Manufacturer 18.10.2017 USER 19.9.2023 10.42

Performance Specification 0067-7067 V05

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	109,8	No	83,5	90,3	95,7	99,7	102,5	103,8	103,7	102,3

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

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: Verkasalo_VE2_RD175x33xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

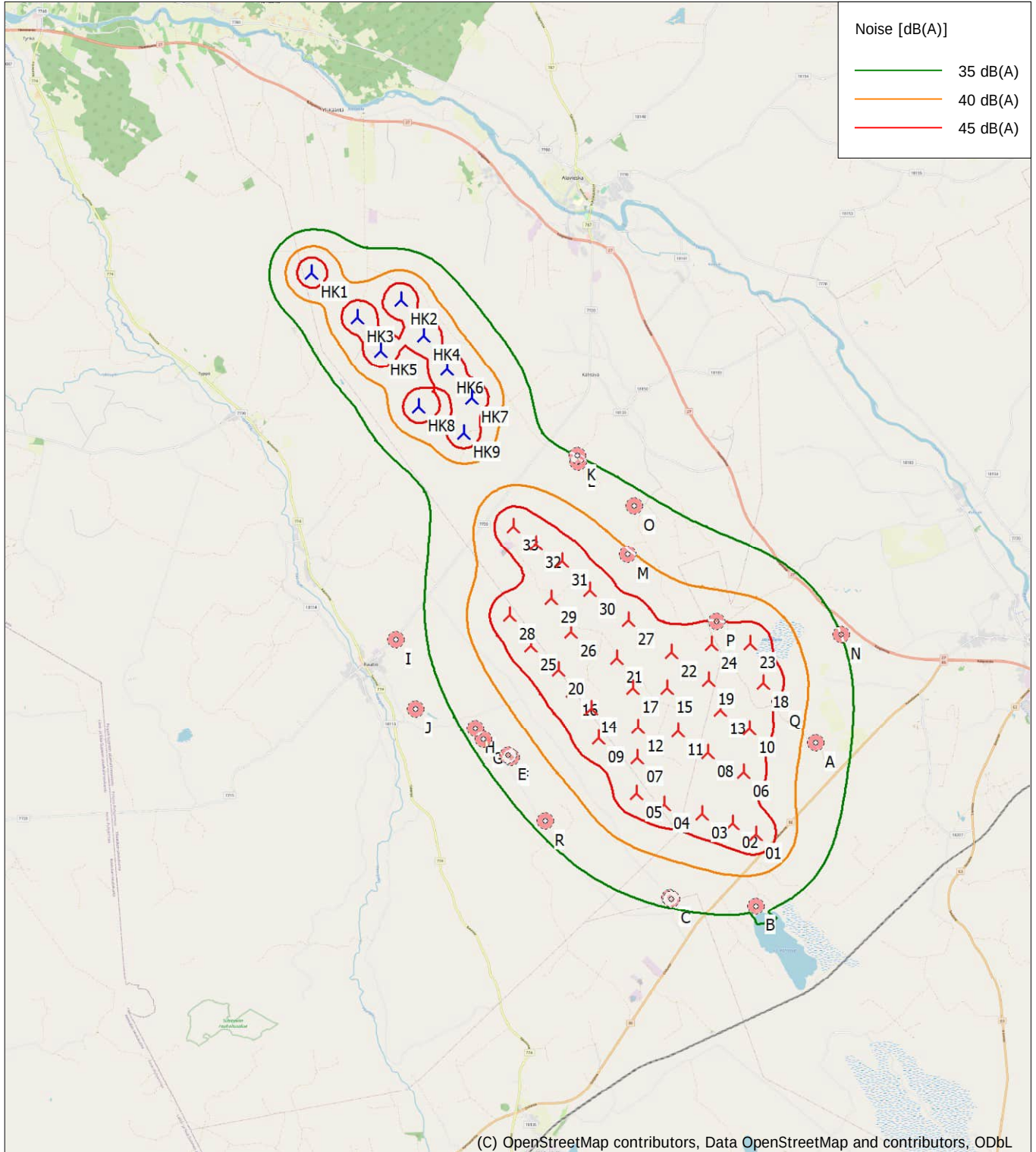
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE2_RD175x33xHH232,5_106.9dB+Hangaskurunkangas_RD200x9xHH200



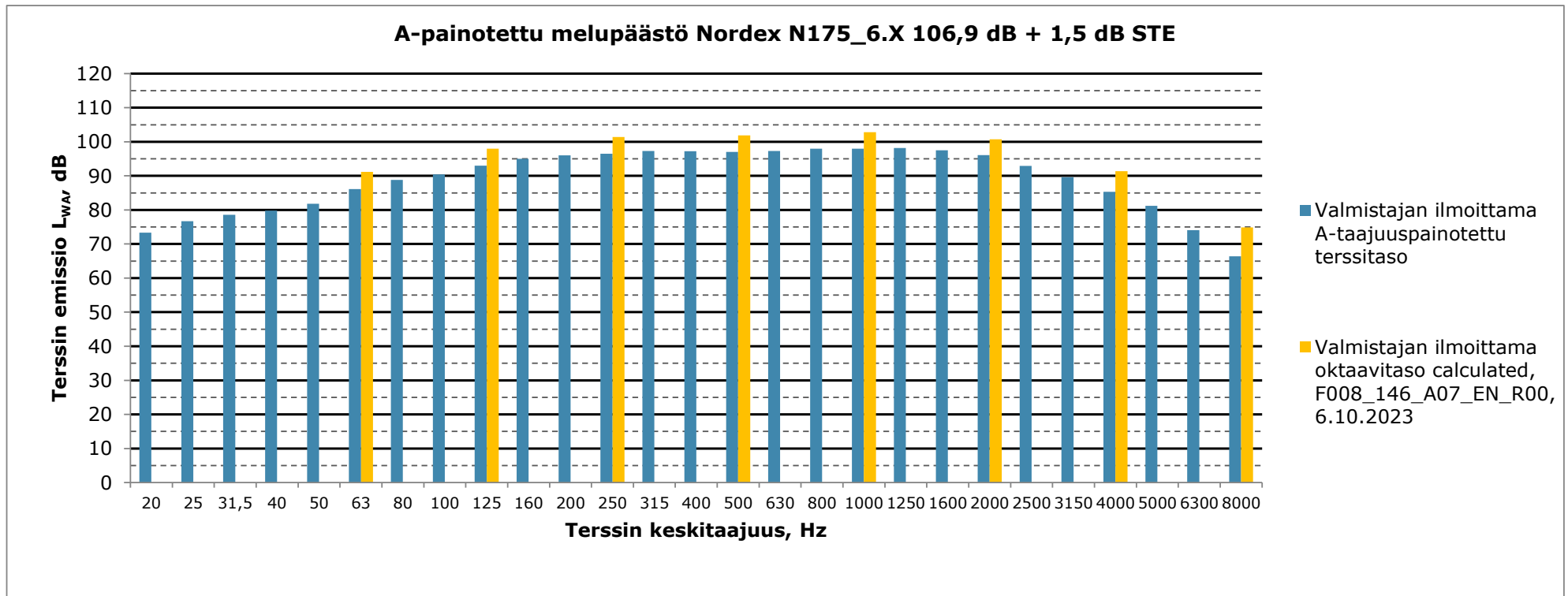
(C) OpenStreetMap contributors, Data OpenStreetMap and contributors, ODbL

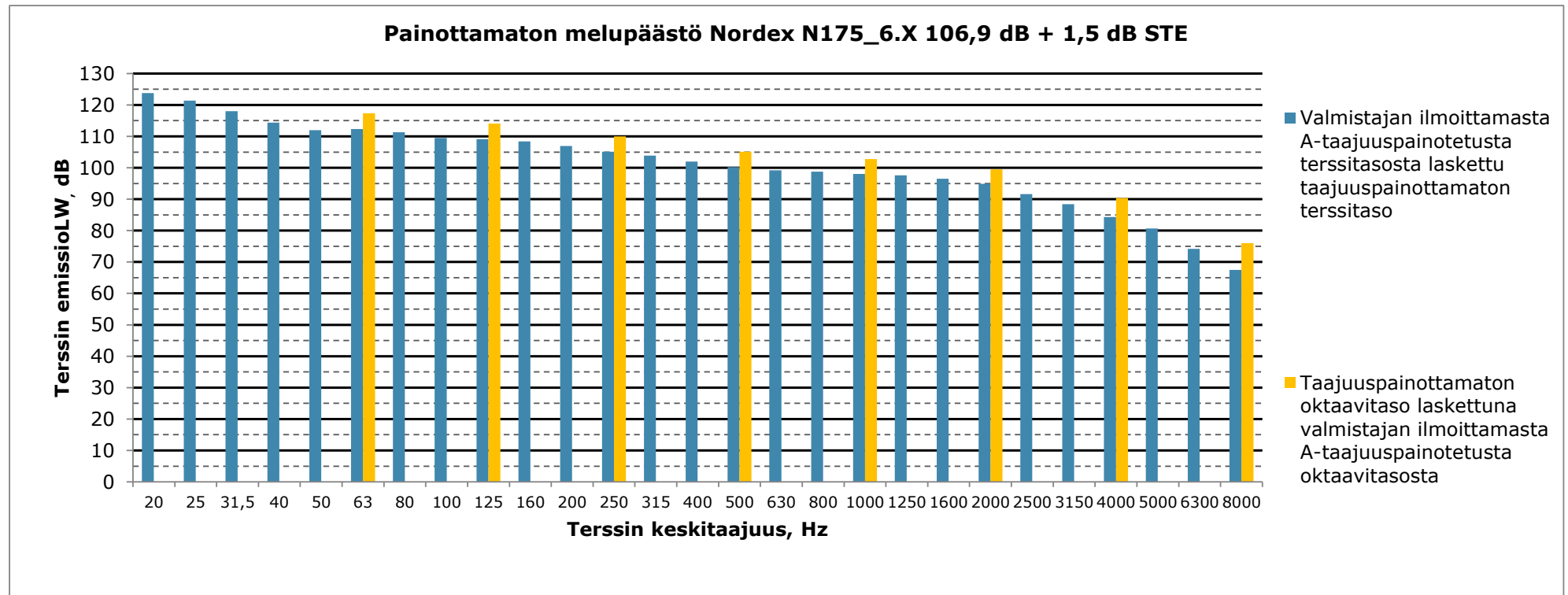
0 2,5 5 7,5 10km

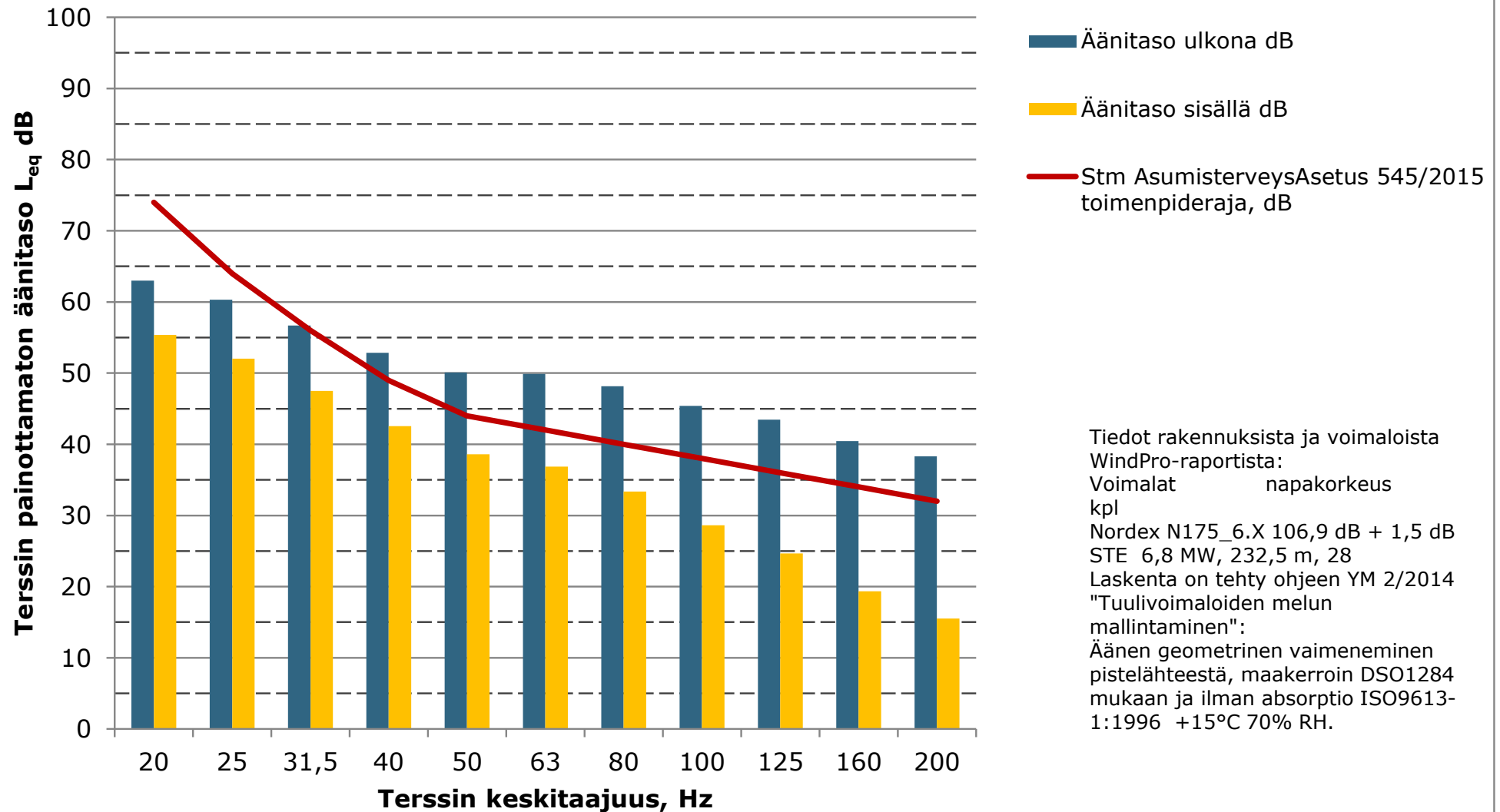
Map: EMD OpenStreetMap, Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 367 674 North: 7 110 556
 New WTG Noise sensitive area
 Noise calculation model: ISO 9613-2 General. Wind speed: 8,0 m/s
 Height above sea level from active line object

11.10.2023

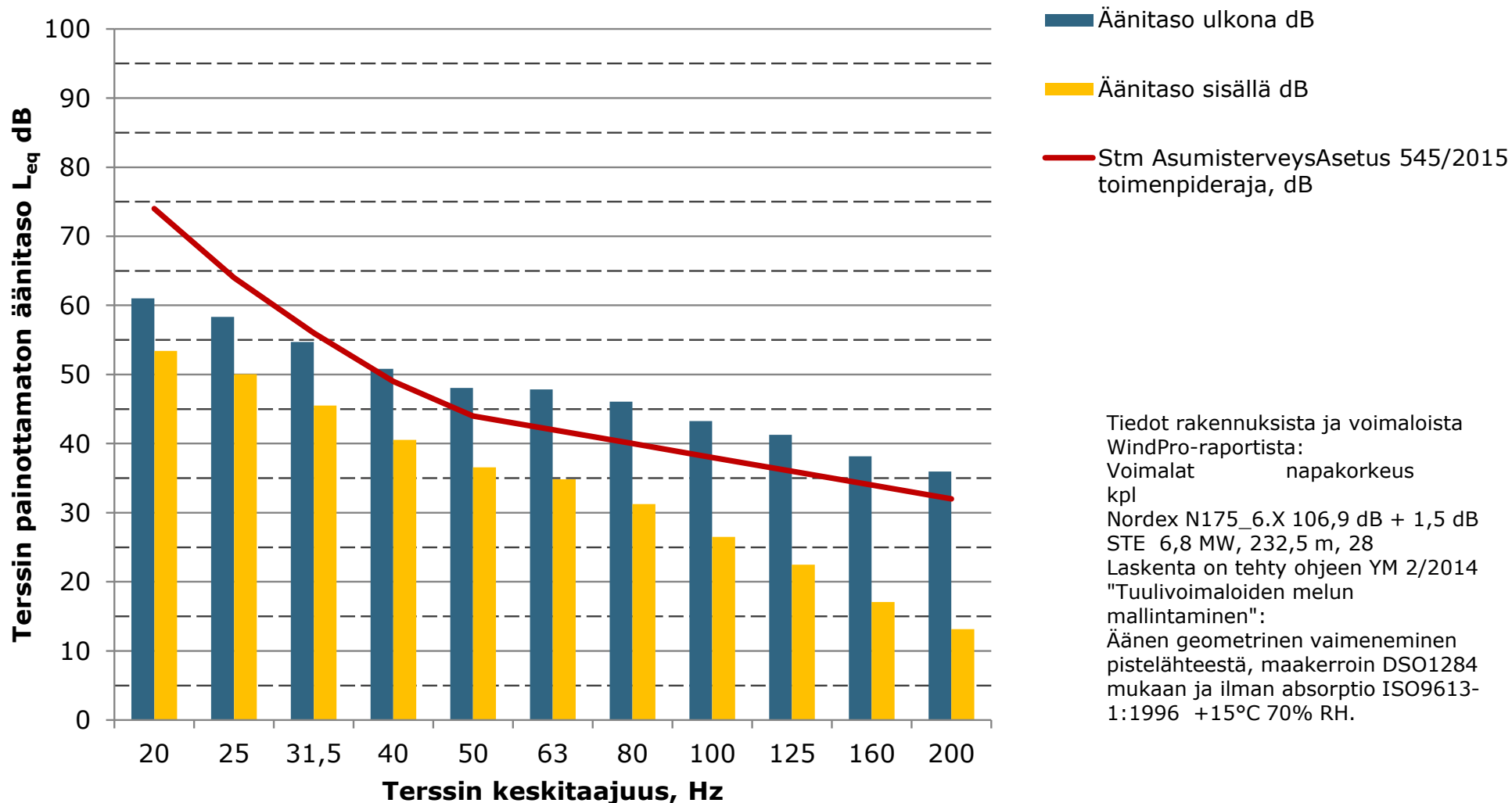
Liite 5. Verkasalon tuulivoimahanke – matalataajuisen melun rakennuskohtaiset arvot VE1 N175 - 6.8 MW.

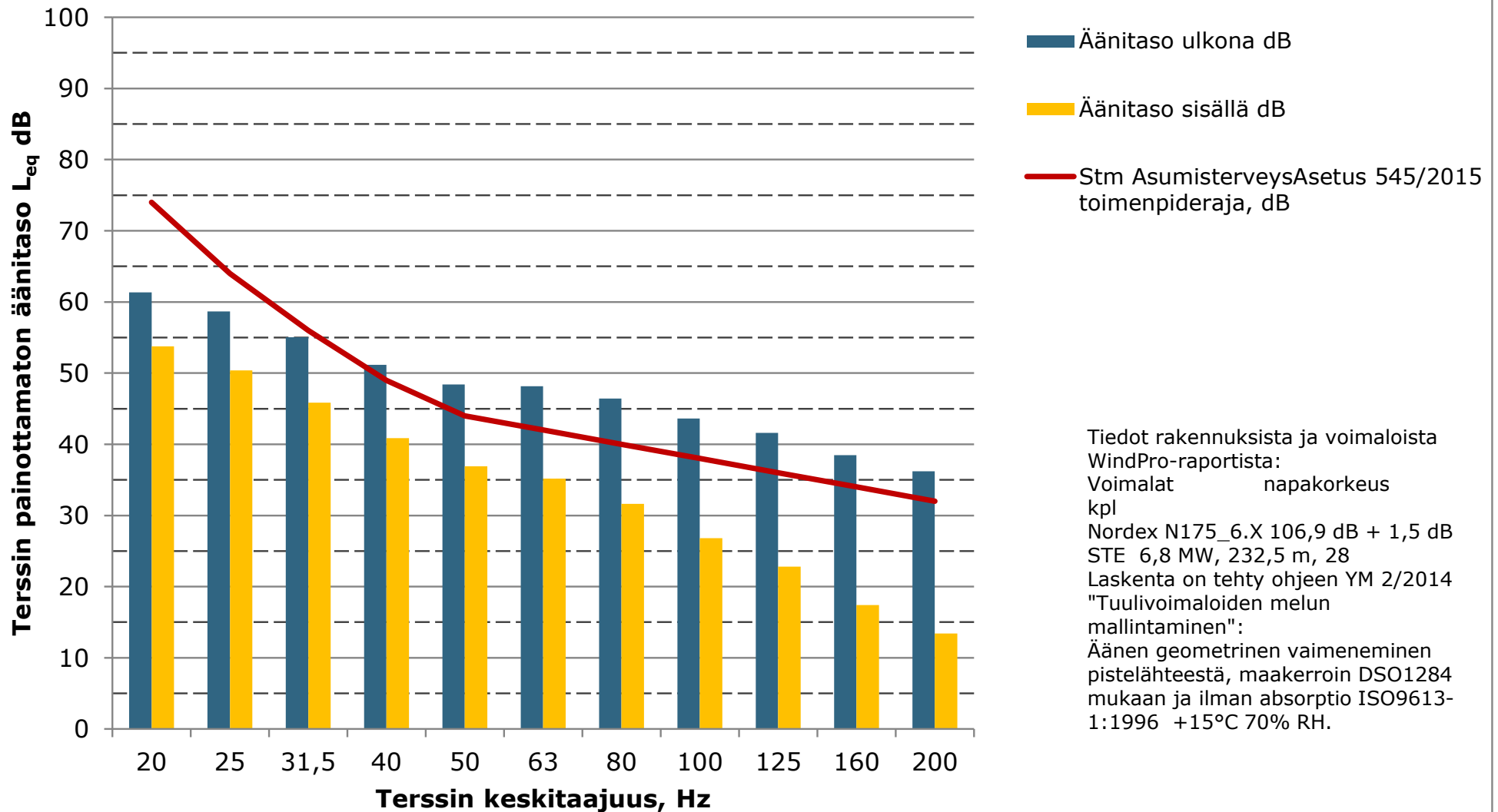


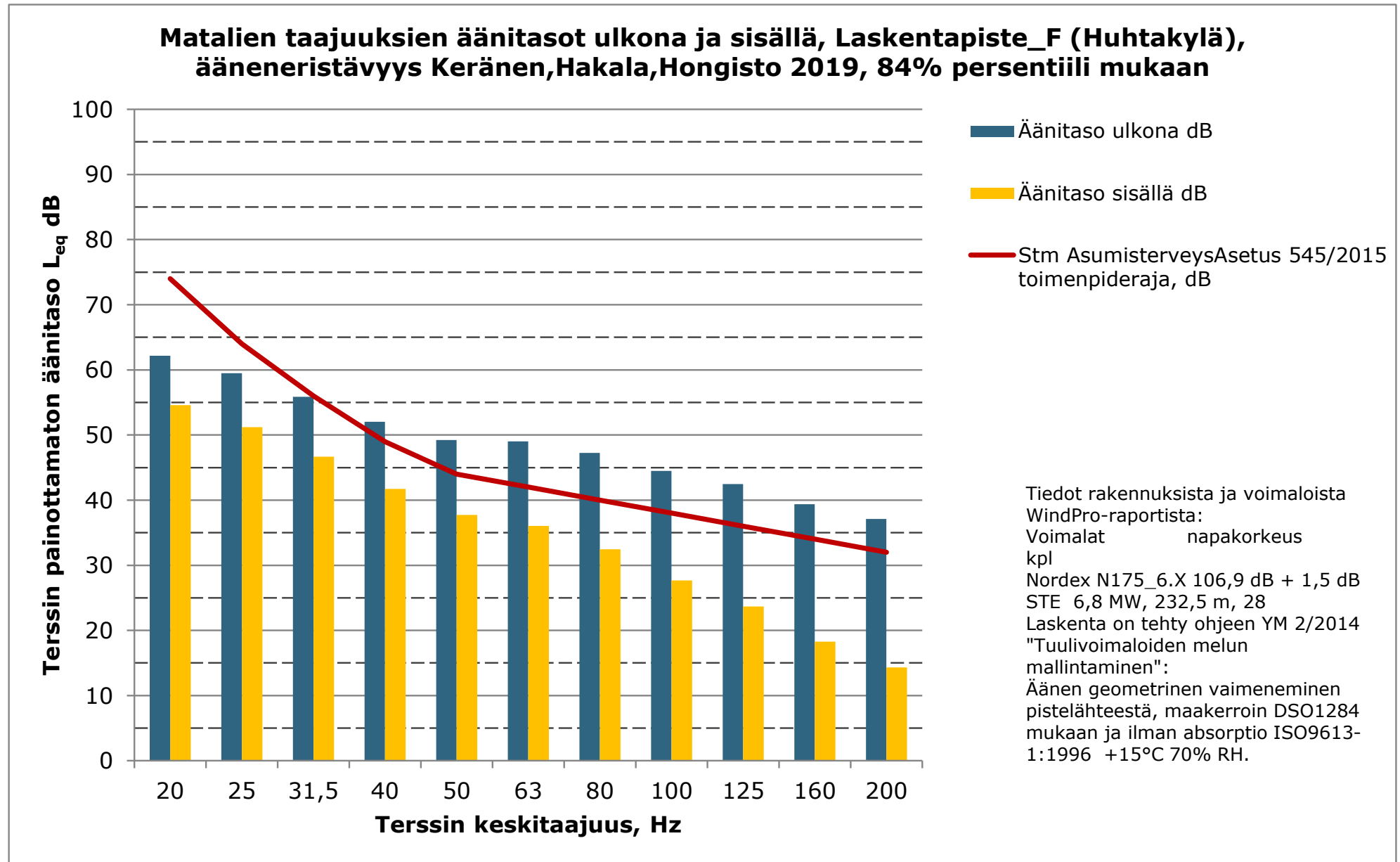


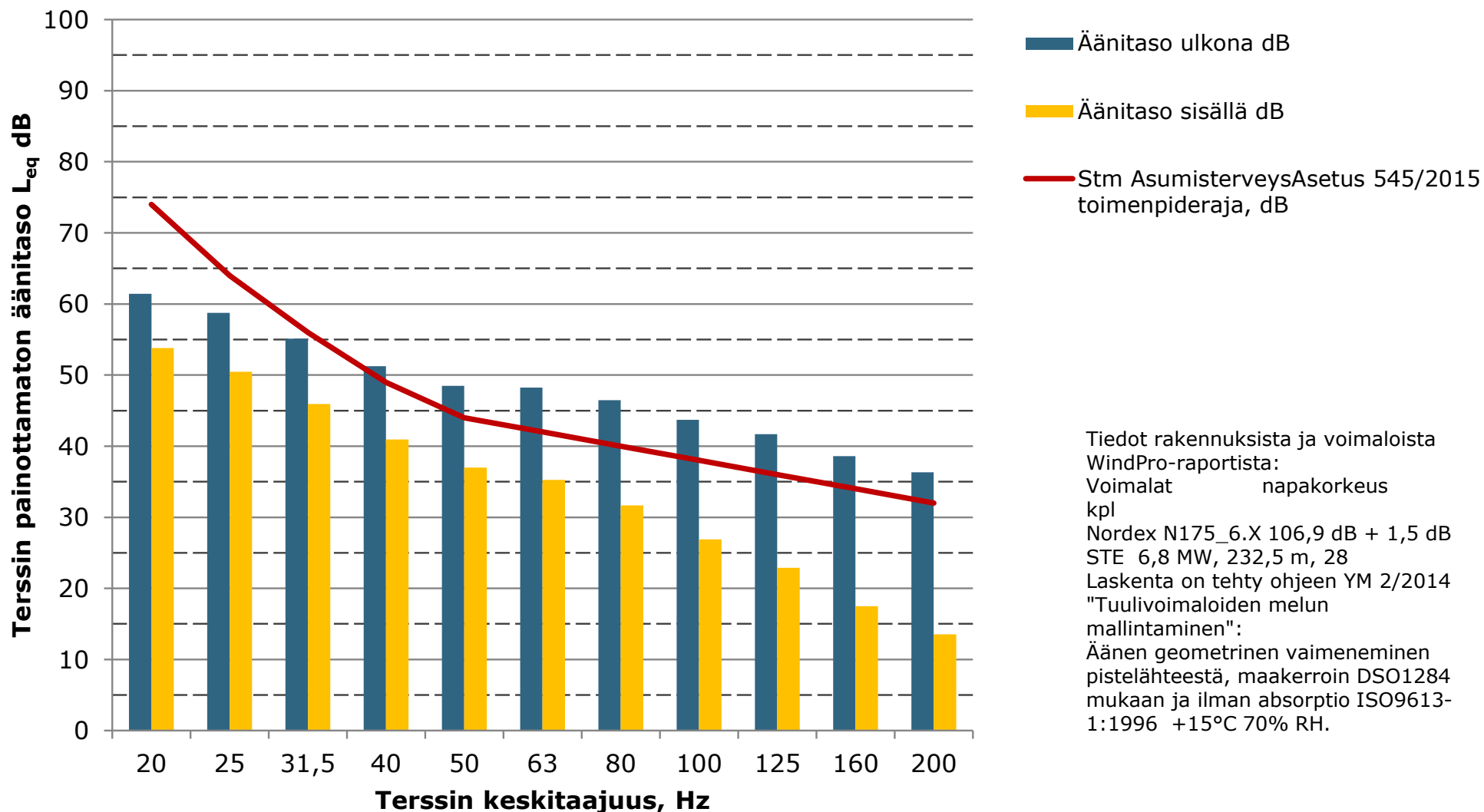
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

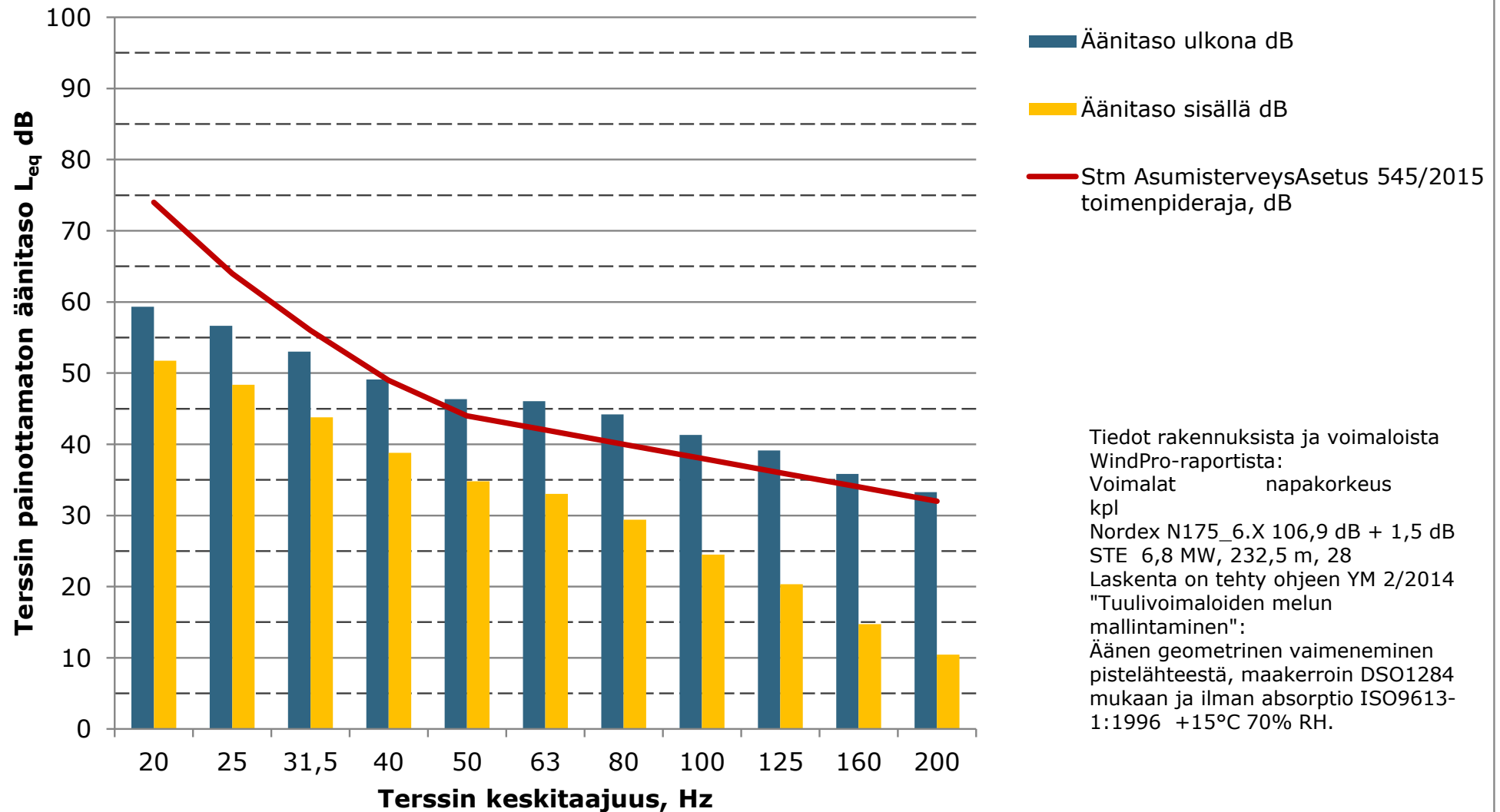


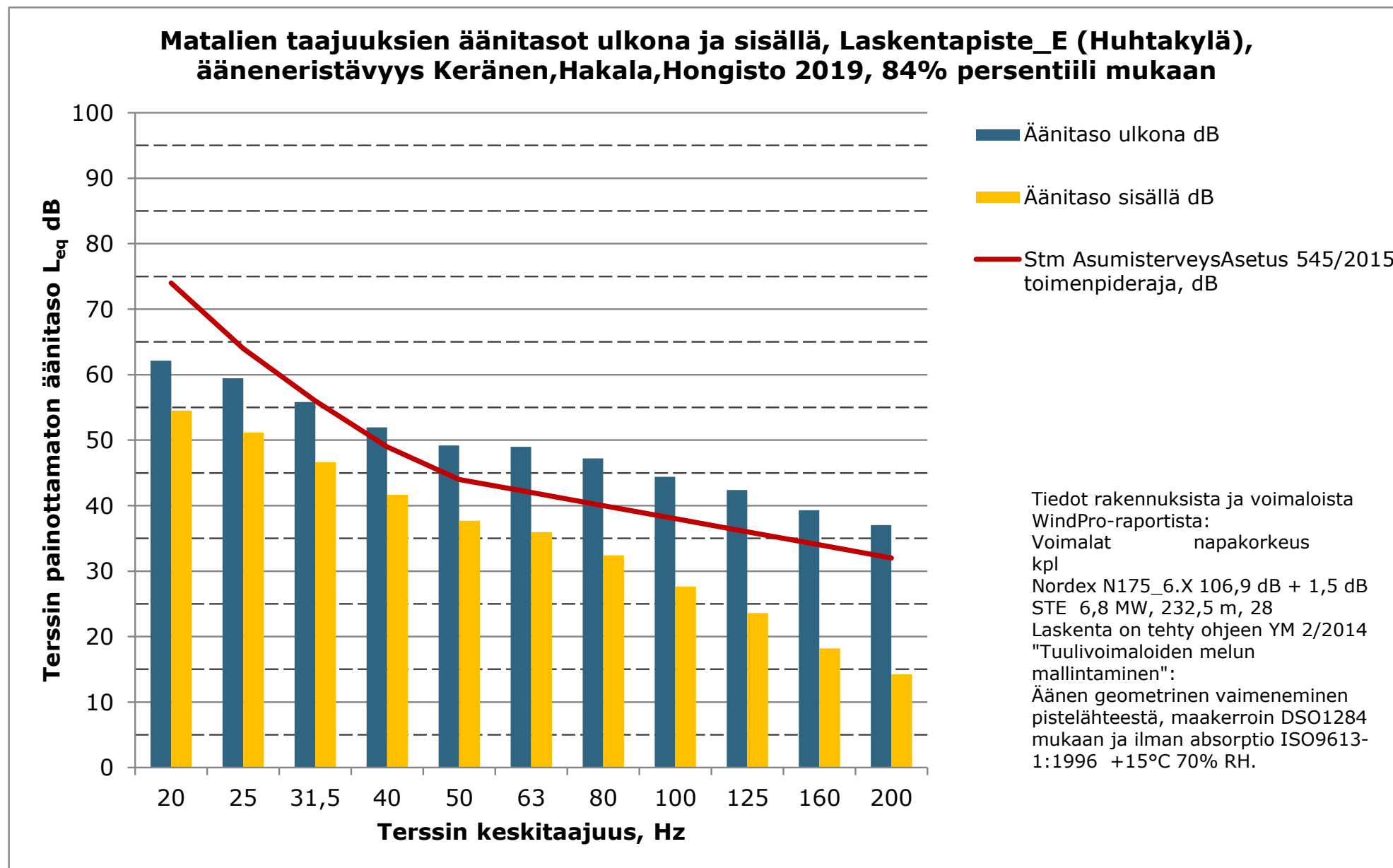
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



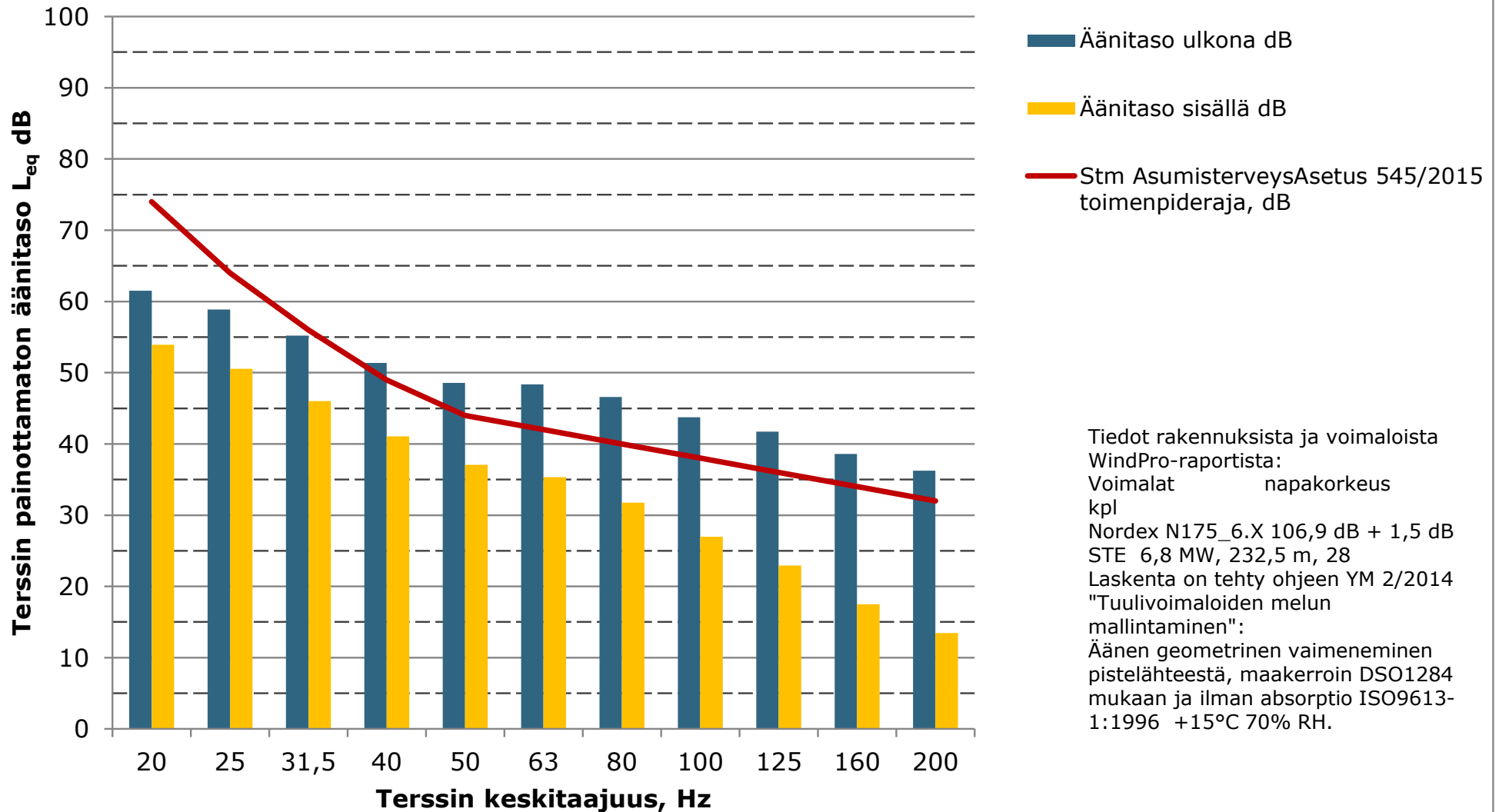
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

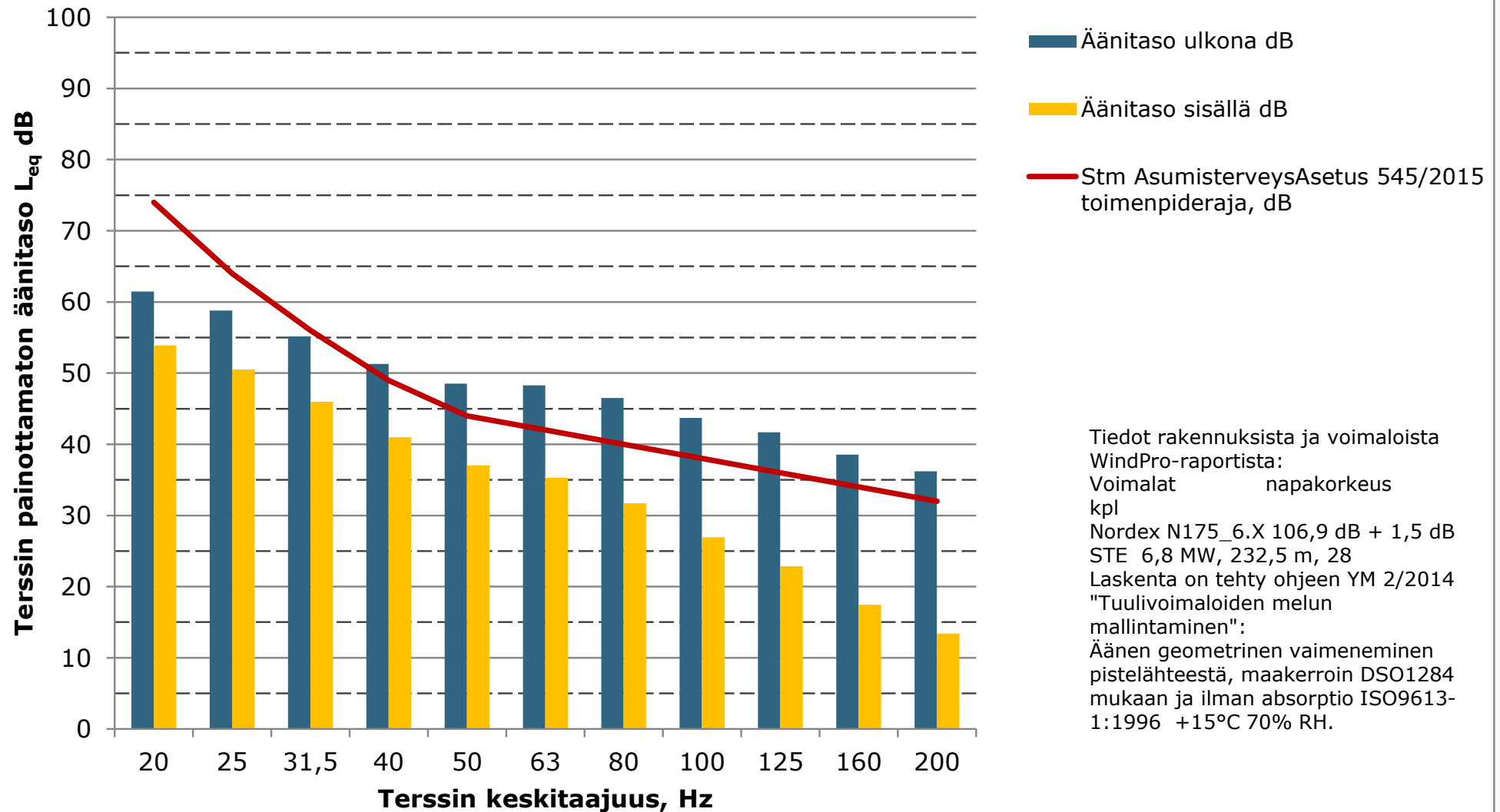




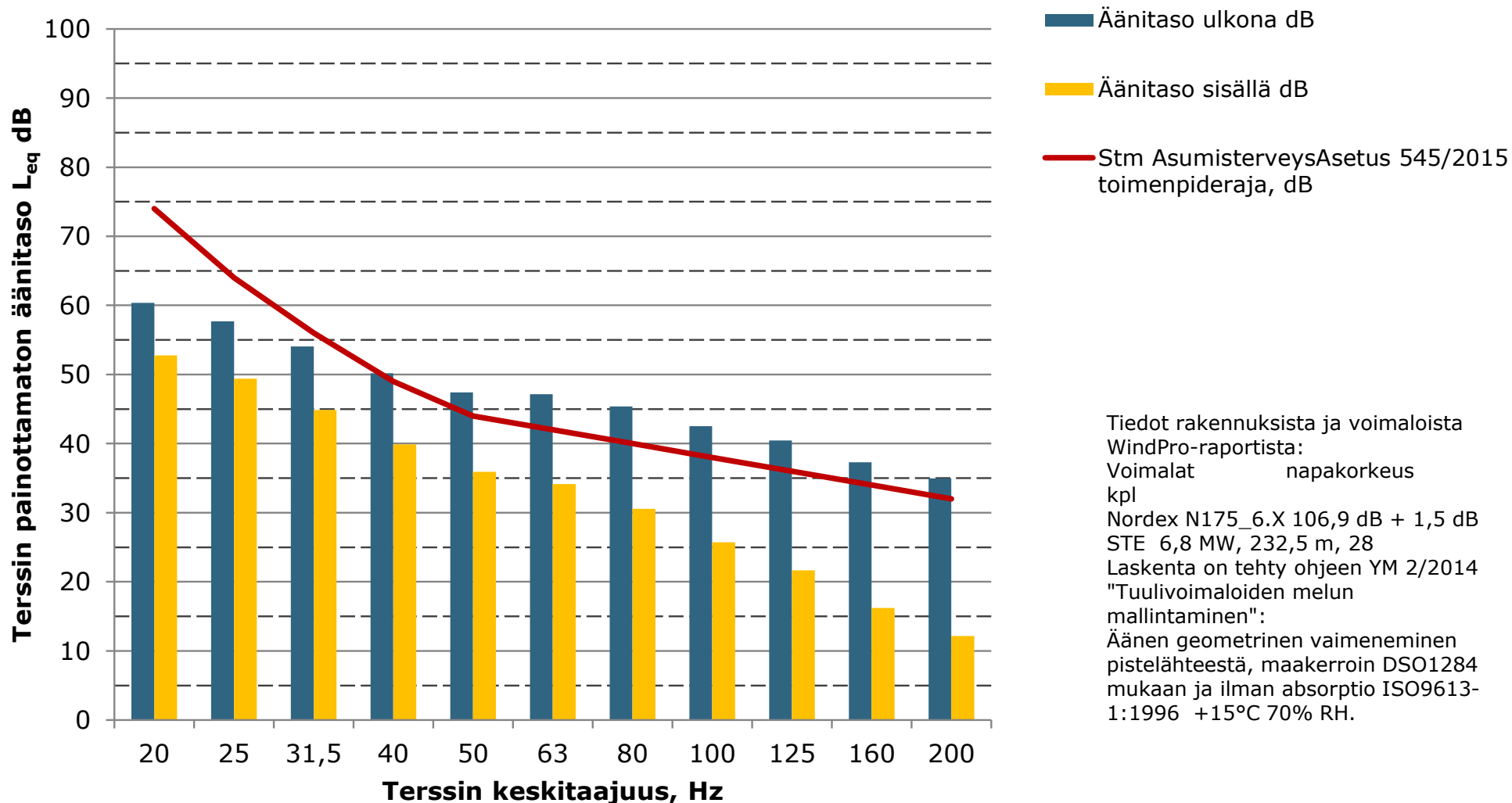
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



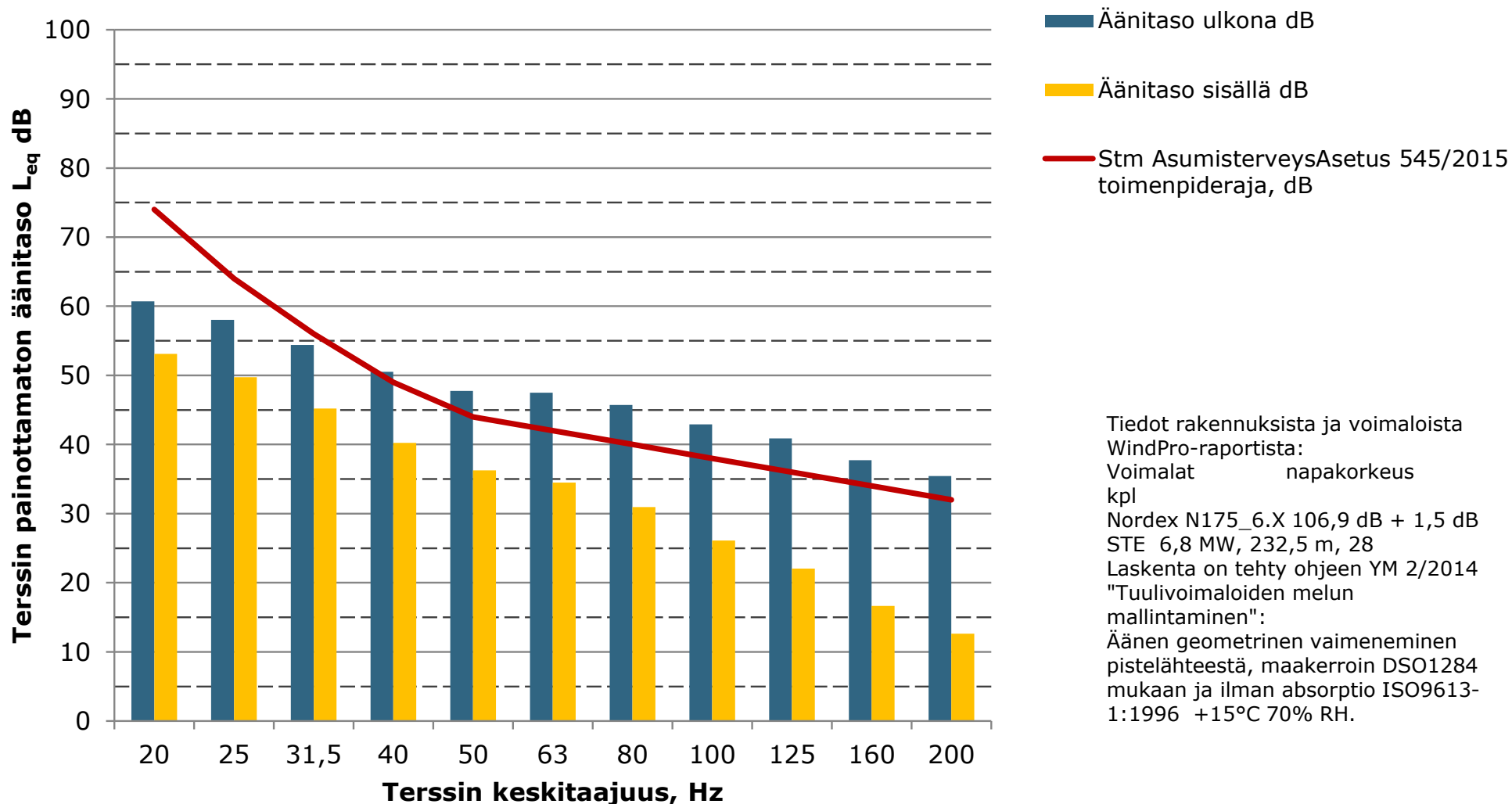
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_H (Karjaneva), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



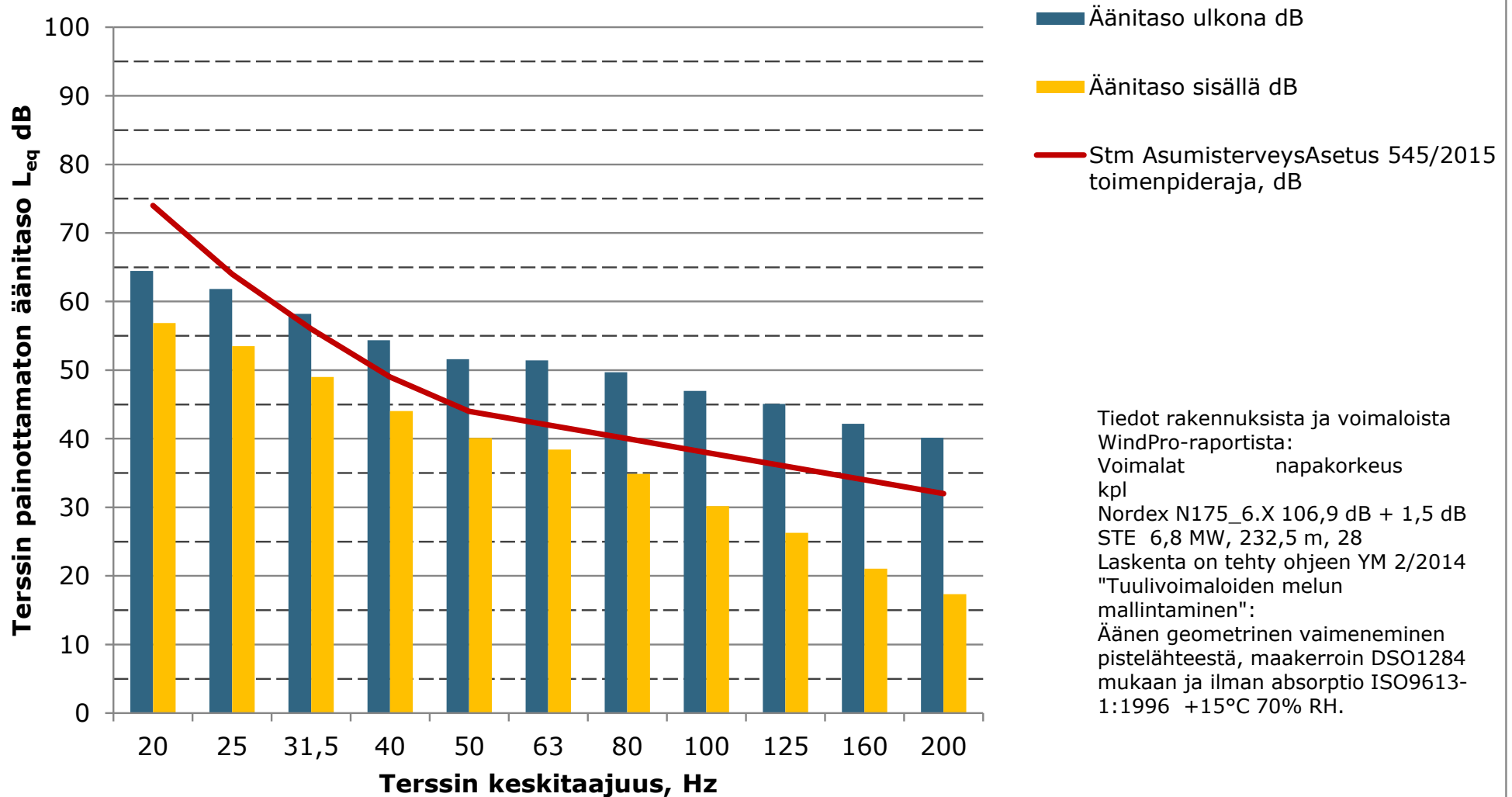
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



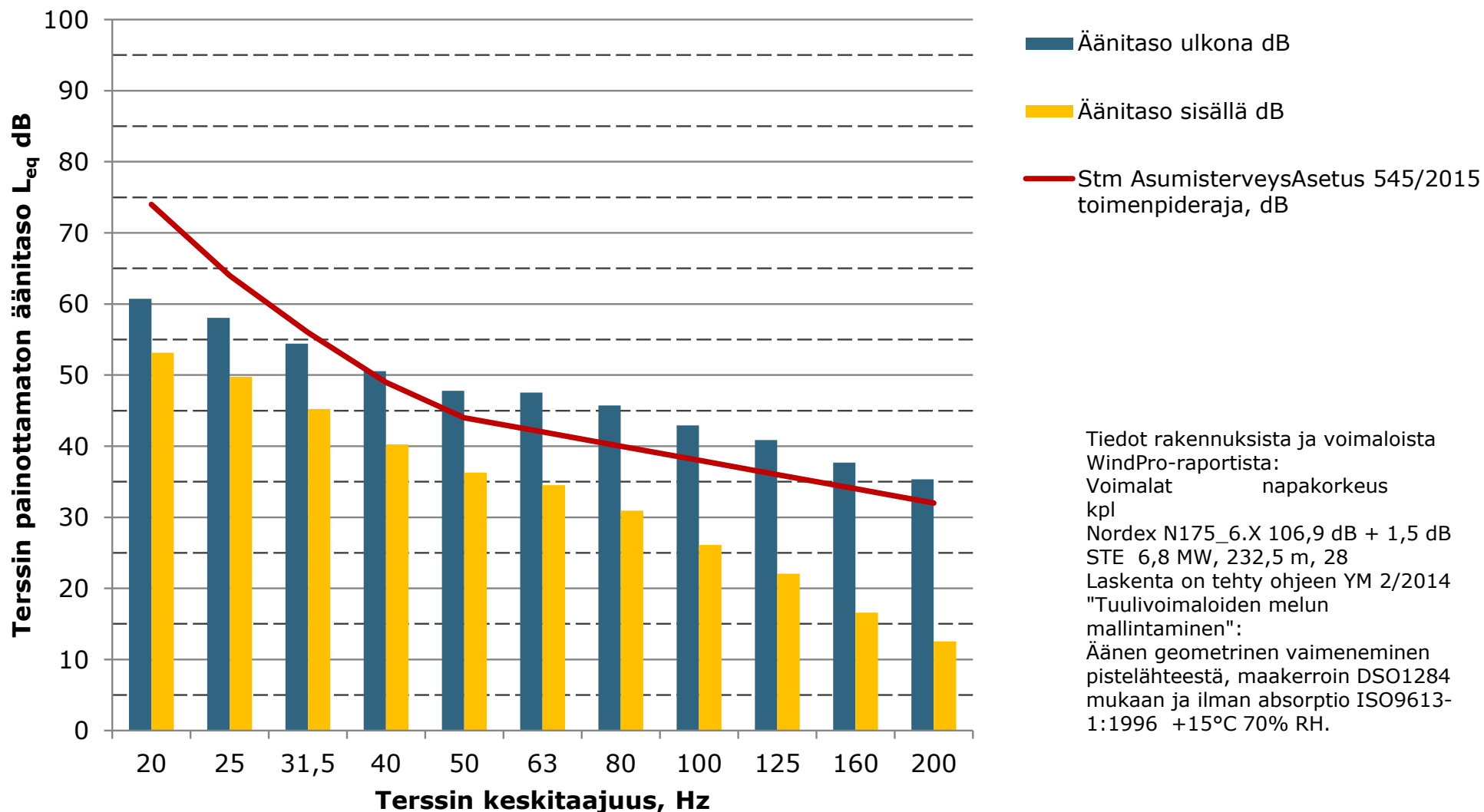
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



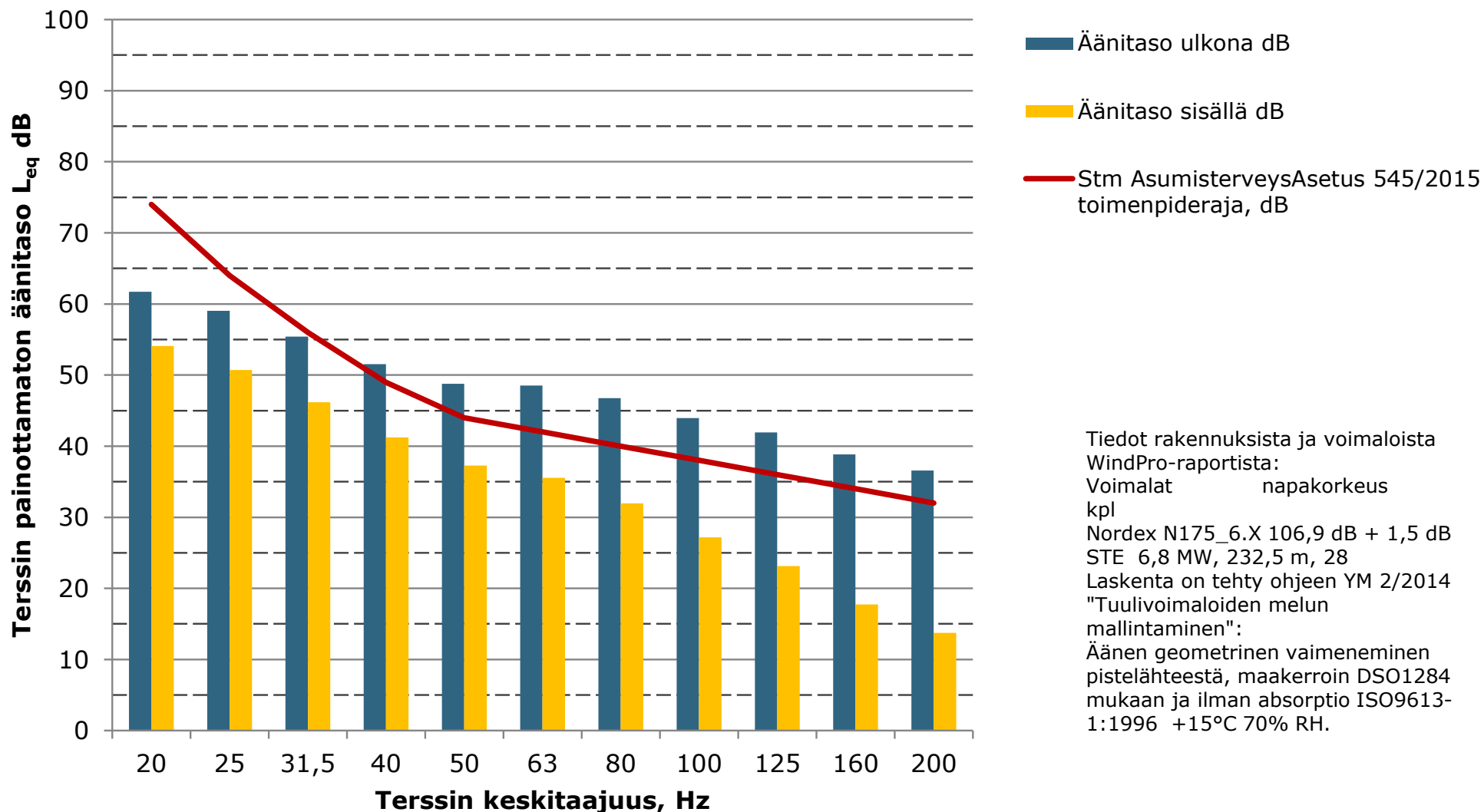
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

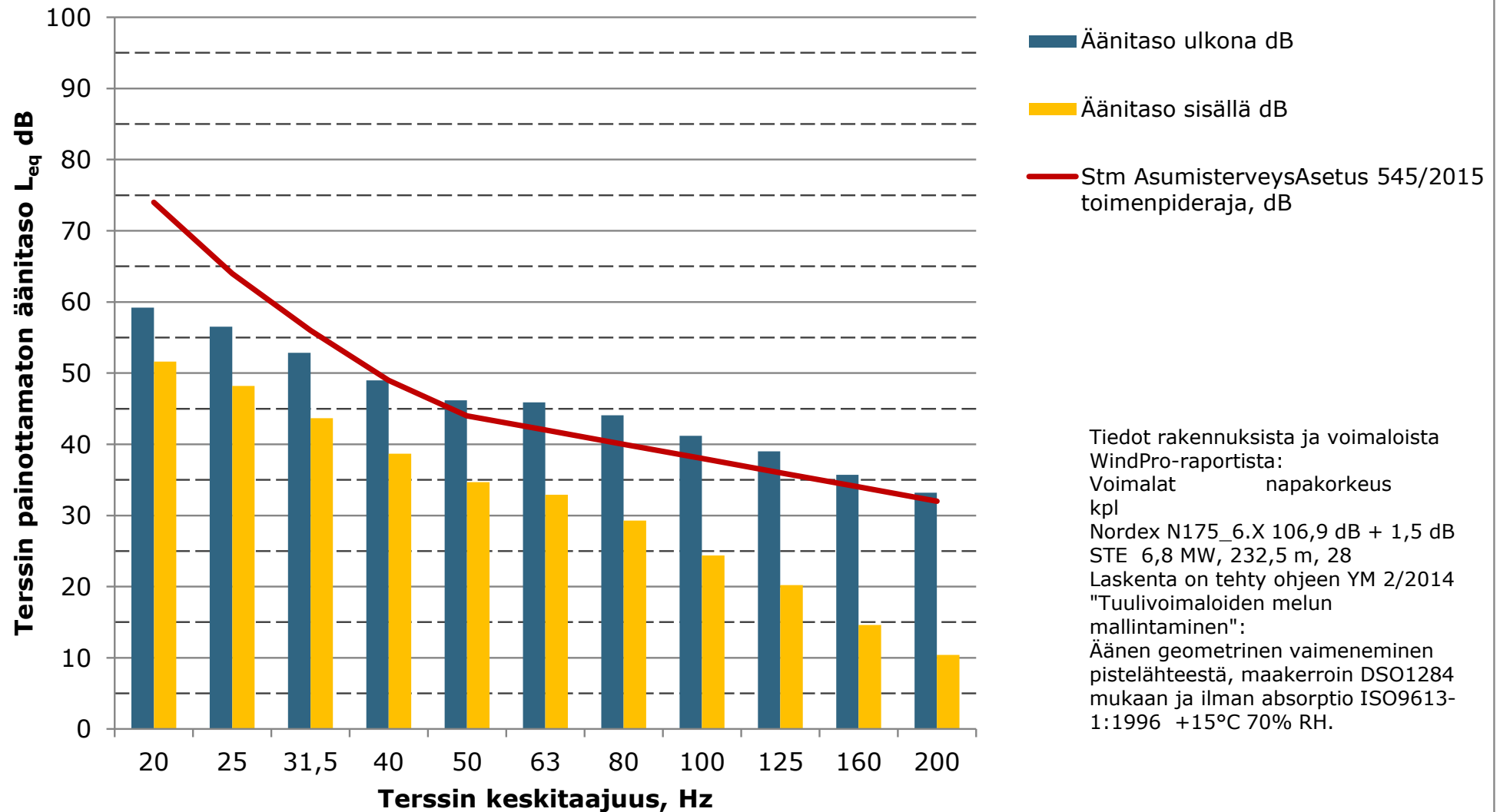


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

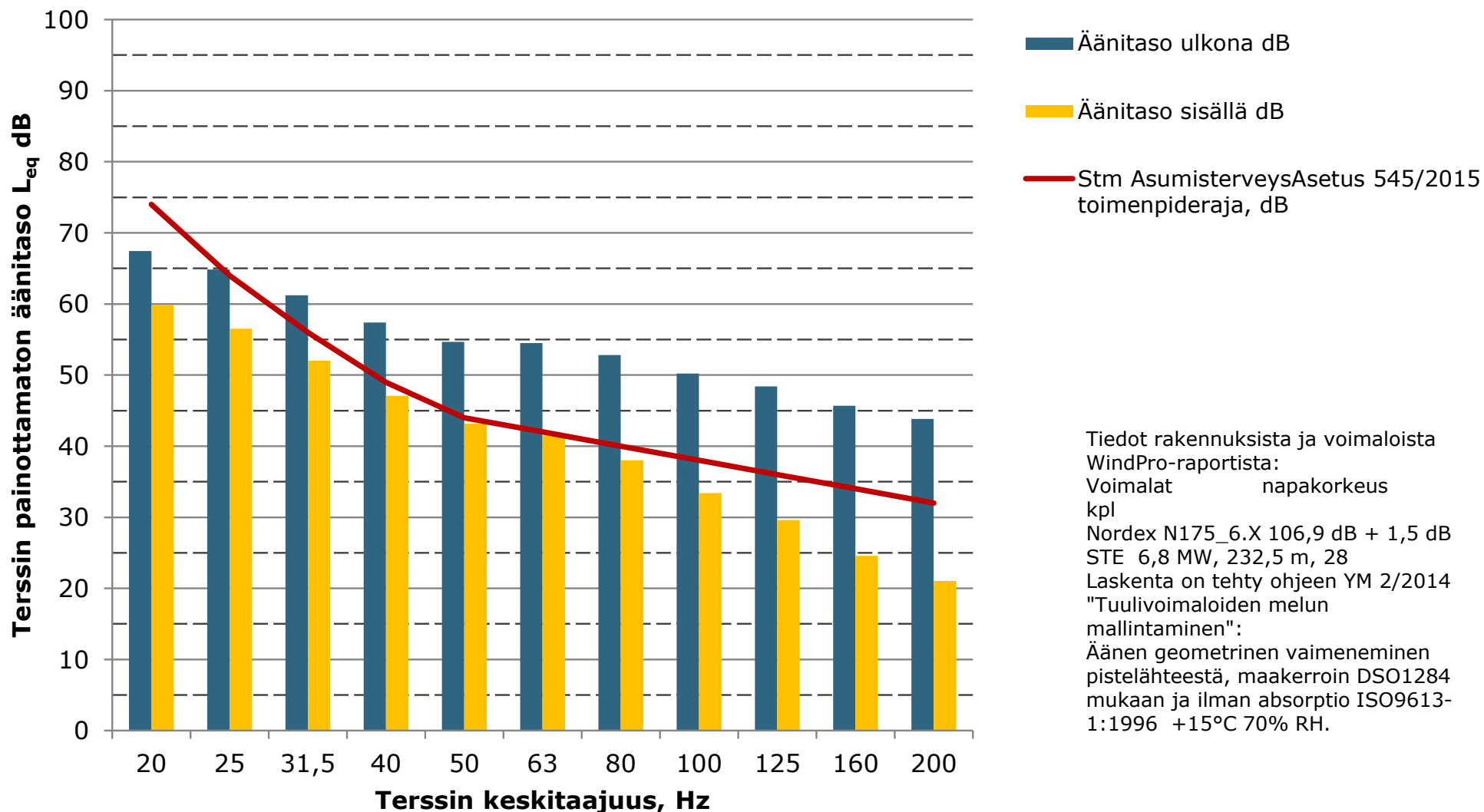


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_O (Nevaranta), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

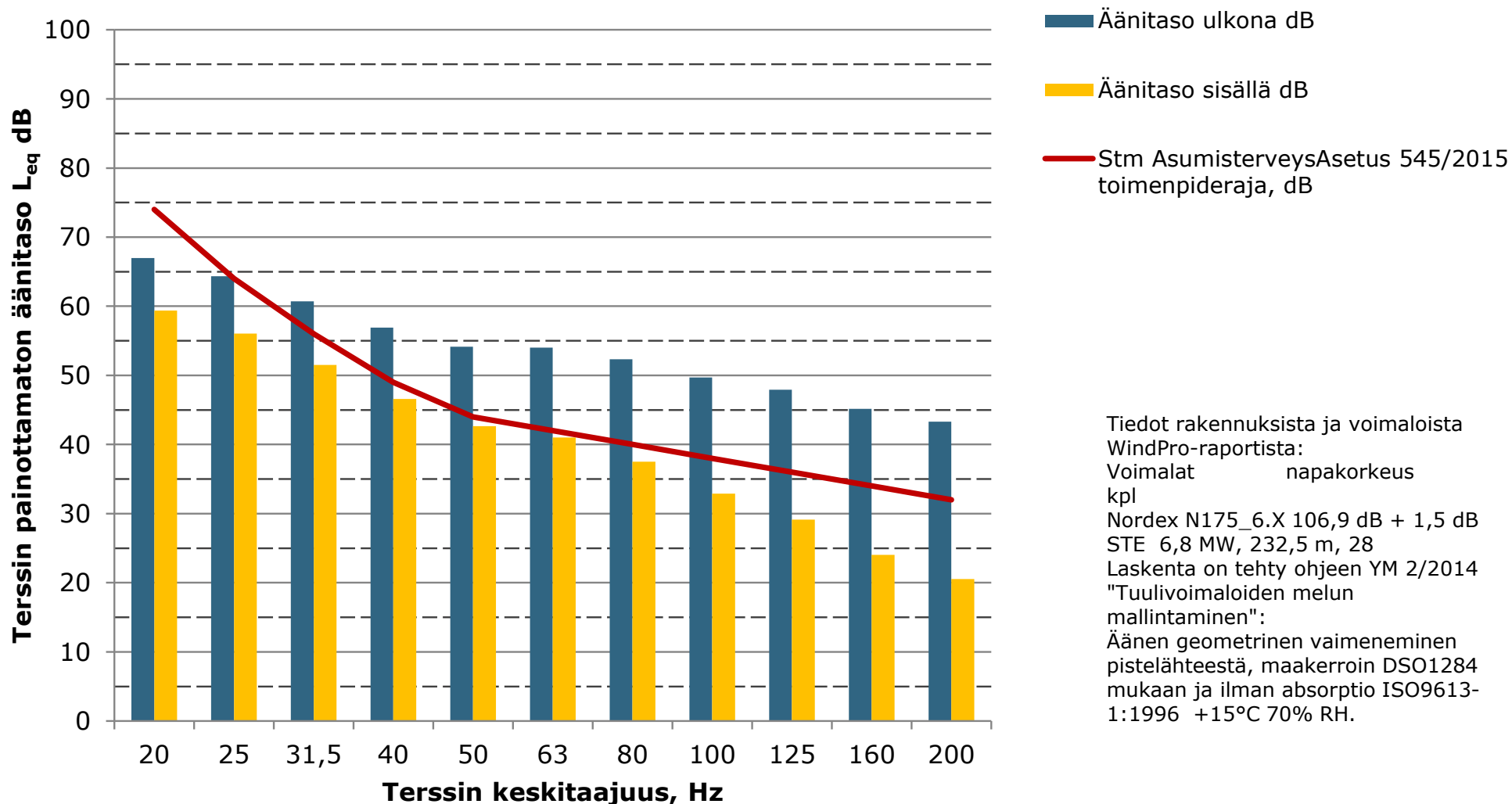


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

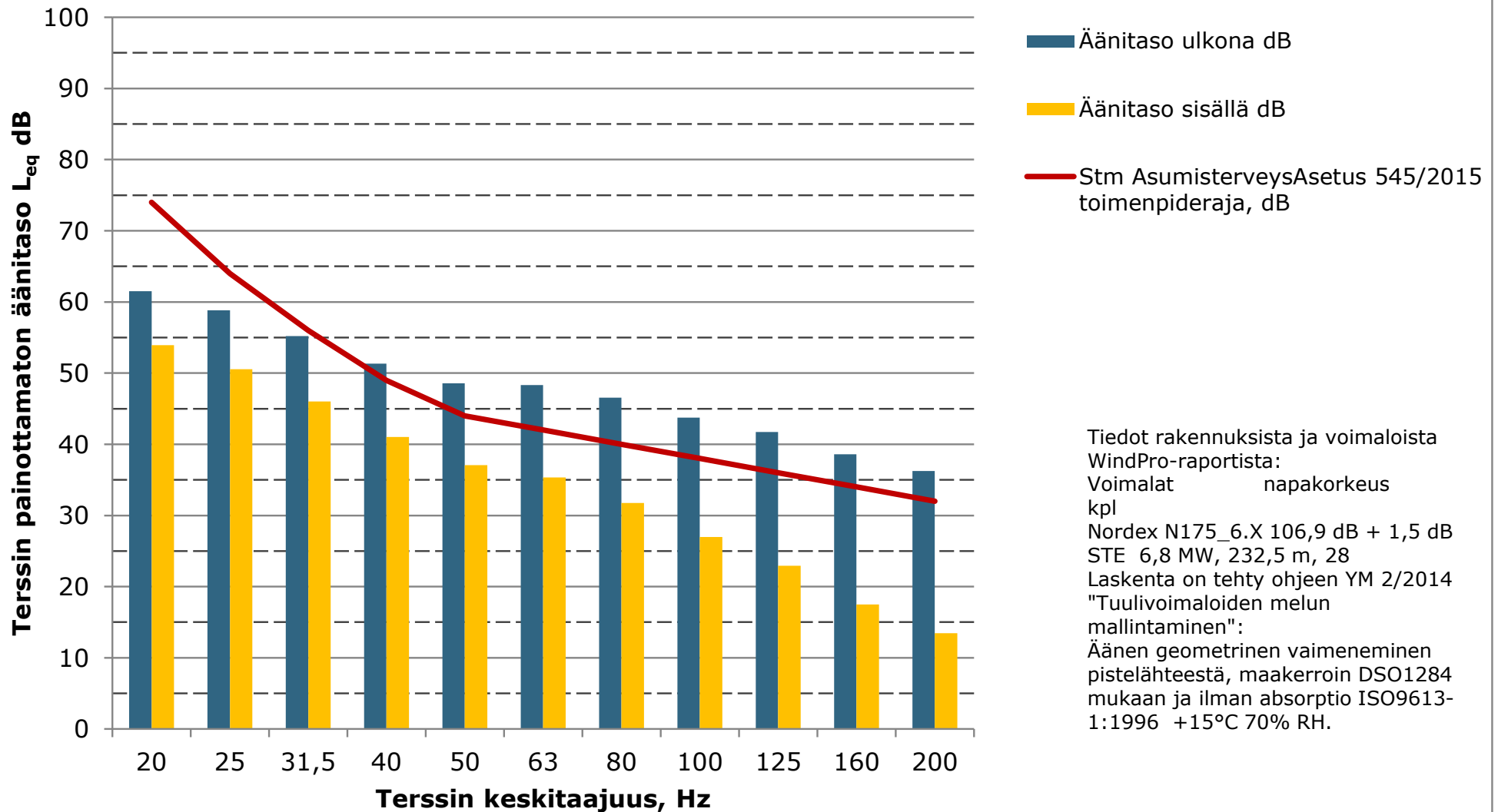
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_P (Niisineva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

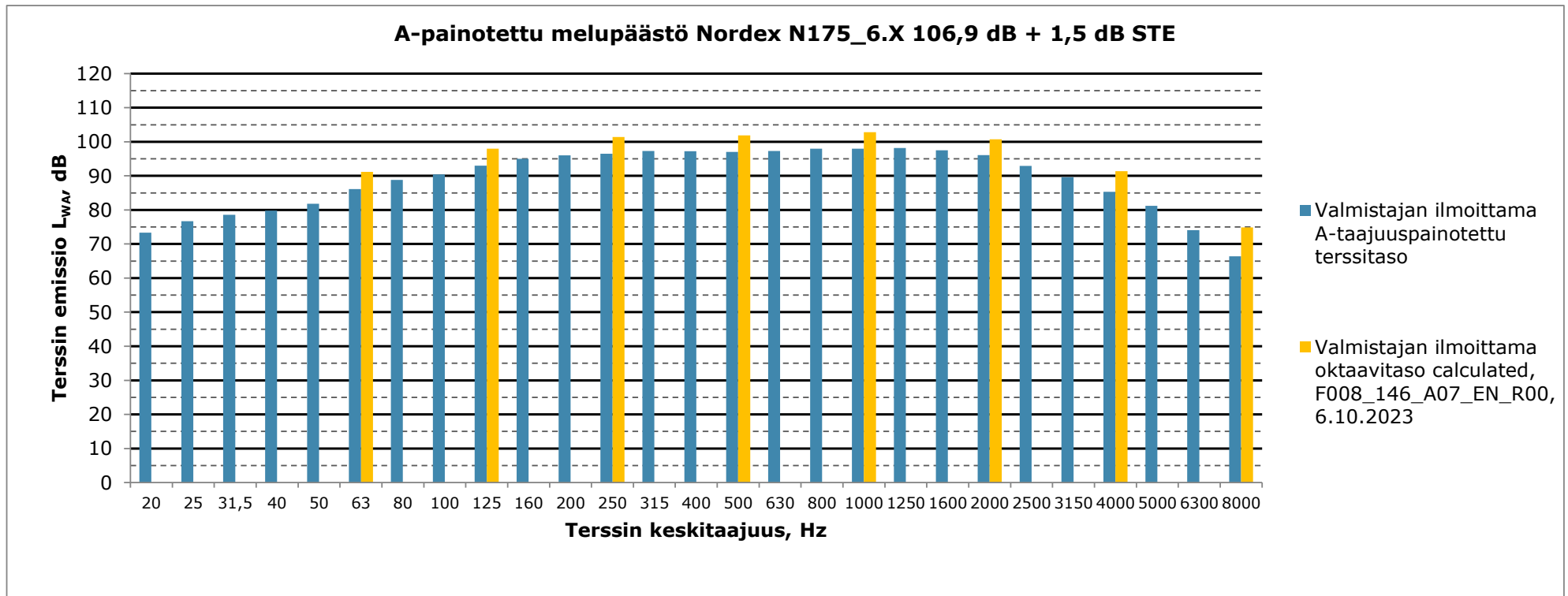


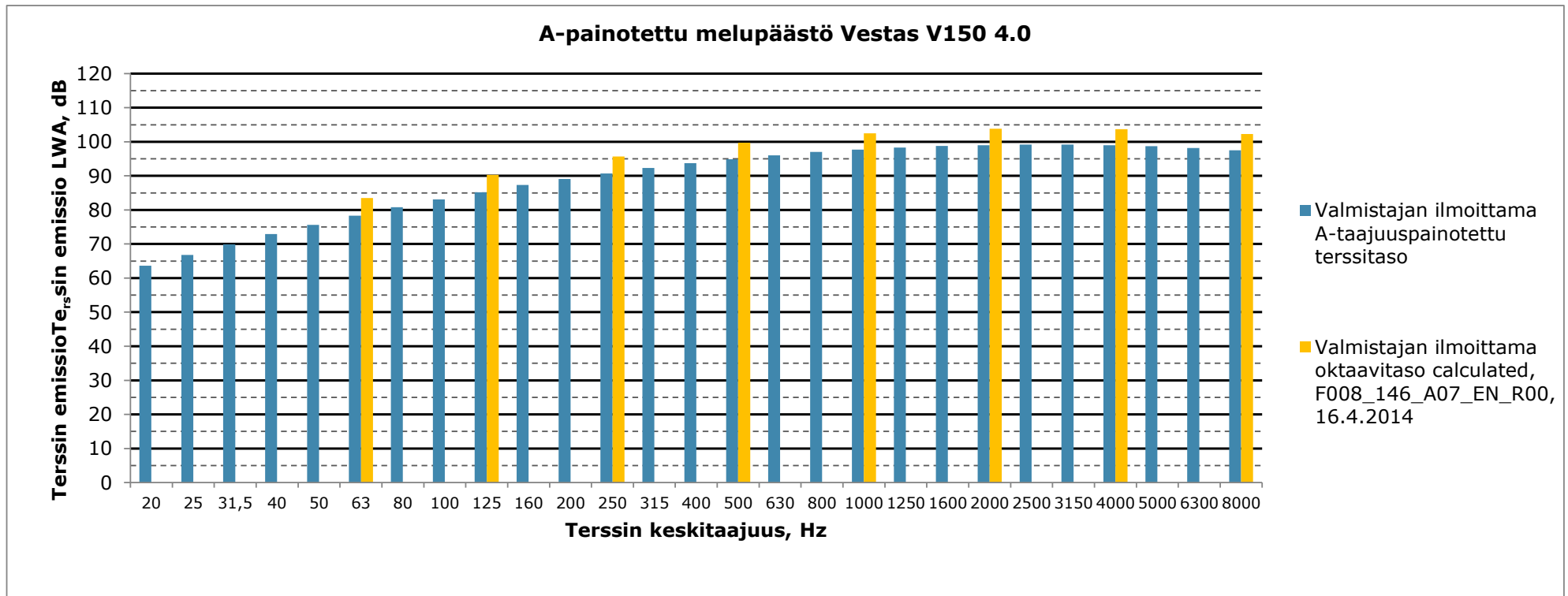
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

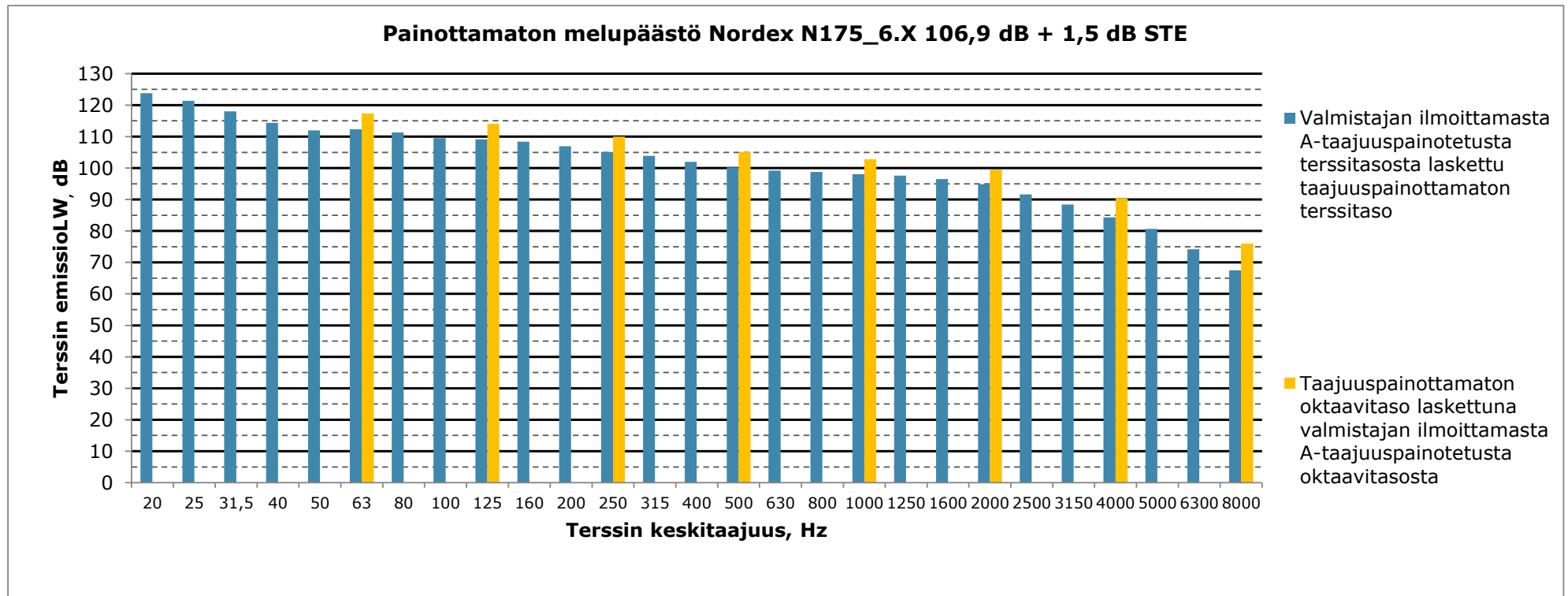


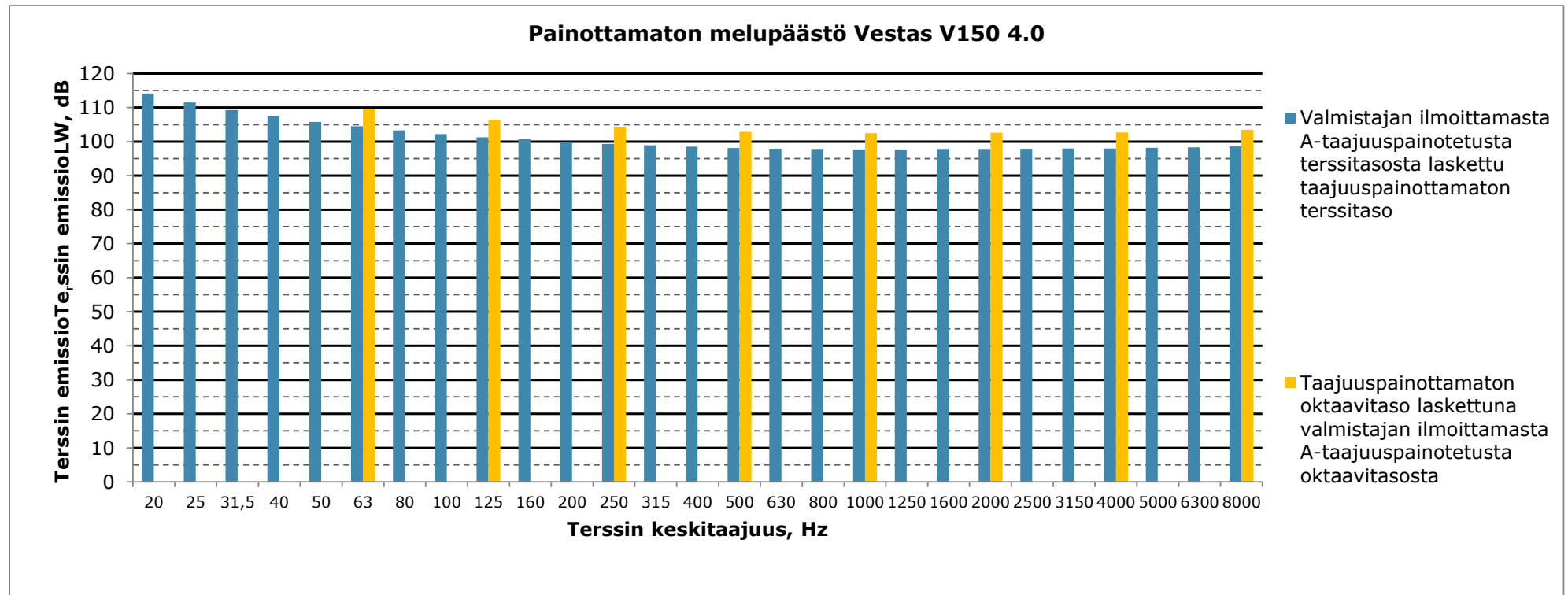
11.10.2023

Liite 6. Verkasalon tuulivoimahanke – matalataajuisen melun rakennuskohtaiset arvot VE1 N175 - 6.8 MW. Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

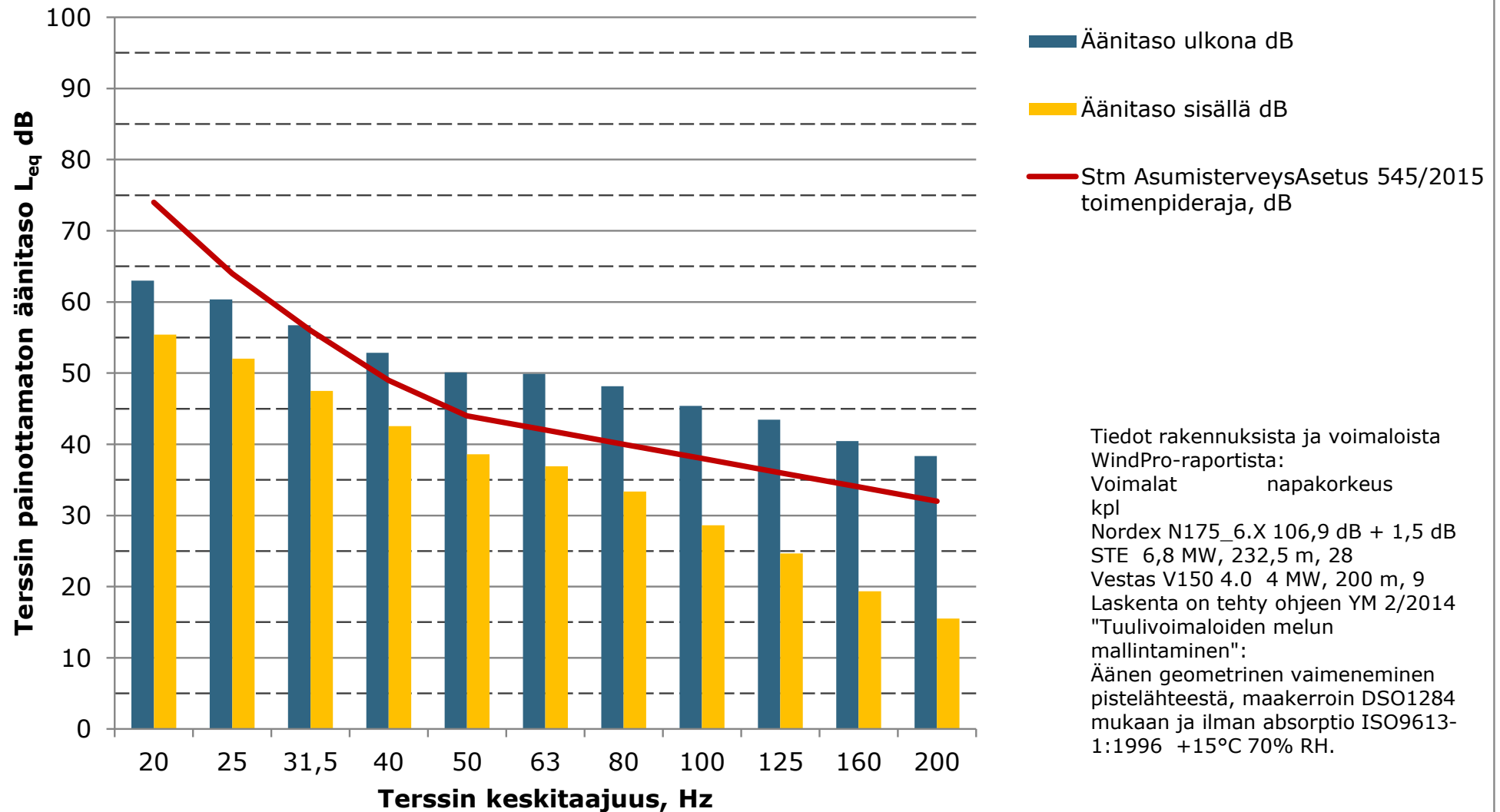




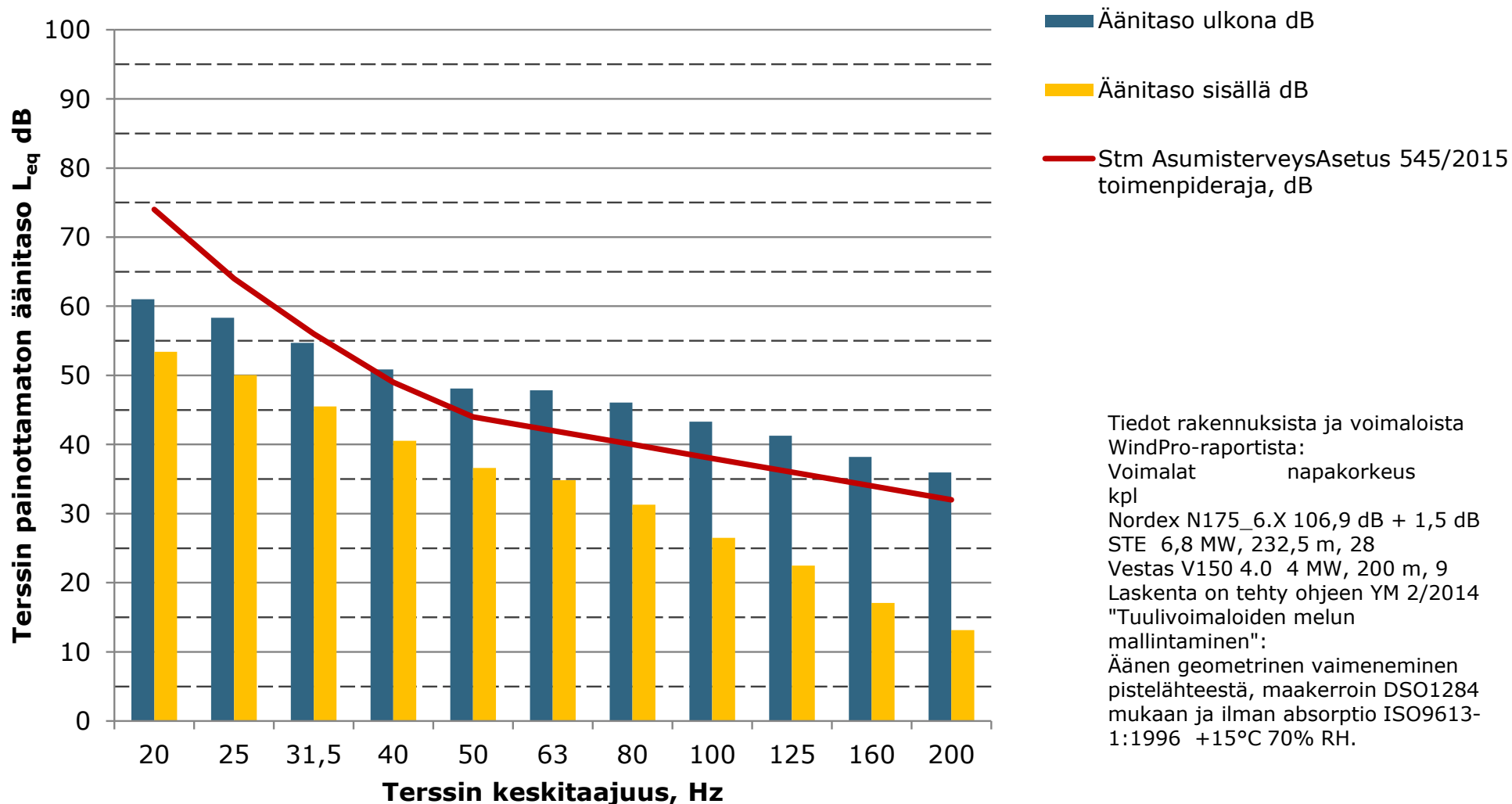




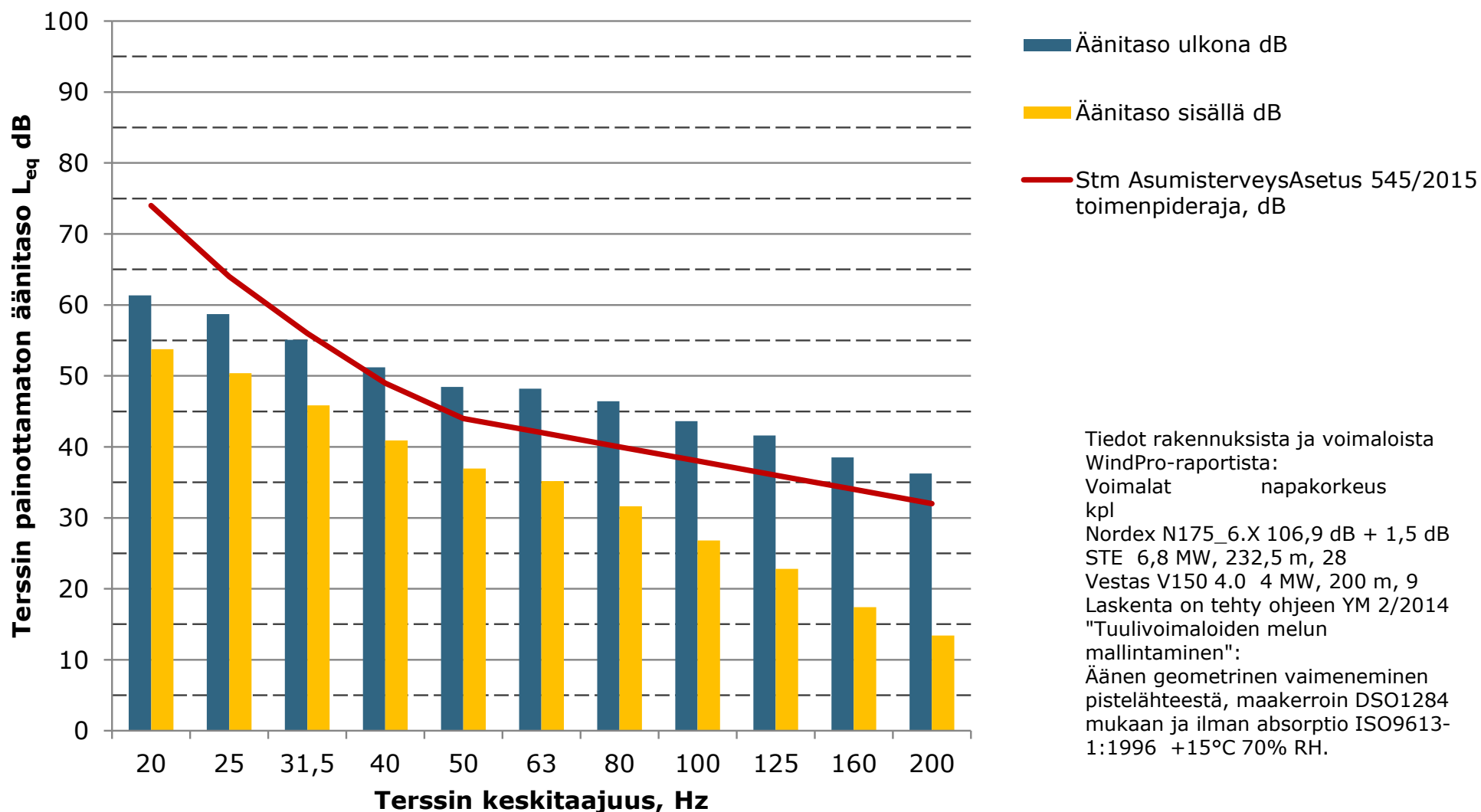
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

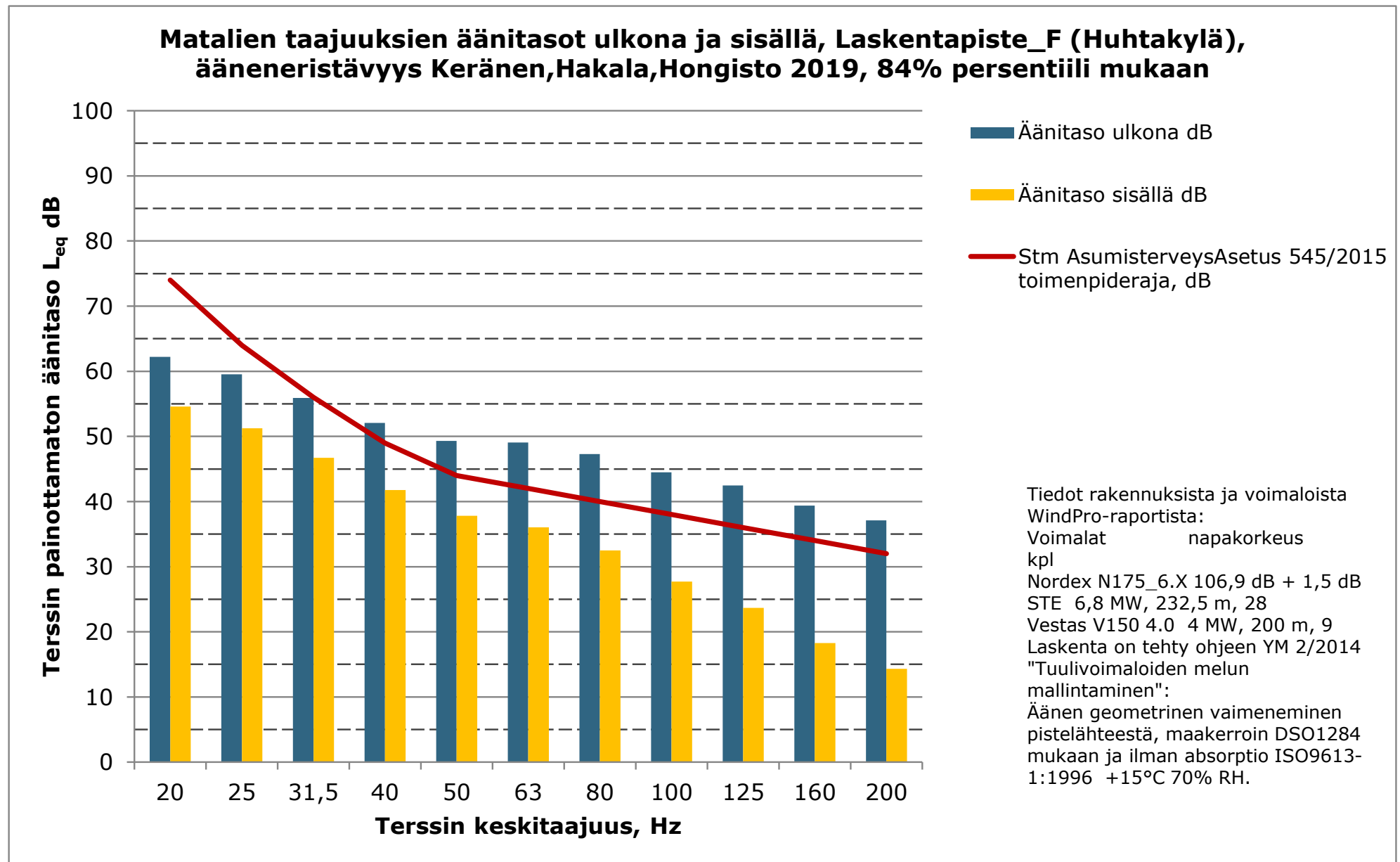


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

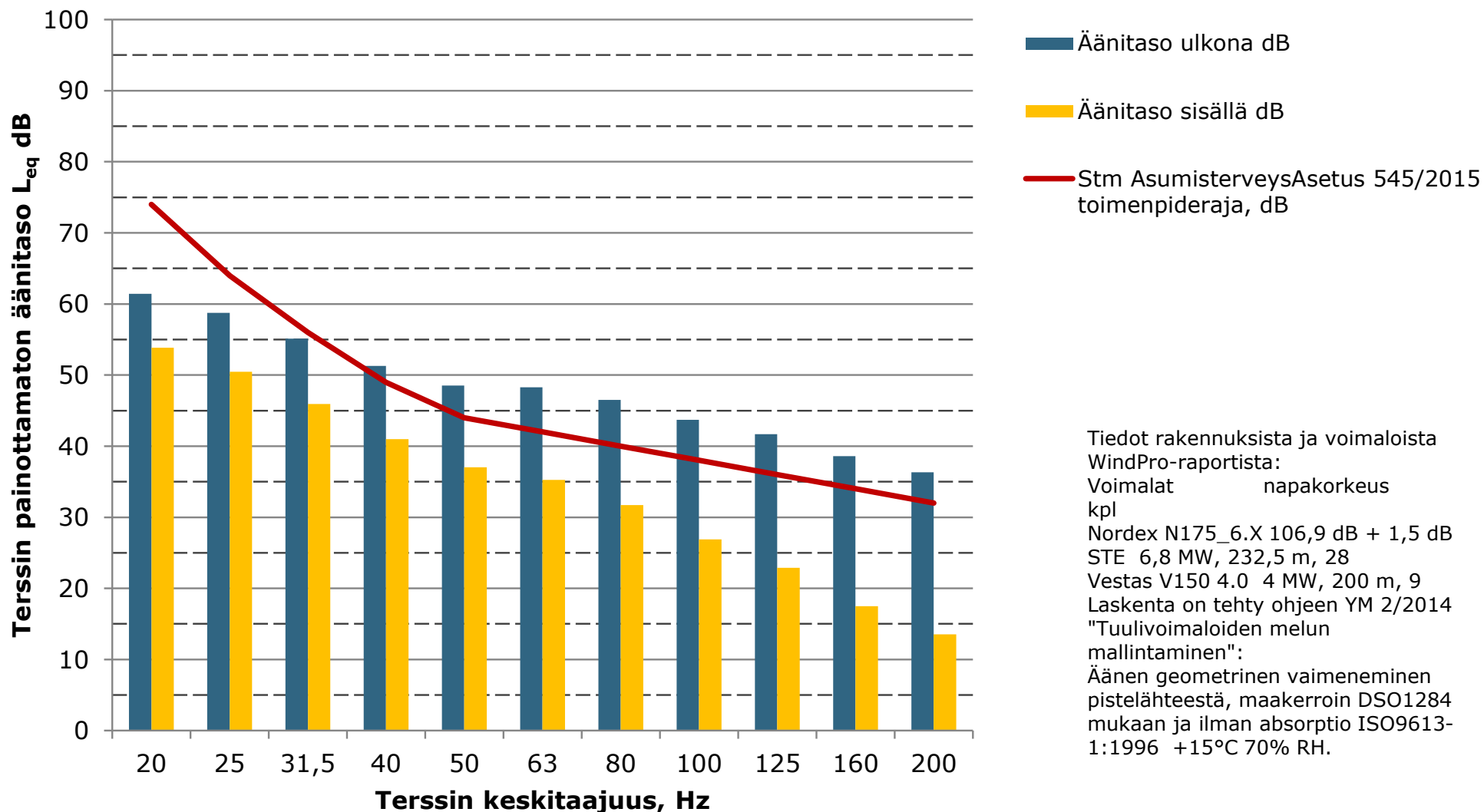


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

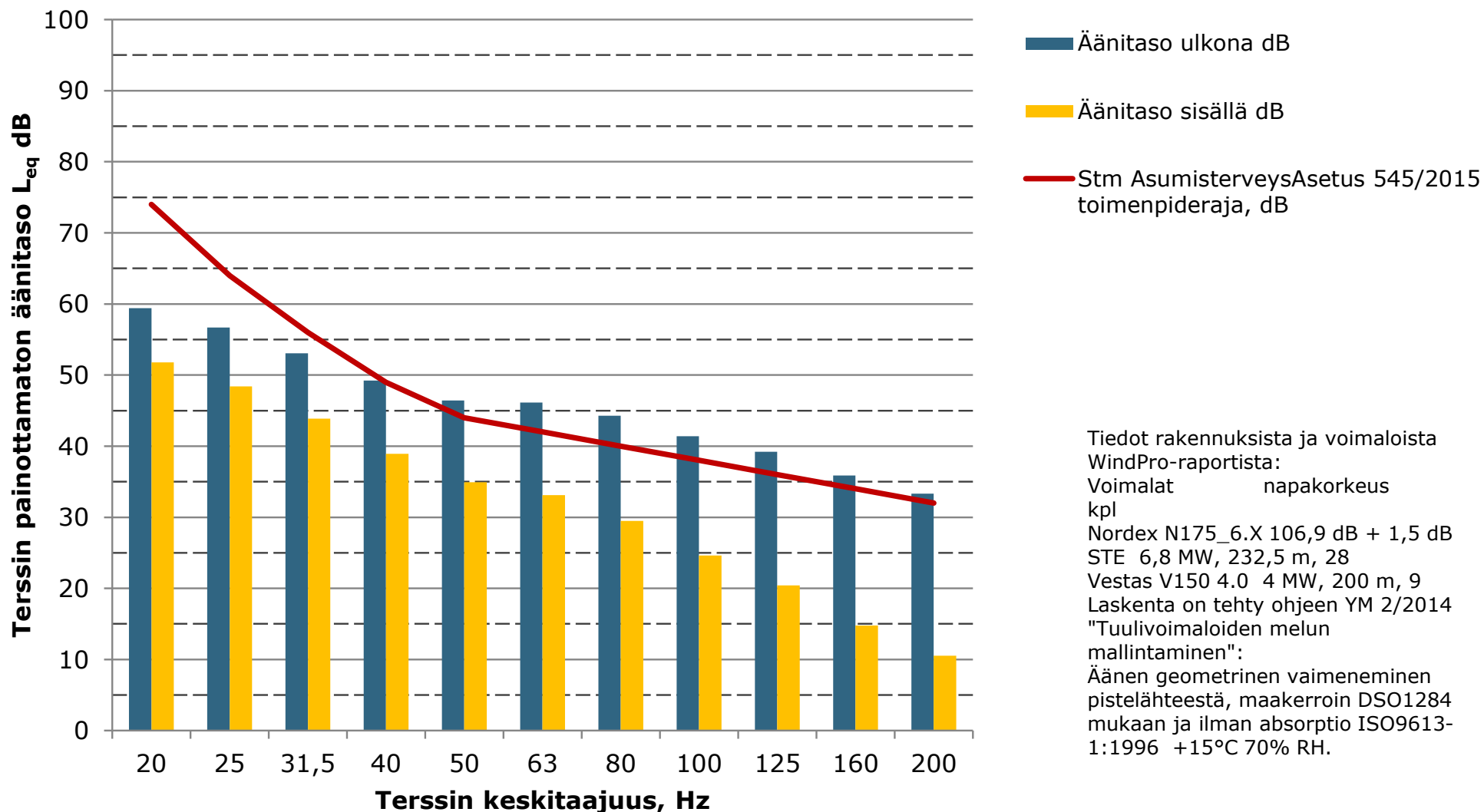


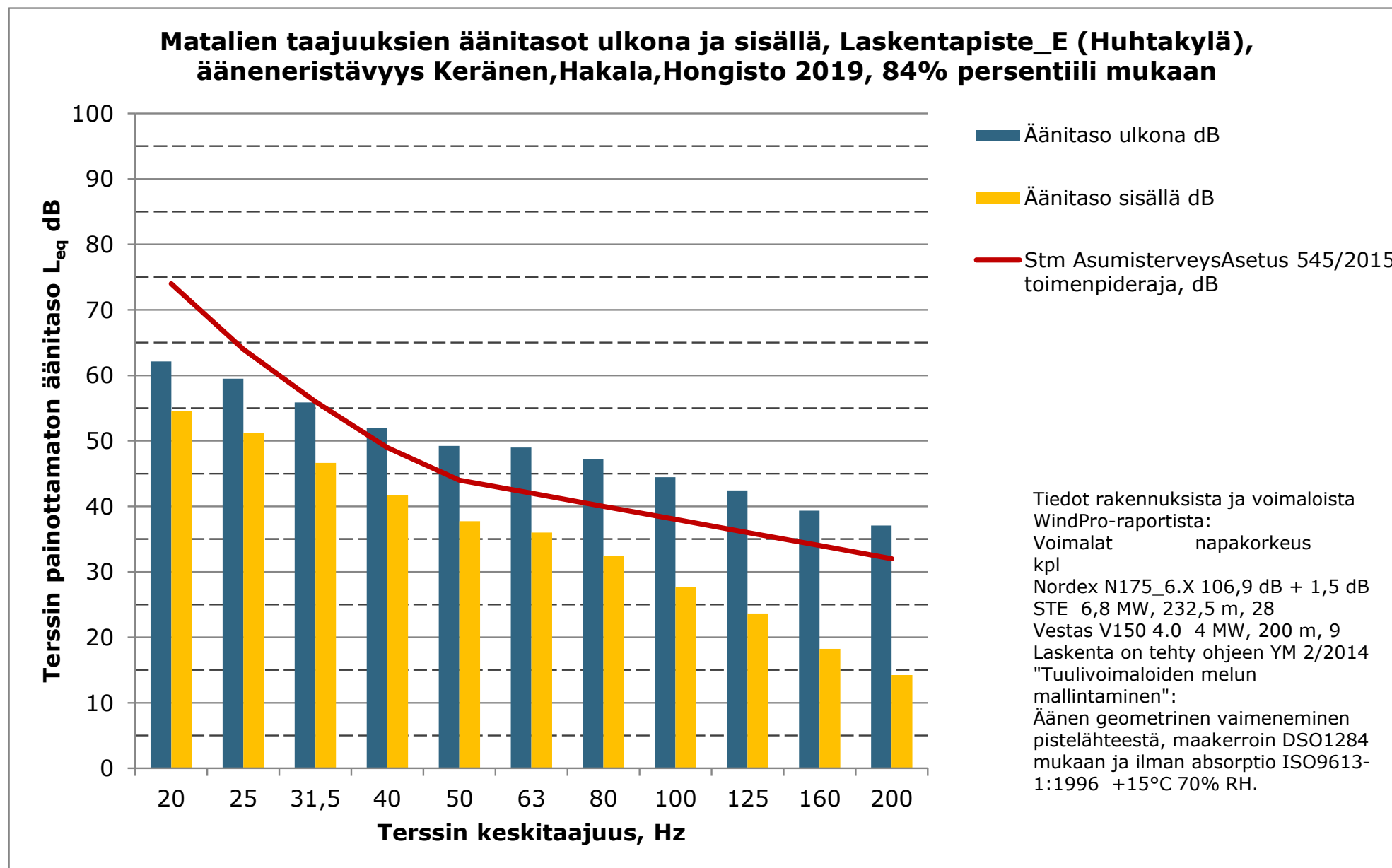


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

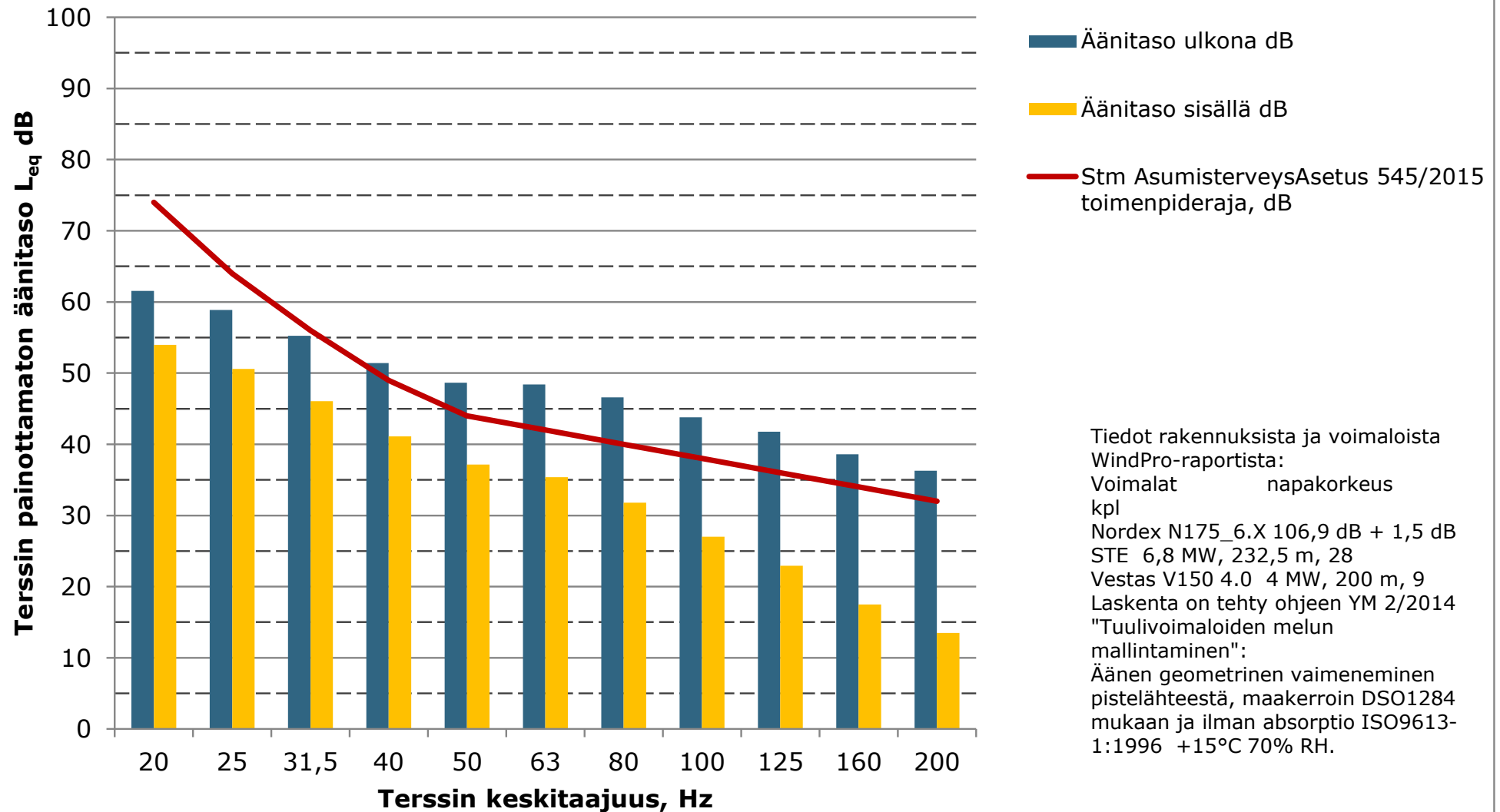


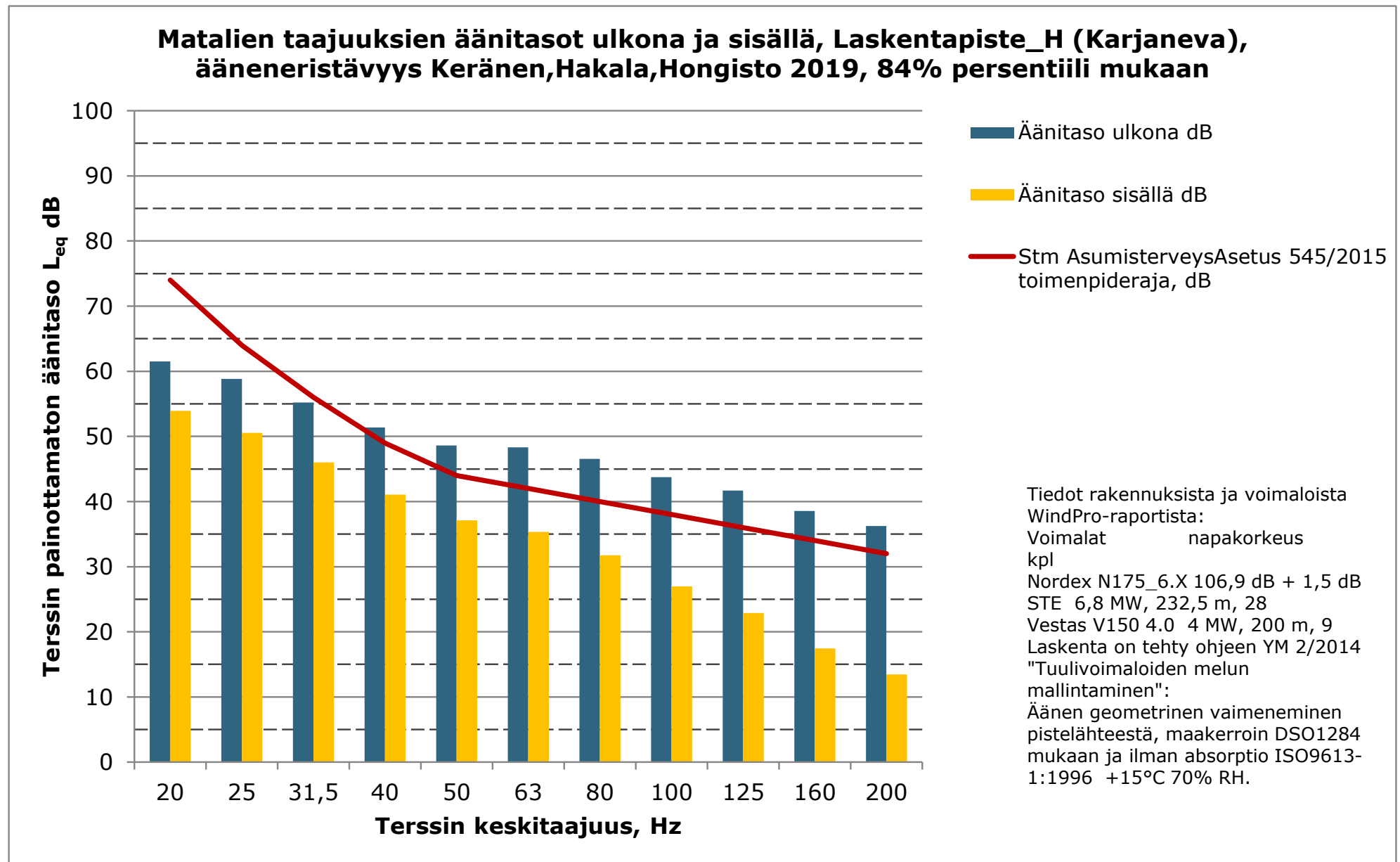
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



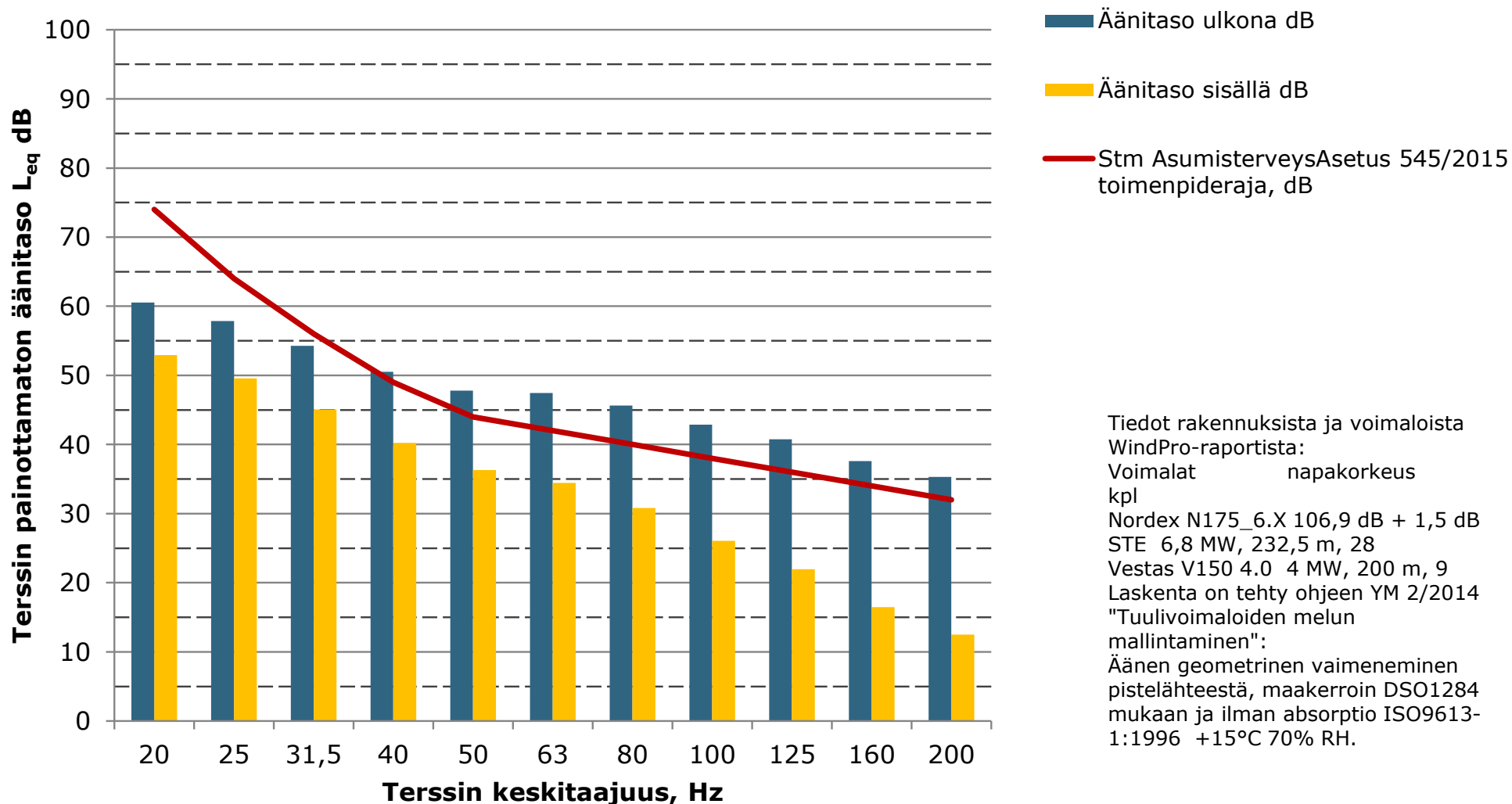


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

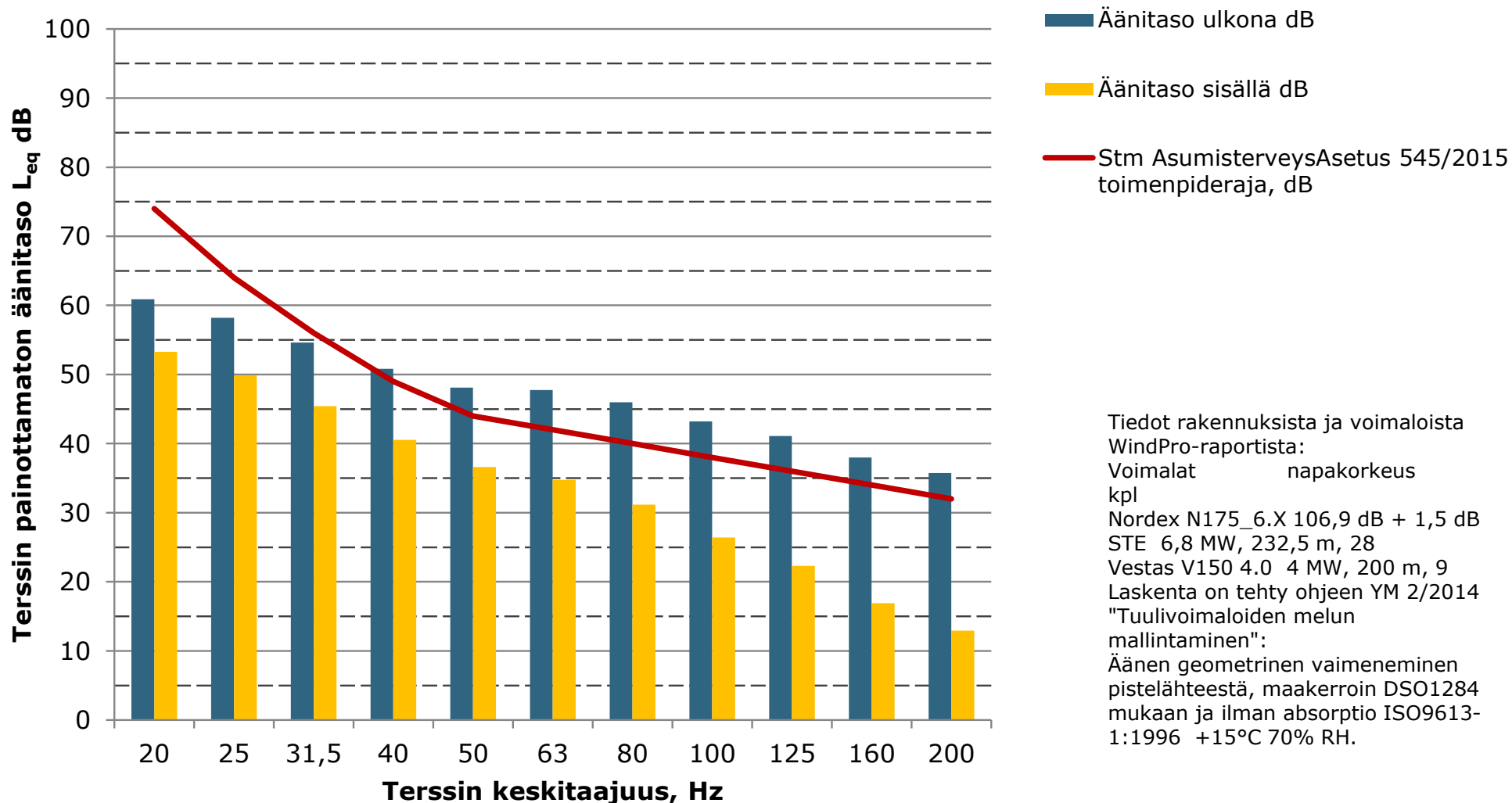




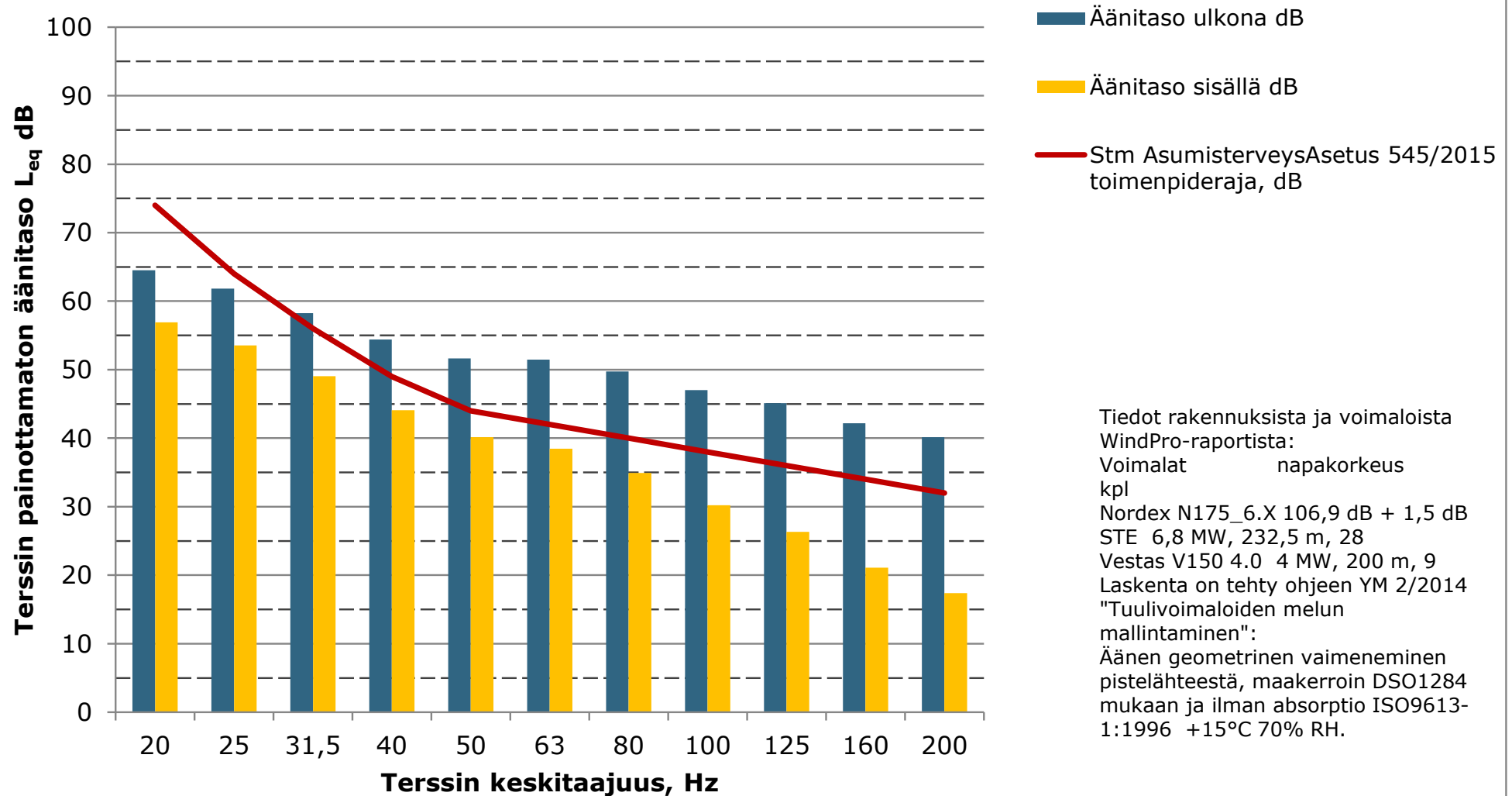
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



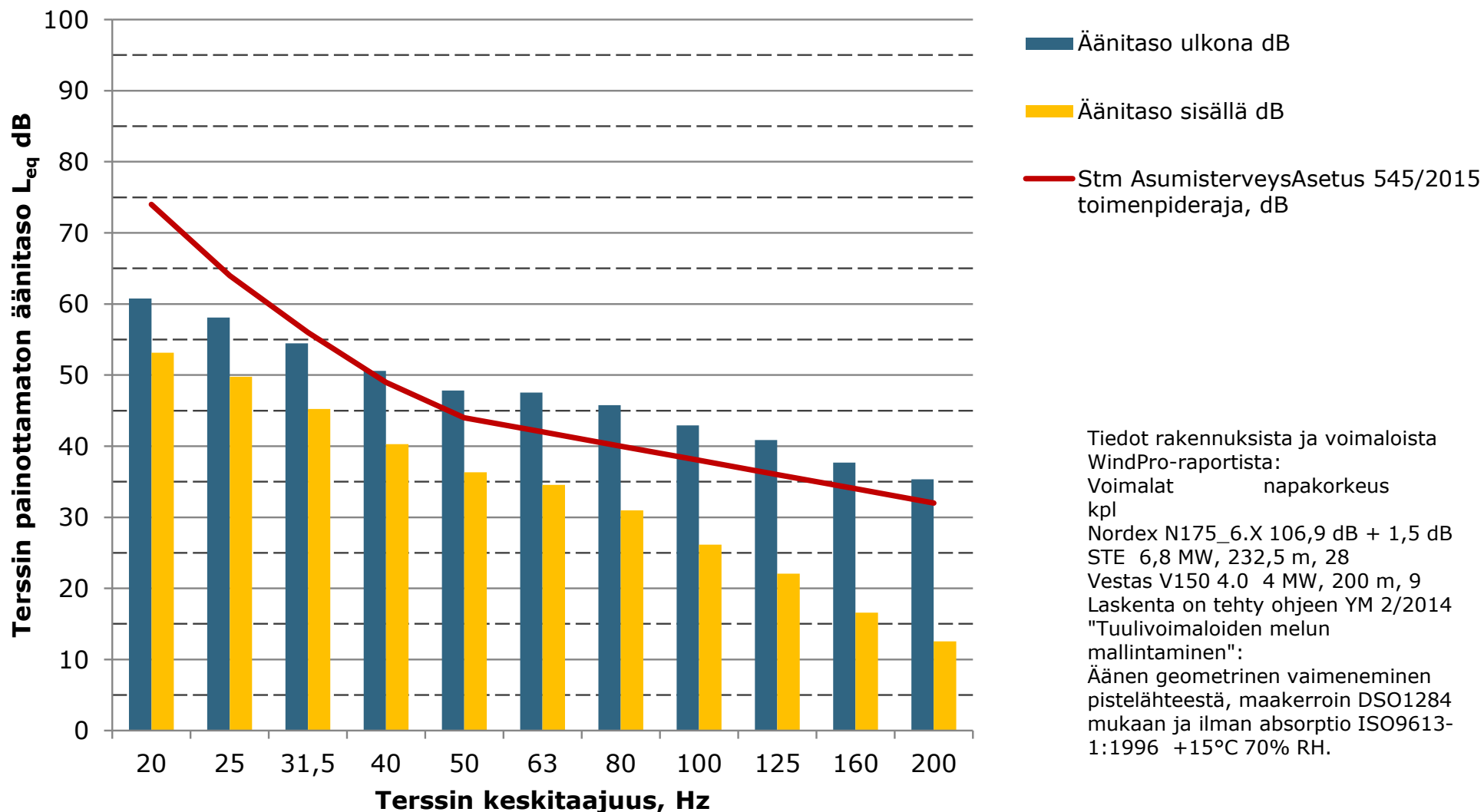
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



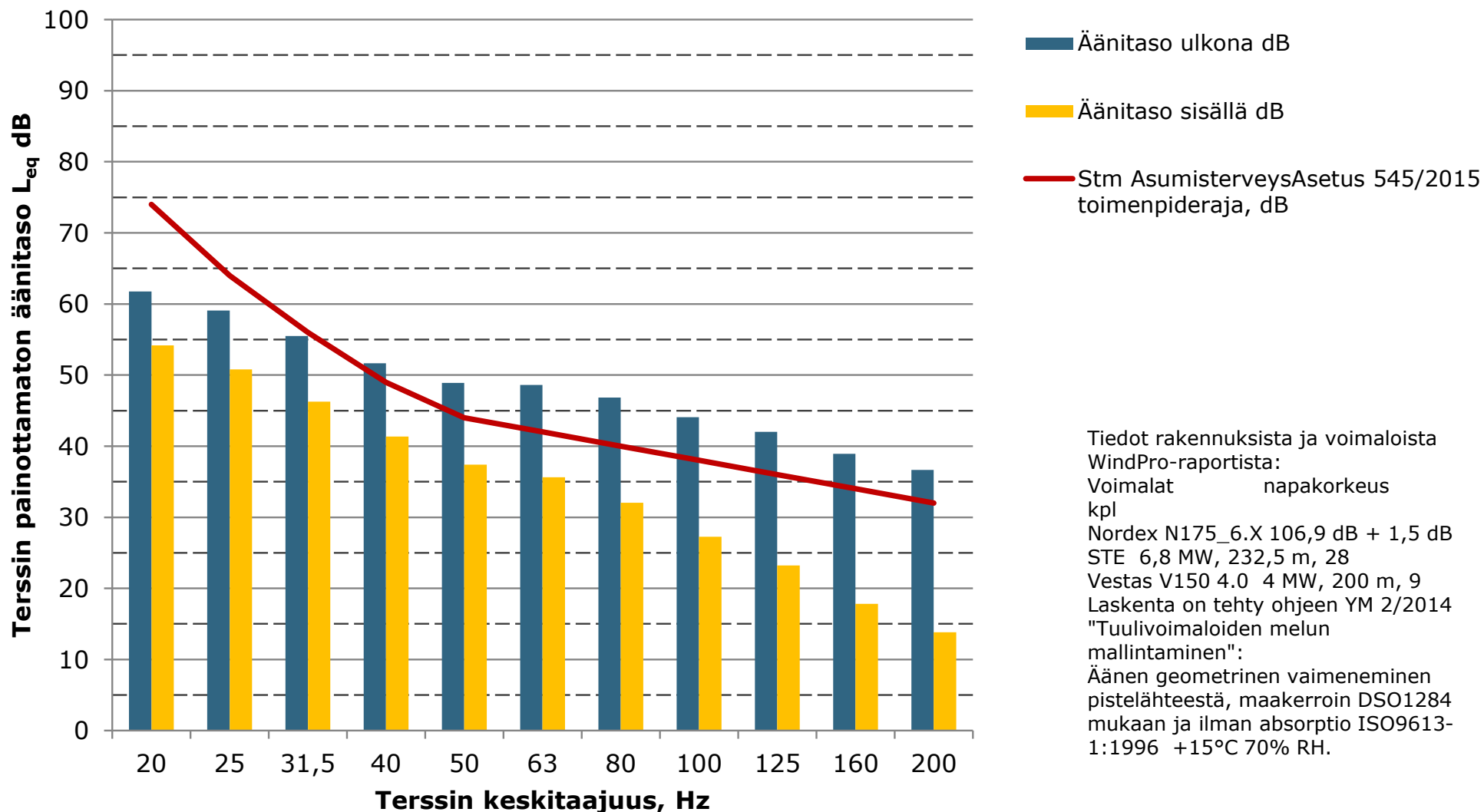
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



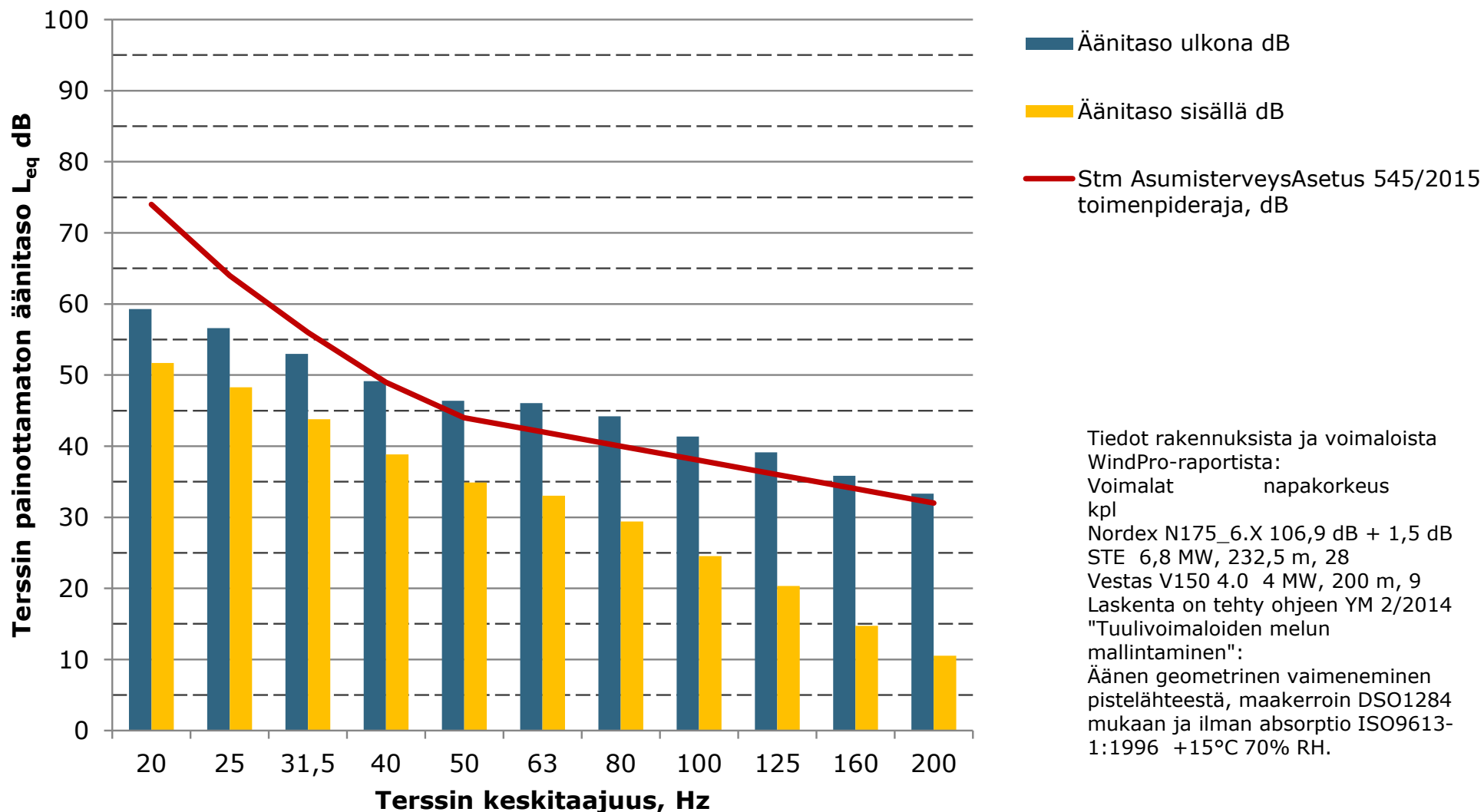
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



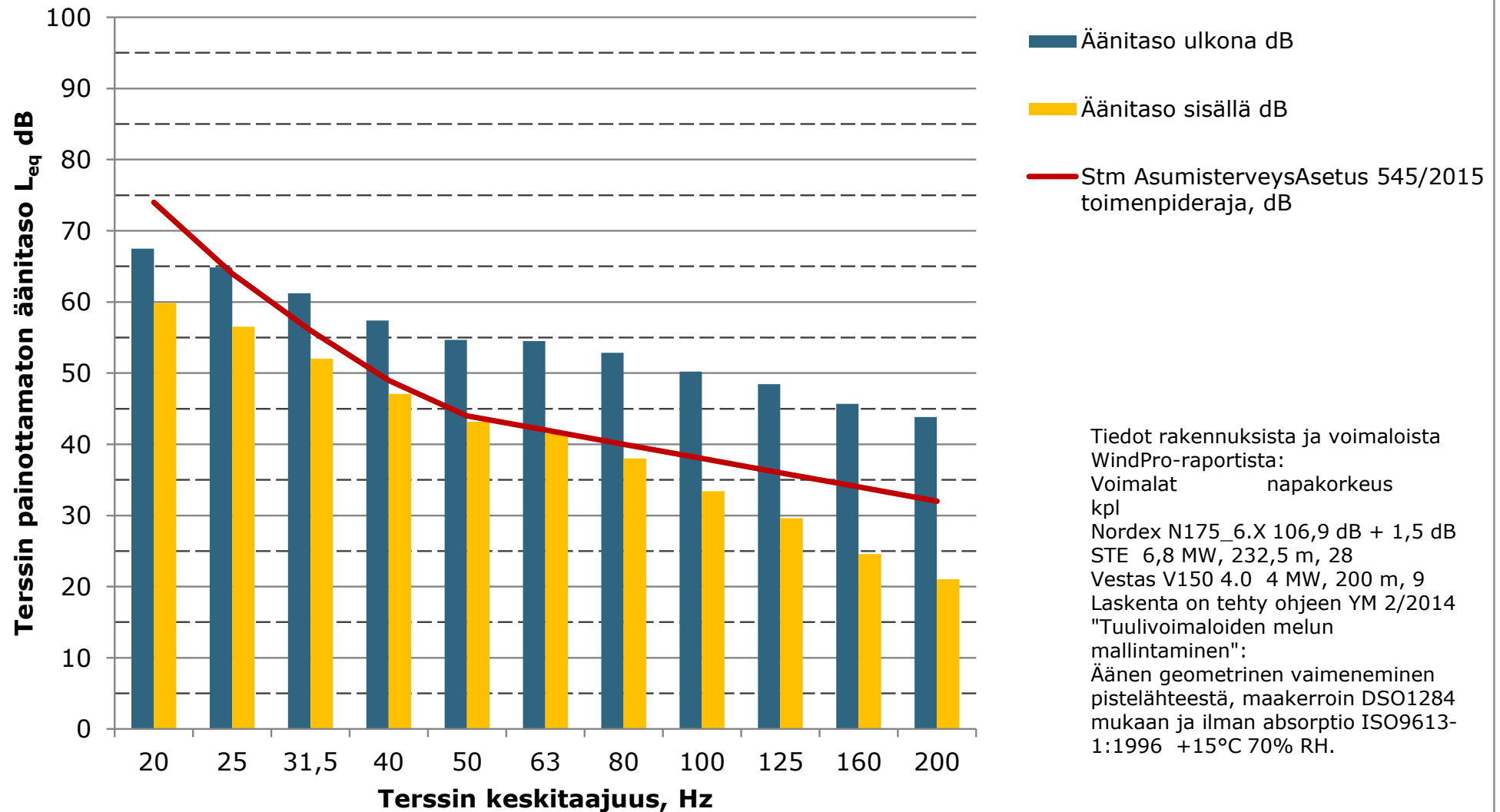
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_O (Nevaranta), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



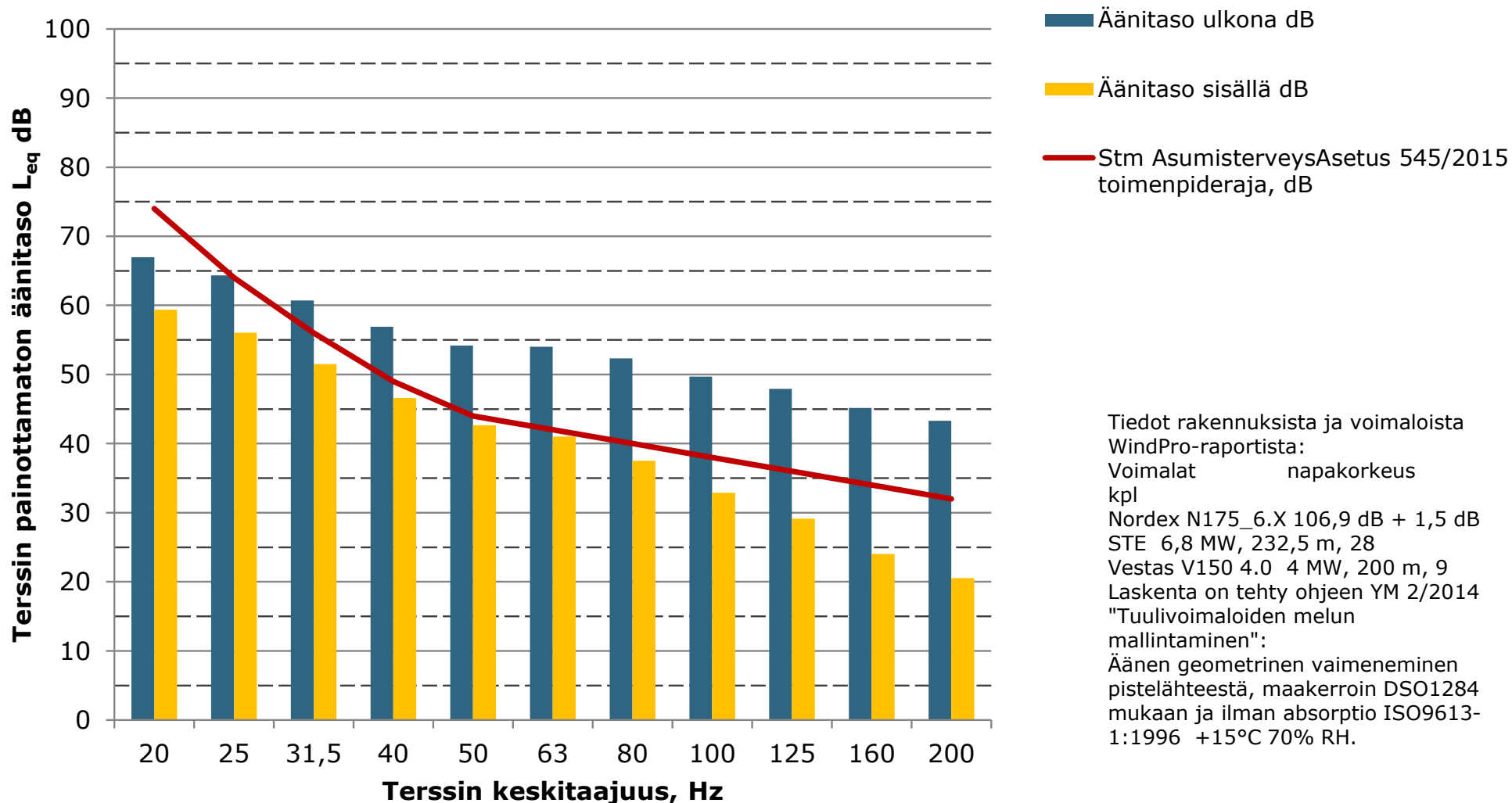
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



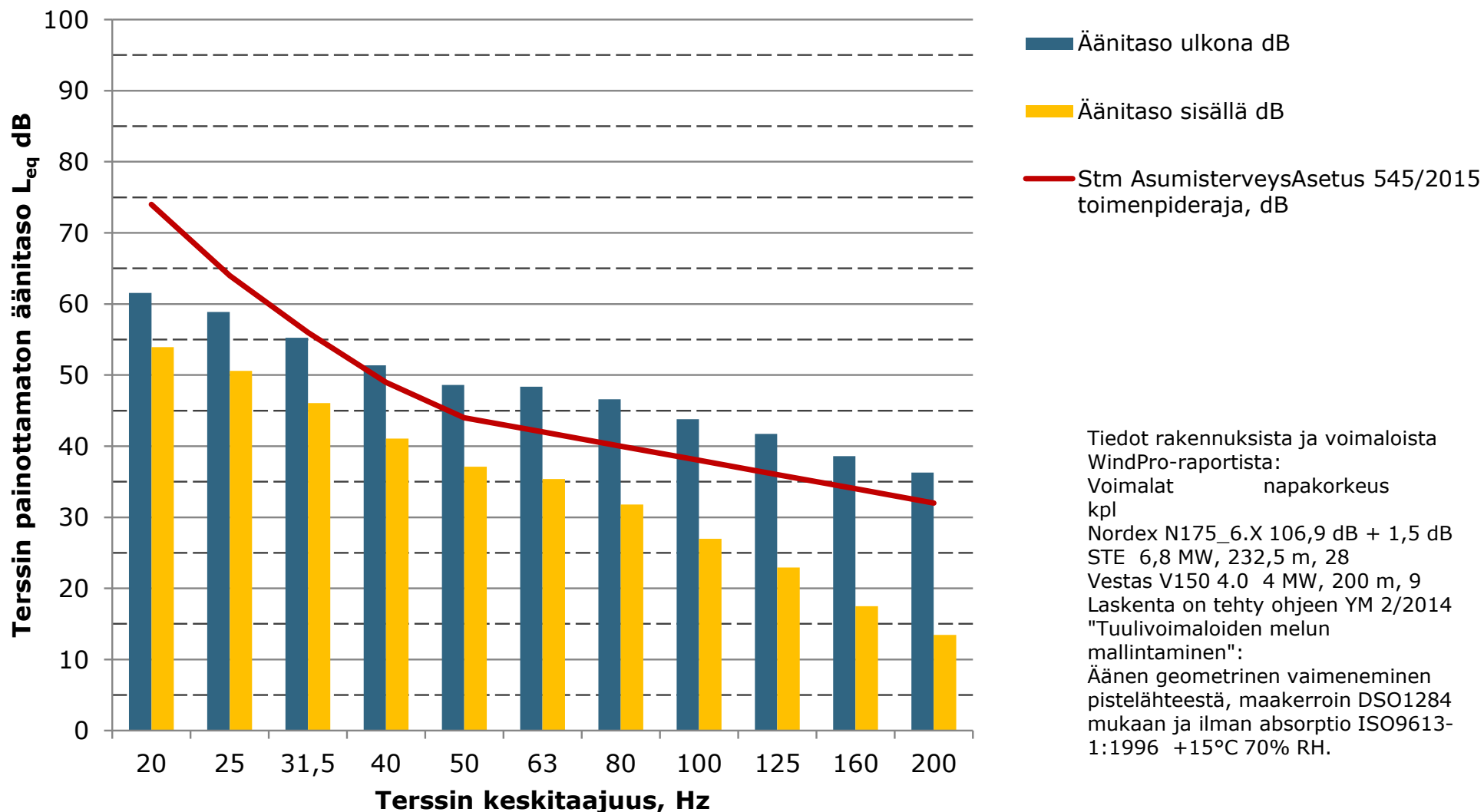
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_P (Niisineva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

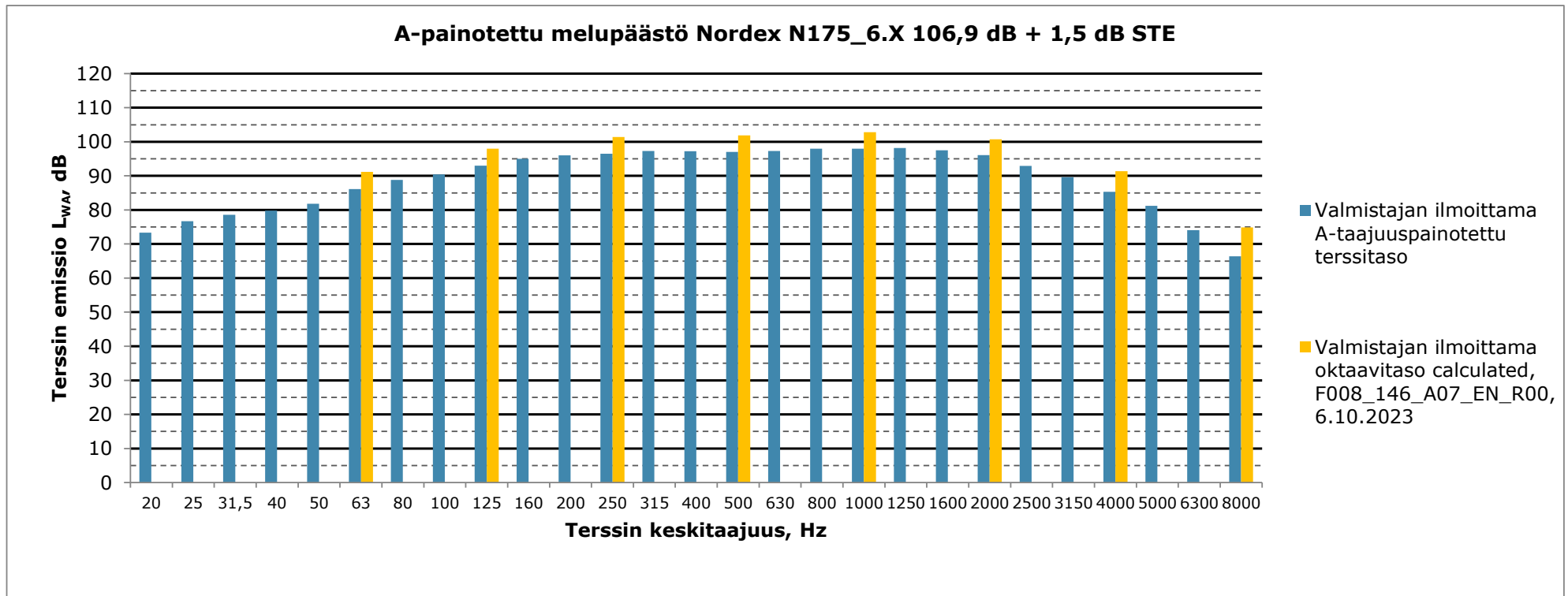


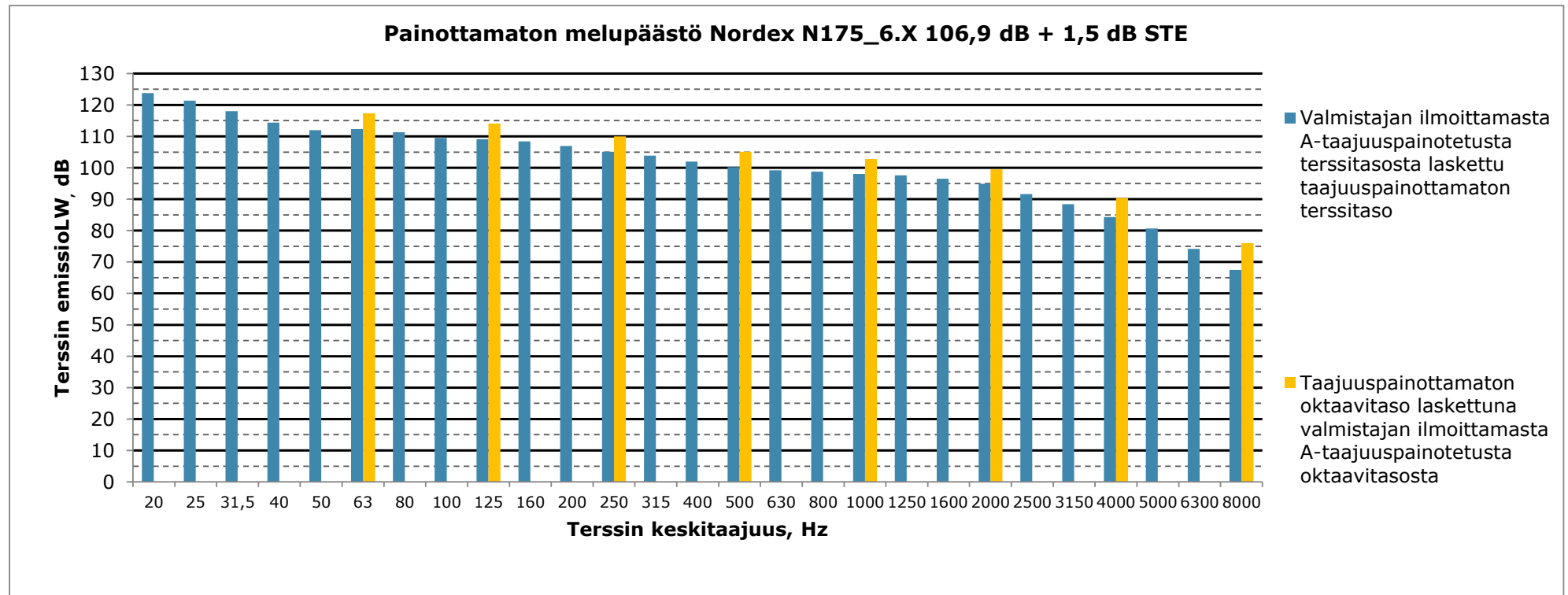
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

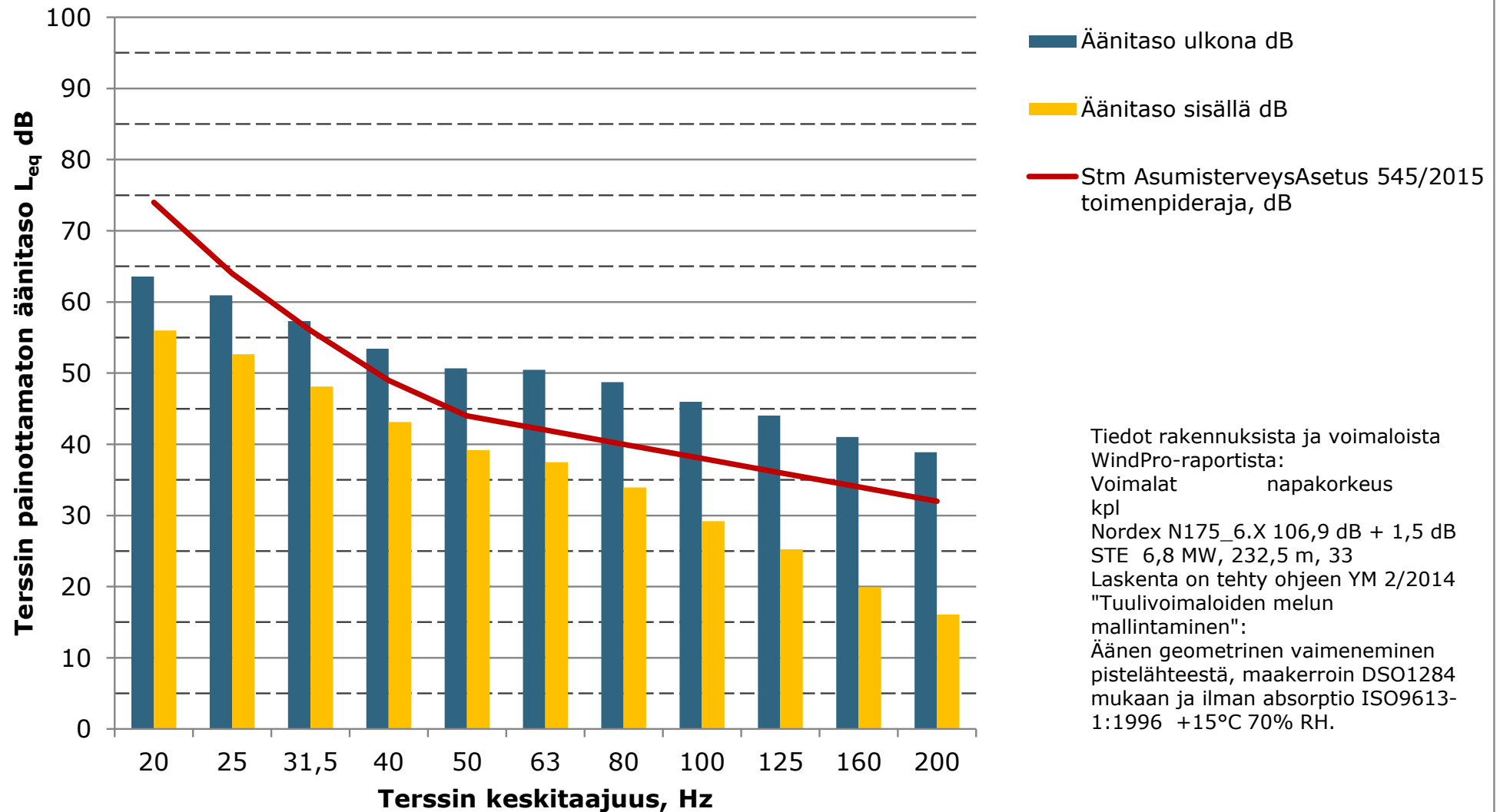


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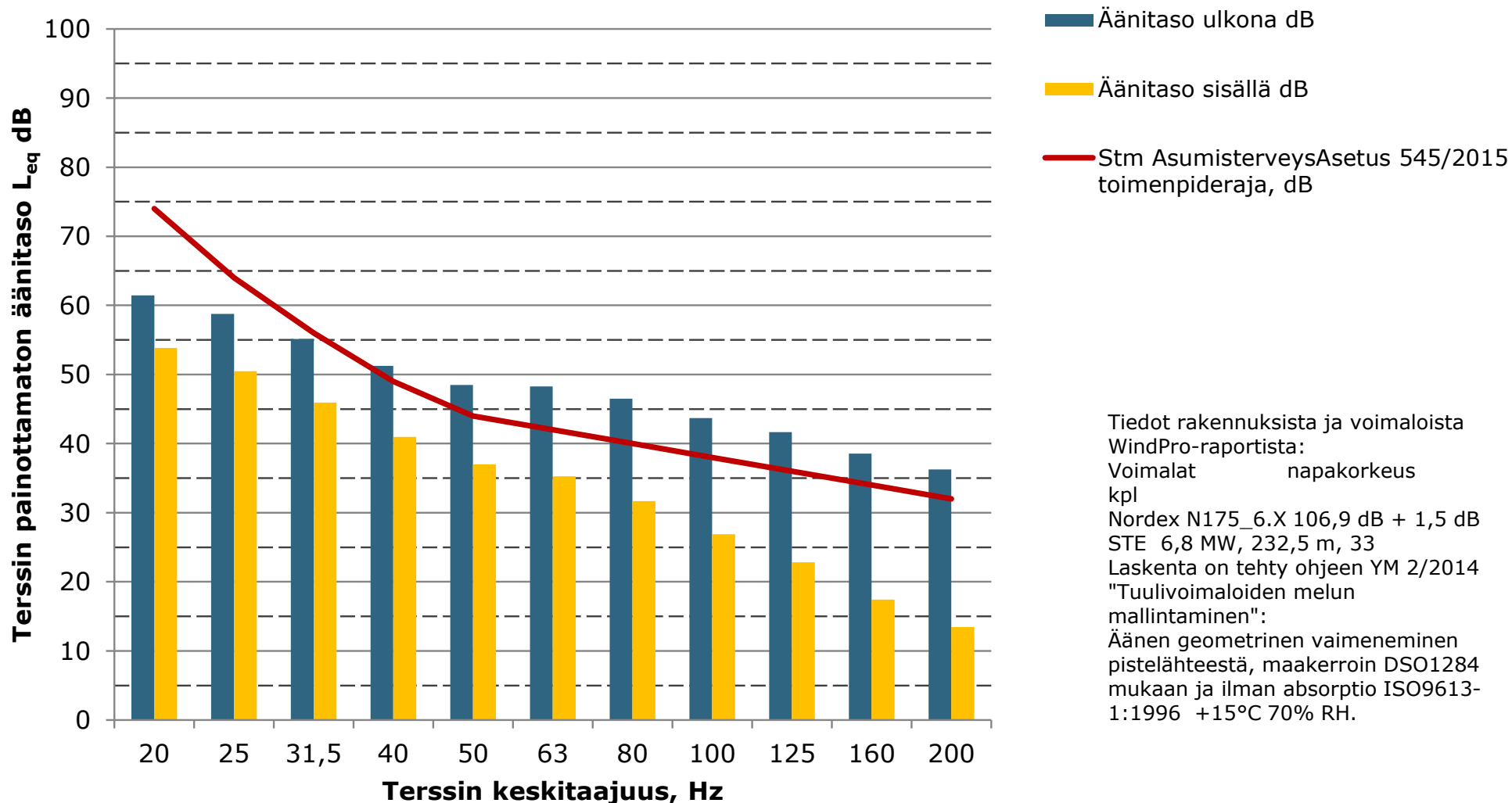
Liite 7. Verkasalon tuulivoimahanke – matalataajuisen melun rakennuskohtaiset arvot VE2 N175 - 6.8 MW.

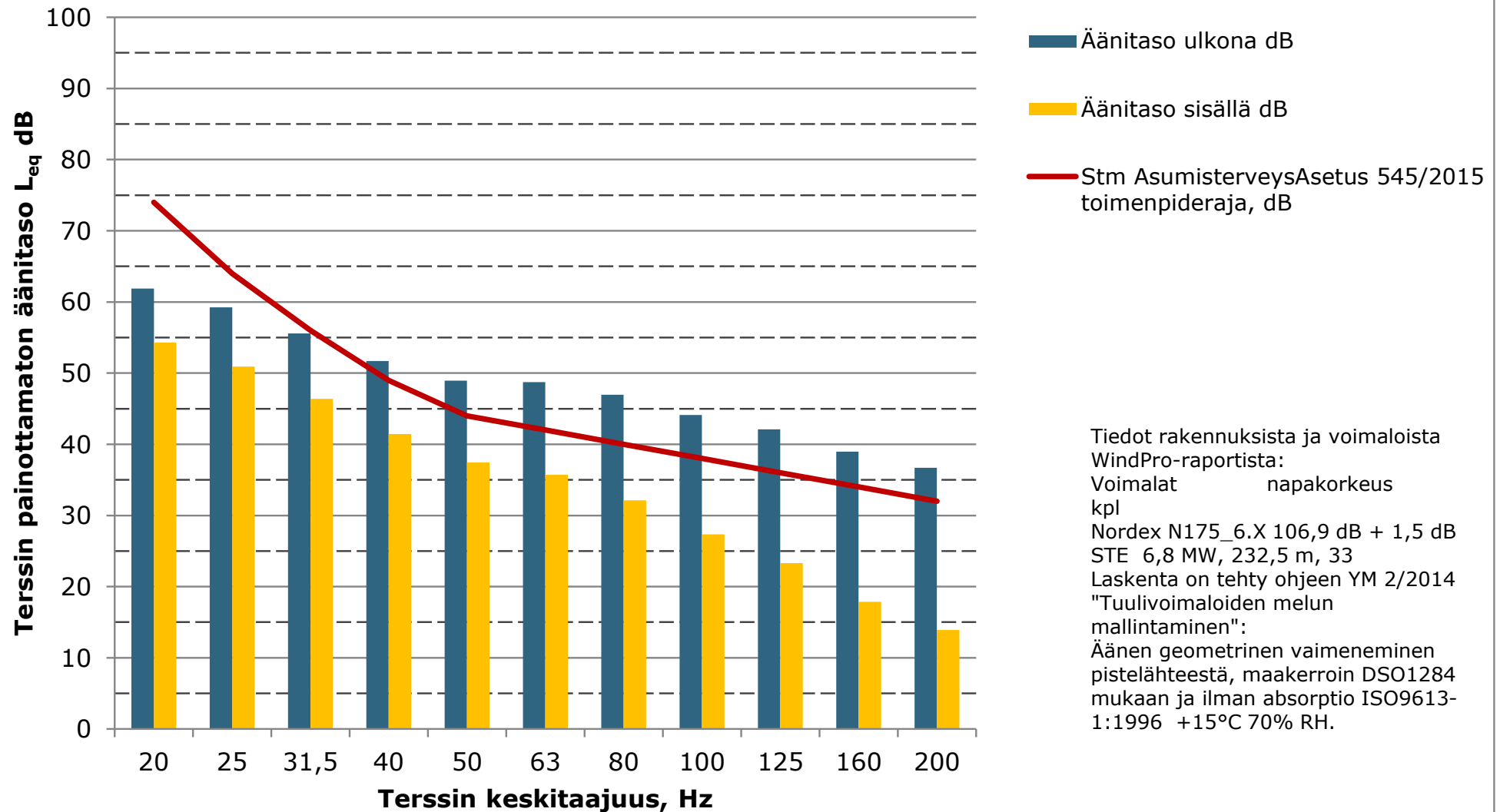


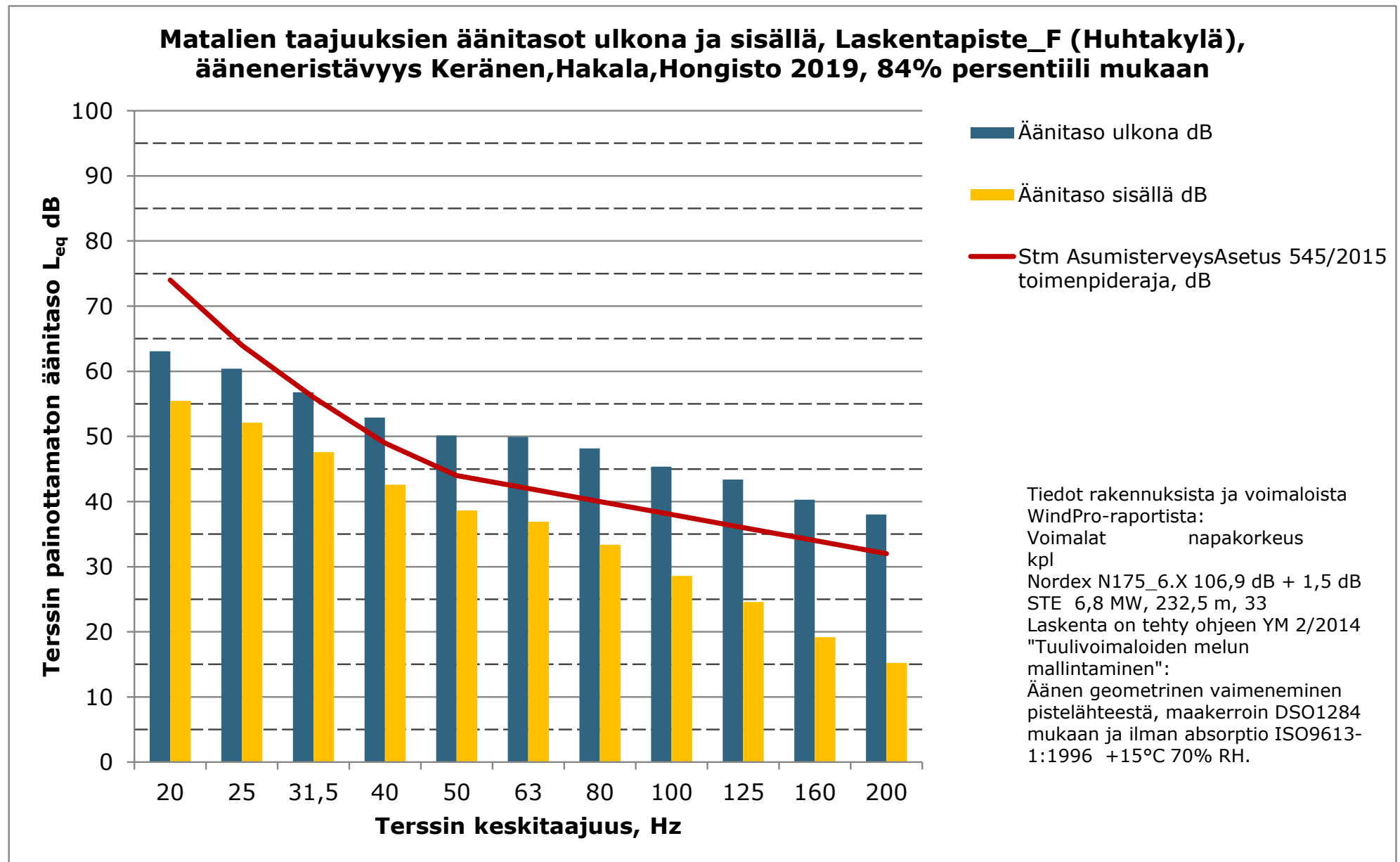


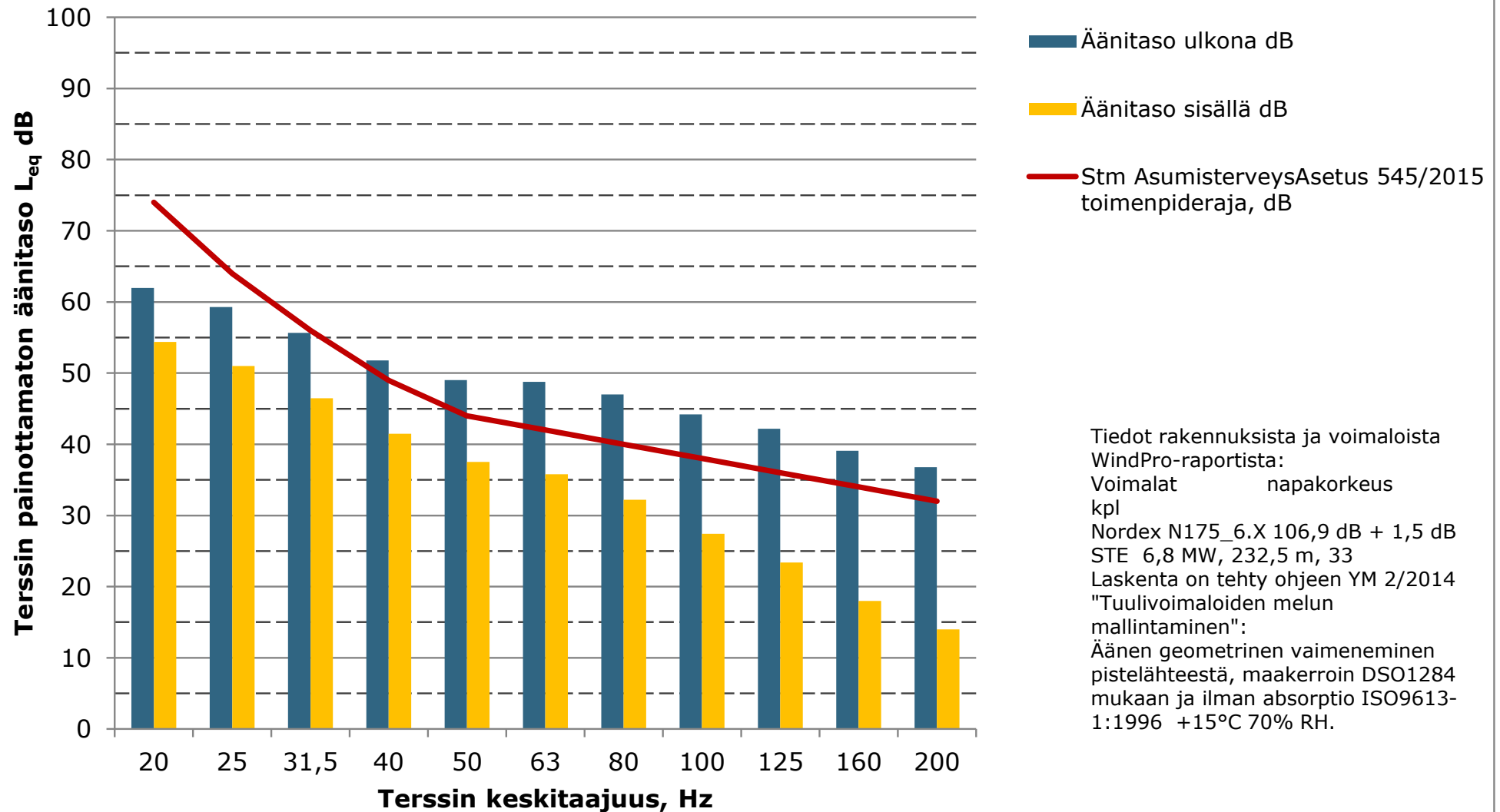
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

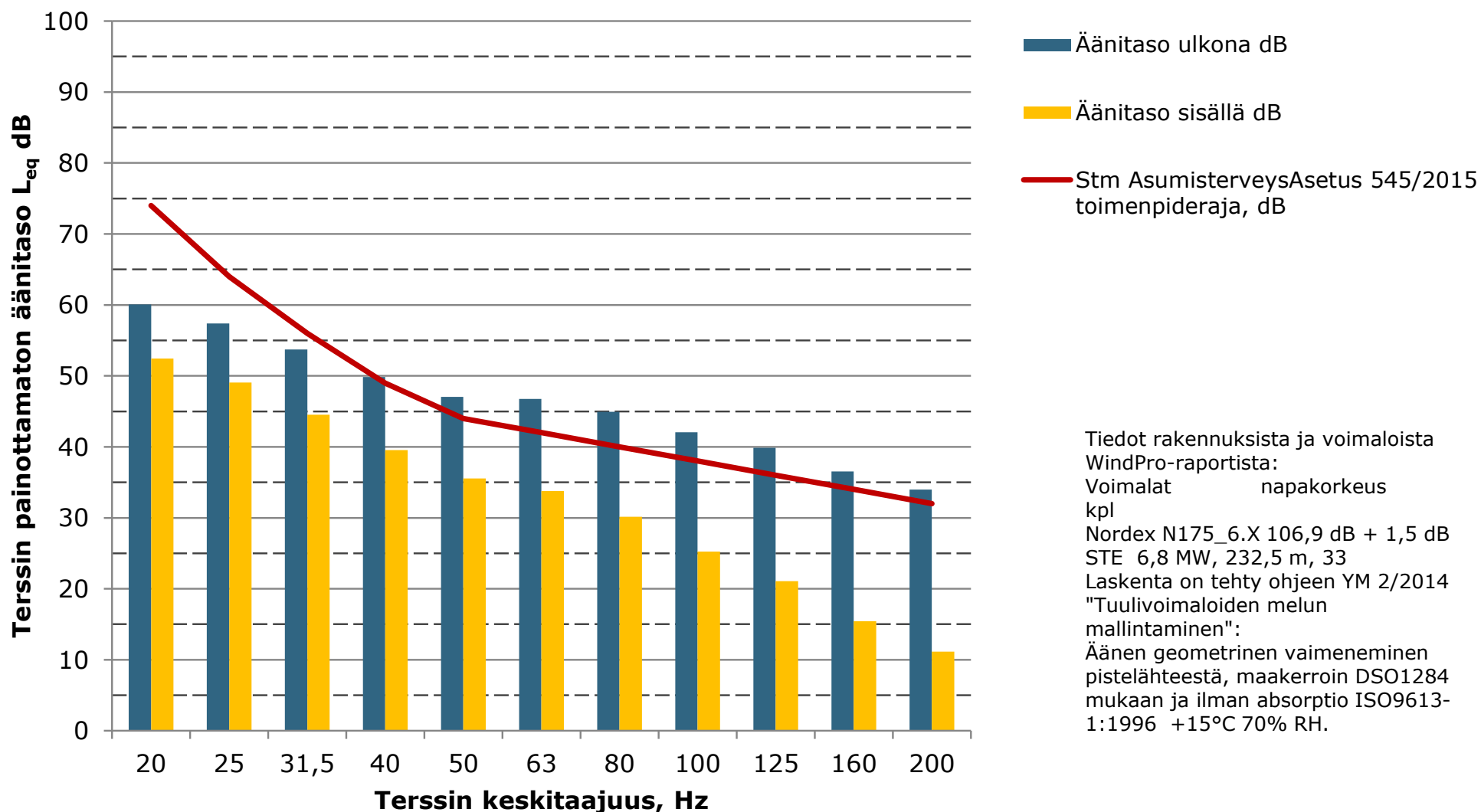
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



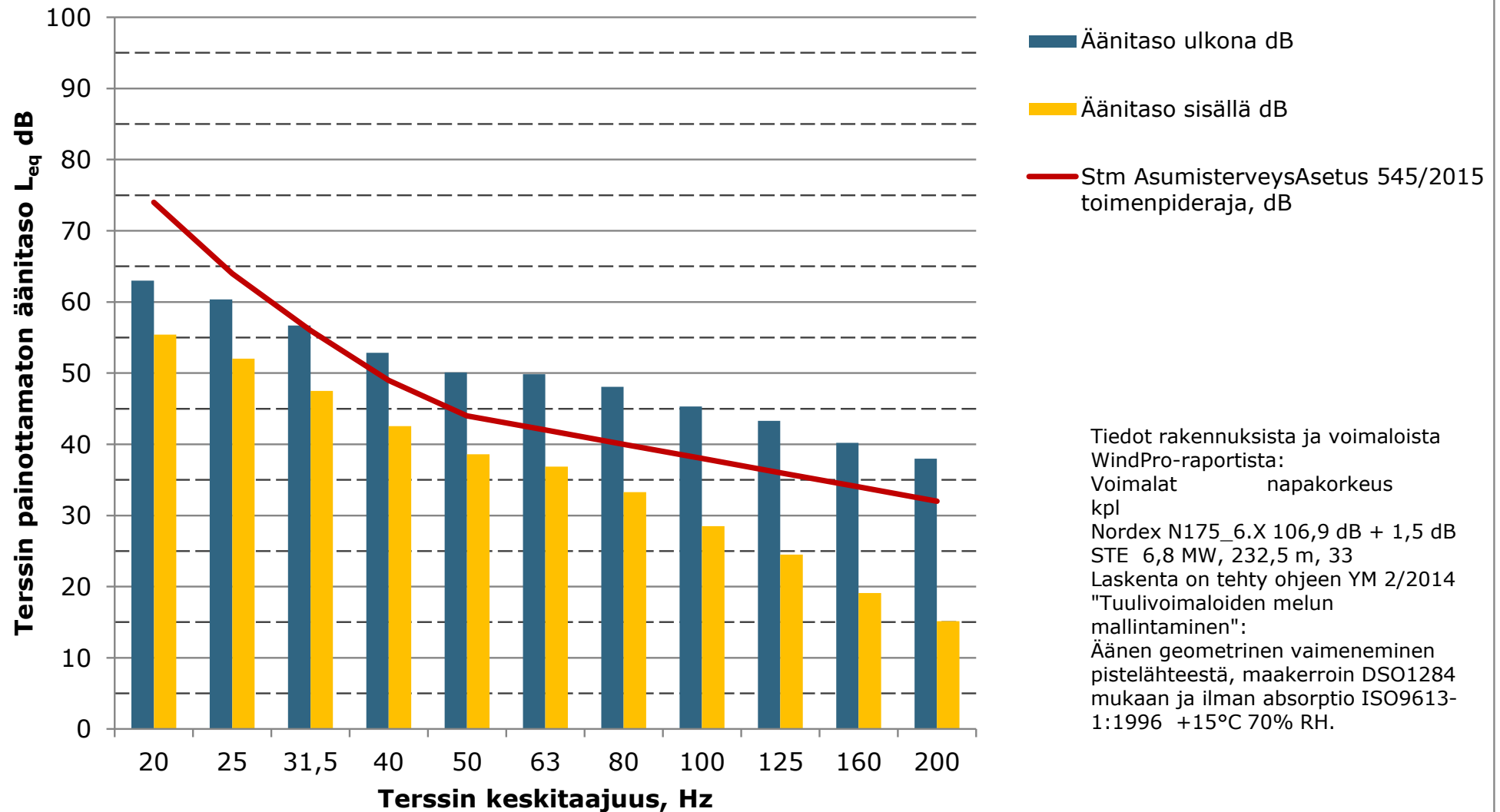
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

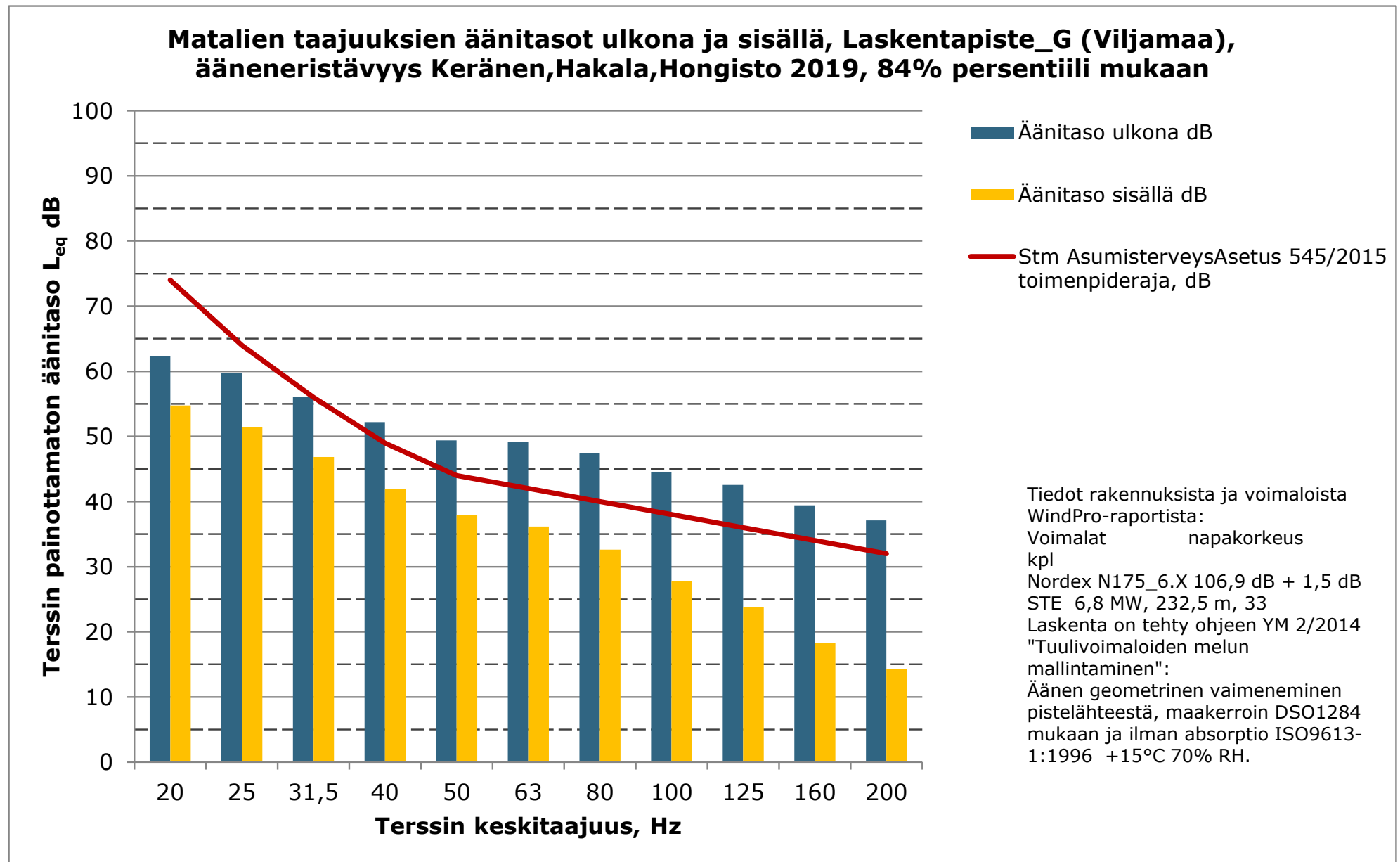


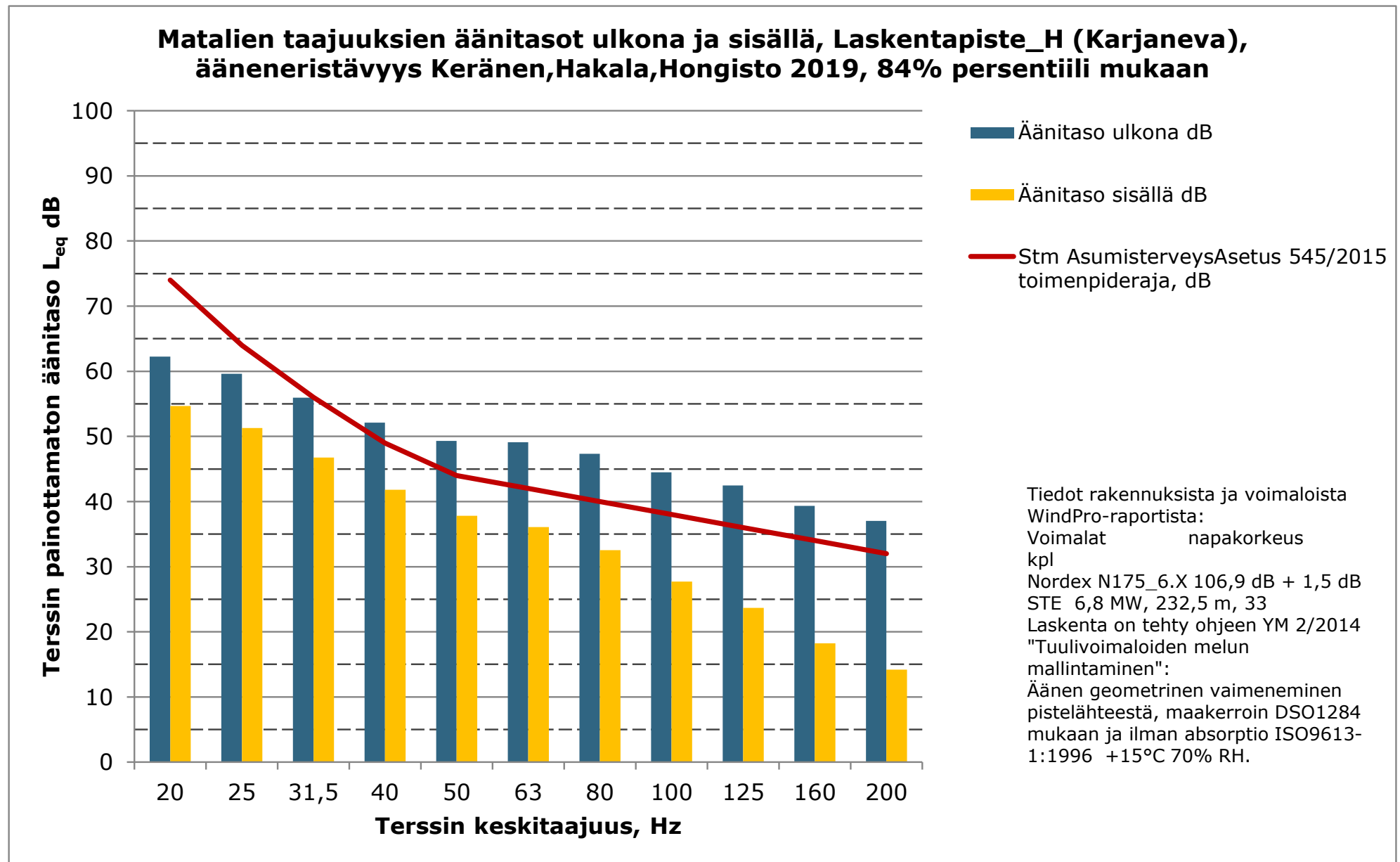
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

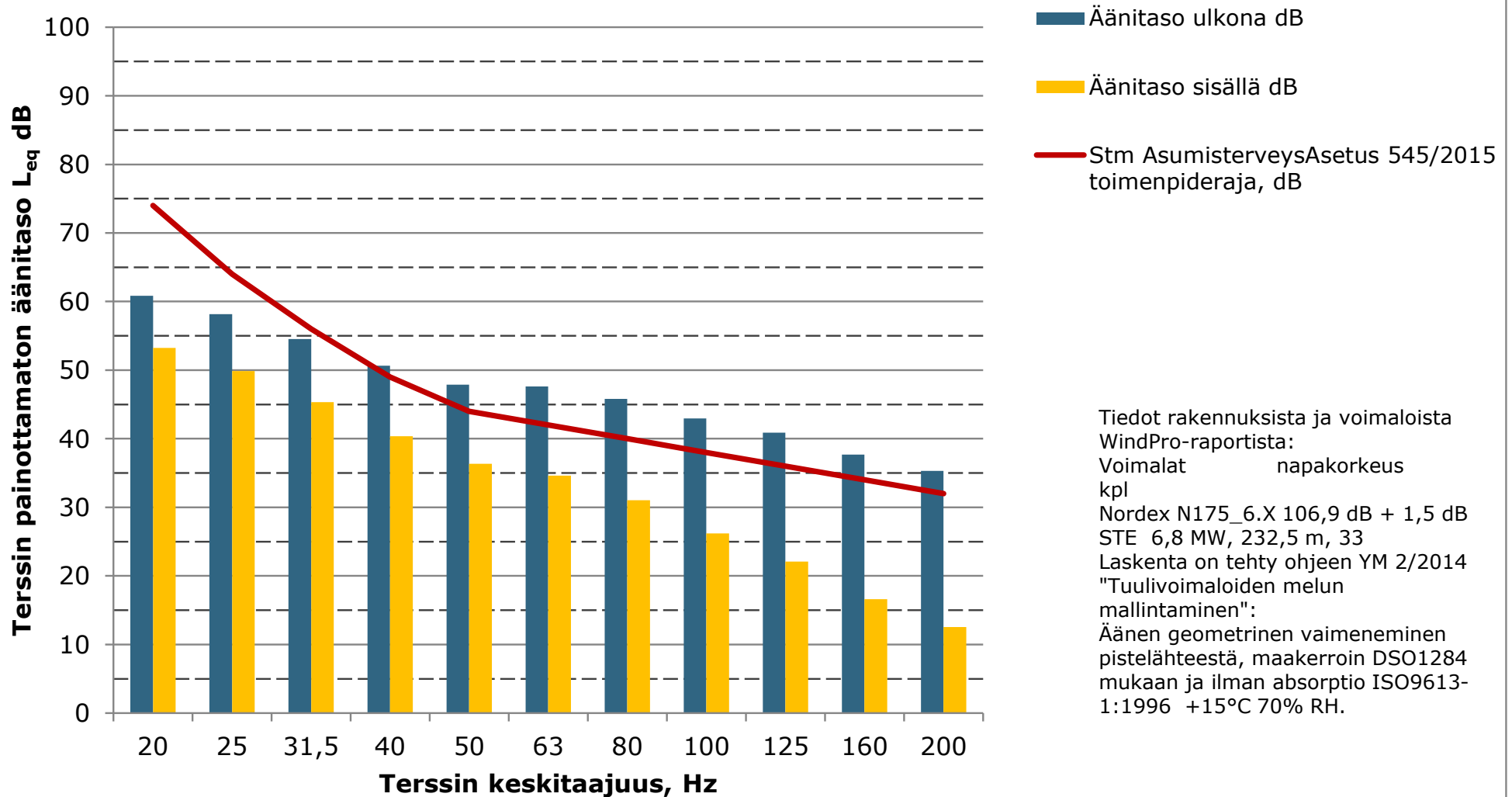
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_E (Huhtakylä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



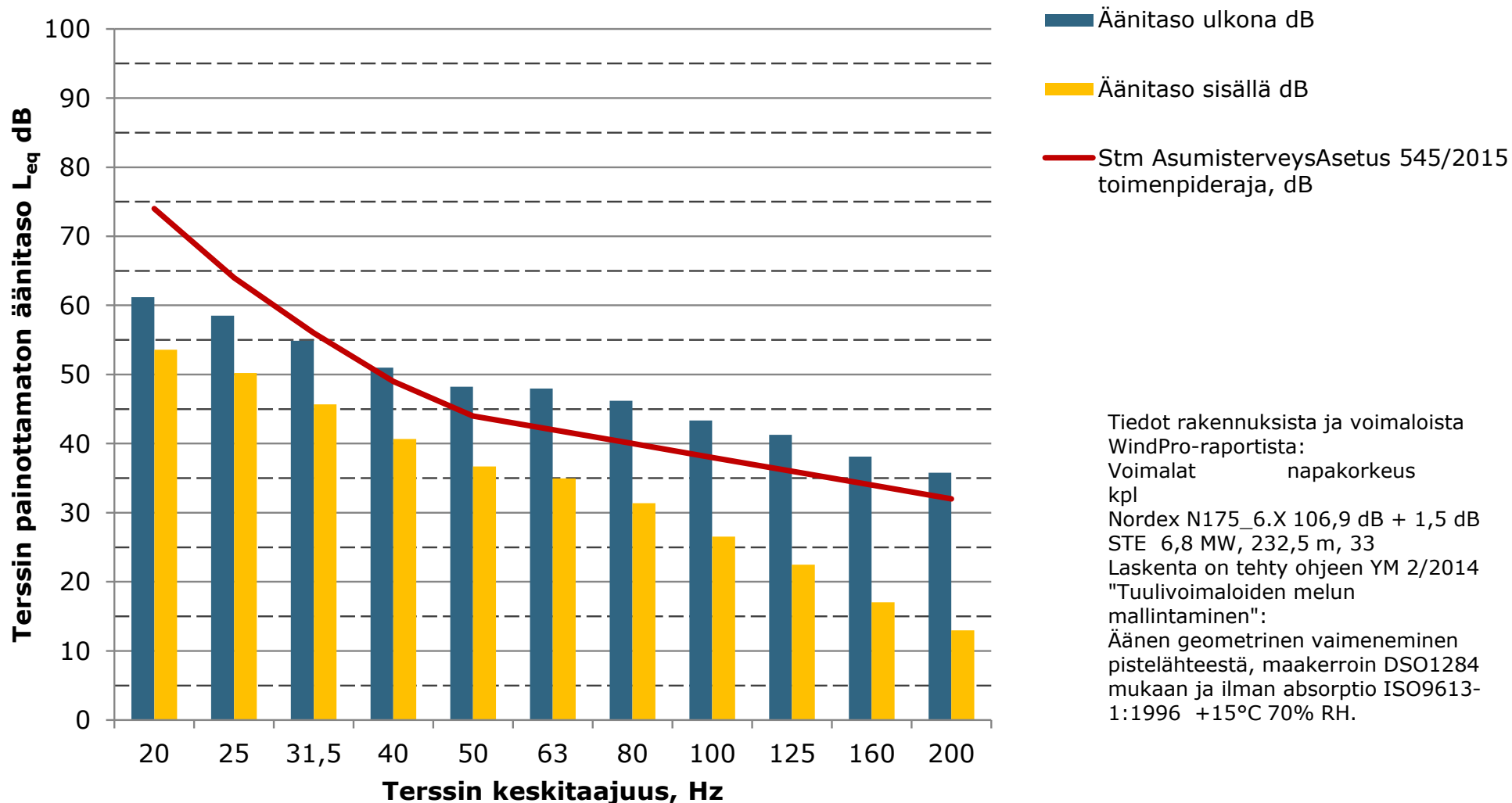




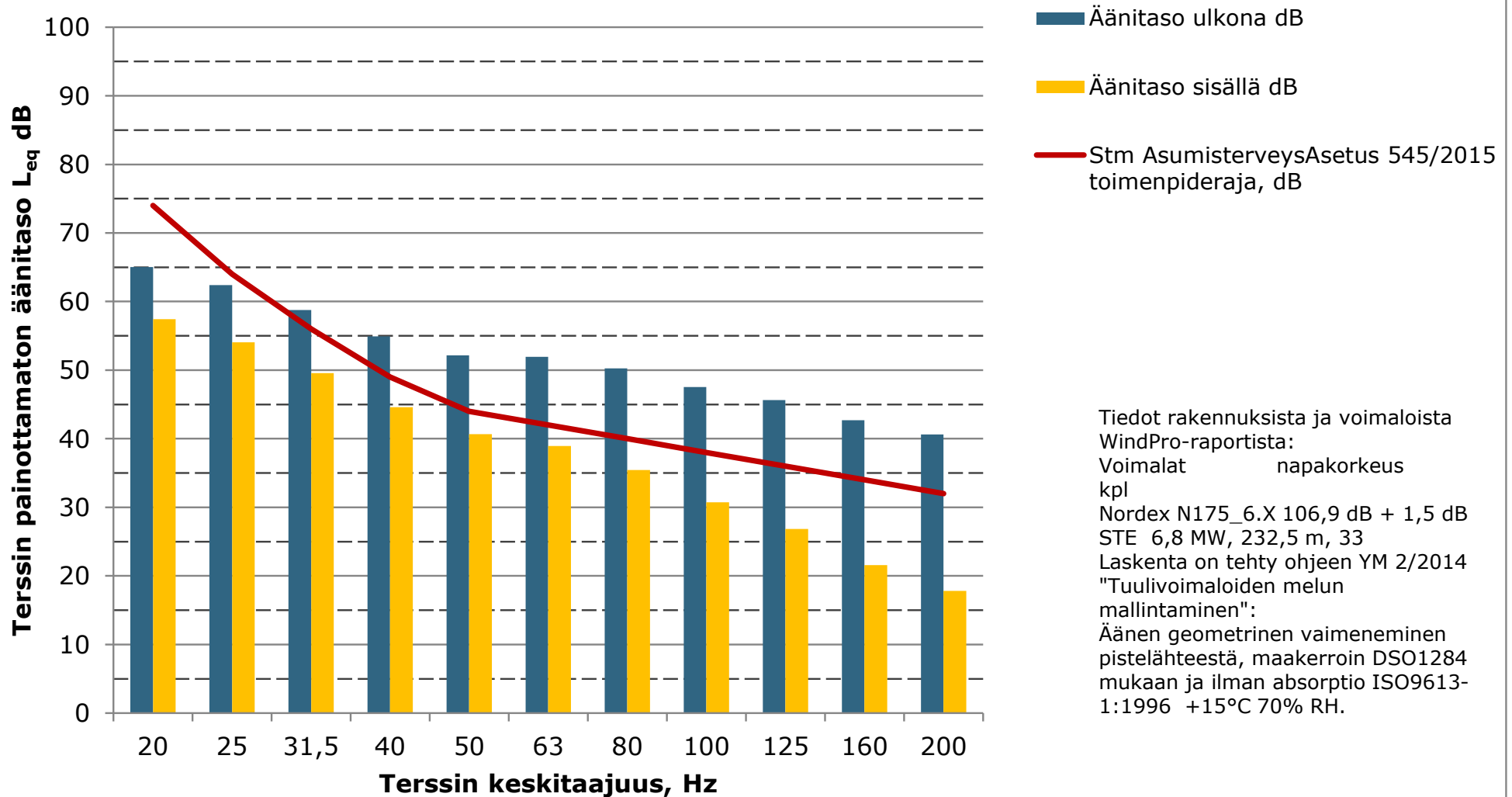
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

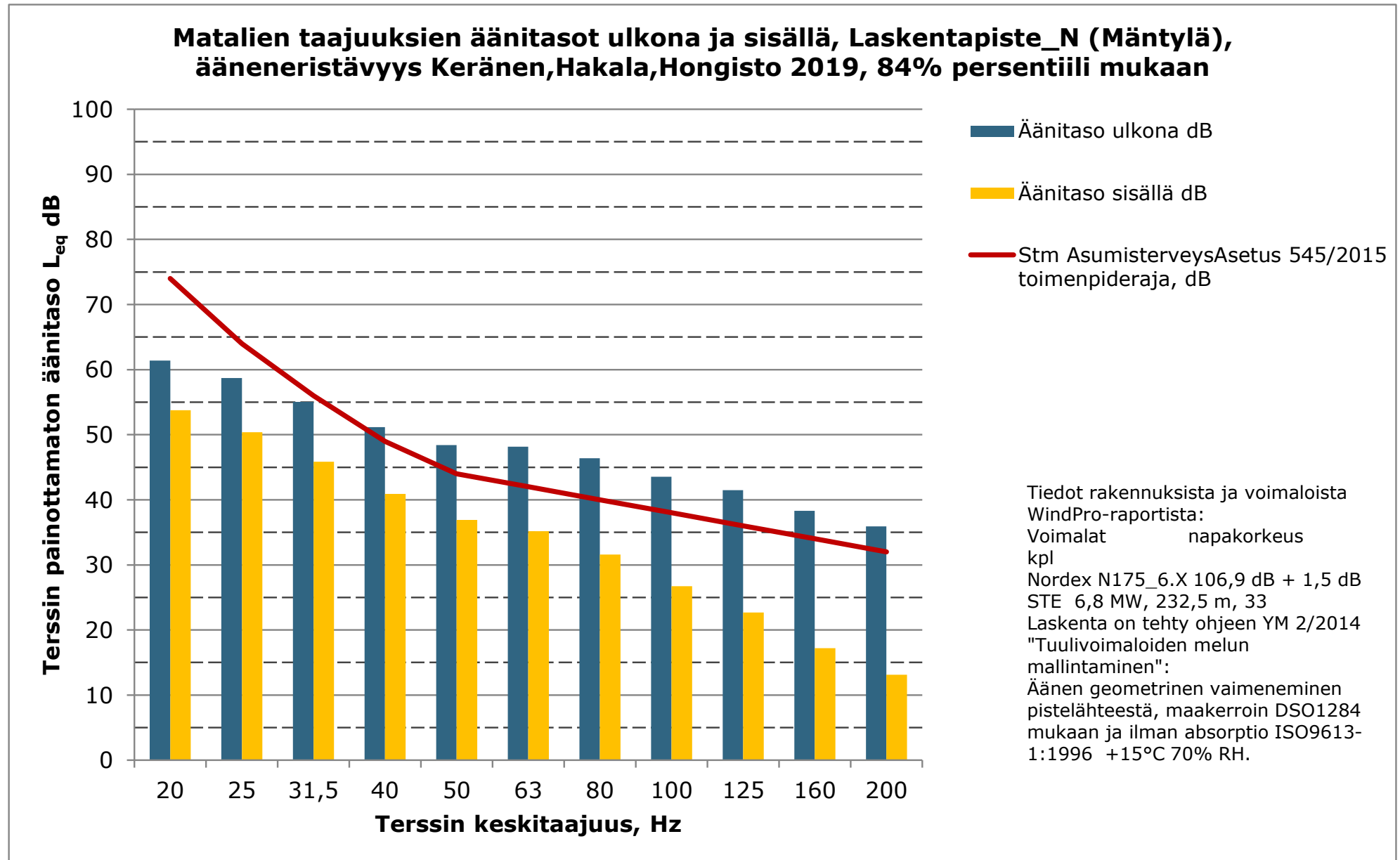


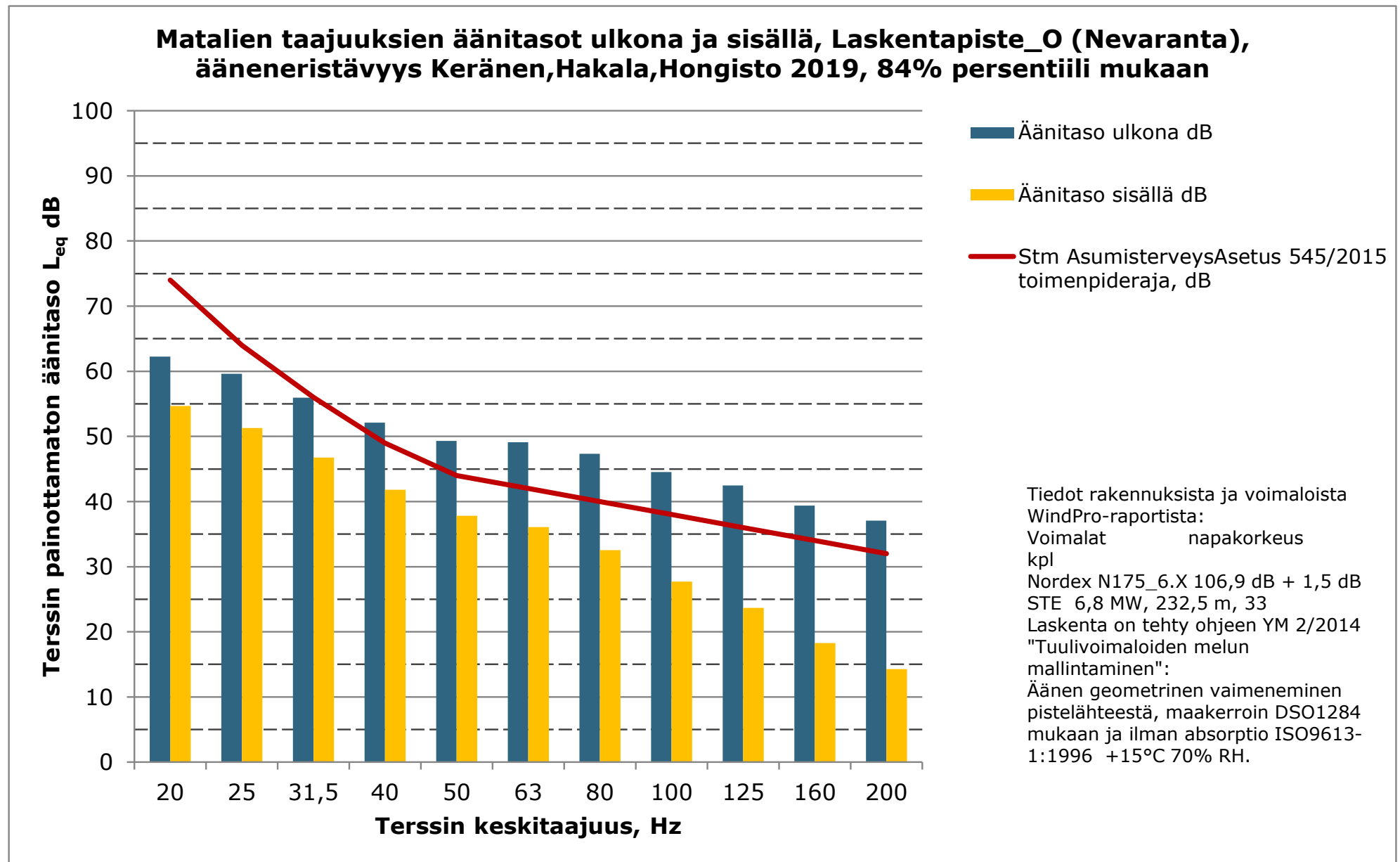
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

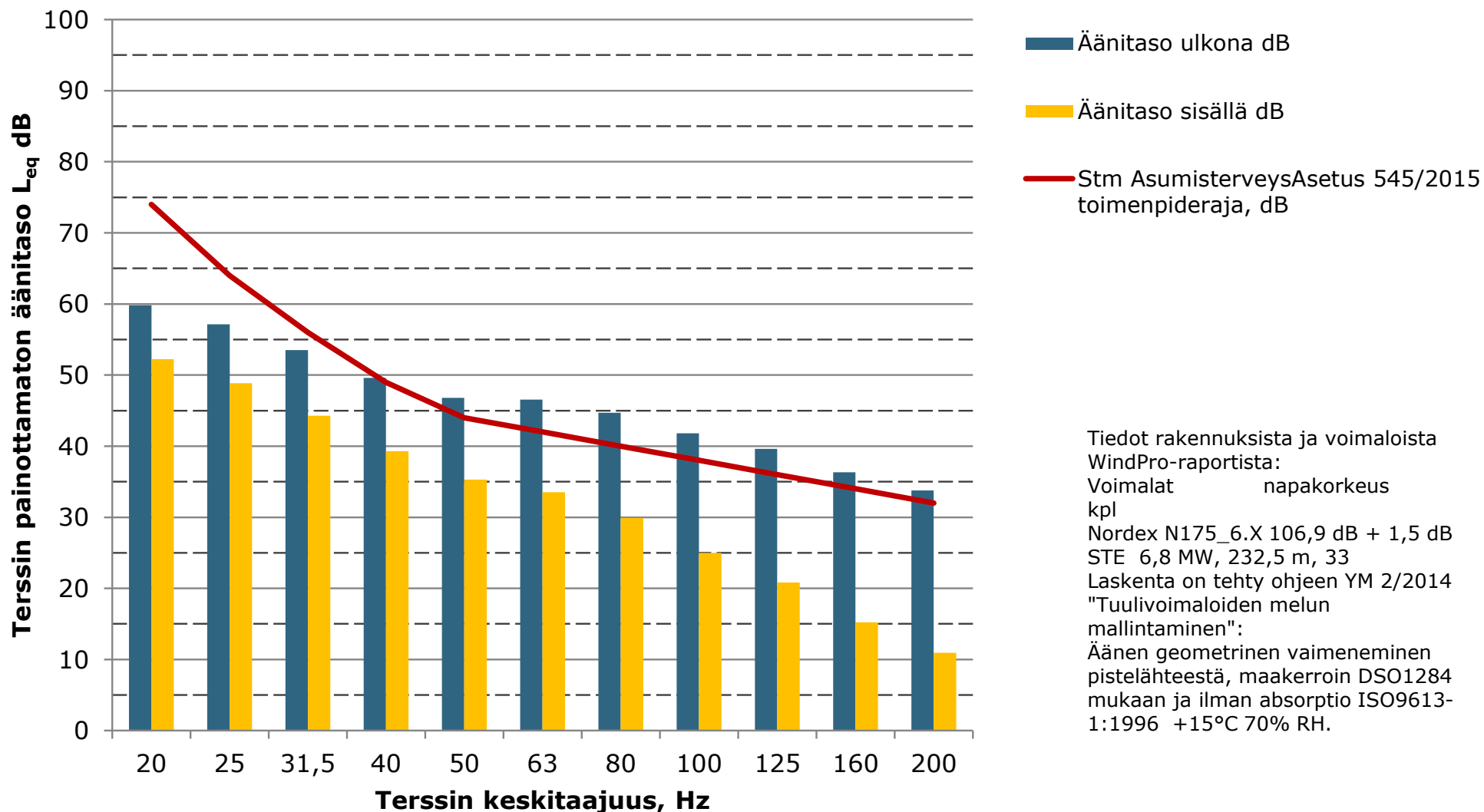


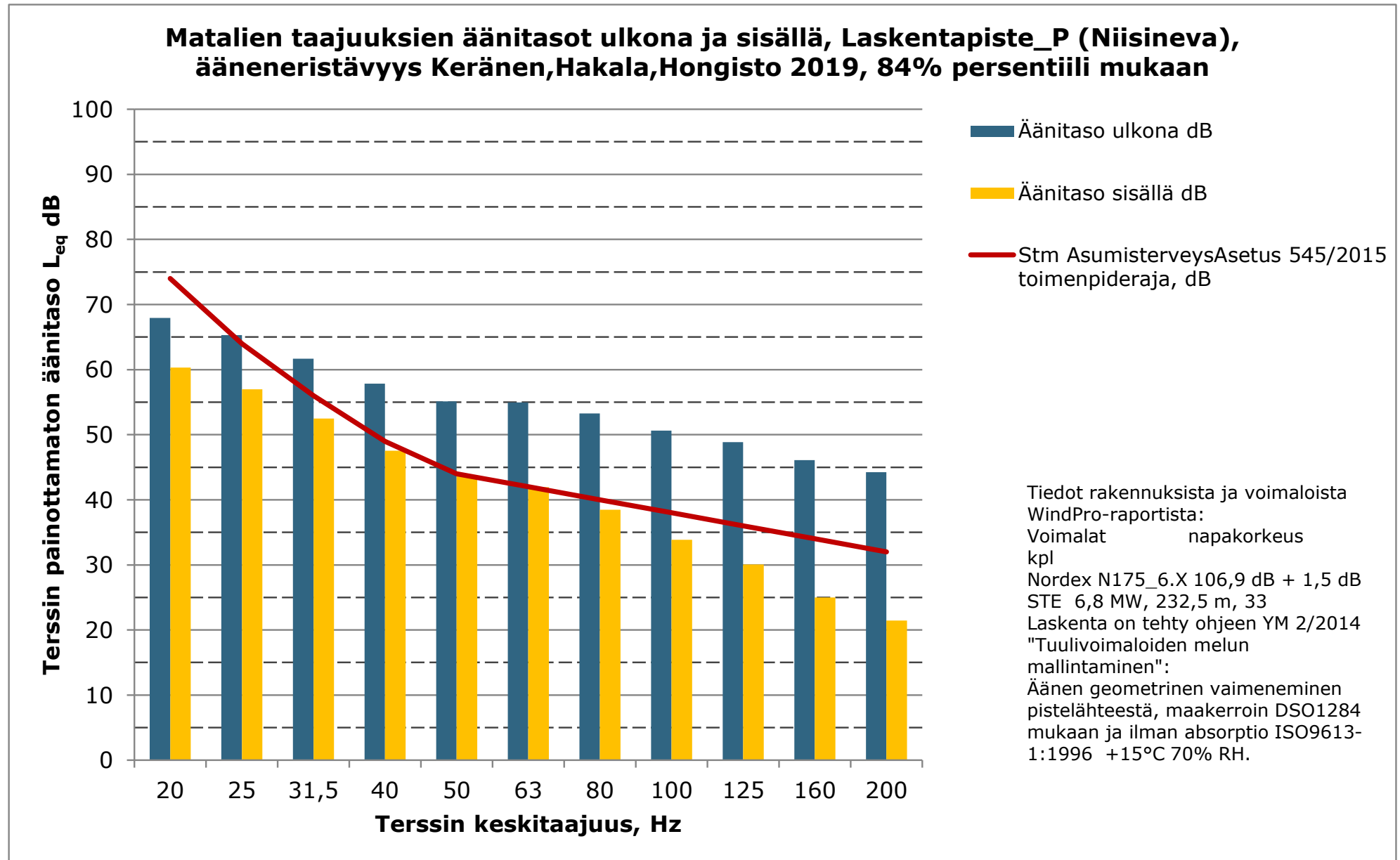
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



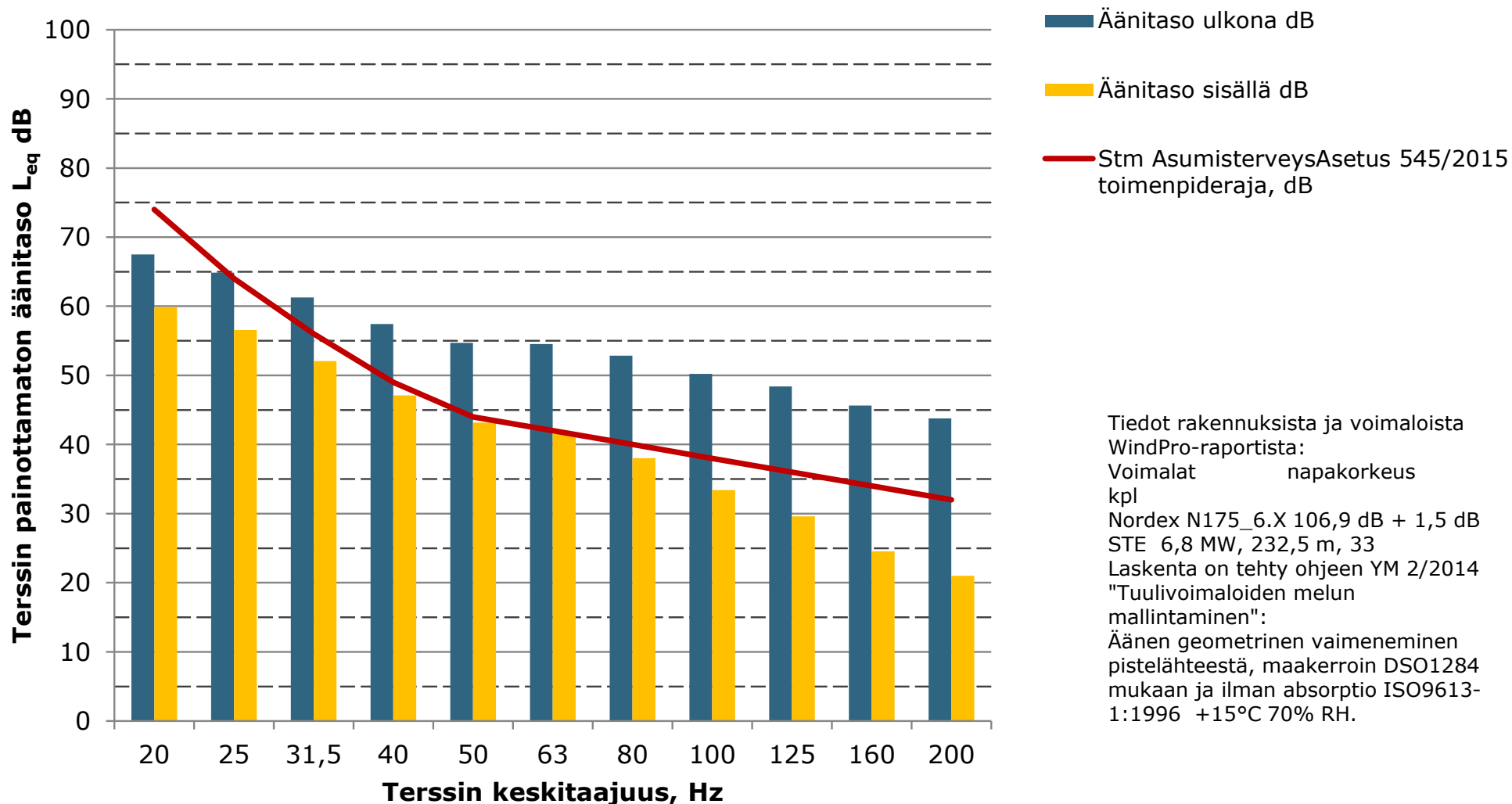




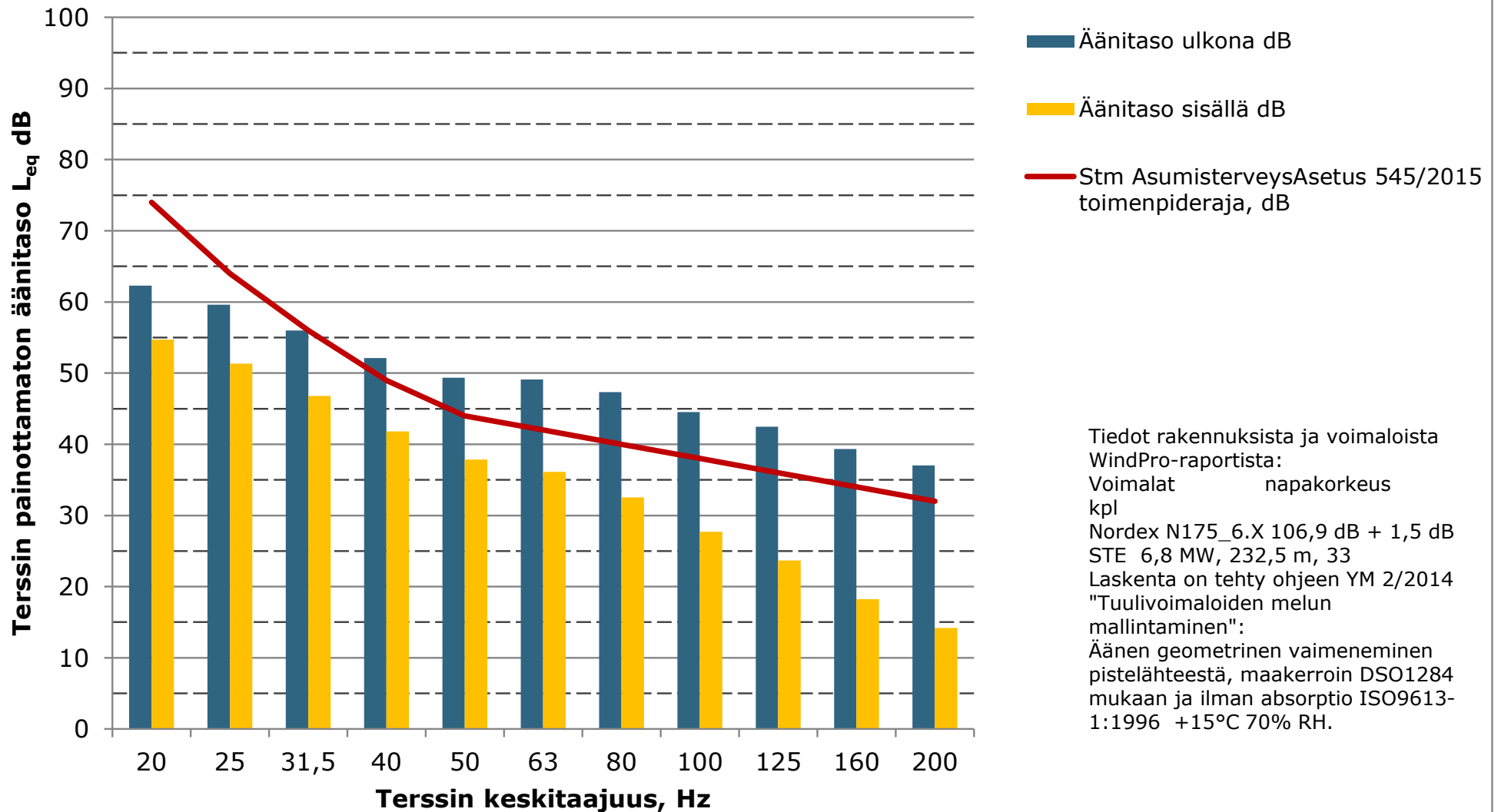
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

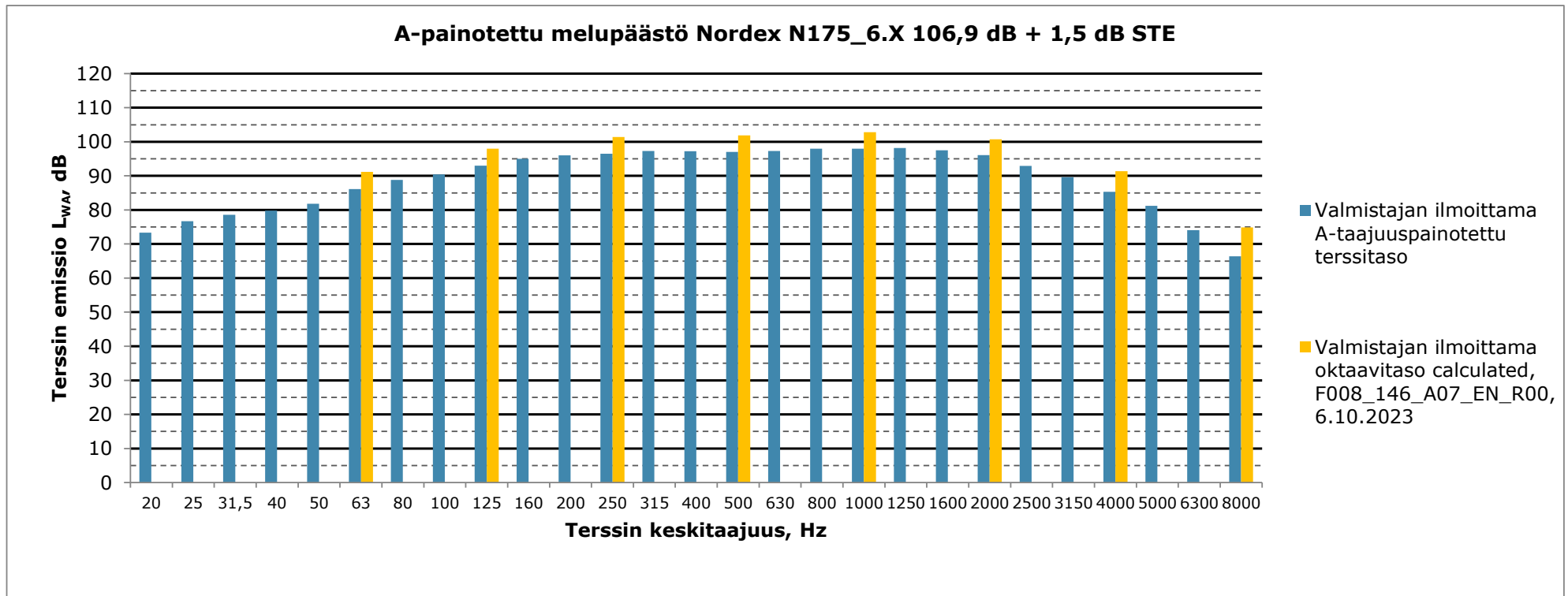


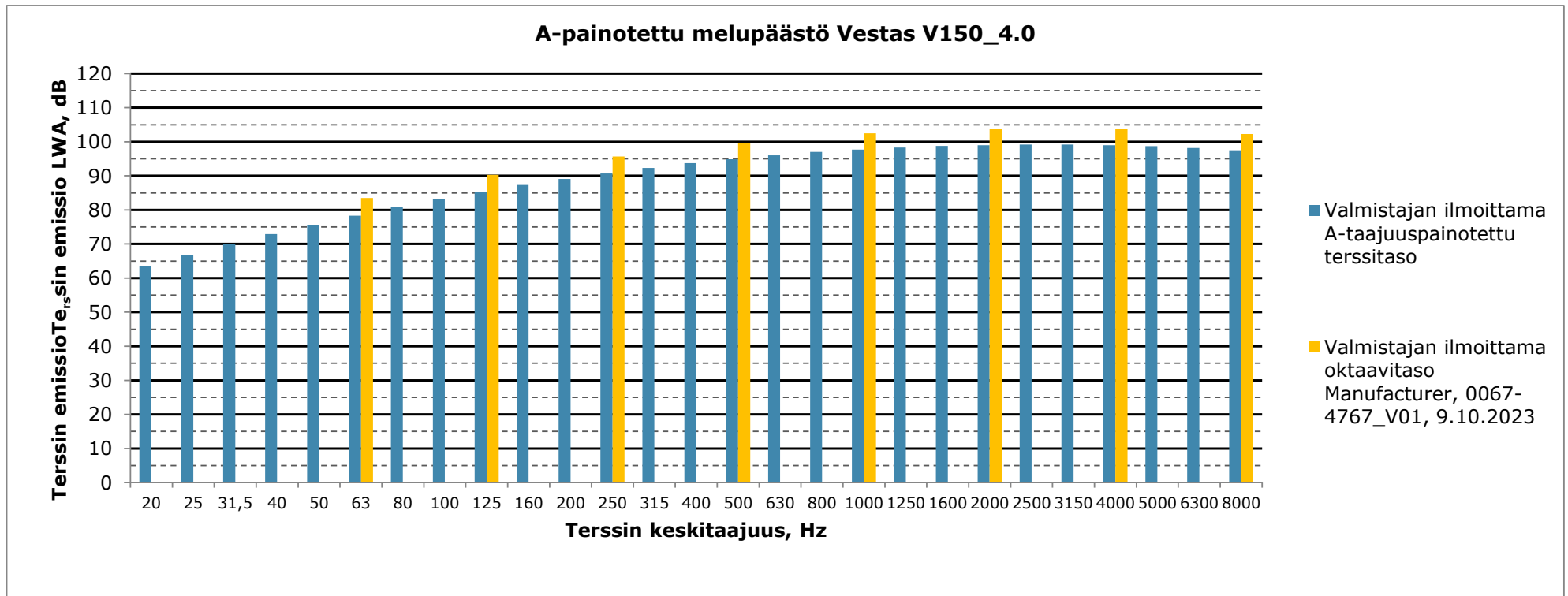
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

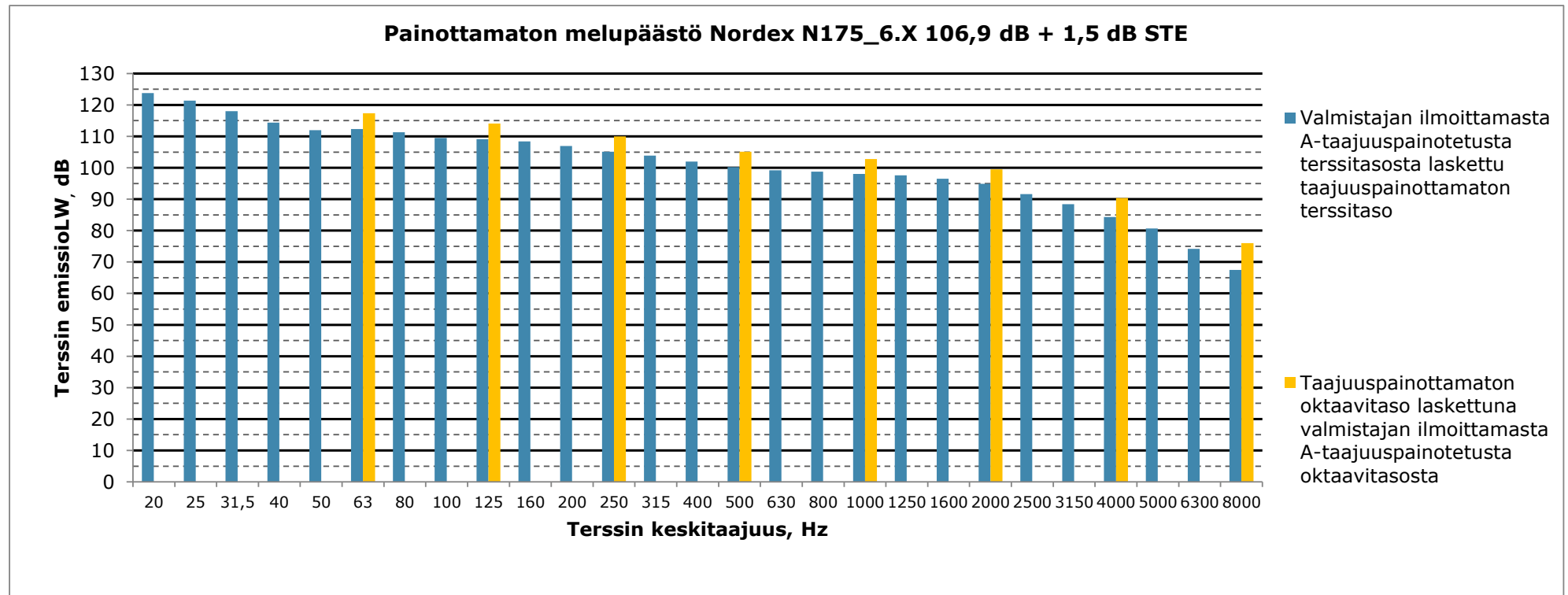


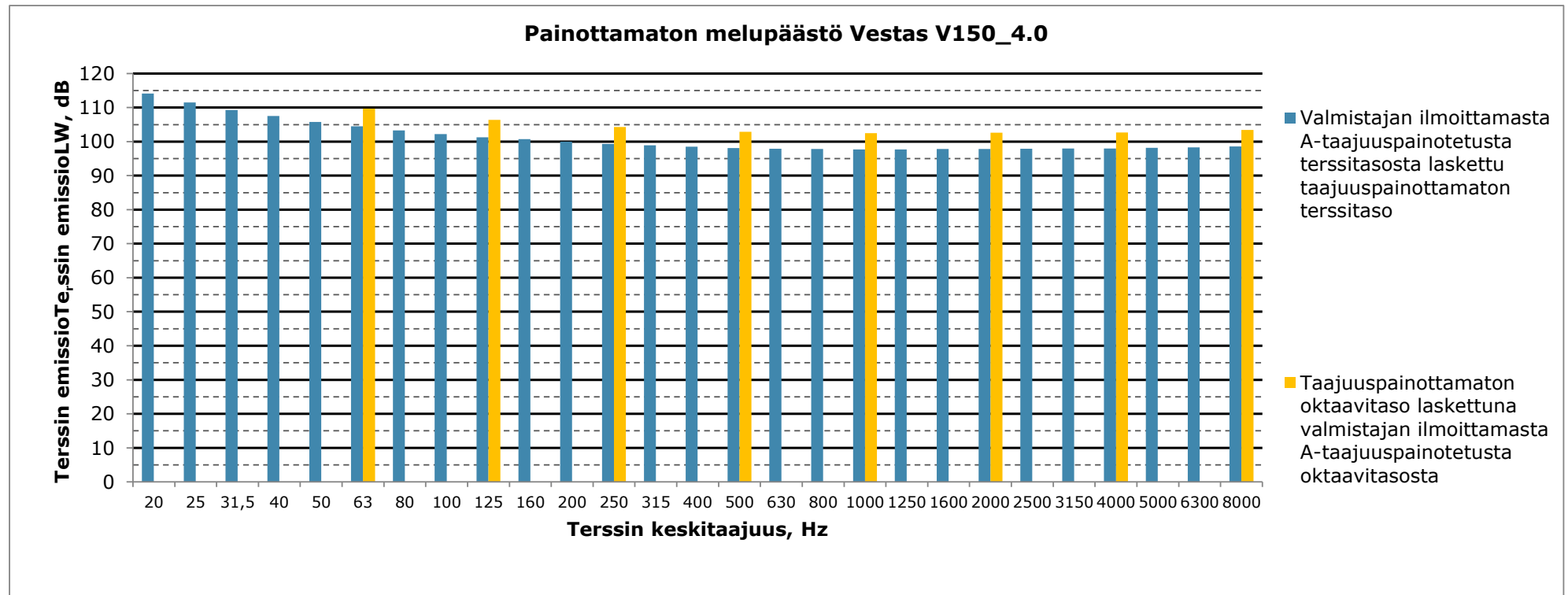
11.10.2023

Liite 8. Verkasalon tuulivoimahanke – matalataajuisen melun rakennuskohtaiset arvot VE2 N175 - 6.8 MW. Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

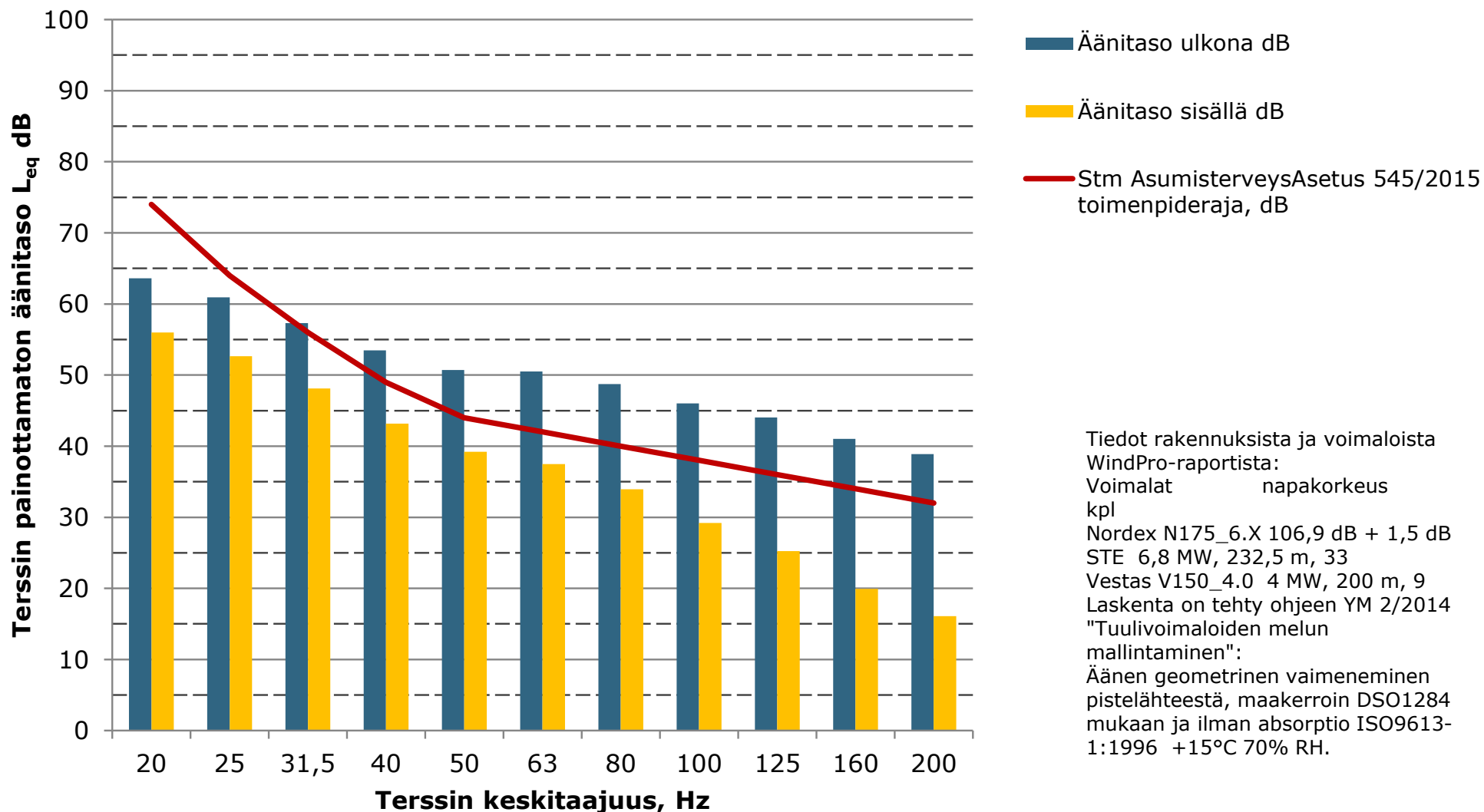




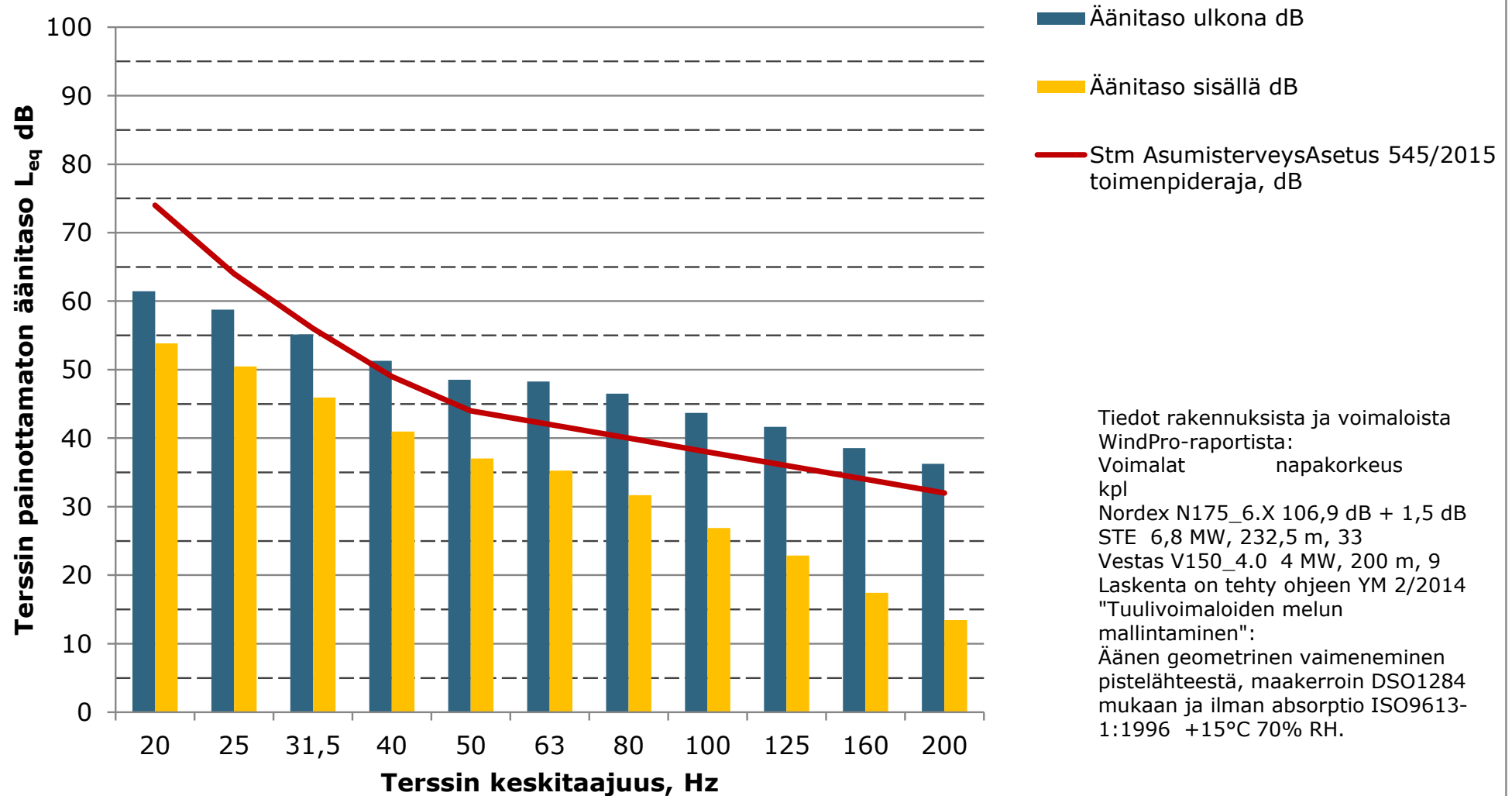




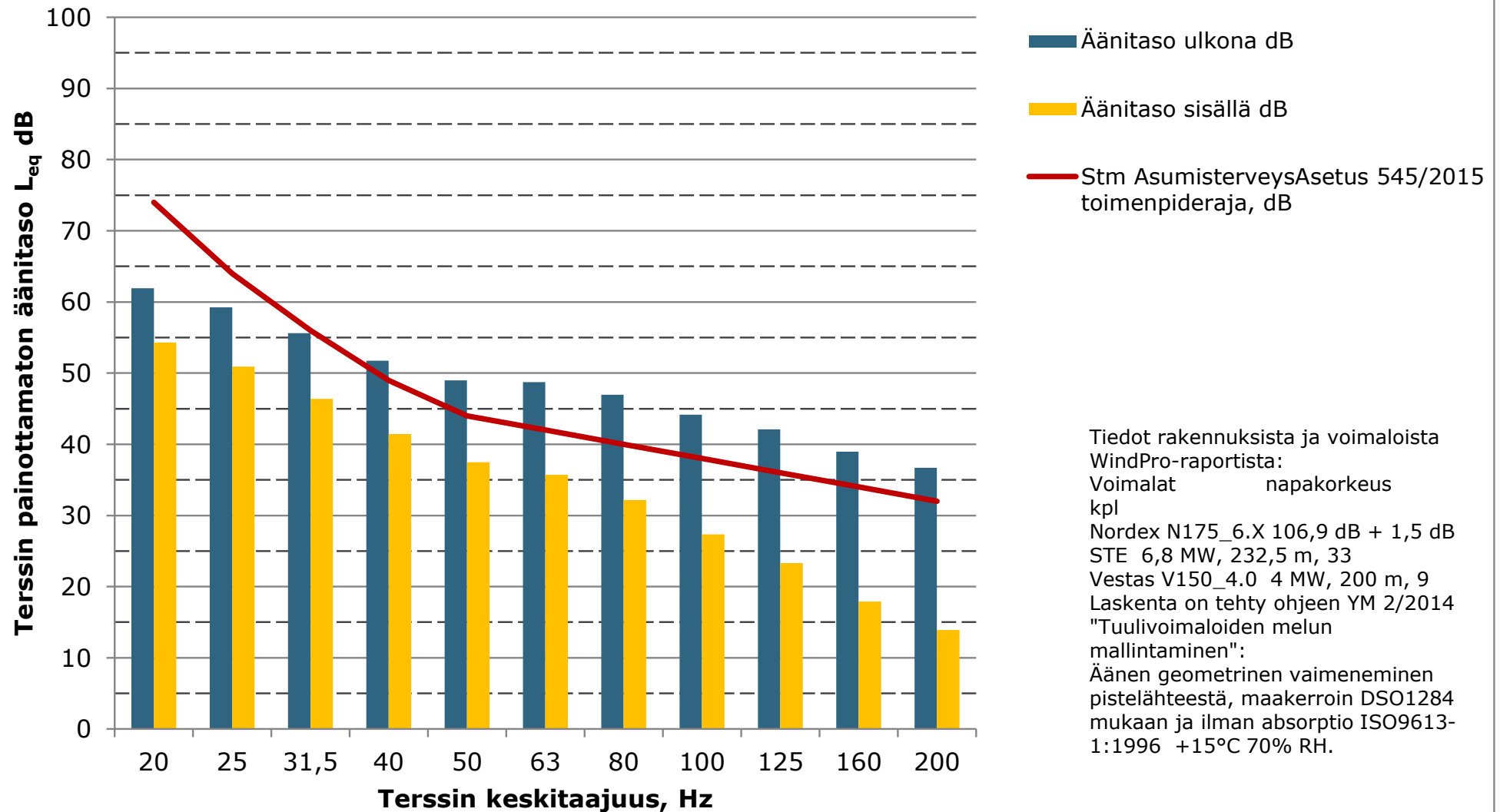
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



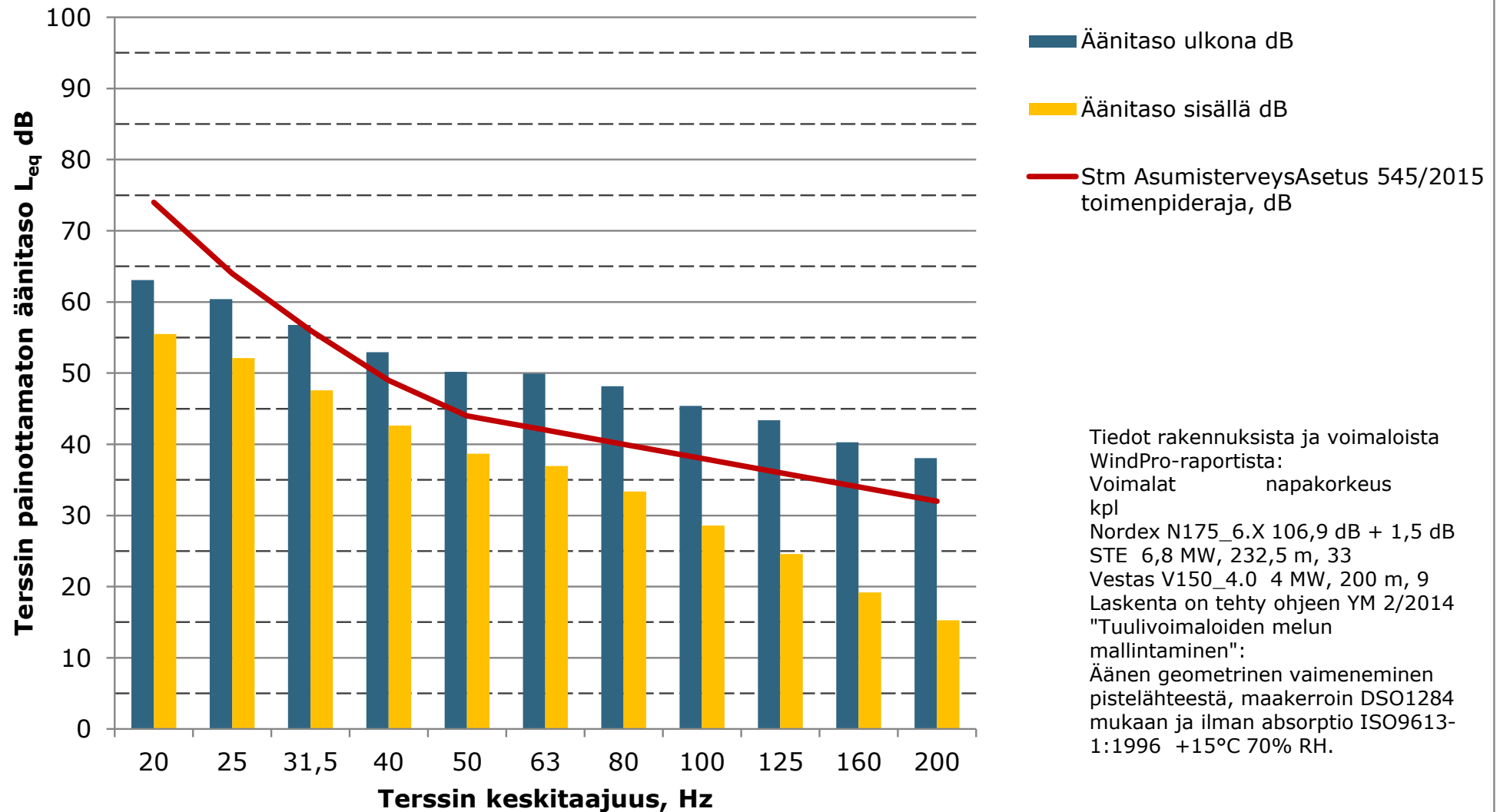
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



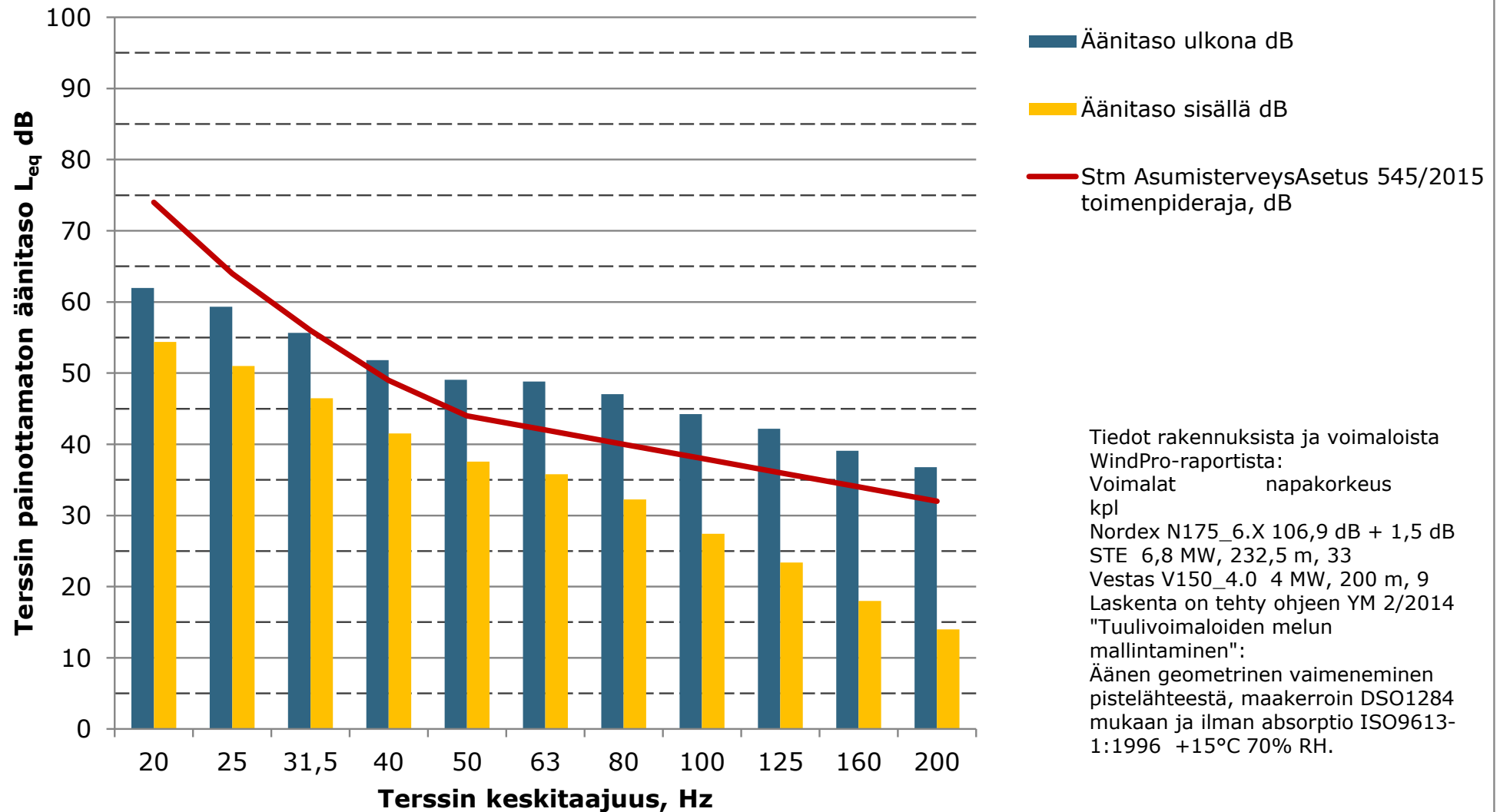
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persenttiili mukaan**



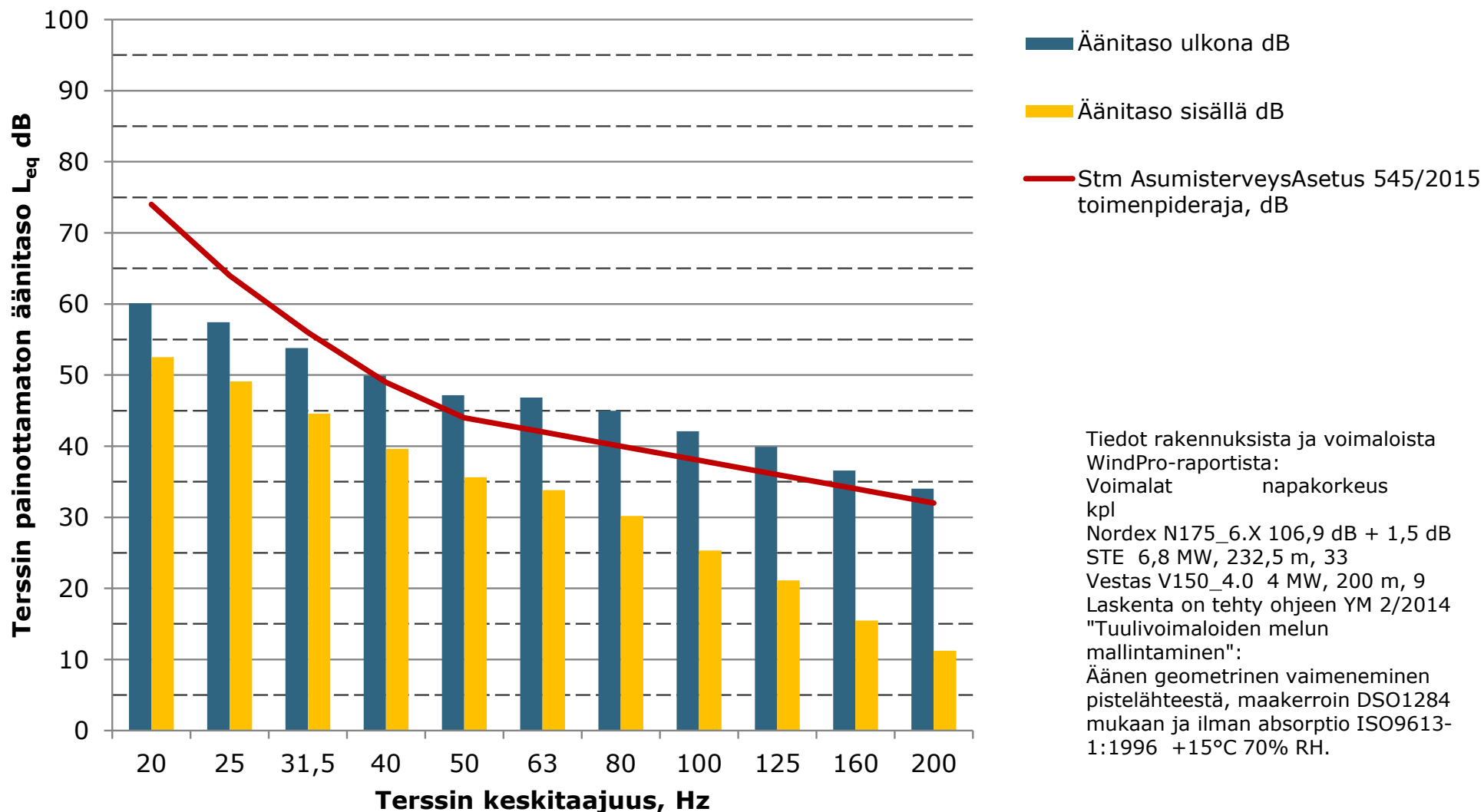
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_F (Huhtakylä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persenttiili mukaan**

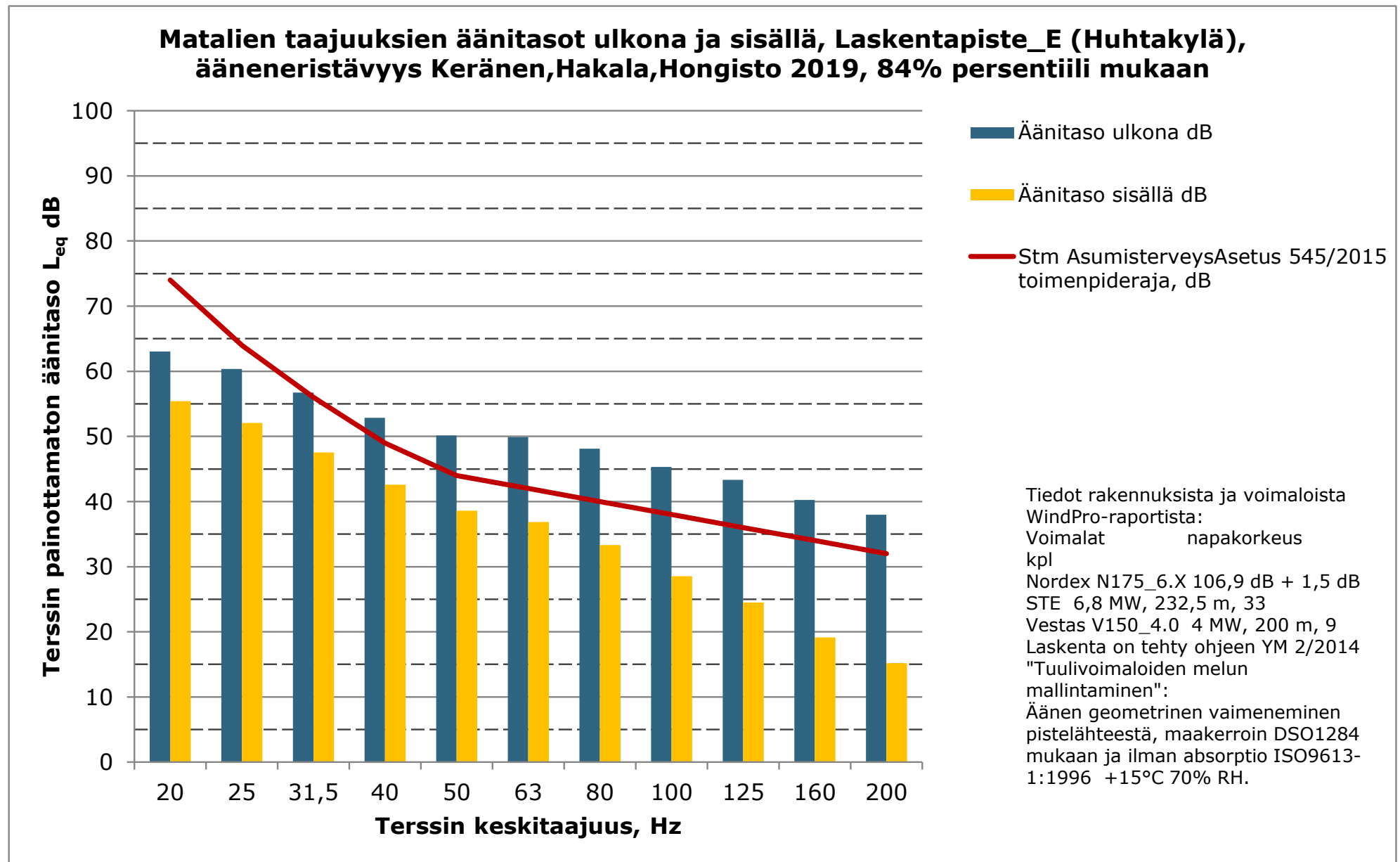


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persenttiili mukaan**

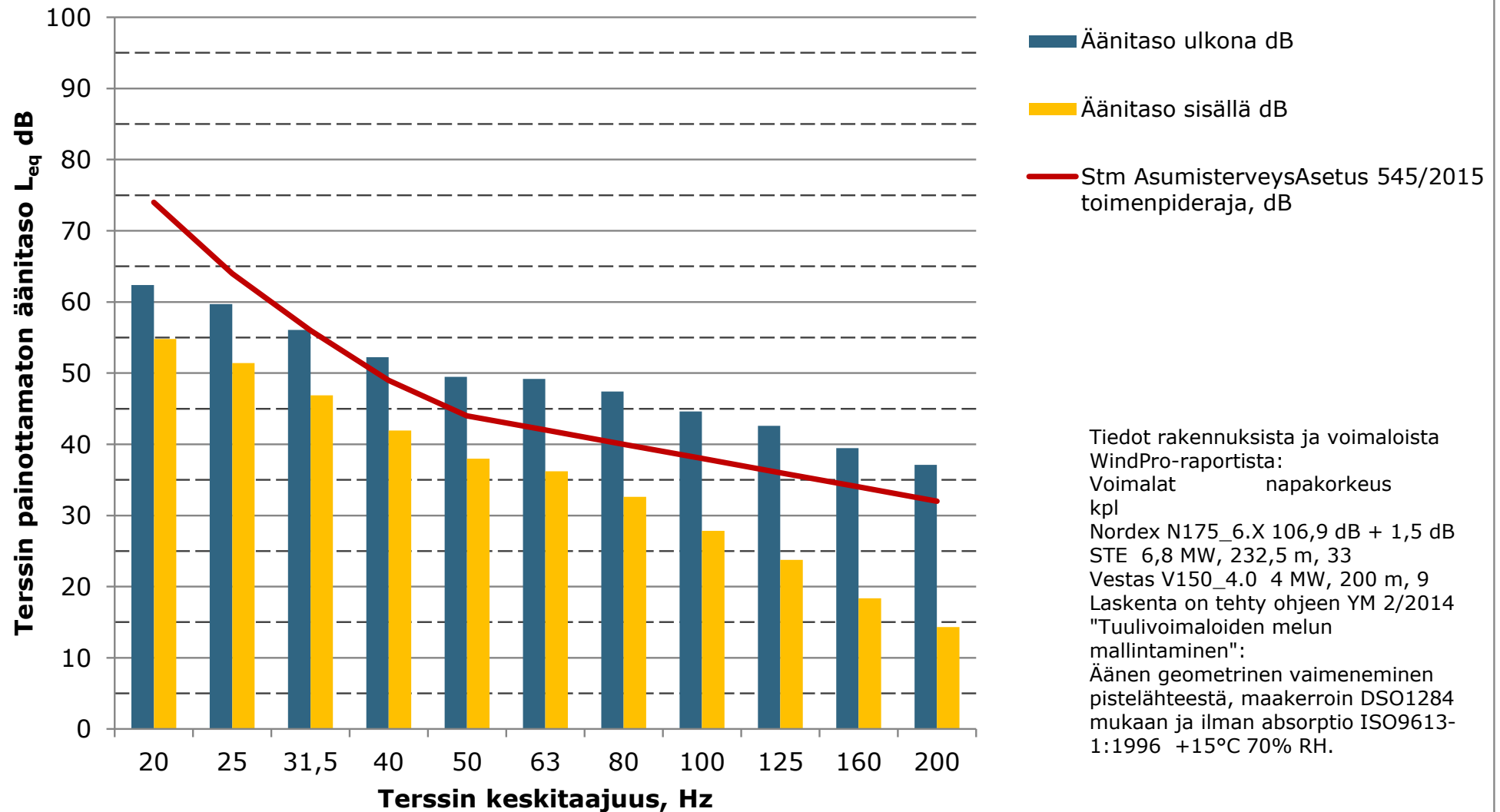


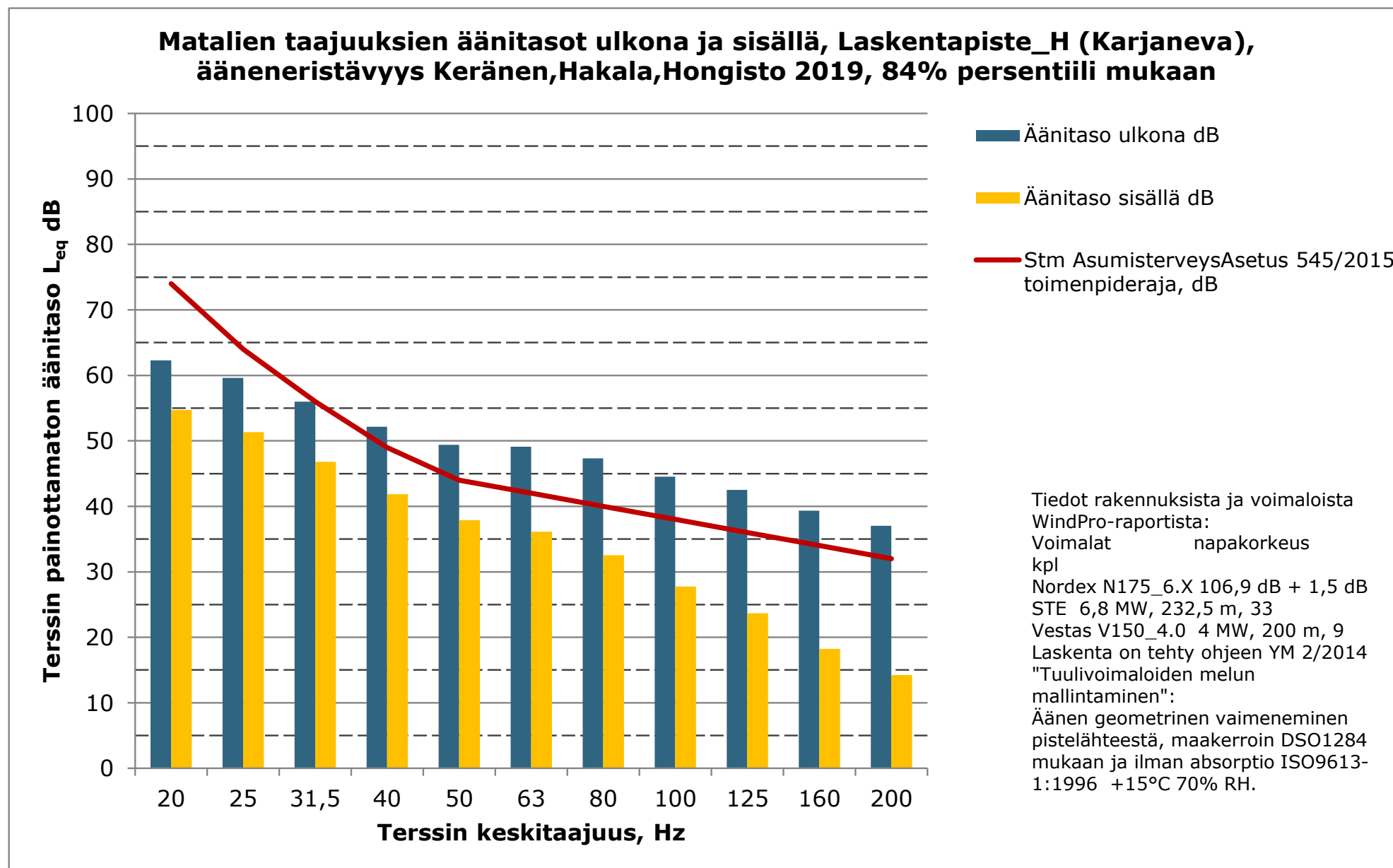
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



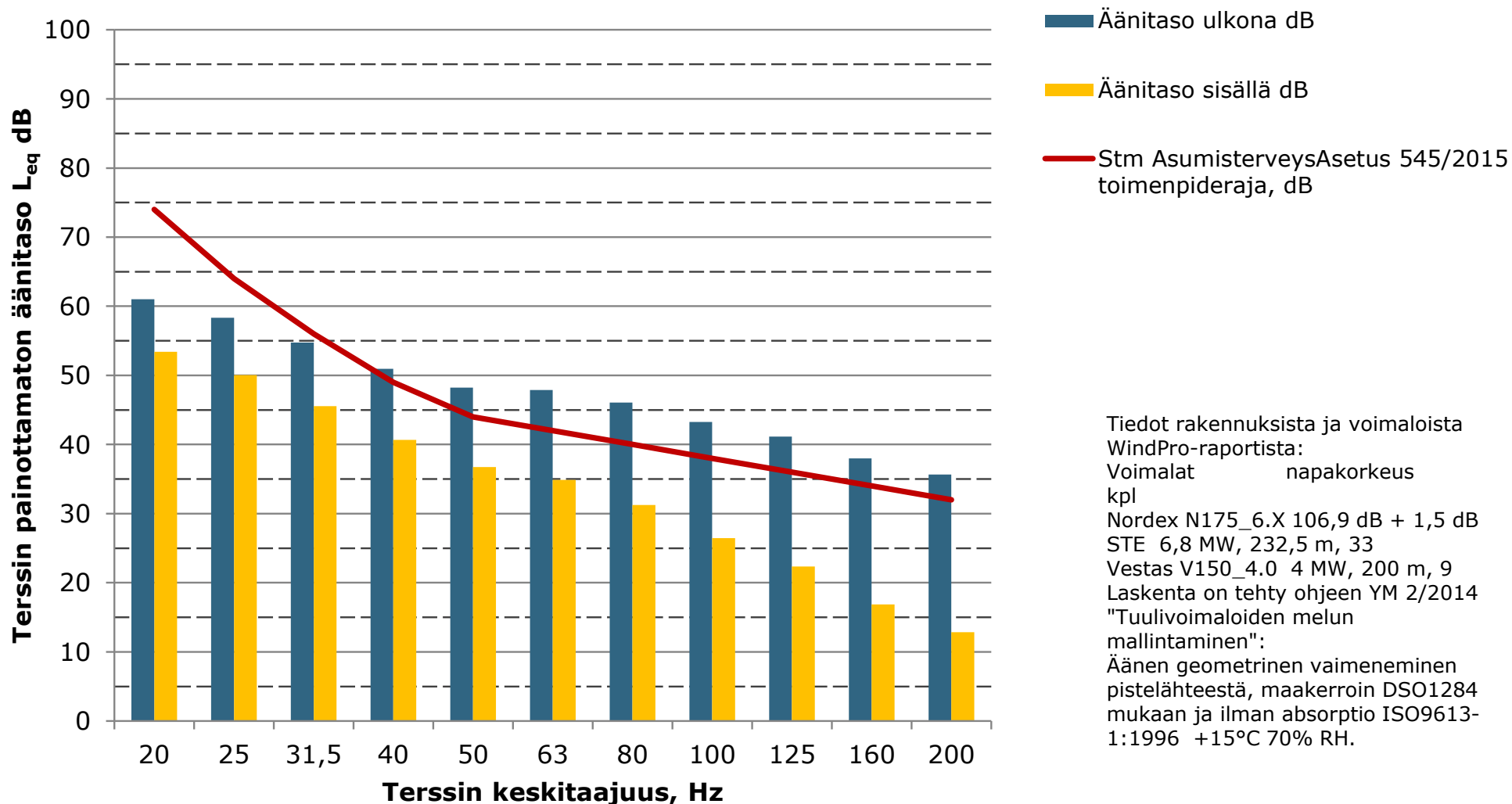


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

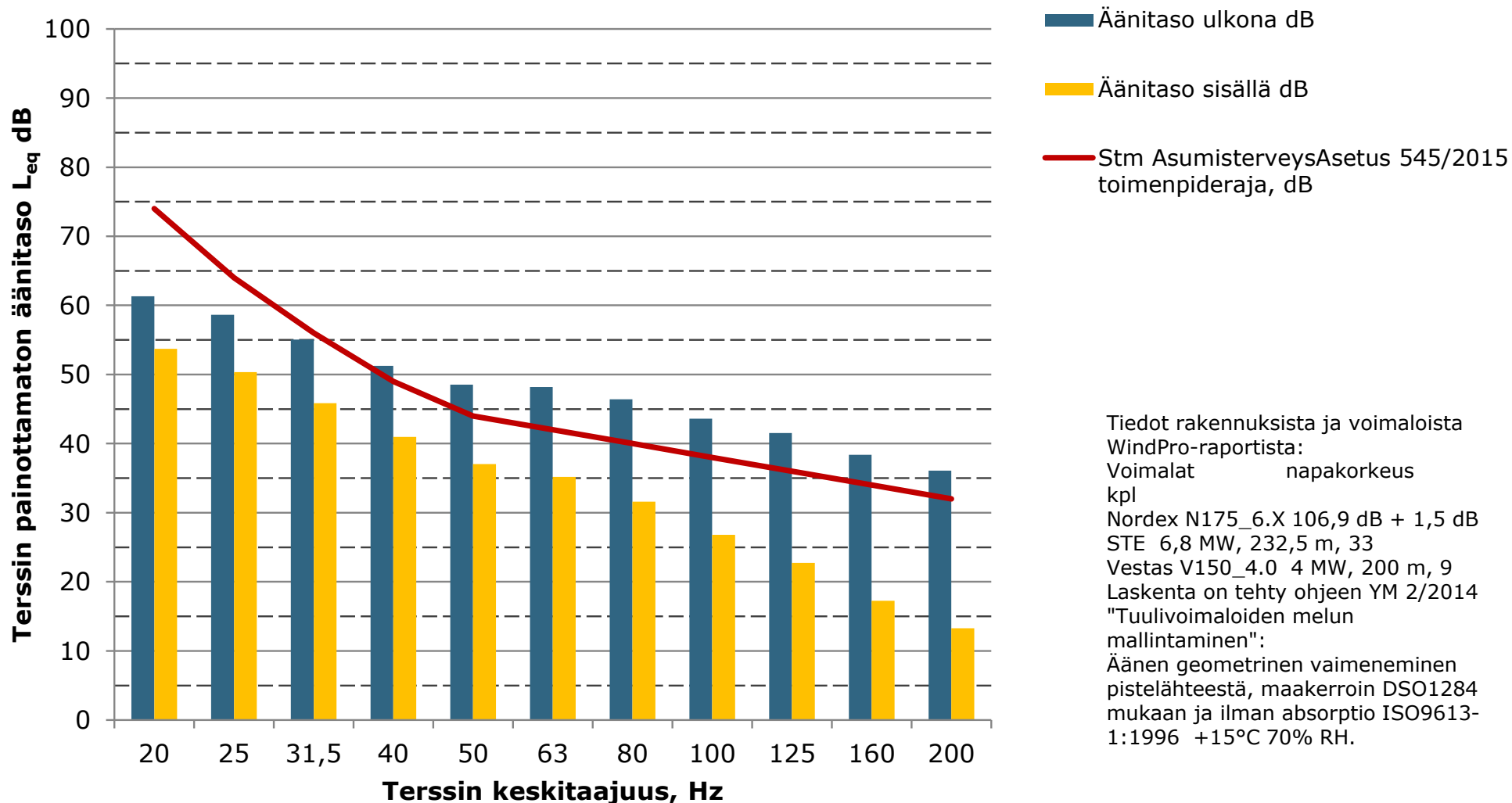




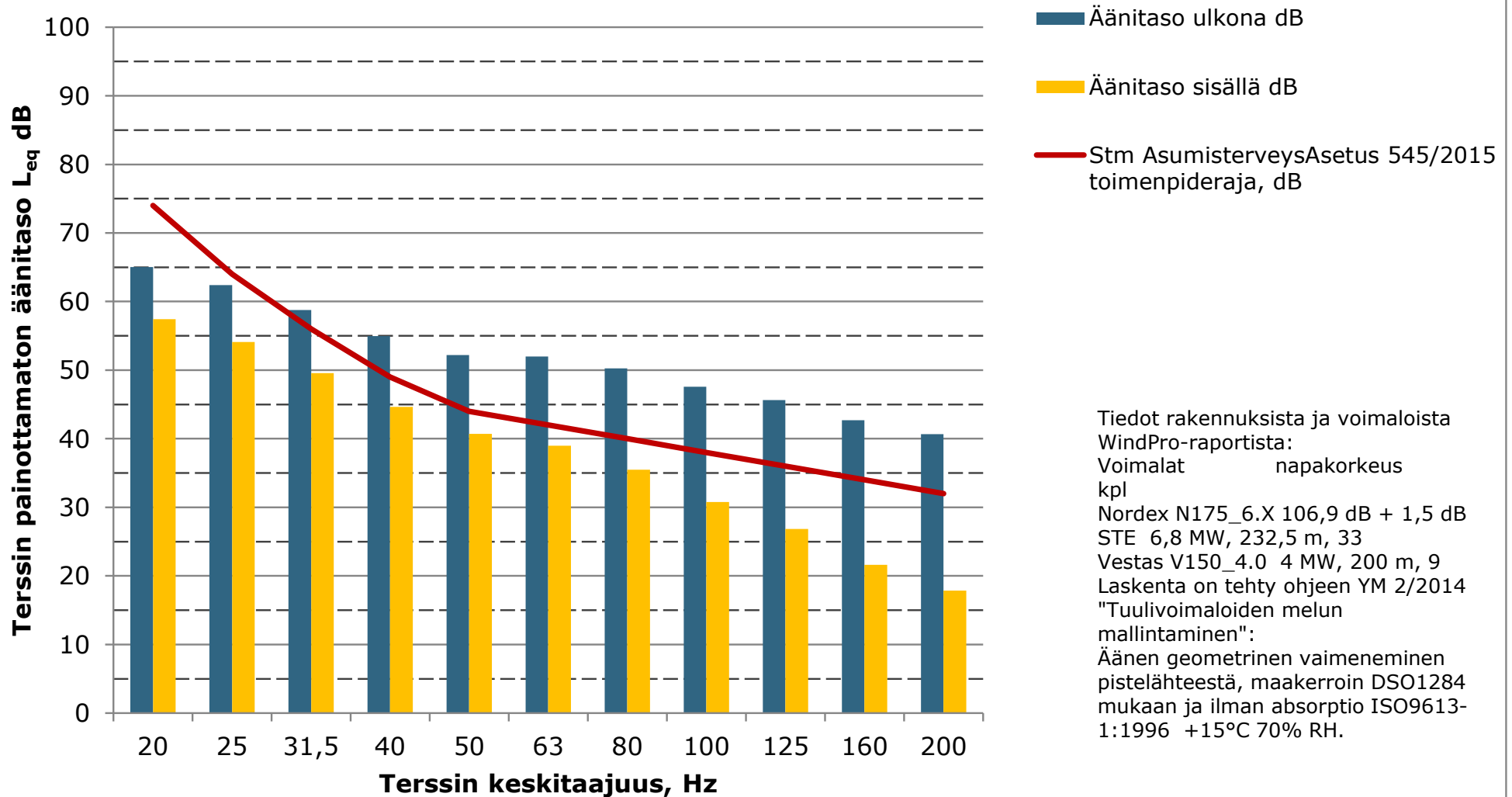
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



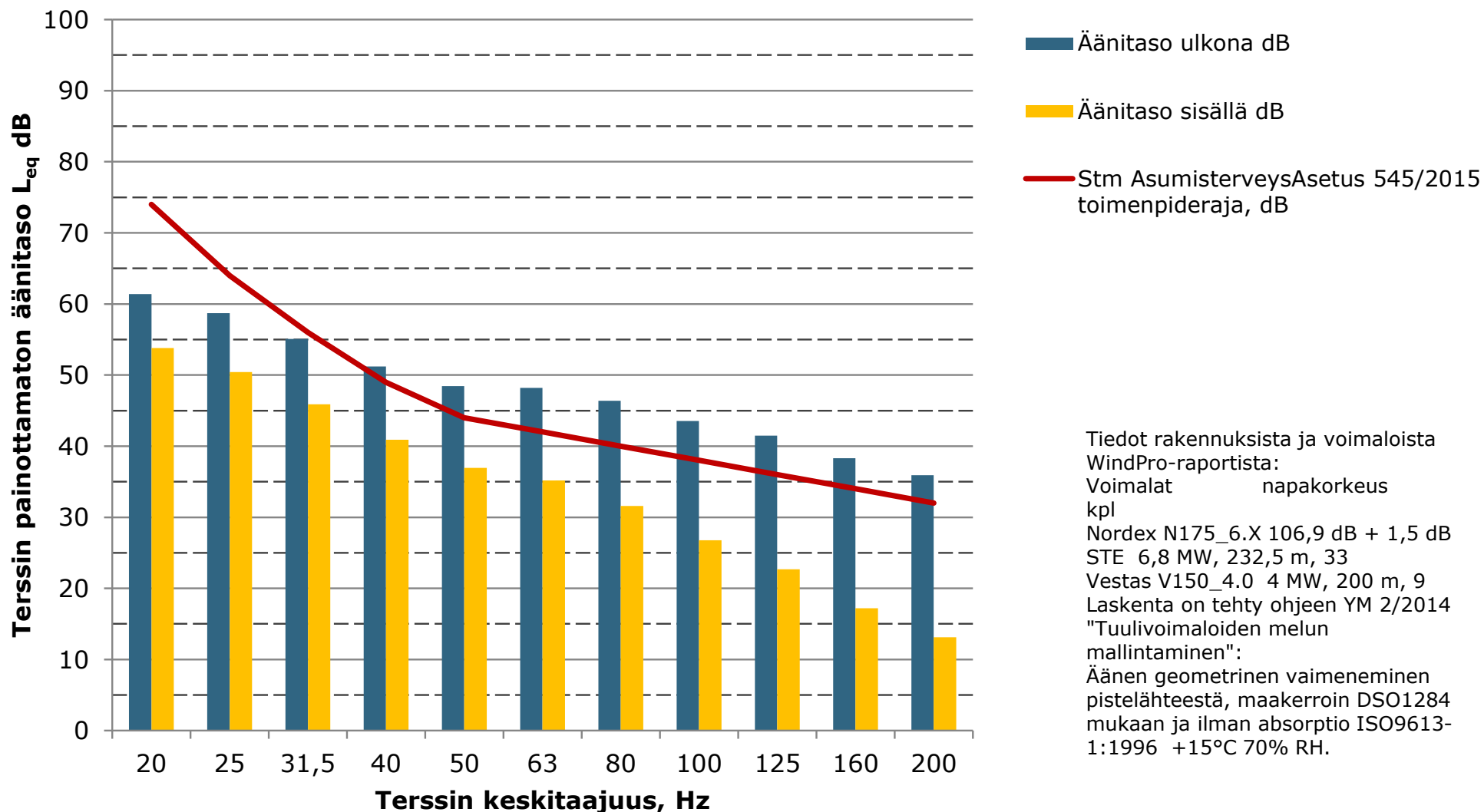
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



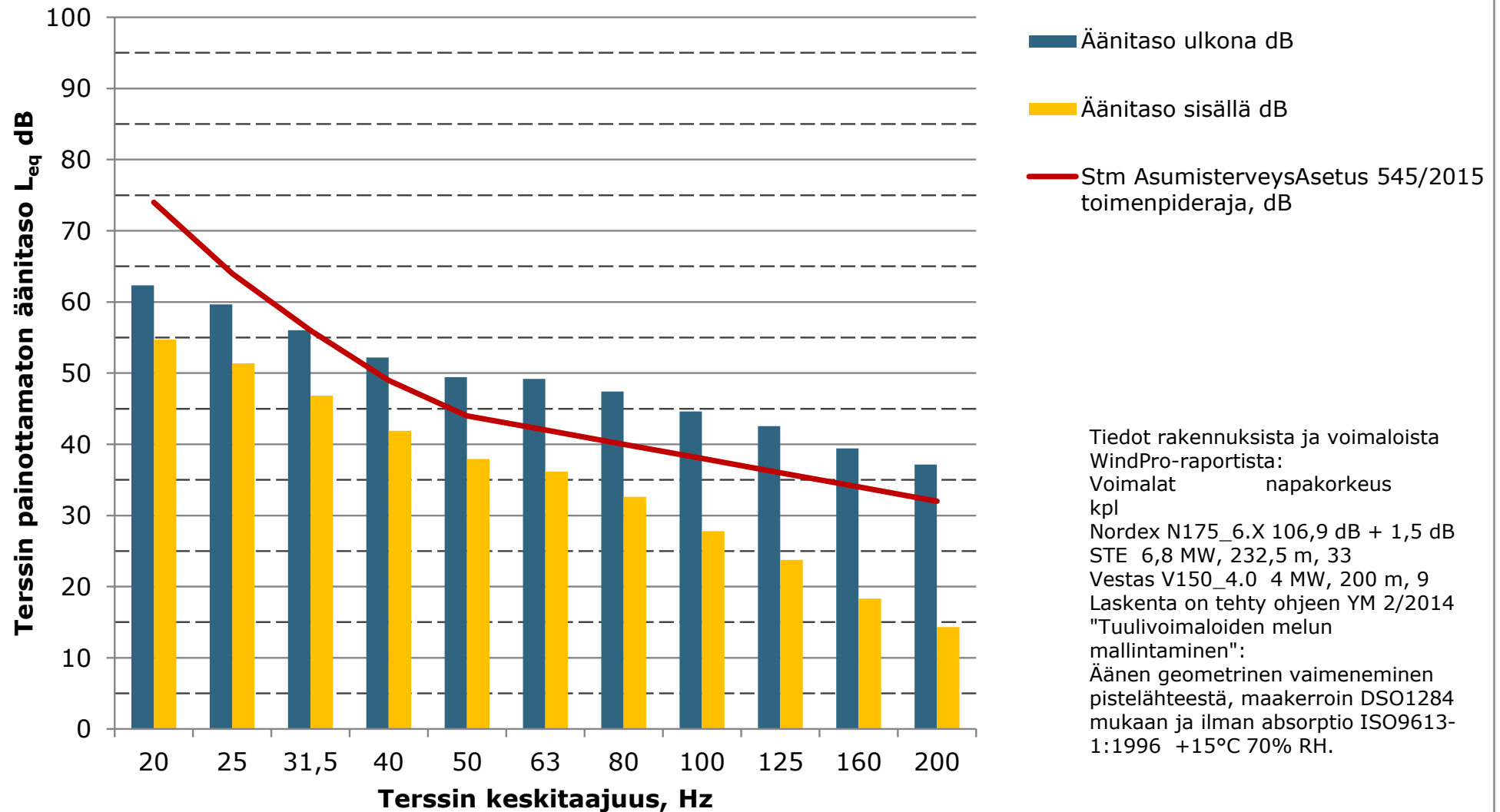
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



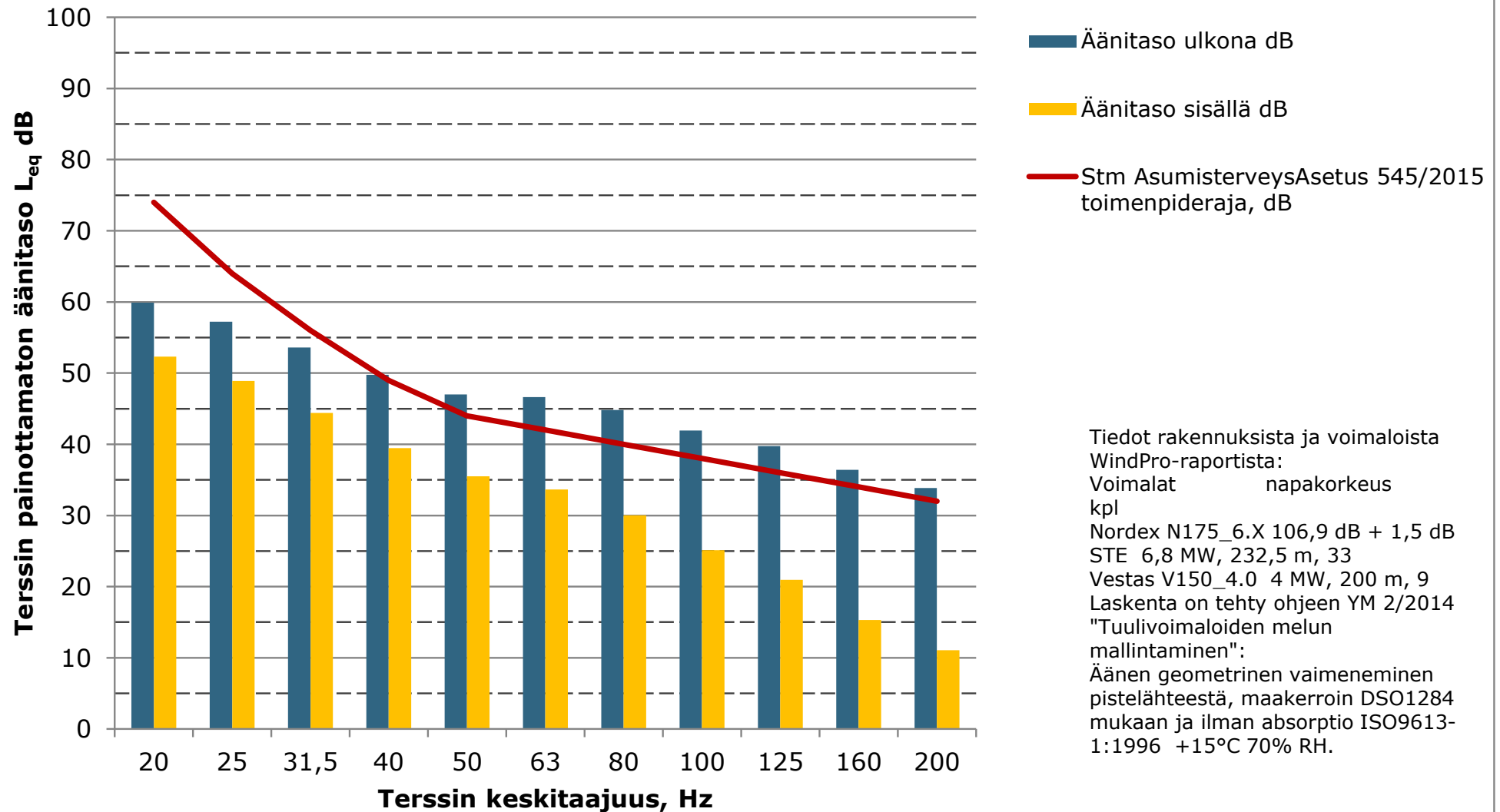
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



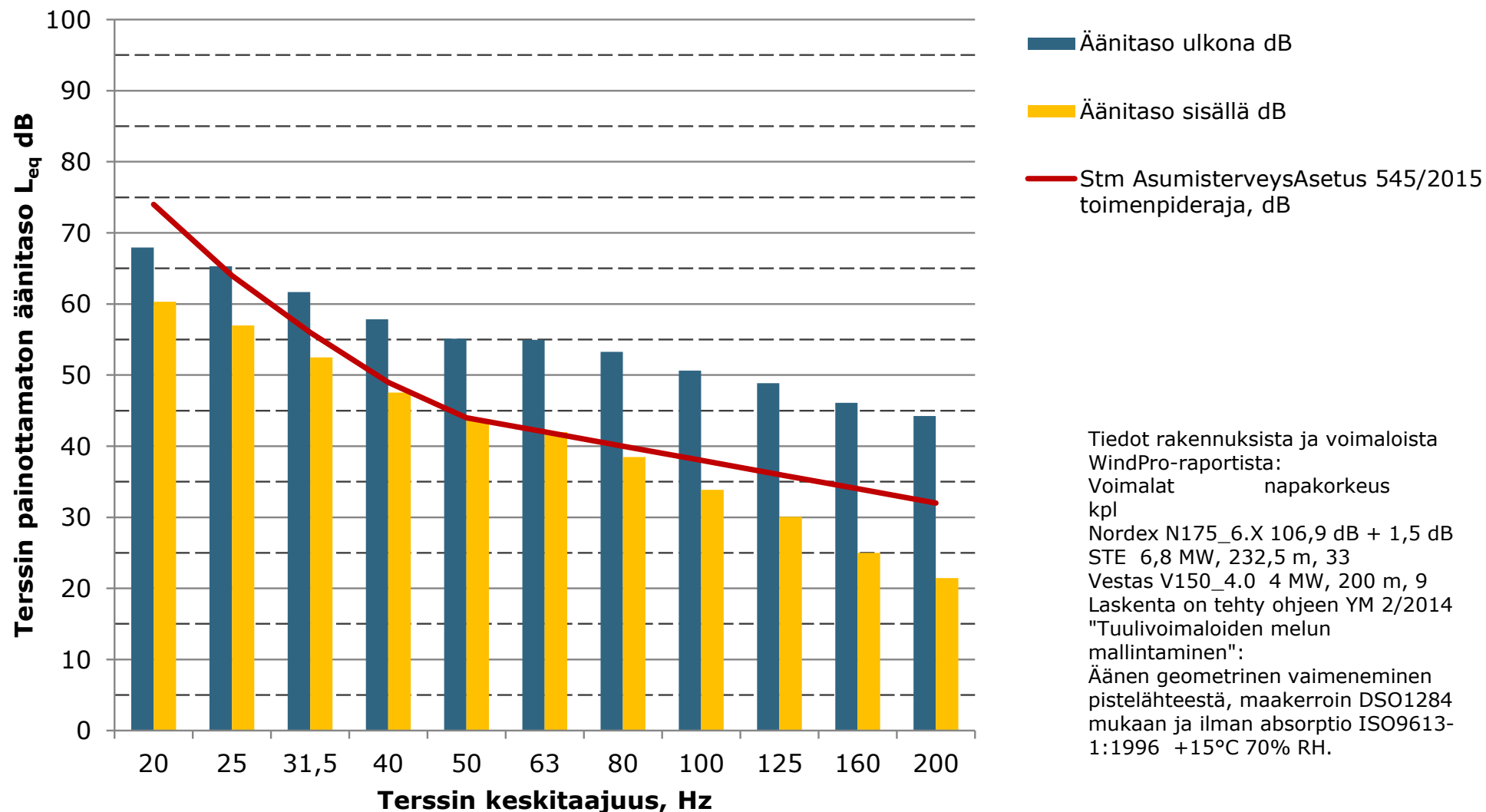
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_O (Nevaranta),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persenttiili mukaan**



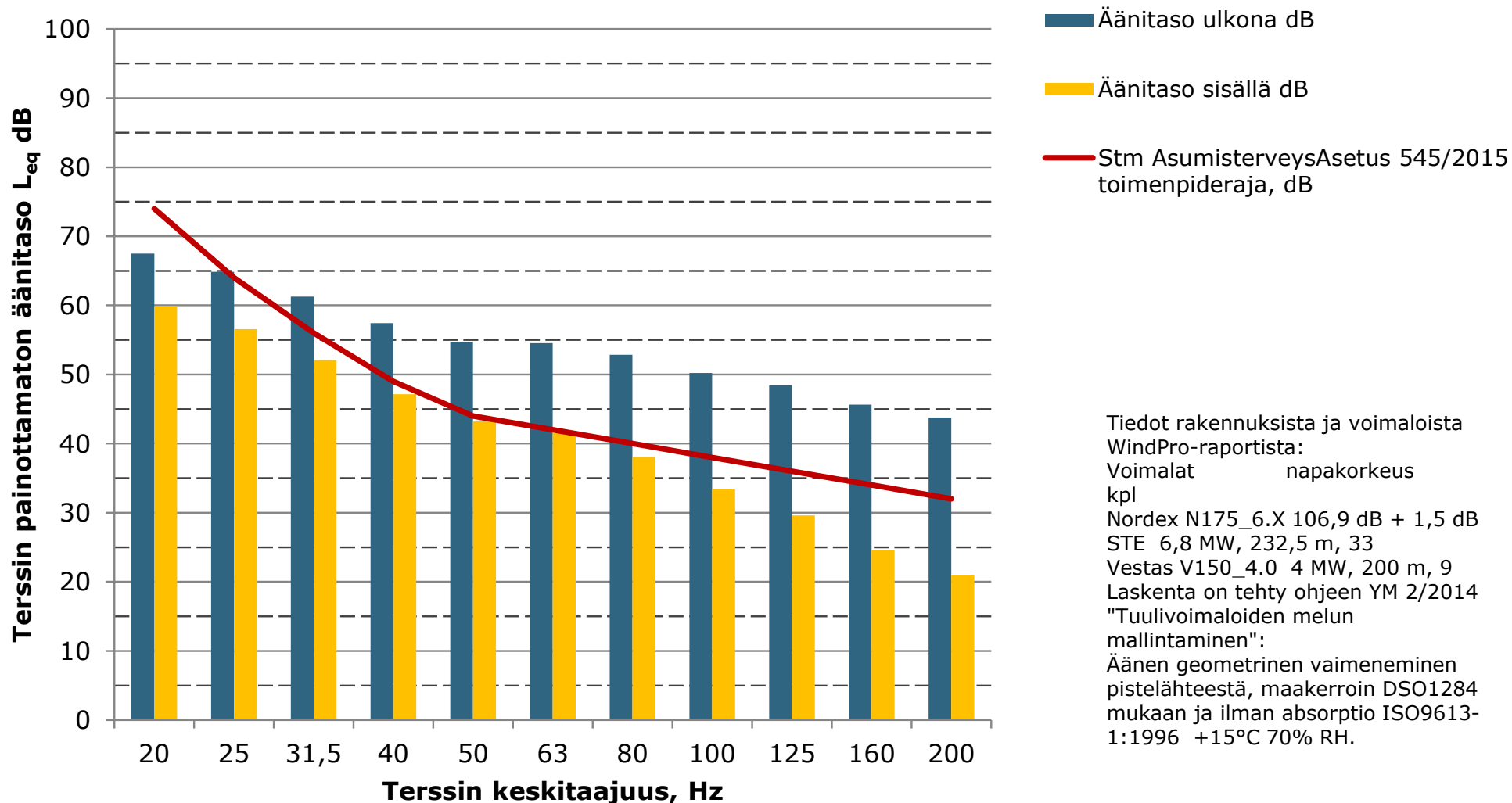
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



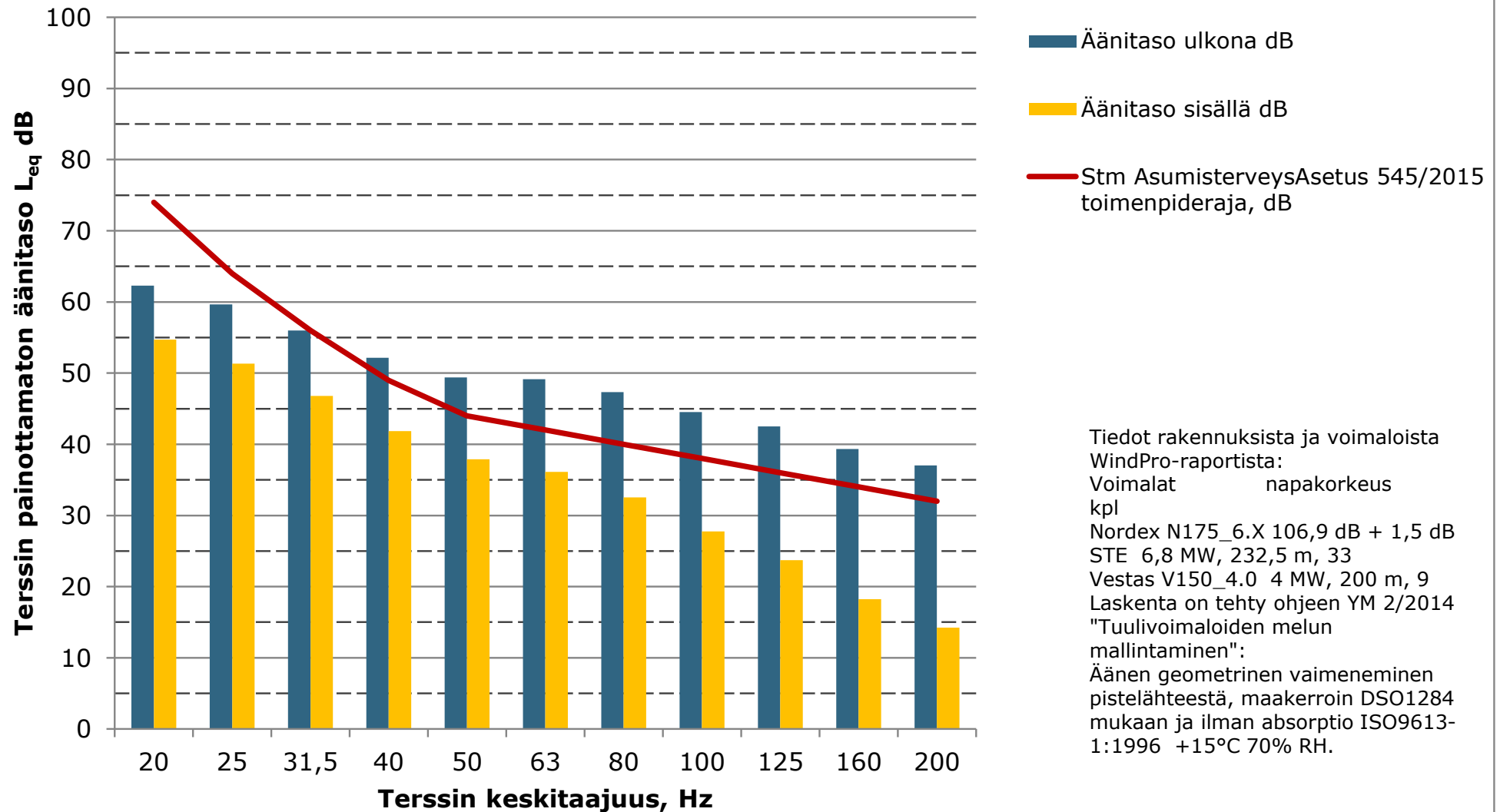
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_P (Niisineva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



11.10.2023

Liite 9. Verkasalon tuulivoimahanke - Kuntakohtaiset melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 (VE1) N175 – 6.8 MW

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 11.07/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE1_Alavieska_RD175x15xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

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

Uncertainty margin:

0,0 dB; Uncertainty margin in NSA has priority

Deviation from "official" noise demands. Negative is more

restrictive, positive is less restrictive.:

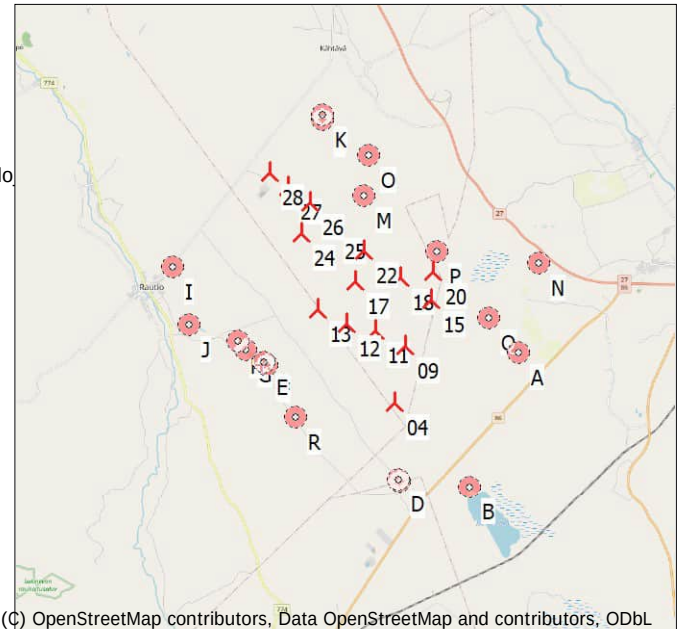
0,0 dB(A)

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.				Creator	Name		
04	370 157	7 104 947	72,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
09	370 503	7 106 453	74,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
11	369 736	7 106 883	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
12	368 953	7 107 128	72,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
13	368 227	7 107 519	68,6	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
15	371 227	7 107 652	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
17	369 253	7 108 202	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
18	370 442	7 108 273	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
20	371 335	7 108 402	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
22	369 525	7 109 029	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
24	367 862	7 109 559	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
25	368 702	7 109 705	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
26	368 126	7 110 369	63,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
27	367 574	7 110 777	62,8	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
28	367 096	7 111 177	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4



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

Scale 1:200 000

New WTG

Noise sensitive area

Calculation Results

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height	Demands Sound level		
						Noise [dB(A)]	From WTGs [dB(A)]	Distance to noise demand [m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	30,7	1 850
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	27,3	2 300
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	30,2	1 386
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	30,4	1 349
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	33,2	1 152
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	33,3	1 140
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	32,2	1 391
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	32,1	1 453
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	29,1	2 576
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	28,9	2 624
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	4,0	40,0	33,4	1 100
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	4,0	40,0	34,0	983
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	39,4	95
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	29,6	1 976
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	34,9	951
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	43,5	-328
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	35,0	756
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	31,5	1 837

Project:

Verkasalo

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Calculated:

4.10.2023 11.07/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE1_Alavieska_RD175x15xHH232,5_106.9dB

Distances (m)

		WTG													
NSA	04	09	11	12	13	15	17	18	20	22	24	25	26	27	28
A	3574	3027	3847	4663	5459	2728	4724	3726	3123	4911	6594	5974	6834	7521	8144
B	3004	4133	4852	5473	6218	5095	6245	5876	5822	6888	8107	7837	8687	9307	9890
C	2085	3602	4048	4447	5061	4897	5425	5416	5652	6204	7096	7007	7790	8343	8879
D	2048	3568	4009	4403	5015	4868	5384	5381	5623	6165	7052	6965	7747	8298	8834
E	3609	3755	3064	2397	1999	4711	3222	4246	5095	3984	3571	4041	4423	4687	5026
F	3535	3700	3018	2364	1992	4670	3209	4220	5064	3980	3603	4059	4455	4728	5075
G	4222	4260	3511	2775	2216	5109	3443	4546	5425	4125	3434	4016	4276	4451	4725
H	4479	4443	3665	2901	2276	5227	3482	4616	5505	4118	3301	3930	4130	4265	4510
I	6919	6527	5658	4838	4023	6908	4874	6049	6930	5113	3526	4378	4024	3721	3576
J	5850	5775	4966	4170	3452	6454	4565	5746	6648	5058	3839	4616	4561	4486	4545
K	7876	6503	5895	5547	5153	5672	4511	4772	5080	3757	3181	2959	2334	2128	2088
L	7741	6371	5760	5409	5016	5549	4374	4644	4963	3623	3048	2821	2200	2009	1996
M	5547	4117	3584	3393	3238	3261	2284	2355	2710	1435	1937	1156	1452	2025	2579
N	5368	4205	4721	5395	6022	3063	4924	3732	2834	4669	6390	5592	6318	6969	7554
O	6589	5126	4640	4468	4285	4142	3358	3322	3499	2505	2727	2100	1995	2303	2679
P	4170	2635	2658	3073	3516	1277	2315	1197	521	1936	3654	2867	3637	4309	4916
Q	3385	2357	3040	3817	4561	1638	3685	2606	1938	3774	5489	4830	5679	6365	6987
R	2651	3468	3122	2832	2921	4750	3921	4628	5327	4785	4886	5158	5716	6093	6506

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_Alavieska_RD175x15xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_Alavieska_RD175x15xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE1_Alavieska_RD175x15xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

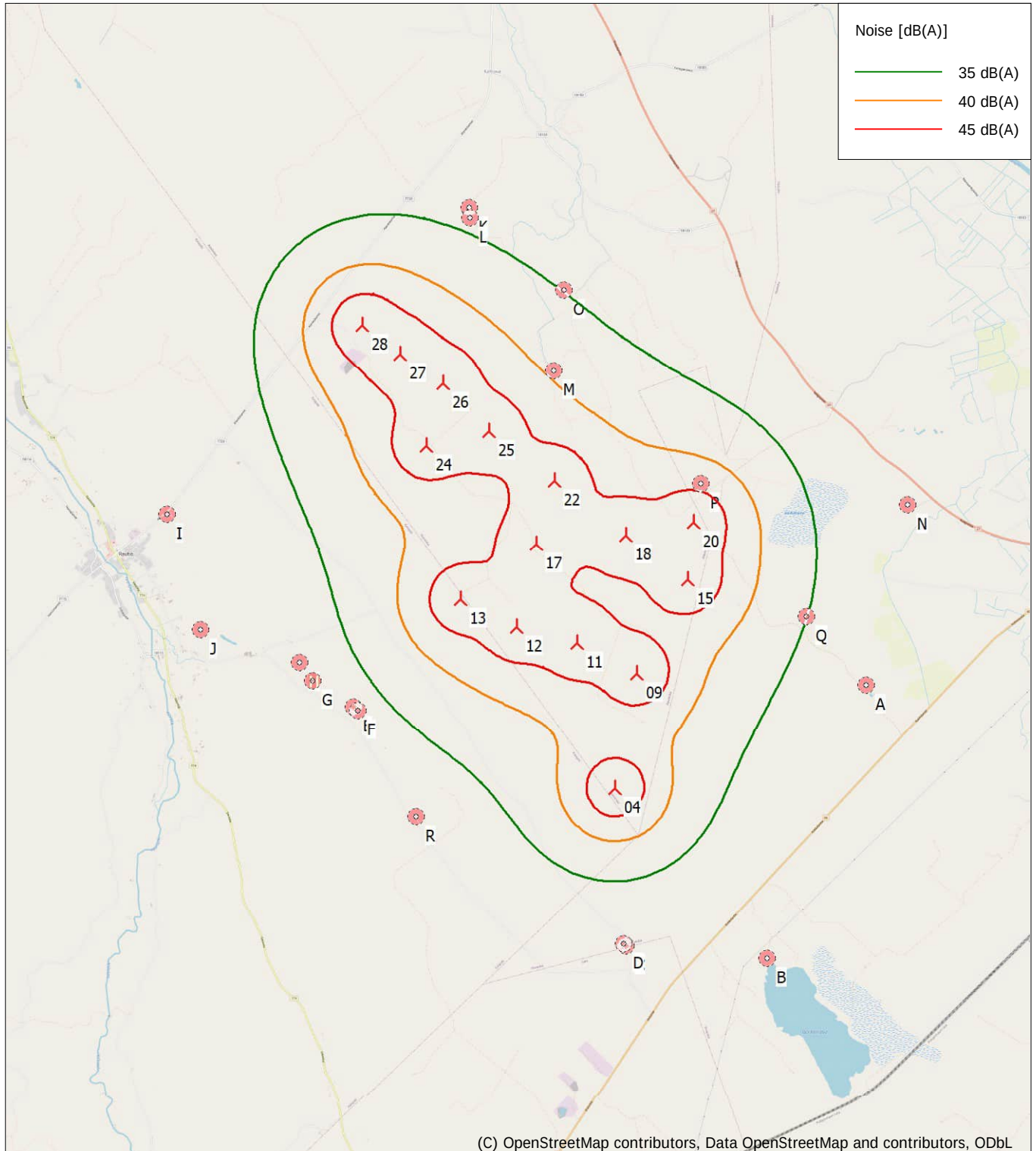
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE1_Alavieska_RD175x15xHH232,5_106.9dB



0 1 2 3 4 km

Map: EMD OpenStreetMap , Print scale 1:75 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 369 291 North: 7 108 062
New WTG Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: 8,0 m/s
Height above sea level from active line object

DECIBEL - Main Result

Calculation: Verkasalo_VE1_Kalajoki_RD175x5xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

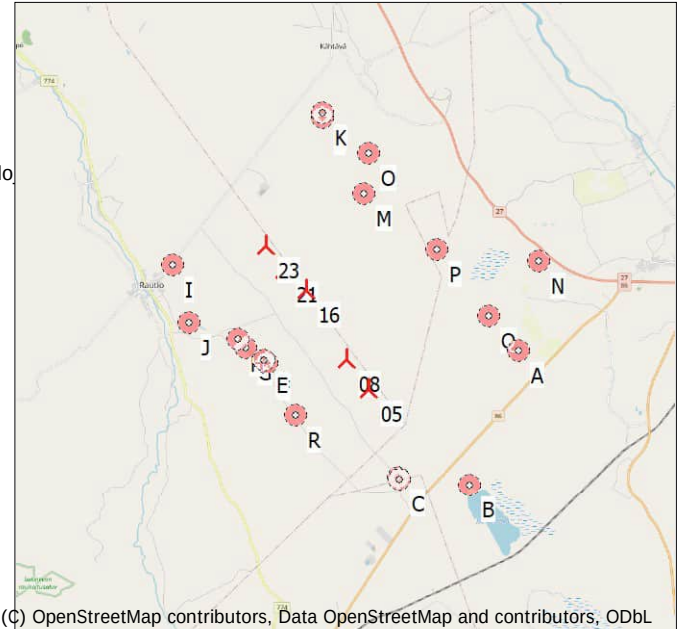
Uncertainty margin:

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)



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

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manuf.	Type-generator				Creator	Name		
05	369 485	7 105 301	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
08	368 920	7 106 101	71,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
16	367 939	7 108 000	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
21	367 367	7 108 547	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
23	366 924	7 109 225	67,2	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4

Calculation Results

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height [m]	Demands		Sound level		Distance to noise demand [m]
						Noise [dB(A)]	From WTGs [dB(A)]	From WTGs [dB(A)]	From WTGs [dB(A)]	
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	22,7	22,7	22,7	3 412
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	22,8	22,8	22,8	3 031
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	26,9	26,9	26,9	1 856
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	27,1	27,1	27,1	1 812
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	32,3	32,3	32,3	1 379
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	32,4	32,4	32,4	1 368
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	31,7	31,7	31,7	1 379
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	31,8	31,8	31,8	1 302
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	28,3	28,3	28,3	1 796
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	28,4	28,4	28,4	2 010
K	Laskentapiste_K (Mattiilanperä)	368 566	7 112 661	59,4	4,0	40,0	23,8	23,8	23,8	3 069
L	Laskentapiste_L (Mattiilanperä)	368 569	7 112 523	60,1	4,0	40,0	24,2	24,2	24,2	2 946
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	28,5	28,5	28,5	2 005
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	20,3	20,3	20,3	4 931
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	25,3	25,3	25,3	2 842
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	26,2	26,2	26,2	2 872
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	24,4	24,4	24,4	3 011
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	31,6	31,6	31,6	1 203

Project:

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Calculated:

4.10.2023 11.00/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE1_Kalajoki_RD175x5xHH232,5_106.9dB

Distances (m)

	WTG				
NSA	05	08	16	21	23
A	4123	4596	5871	6594	7267
B	3716	4687	6775	7559	8365
C	2544	3486	5618	6356	7161
D	2500	3441	5572	6310	7115
E	2859	2162	2185	2462	3067
F	2786	2101	2197	2498	3117
G	3467	2711	2244	2309	2779
H	3722	2929	2227	2186	2584
I	6164	5255	3614	2962	2541
J	5094	4295	3239	2884	2902
K	7417	6569	4702	4284	3808
L	7280	6431	4566	4154	3686
M	5163	4410	2956	2923	2926
N	5679	5775	6249	6799	7277
O	6228	5485	3962	3814	3645
P	4111	3784	3633	4106	4544
Q	3744	3976	4913	5593	6220
R	2061	1993	3342	3865	4579

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_Kalajoki_RD175x5xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_Kalajoki_RD175x5xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE1_Kalajoki_RD175x5xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

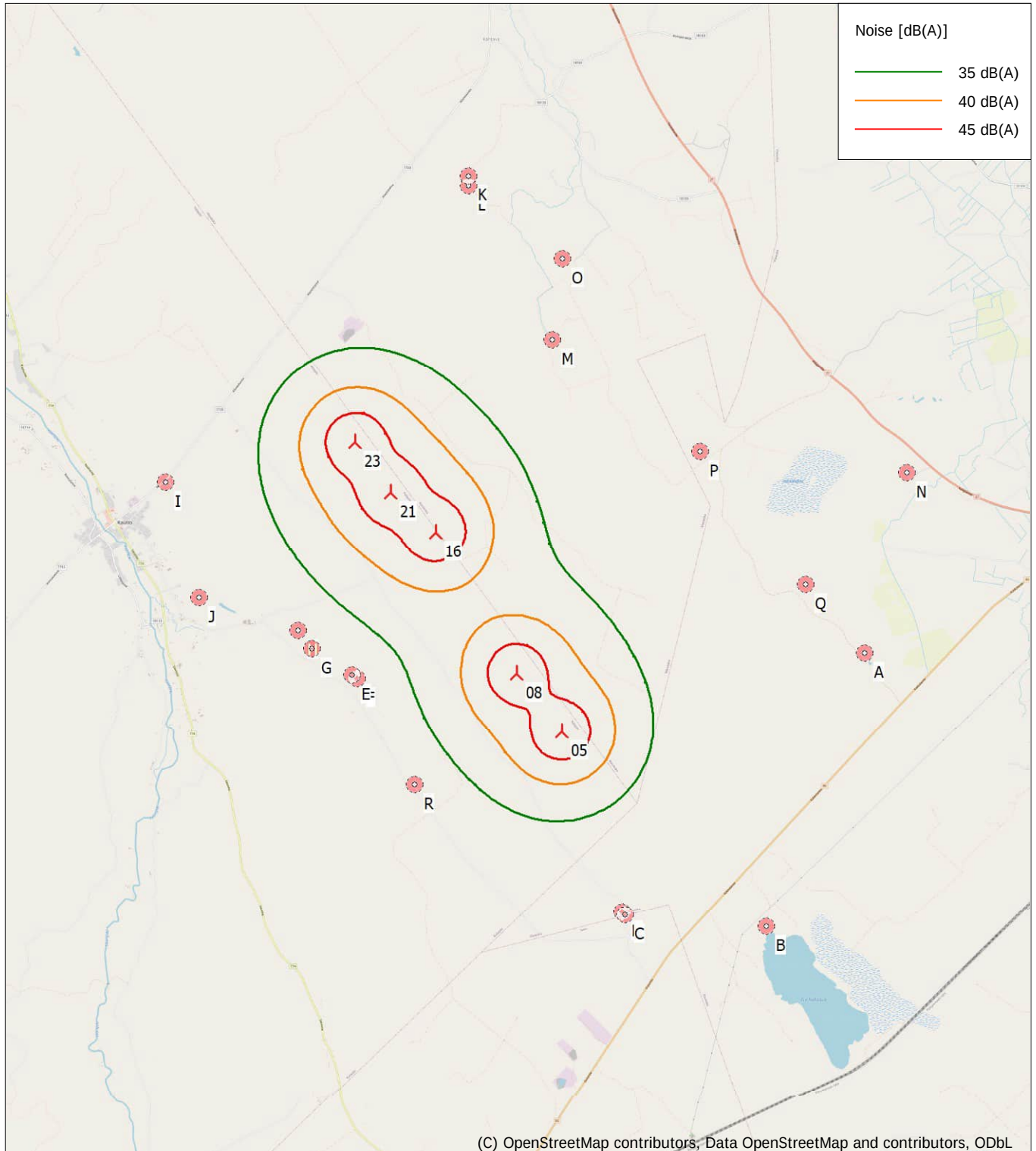
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE1_Kalajoki_RD175x5xHH232,5_106.9dB



0 1 2 3 4 km

Map: EMD OpenStreetMap, Print scale 1:75 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 369 291 North: 7 107 644
 New WTG Noise sensitive area

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

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 12.12/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE1_Ylivieska_RD175x8xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

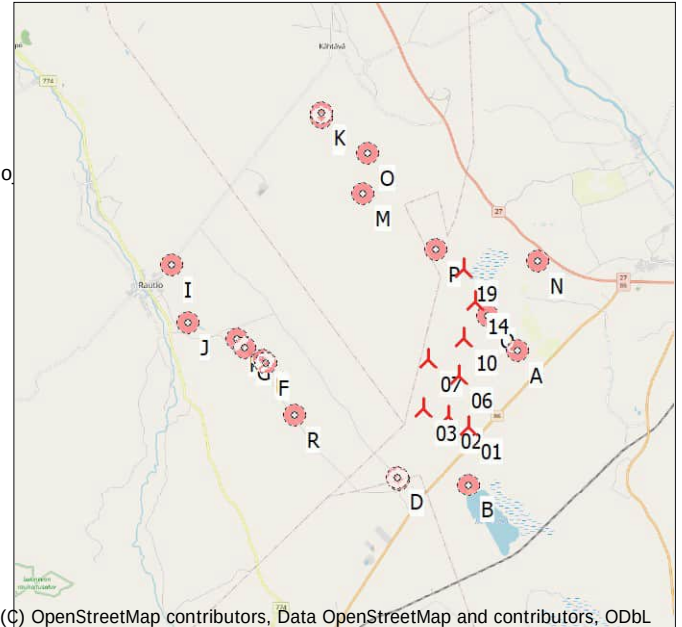
Uncertainty margin:

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)



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

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	Lwa,ref [dB(A)]
					Valid	Manufact.	Type-generator				Creator	Name		
01	372 136	7 104 203	80,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
02	371 622	7 104 479	80,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
03	370 957	7 104 711	79,4	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
06	371 914	7 105 569	73,3	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
07	371 150	7 106 037	77,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
10	372 083	7 106 541	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
14	372 422	7 107 527	67,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
19	372 176	7 108 397	63,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4

Calculation Results

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height [m]	Demands Noise [dB(A)]	Sound level		Distance to noise demand [m]
							From WTGs [dB(A)]	From WTGs [dB(A)]	
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	36,7		526
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	34,3		748
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	32,9		1 084
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	32,9		1 070
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	24,9		3 545
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	25,1		3 482
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	23,6		4 094
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	23,1		4 299
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	19,2		6 462
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	20,4		5 653
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	4,0	40,0	20,6		4 870
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	4,0	40,0	20,8		4 763
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	26,2		2 600
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	32,5		1 129
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	24,0		3 240
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	38,3		158
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	43,6		-391
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	27,0		2 626

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

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Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 12.12/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE1_Ylivieska_RD175x8xHH232,5_106.9dB

Distances (m)

	WTG							
NSA	01	02	03	06	07	10	14	19
A	2400	2537	2944	1710	2369	1481	1745	2602
B	1578	1905	2361	2946	3532	3915	4914	5772
C	2346	2146	1994	3197	3311	4128	5162	5873
D	2351	2140	1972	3184	3285	4110	5143	5849
E	5723	5146	4442	5189	4393	5338	5826	5860
F	5648	5073	4368	5123	4332	5282	5780	5825
G	6335	5757	5052	5751	4932	5840	6259	6220
H	6590	6010	5306	5966	5133	6016	6393	6313
I	8989	8407	7718	8167	7282	7995	8108	7771
J	7962	7382	6679	7327	6482	7334	7642	7478
K	9180	8734	8301	7843	7110	7059	6421	5587
L	9052	8604	8168	7717	6980	6938	6309	5480
M	6764	6325	5916	5425	4698	4656	4090	3322
N	4767	4772	4978	3710	3904	2870	2005	1994
O	7698	7288	6917	6334	5661	5500	4806	3955
P	4754	4433	4227	3371	2888	2449	1685	883
Q	2965	2860	2998	1754	1936	884	551	1427
R	4642	4109	3438	4483	3875	4927	5668	5956

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_Ylivieska_RD175x8xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE1_Ylivieska_RD175x8xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE1_Ylivieska_RD175x8xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

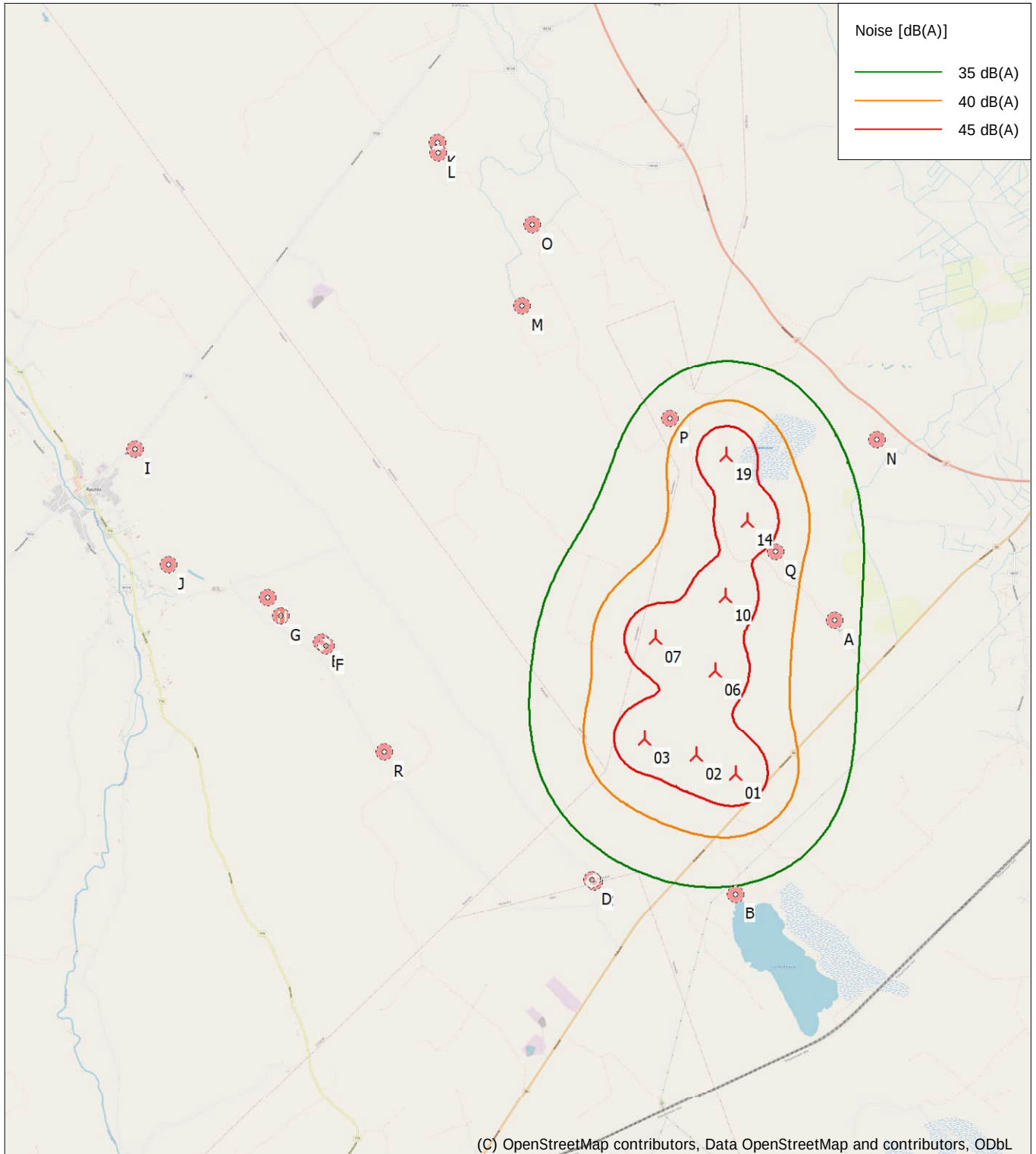
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE1_Ylivieska_RD175x8xHH232,5_106.9dB



Map: EMD OpenStreetMap , Print scale 1:75 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 369 669 North: 7 107 182

New WTG Noise sensitive area

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

11.10.2023

Liite 10. Verkasalon tuulivoimahanke - Kuntakohtaiset melun leviämismallinnuksen tulokset ISO 9613-2, YM 2 /2014 (VE2) N175 – 6.8 MW

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

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Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 12.16/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE2_Alavieska_RD175x19xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

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

Uncertainty margin:

0,0 dB; Uncertainty margin in NSA has priority

Deviation from "official" noise demands. Negative is more

restrictive, positive is less restrictive.:

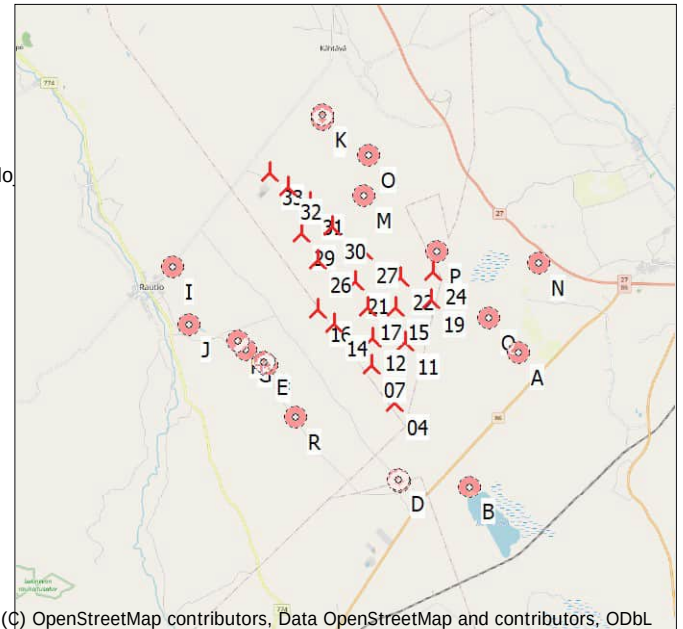
0,0 dB(A)

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manufact.				Creator	Name		
04	370 157	7 104 947	72,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
07	369 591	7 105 980	71,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
11	370 521	7 106 556	73,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
12	369 636	7 106 678	75,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
14	368 628	7 107 123	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
15	370 306	7 107 506	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
16	368 227	7 107 519	68,6	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
17	369 568	7 107 523	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
19	371 227	7 107 652	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
21	369 253	7 108 202	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
22	370 442	7 108 273	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
24	371 335	7 108 402	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
26	368 250	7 108 818	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
27	369 525	7 109 029	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
29	367 862	7 109 559	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
30	368 702	7 109 705	65,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
31	368 126	7 110 369	63,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
32	367 574	7 110 777	62,8	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4
33	367 096	7 111 177	62,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	8,0	108,4



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

Scale 1:200 000

New WTG

Noise sensitive area

Calculation Results

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height [m]	Demands			Distance to noise demand [m]
						Noise [dB(A)]	From WTGs [dB(A)]	Sound level [dB(A)]	
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	31,7	1 759	
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	28,4	2 262	
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	31,3	1 347	
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	31,4	1 310	
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	34,7	969	
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	34,8	950	
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	33,6	1 238	
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	33,4	1 307	
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	30,0	2 479	
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	30,0	2 472	
K	Laskentapiste_K (Mattiilanperä)	368 566	7 112 661	59,4	4,0	40,0	33,8	1 081	
L	Laskentapiste_L (Mattiilanperä)	368 569	7 112 523	60,1	4,0	40,0	34,3	963	
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	39,9	24	
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	30,4	1 928	

To be continued on next page...

DECIBEL - Main Result

Calculation: Verkasalo_VE2_Alavieska_RD175x19xHH232,5_106.9dB

...continued from previous page

Noise sensitive area

No.	Name	East	North	Z	Immission height	Demands	Sound level	Distance to noise demand
				[m]	[m]	Noise [dB(A)]	From WTGs [dB(A)]	[m]
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	35,4	903
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	43,8	-377
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	35,8	681
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	33,3	1 424

Distances (m)

WTG	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
04	3574	3004	2085	2048	3609	3535	4222	4479	6919	5850	7876	7741	5547	5368	6589	4170	3385	2651
07	3930	4168	3178	3137	2838	2775	3392	3609	5897	4974	6759	6622	4483	5232	5545	3473	3370	2443
11	3021	4222	3706	3673	3782	3728	4277	4454	6507	5779	6410	6278	4020	4140	5026	2533	2314	3537
12	3913	4724	3858	3818	2924	2874	3396	3566	5638	4887	6078	5942	3786	4889	4847	2880	3161	2908
14	4980	5660	4545	4500	2102	2074	2458	2578	4537	3846	5538	5400	3471	5710	4541	3345	4141	2679
15	3478	5187	4644	4609	3793	3756	4178	4294	6031	5526	5440	5309	3046	3991	4055	1815	2497	3965
16	5459	6218	5061	5015	1999	1992	2216	2276	4023	3452	5153	5016	3238	6022	4285	3516	4561	2921
17	4175	5497	4705	4665	3122	3091	3470	3572	5309	4790	5234	5098	2940	4704	4004	2343	3229	3501
19	2728	5095	4897	4868	4711	4670	5109	5227	6908	6454	5672	5549	3261	3063	4142	1277	1638	4750
21	4724	6245	5425	5384	3222	3209	3443	3482	4874	4565	4511	4374	2284	4924	3358	2315	3685	3921
22	3726	5876	5416	5381	4246	4220	4546	4616	6049	5746	4772	4644	2355	3732	3322	1197	2606	4628
24	3123	5822	5652	5623	5095	5064	5425	5505	6930	6648	5080	4963	2710	2834	3499	521	1938	5327
26	5895	7272	6269	6225	3046	3062	3043	2979	3834	3798	3856	3719	2112	5924	3095	3208	4835	4197
27	4911	6888	6204	6165	3984	3980	4125	4118	5113	5058	3757	3623	1435	4669	2505	1936	3774	4785
29	6594	8107	7096	7052	3571	3603	3434	3301	3526	3839	3181	3048	1937	6390	2727	3654	5489	4886
30	5974	7837	7007	6965	4041	4059	4016	3930	4378	4616	2959	2821	1156	5592	2100	2867	4830	5158
31	6834	8687	7790	7747	4423	4455	4276	4130	4024	4561	2334	2200	1452	6318	1995	3637	5679	5716
32	7521	9307	8343	8298	4687	4728	4451	4265	3721	4486	2128	2009	2025	6969	2303	4309	6365	6093
33	8144	9890	8879	8834	5026	5075	4725	4510	3576	4545	2088	1996	2579	7554	2679	4916	6987	6506

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_Alavieska_RD175x19xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_Alavieska_RD175x19xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE2_Alavieska_RD175x19xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

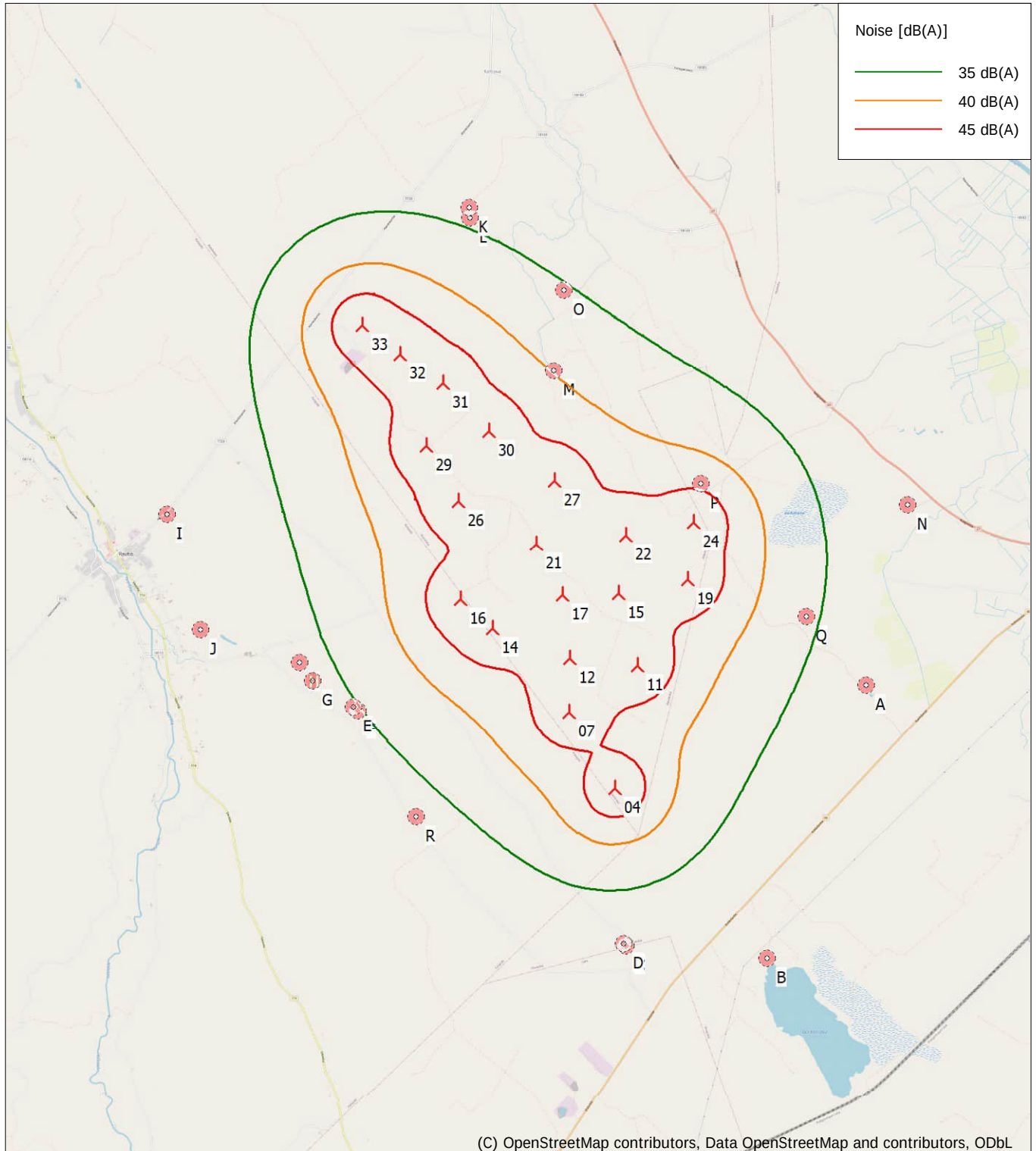
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE2_Alavieska_RD175x19xHH232,5_106.9dB



0 1 2 3 4 km

Map: EMD OpenStreetMap , Print scale 1:75 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 369 291 North: 7 108 062
New WTG Noise sensitive area
Noise calculation model: ISO 9613-2 General. Wind speed: 8,0 m/s
Height above sea level from active line object

DECIBEL - Main Result

Calculation: Verkasalo_VE2_Kalajoki_RD175x5xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

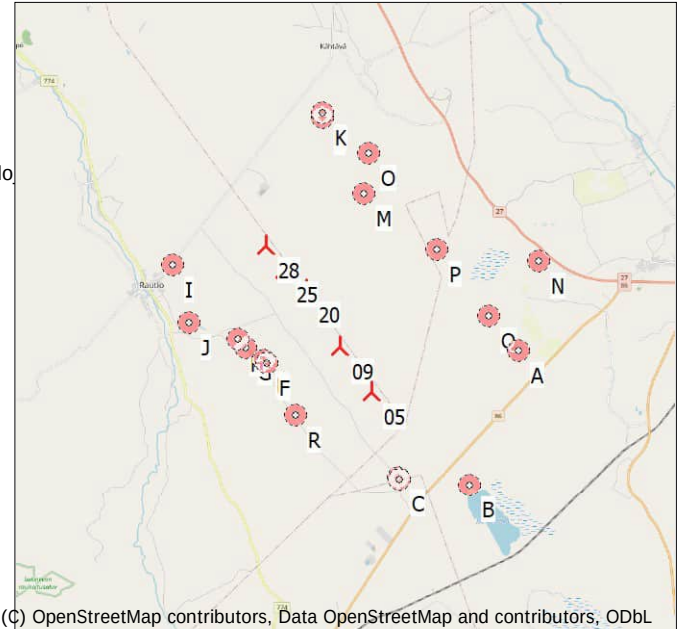
Uncertainty margin:

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)



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

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type			Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Noise data		Wind speed [m/s]	LwA,ref [dB(A)]
					Valid	Manuf.	Type-generator				Creator	Name		
05	369 541	7 105 227	72,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
09	368 764	7 106 453	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
20	367 939	7 108 000	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
25	367 367	7 108 547	67,5	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
28	366 924	7 109 225	67,2	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4

Calculation Results

Sound level

Noise sensitive area

No.	Name	East	North	Z	Immission height [m]	Demands		Sound level From WTGs [dB(A)]	Distance to noise demand [m]
						Noise [dB(A)]	From WTGs [dB(A)]		
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	4,0	40,0	22,6		3 403
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	4,0	40,0	22,7		2 954
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	4,0	40,0	26,9		1 786
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	4,0	40,0	27,1		1 742
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	4,0	40,0	32,5		1 293
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	4,0	40,0	32,6		1 243
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	4,0	40,0	31,8		1 369
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	4,0	40,0	32,0		1 294
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	4,0	40,0	28,3		1 796
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	4,0	40,0	28,4		2 007
K	Laskentapiste_K (Mattiilanperä)	368 566	7 112 661	59,4	4,0	40,0	23,9		3 068
L	Laskentapiste_L (Mattiilanperä)	368 569	7 112 523	60,1	4,0	40,0	24,3		2 945
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	4,0	40,0	28,6		2 001
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	4,0	40,0	20,2		4 978
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	4,0	40,0	25,4		2 841
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	4,0	40,0	26,2		2 857
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	4,0	40,0	24,4		3 040
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	4,0	40,0	31,2		1 376

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 12.14/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE2_Kalajoki_RD175x5xHH232,5_106.9dB

Distances (m)

	WTG				
NSA	05	09	20	25	28
A	4085	4760	5871	6594	7267
B	3624	5054	6775	7559	8365
C	2457	3871	5618	6356	7161
D	2414	3825	5572	6310	7115
E	2935	2027	2185	2462	3067
F	2862	1975	2197	2498	3117
G	3546	2522	2244	2309	2779
H	3802	2712	2227	2186	2584
I	6253	4945	3614	2962	2541
J	5174	4061	3239	2884	2902
K	7498	6211	4702	4284	3808
L	7361	6073	4566	4154	3686
M	5237	4091	2956	2923	2926
N	5676	5783	6249	6799	7277
O	6300	5166	3962	3814	3645
P	4151	3644	3633	4106	4544
Q	3732	4057	4913	5593	6220
R	2093	2162	3342	3865	4579

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_Kalajoki_RD175x5xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_Kalajoki_RD175x5xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE2_Kalajoki_RD175x5xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

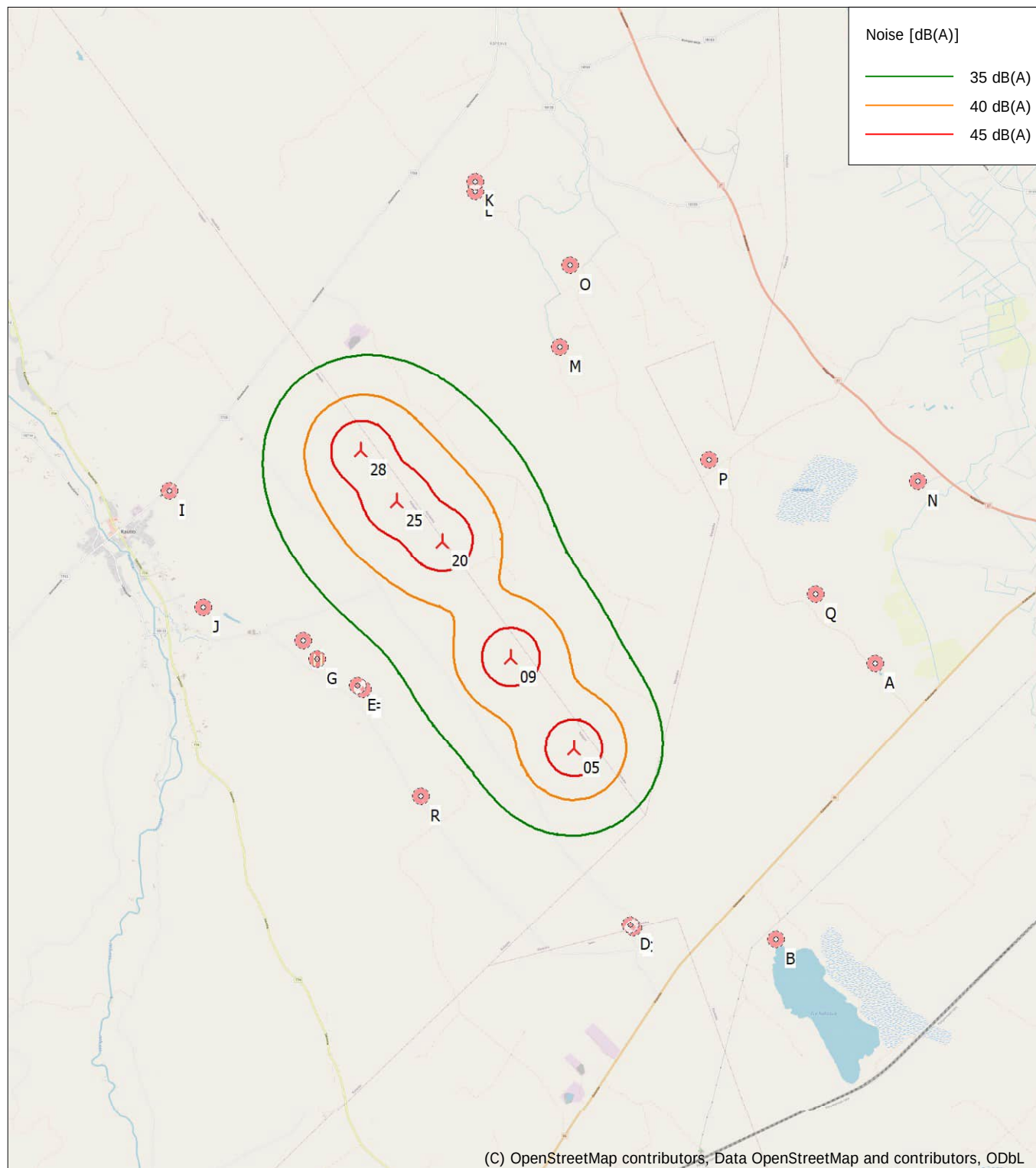
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE2_Kalajoki_RD175x5xHH232,5_106.9dB



DECIBEL - Main Result

Calculation: Verkasalo_VE2_Ylivieska_RD175x9xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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

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

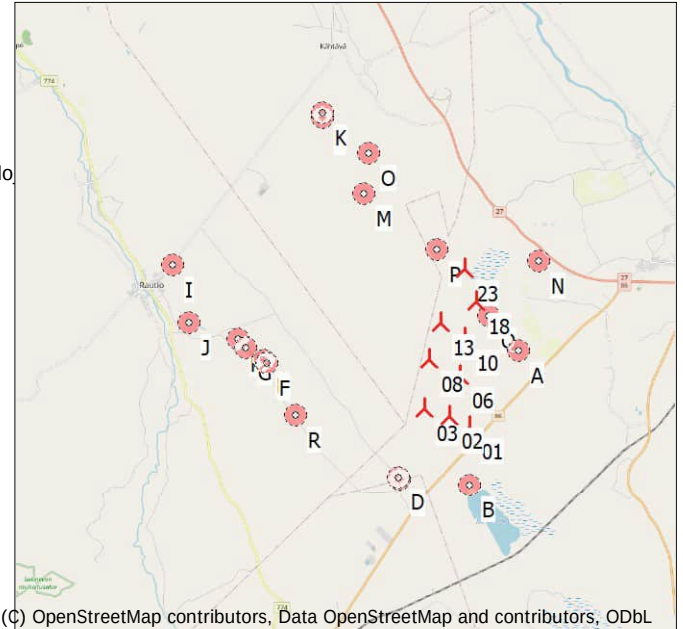
Uncertainty margin:

0,0 dB; Uncertainty margin in NSA has priority

Deviation from "official" noise demands. Negative is more

restrictive, positive is less restrictive.:

0,0 dB(A)



All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type			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		
01	372 136	7 104 203	80,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
02	371 622	7 104 479	80,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
03	370 957	7 104 711	79,4	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
06	371 914	7 105 569	73,3	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
08	371 150	7 106 037	77,1	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
10	372 083	7 106 541	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
13	371 464	7 106 967	70,0	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
18	372 422	7 107 527	67,9	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4
23	372 176	7 108 397	63,7	NORDEX N175/6.X 6800 17...	Yes	NORDEX	N175/6.X-6 800	6 800	175,0	232,5	USER	Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)	8,0	108,4

Calculation Results

Sound level

Noise sensitive area

No.		East		North		Z		Immission height		Noise		From WTGs		Distance to noise demand	
						[m]		[m]		[dB(A)]		[dB(A)]		[m]	
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0		4,0		40,0		37,1				469	
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5		4,0		40,0		34,4				743	
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5		4,0		40,0		33,0				1 077	
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5		4,0		40,0		33,1				1 063	
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5		4,0		40,0		25,5				3 483	
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5		4,0		40,0		25,7				3 420	
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0		4,0		40,0		24,2				4 025	
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5		4,0		40,0		23,7				4 226	
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2		4,0		40,0		19,9				6 336	
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9		4,0		40,0		21,0				5 574	
K	Laskentapiste_K (Mattiilanperä)	368 566	7 112 661	59,4		4,0		40,0		21,3				4 846	
L	Laskentapiste_L (Mattiilanperä)	368 569	7 112 523	60,1		4,0		40,0		21,5				4 739	
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0		4,0		40,0		27,0				2 570	
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2		4,0		40,0		32,9				1 101	
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6		4,0		40,0		24,7				3 217	
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7		4,0		40,0		38,7				129	
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9		4,0		40,0		43,9				-443	
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6		4,0		40,0		27,5				2 612	

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

4.10.2023 12.18/3.6.355

DECIBEL - Main Result

Calculation: Verkasalo_VE2_Ylivieska_RD175x9xHH232,5_106.9dB

Distances (m)

	WTG									
NSA	01	02	03	06	08	10	13	18	23	
A	2400	2537	2944	1710	2369	1481	2203	1745	2602	
B	1578	1905	2361	2946	3532	3915	4382	4914	5772	
C	2346	2146	1994	3197	3311	4128	4292	5162	5873	
D	2351	2140	1972	3184	3285	4110	4266	5143	5849	
E	5723	5146	4442	5189	4393	5338	4774	5826	5860	
F	5648	5073	4368	5123	4332	5282	4723	5780	5825	
G	6335	5757	5052	5751	4932	5840	5239	6259	6220	
H	6590	6010	5306	5966	5133	6016	5395	6393	6313	
I	8989	8407	7718	8167	7282	7995	7284	8108	7771	
J	7962	7382	6679	7327	6482	7334	6686	7642	7478	
K	9180	8734	8301	7843	7110	7059	6389	6421	5587	
L	9052	8604	8168	7717	6980	6938	6265	6309	5480	
M	6764	6325	5916	5425	4698	4656	3974	4090	3322	
N	4767	4772	4978	3710	3904	2870	3115	2005	1994	
O	7698	7288	6917	6334	5661	5500	4866	4806	3955	
P	4754	4433	4227	3371	2888	2449	1941	1685	883	
Q	2965	2860	2998	1754	1936	884	1312	551	1427	
R	4642	4109	3438	4483	3875	4927	4558	5668	5956	

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_Ylivieska_RD175x9xHH232,5_106.9dB

Noise calculation model:

ISO 9613-2 General

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): REGIONS_Verkasalo_10.w2r (9)

Area type with hard ground: Vesistöt

Ground factor for hard ground: 0,0

Meteorological coefficient, C0:

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:

Ignore pure tones setting on WTG

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: NORDEX N175/6.X 6800 175.0 !O!

Noise: Nordex N175/6.X MODE 0 STE 106.9dB (6.8MW)

Source Source/Date Creator Edited

USER 4.10.2023 USER 4.10.2023 10.19

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	232,5	8,0	108,4	No	91,2	98,0	101,4	101,9	102,8	100,7	91,4	74,9

Noise sensitive area: A Laskentapiste_A (Oivo)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: B Laskentapiste_B (Järviojanniittu)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: C Laskentapiste_C (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Assumptions for noise calculation

Calculation: Verkasalo_VE2_Ylivieska_RD175x9xHH232,5_106.9dB

Noise sensitive area: D Laskentapiste_D (Sorvari)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: E Laskentapiste_E (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: F Laskentapiste_F (Huhtakylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: G Laskentapiste_G (Viljamaa)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: H Laskentapiste_H (Karjaneva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: I Laskentapiste_I (Rautio)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: J Laskentapiste_J (Pöllä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: K Laskentapiste_K (Mattilanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: L Laskentapiste_L (Mattilanperä)

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: Verkasalo_VE2_Ylivieska_RD175x9xHH232,5_106.9dB

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: M Laskentapiste_M (Tiennevanperä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: N Laskentapiste_N (Mäntylä)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: O Laskentapiste_O (Nevaranta)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: P Laskentapiste_P (Niisineva)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: Q Laskentapiste_Q (Rinkkala-Kähtävä metsätie)

Predefined calculation standard:

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

Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

Noise sensitive area: R Laskentapiste_R (Huhtala)

Predefined calculation standard:

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

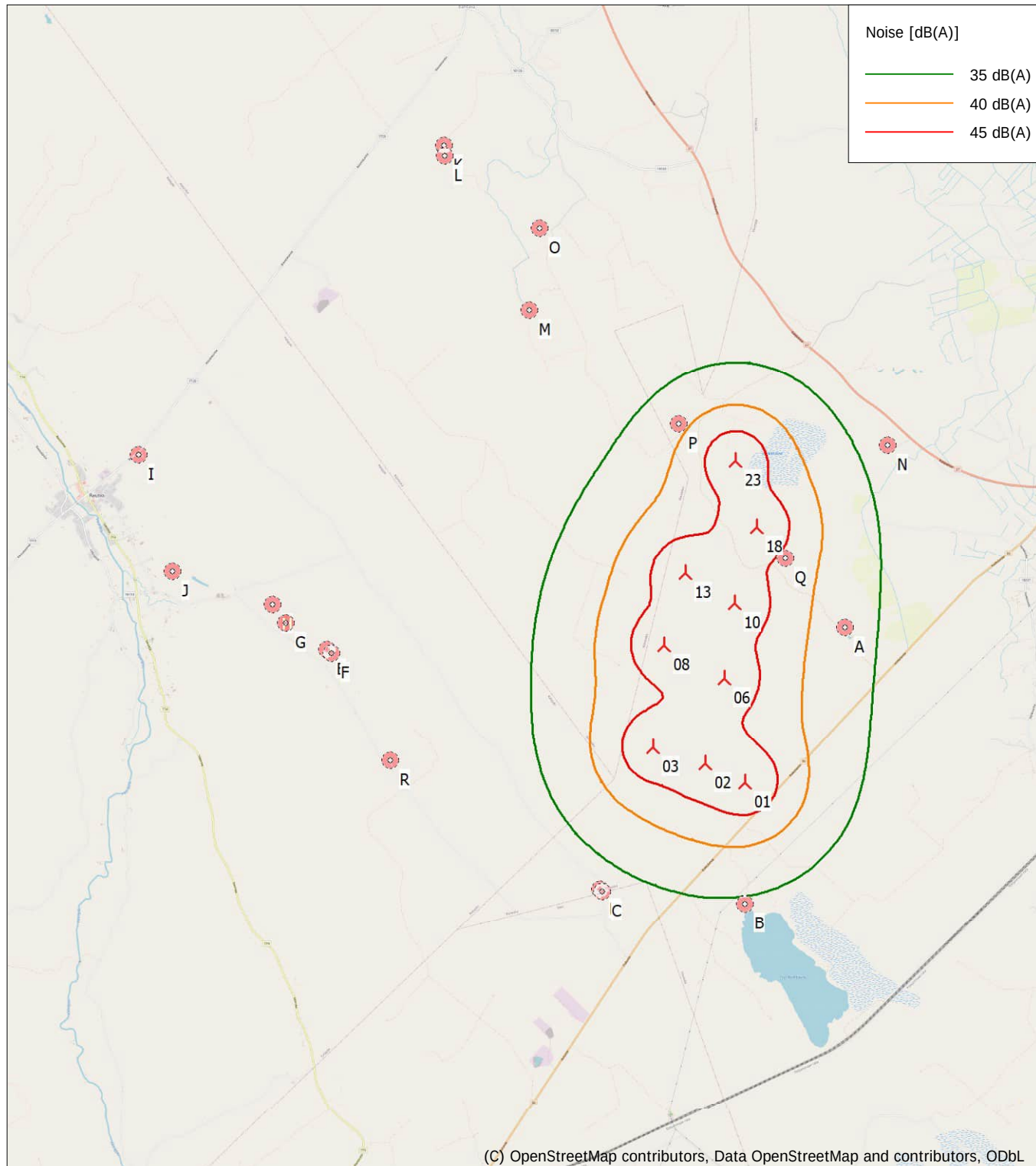
Uncertainty margin: Use default value from calculation model

Noise demand: 40,0 dB(A)

No distance demand

DECIBEL - Map 8,0 m/s

Calculation: Verkasalo_VE2_Ylivieska_RD175x9xHH232,5_106.9dB

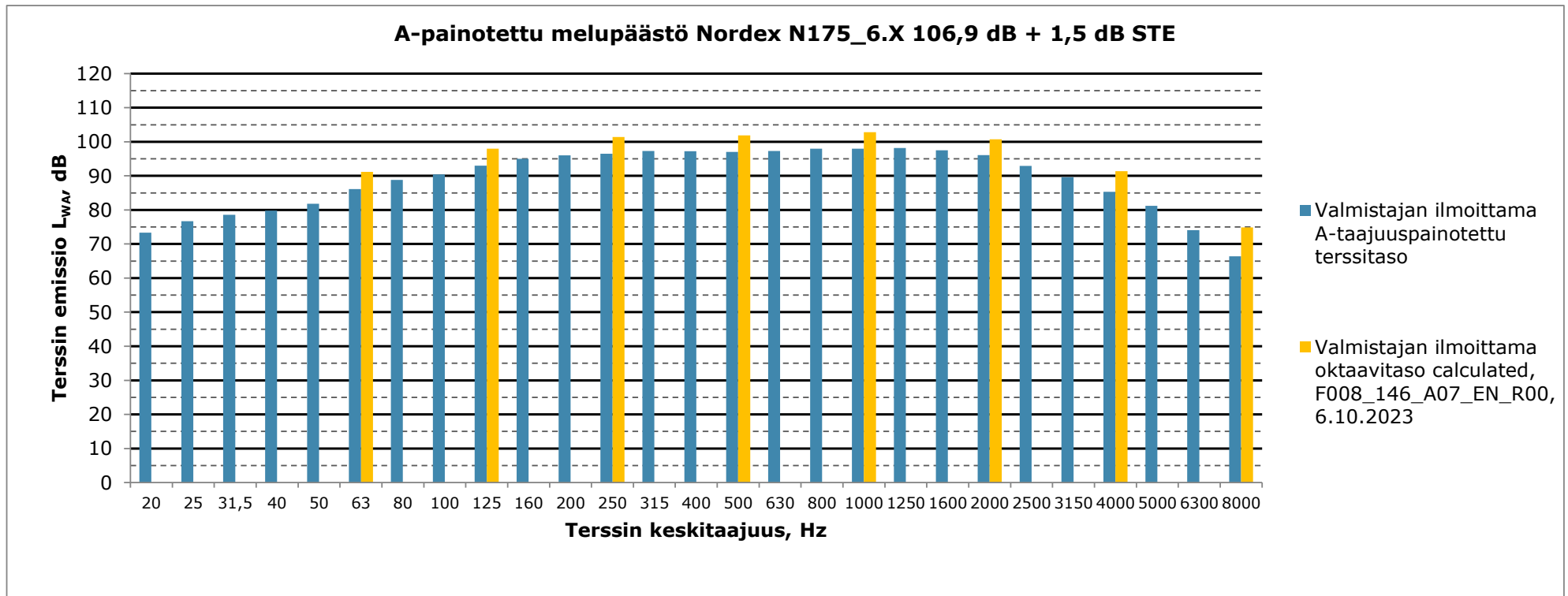


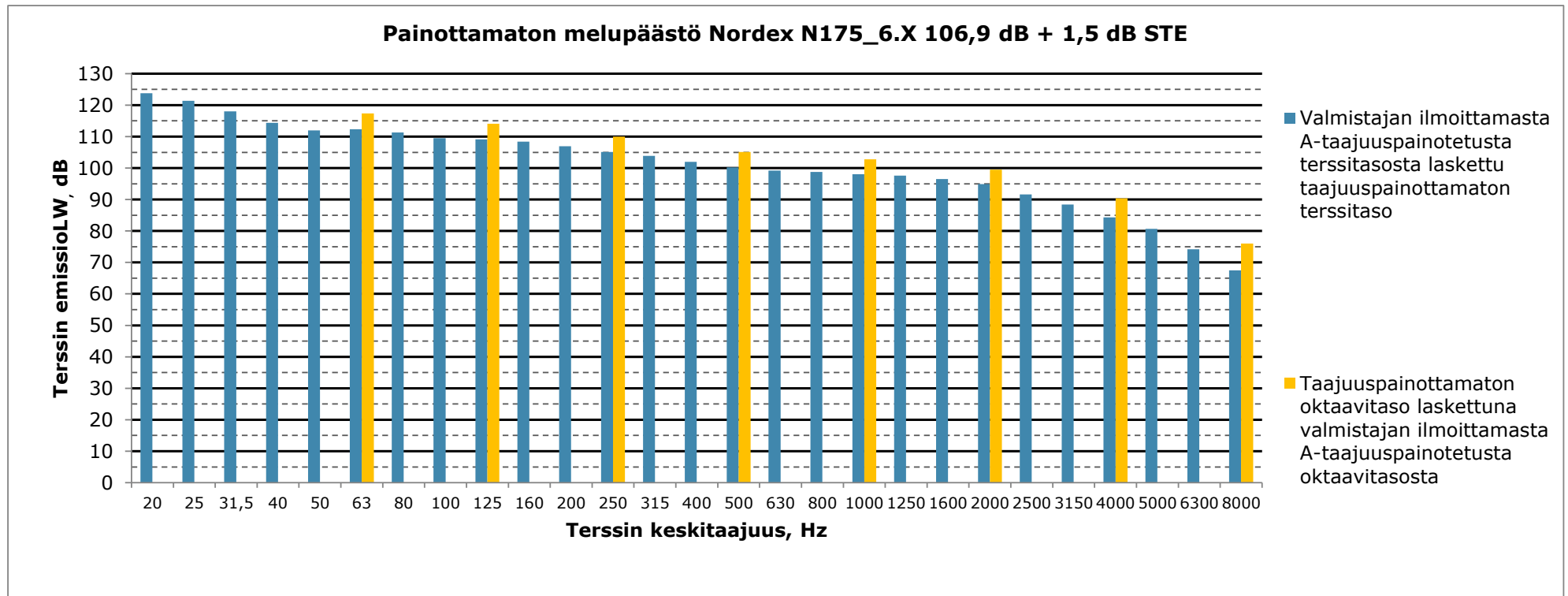
0 1 2 3 4 km

Map: EMD OpenStreetMap, Print scale 1:75 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 369 669 North: 7 107 182
 New WTG Noise sensitive area
 Noise calculation model: ISO 9613-2 General. Wind speed: 8,0 m/s
 Height above sea level from active line object

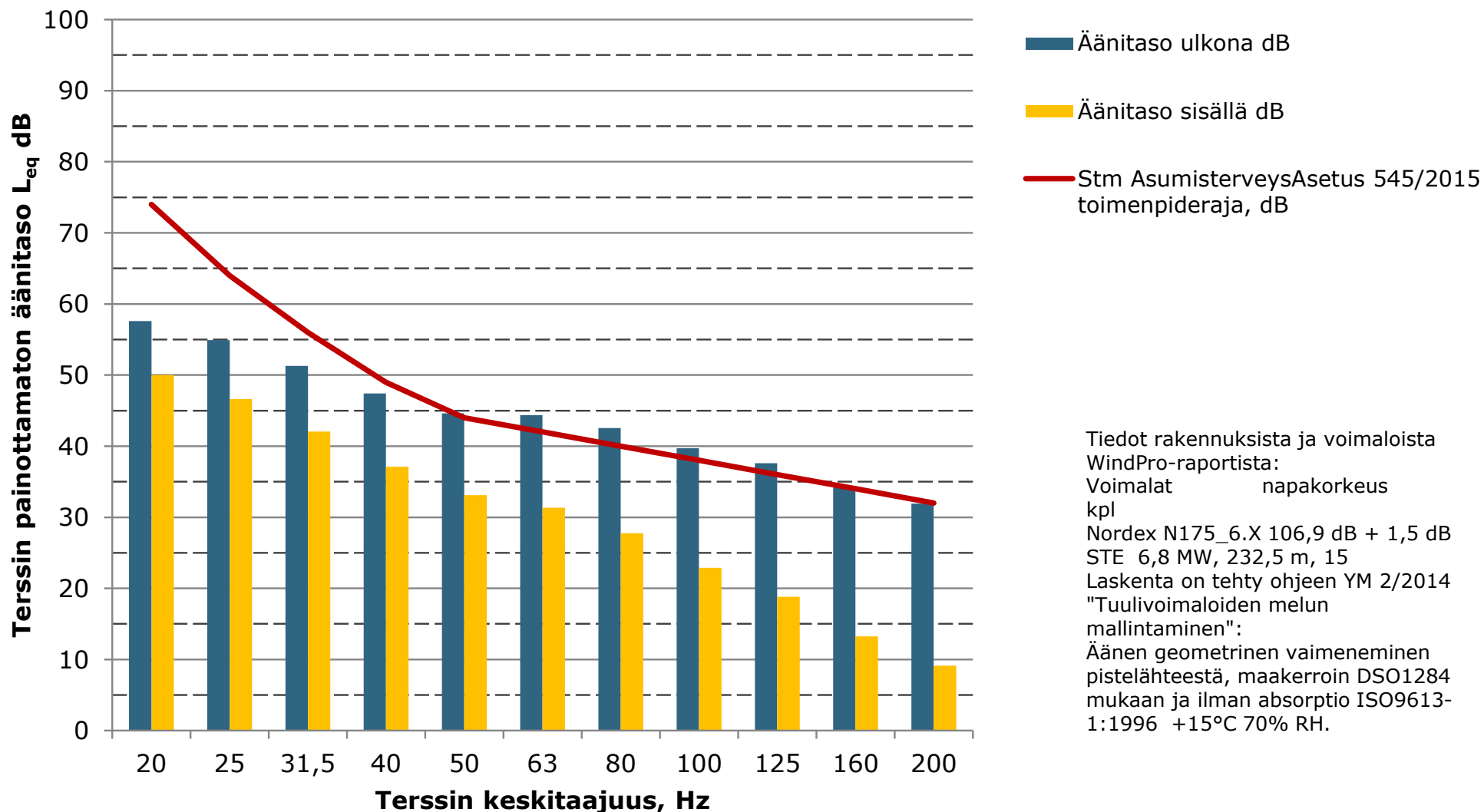
11.10.2023

Liite 11. Verkasalon tuulivoimahanke, Alavieskan alueella olevat voimalat – matalataajuisen melun rakennuskohtaiset arvot VE1 N175 - 6.8 MW.

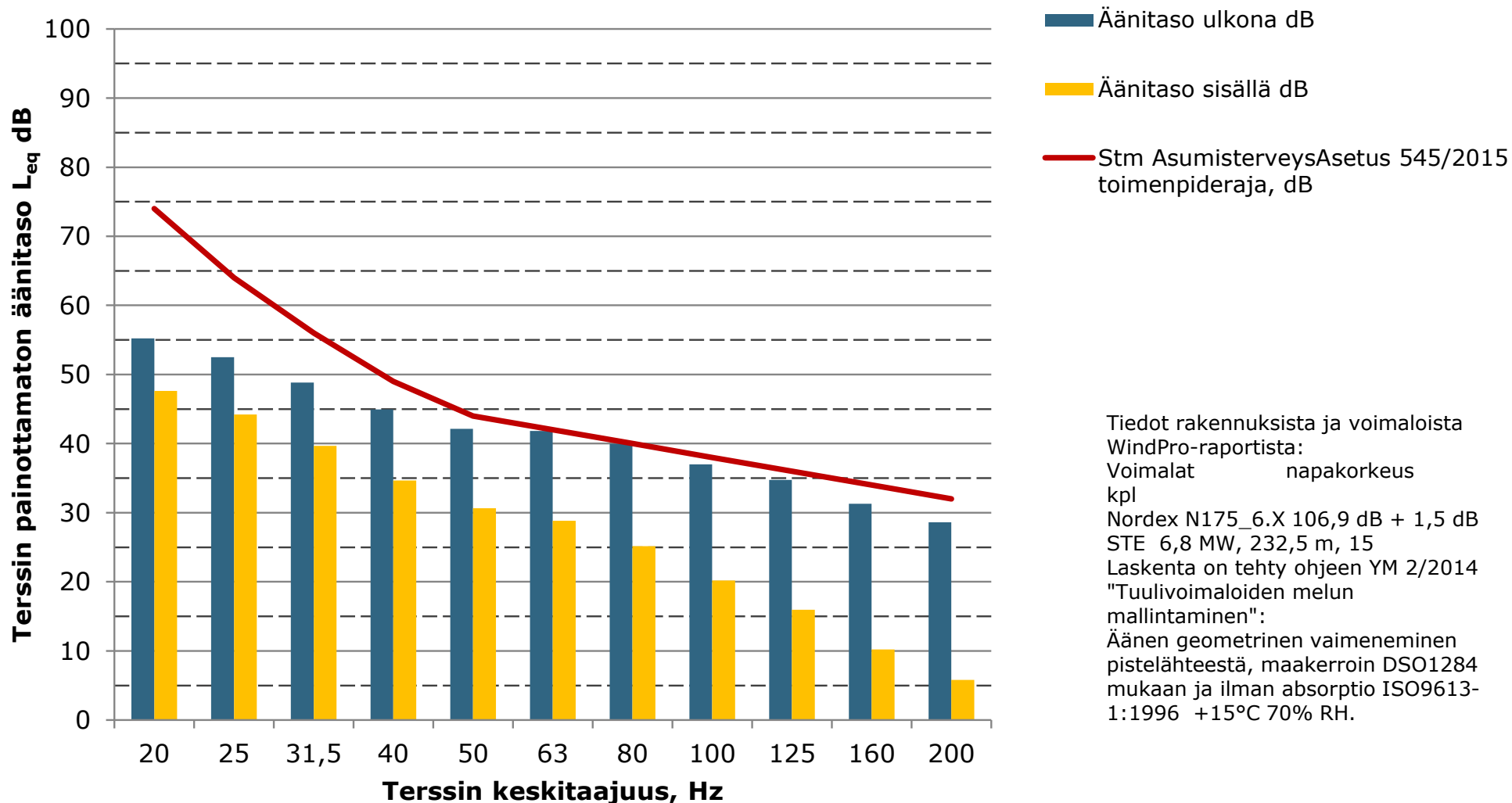


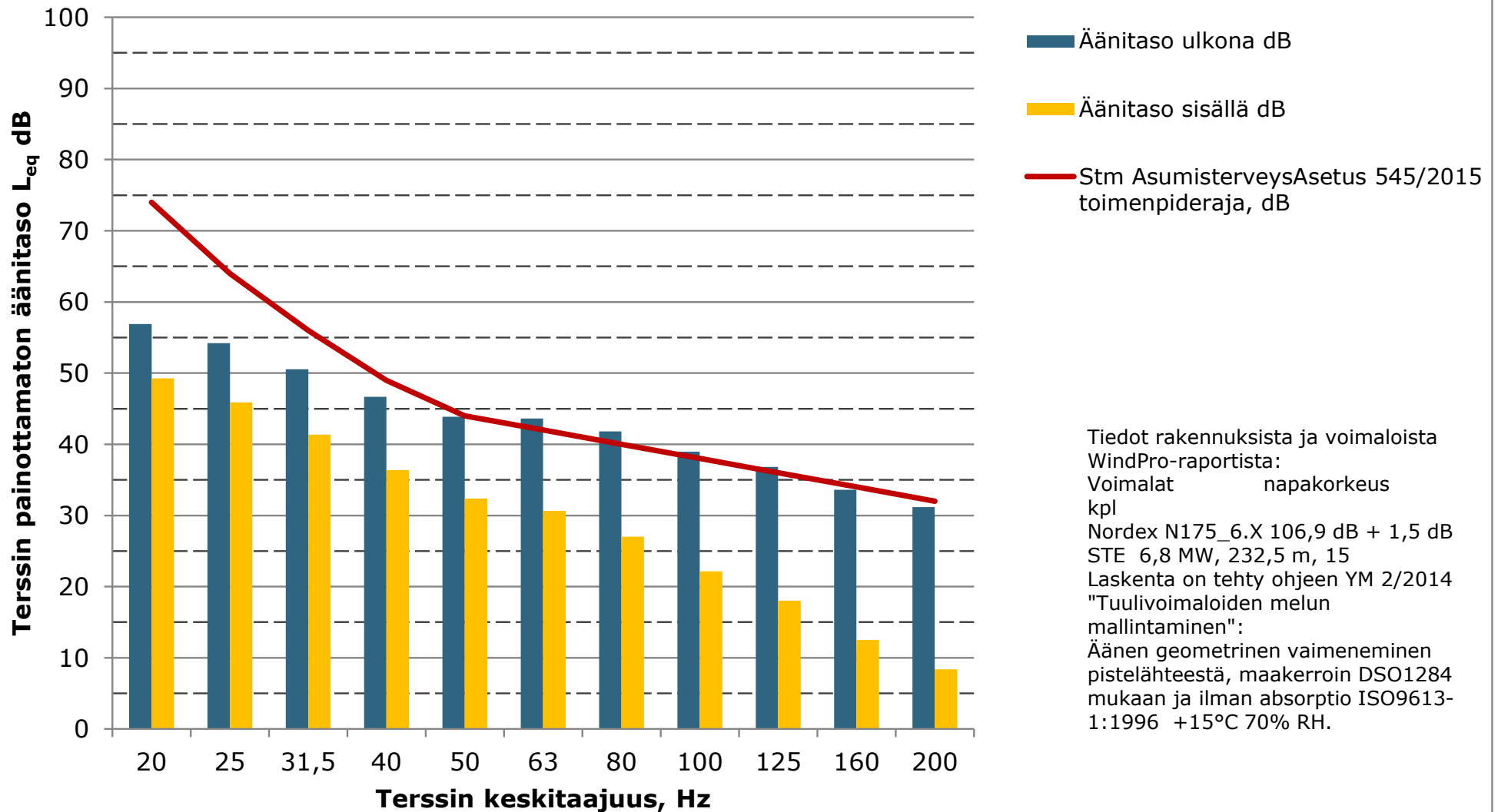


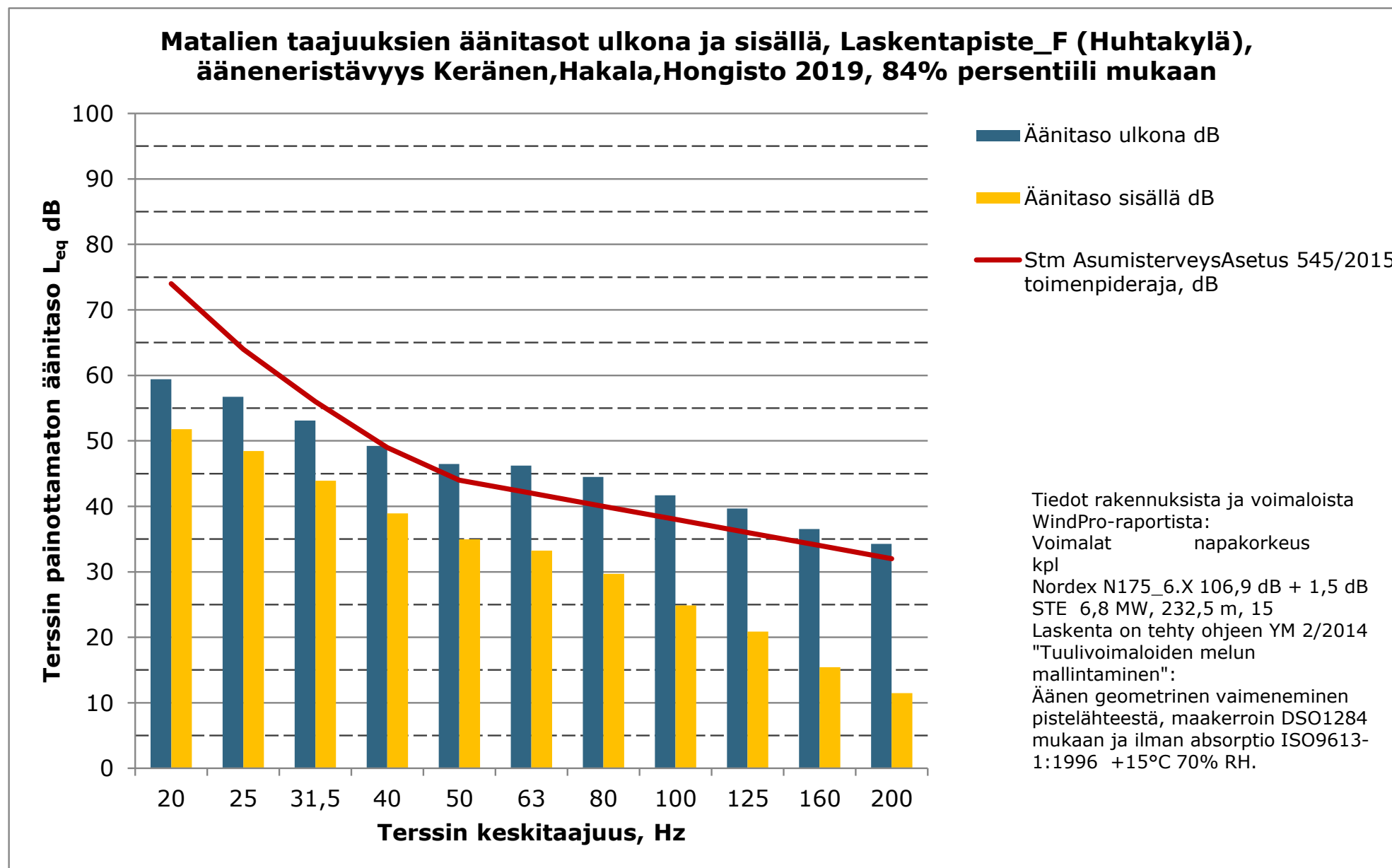
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



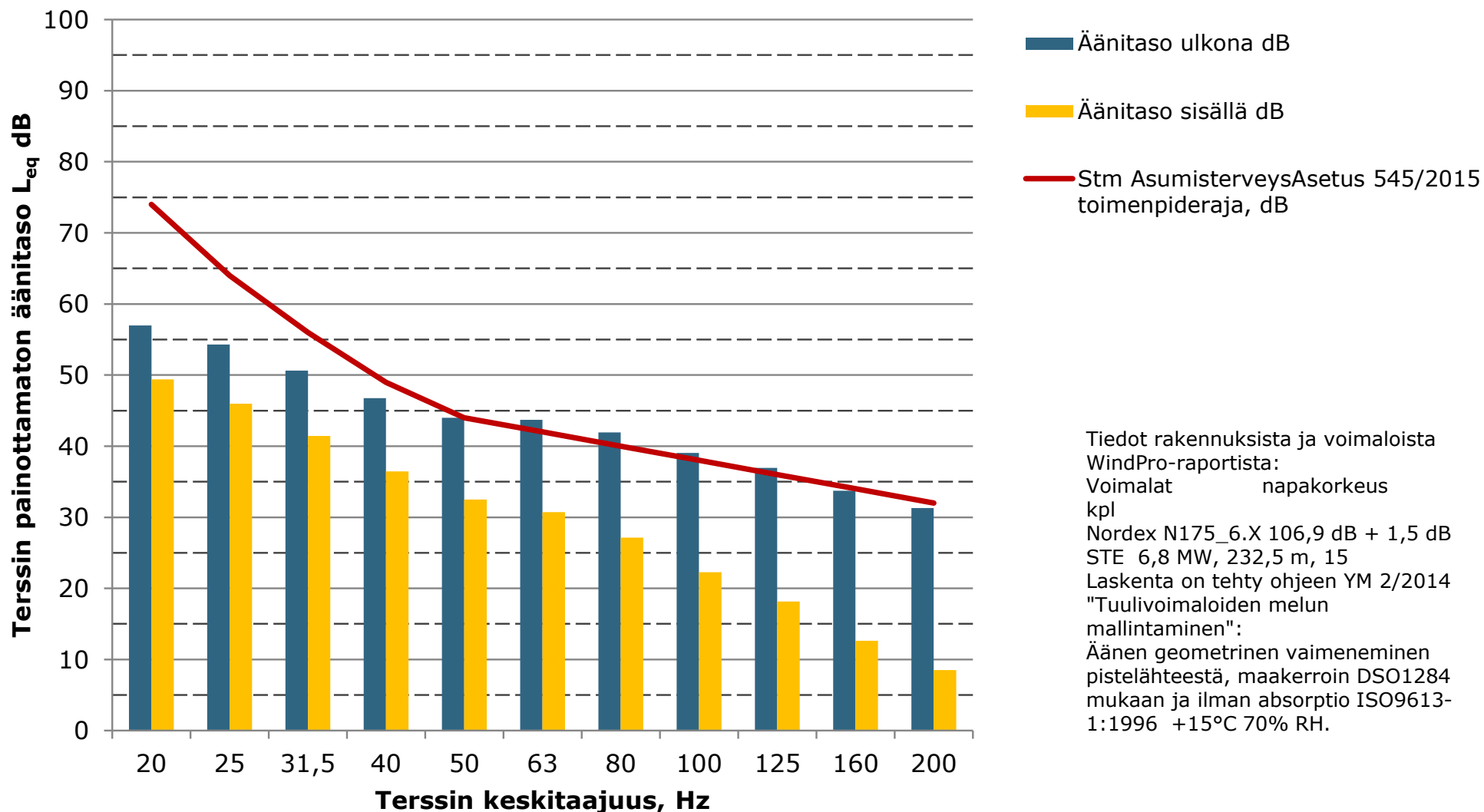
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



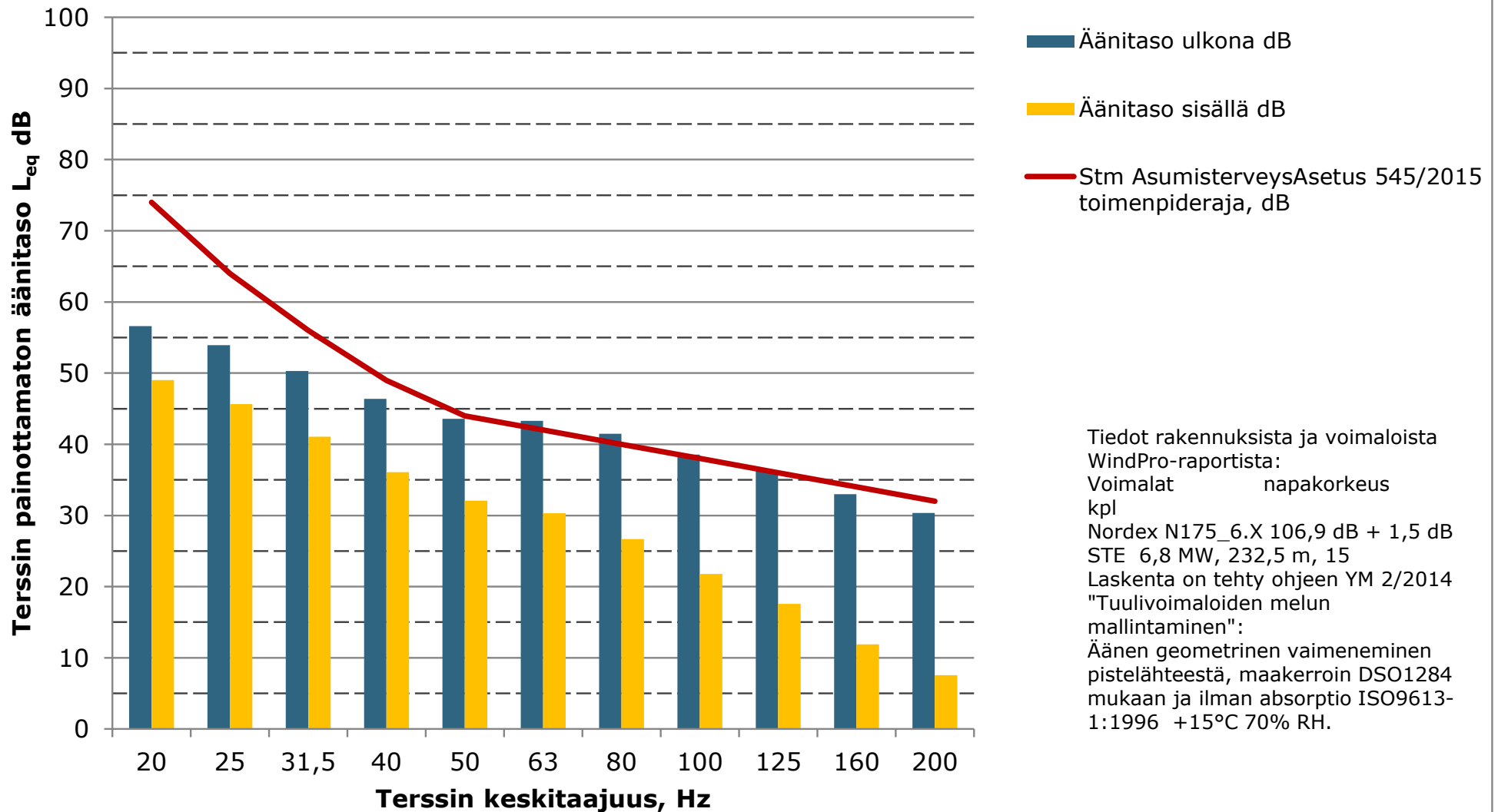
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

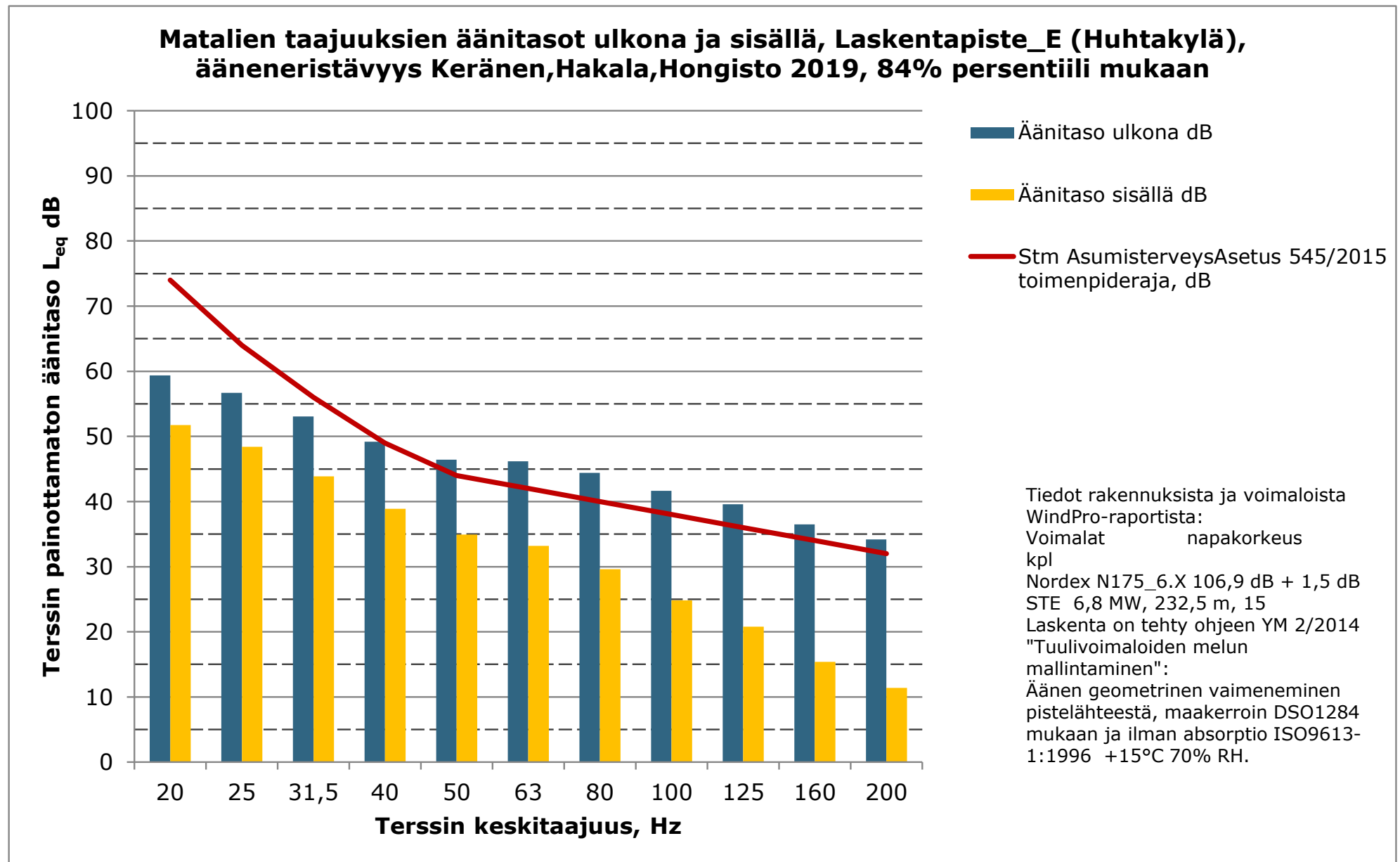


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

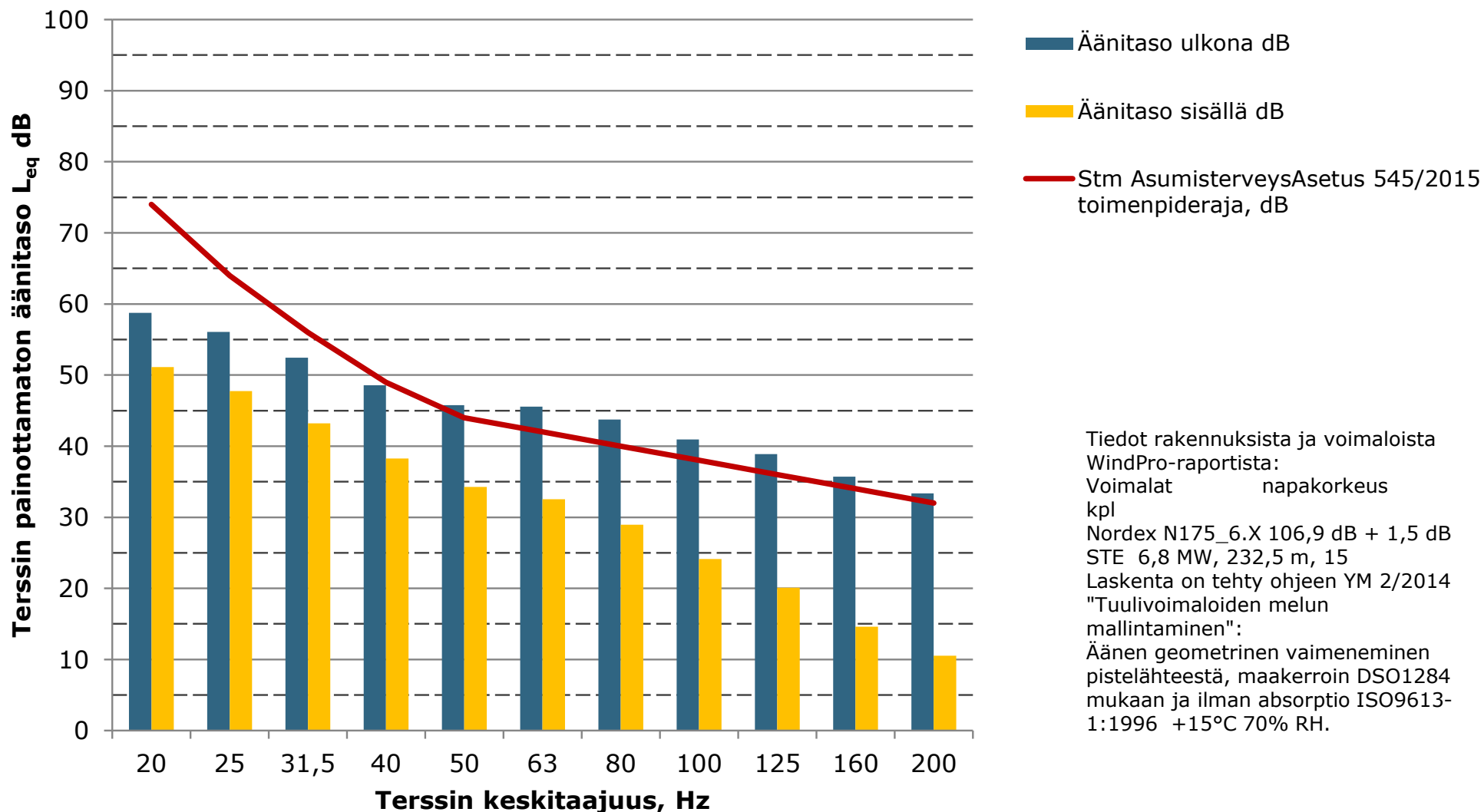


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

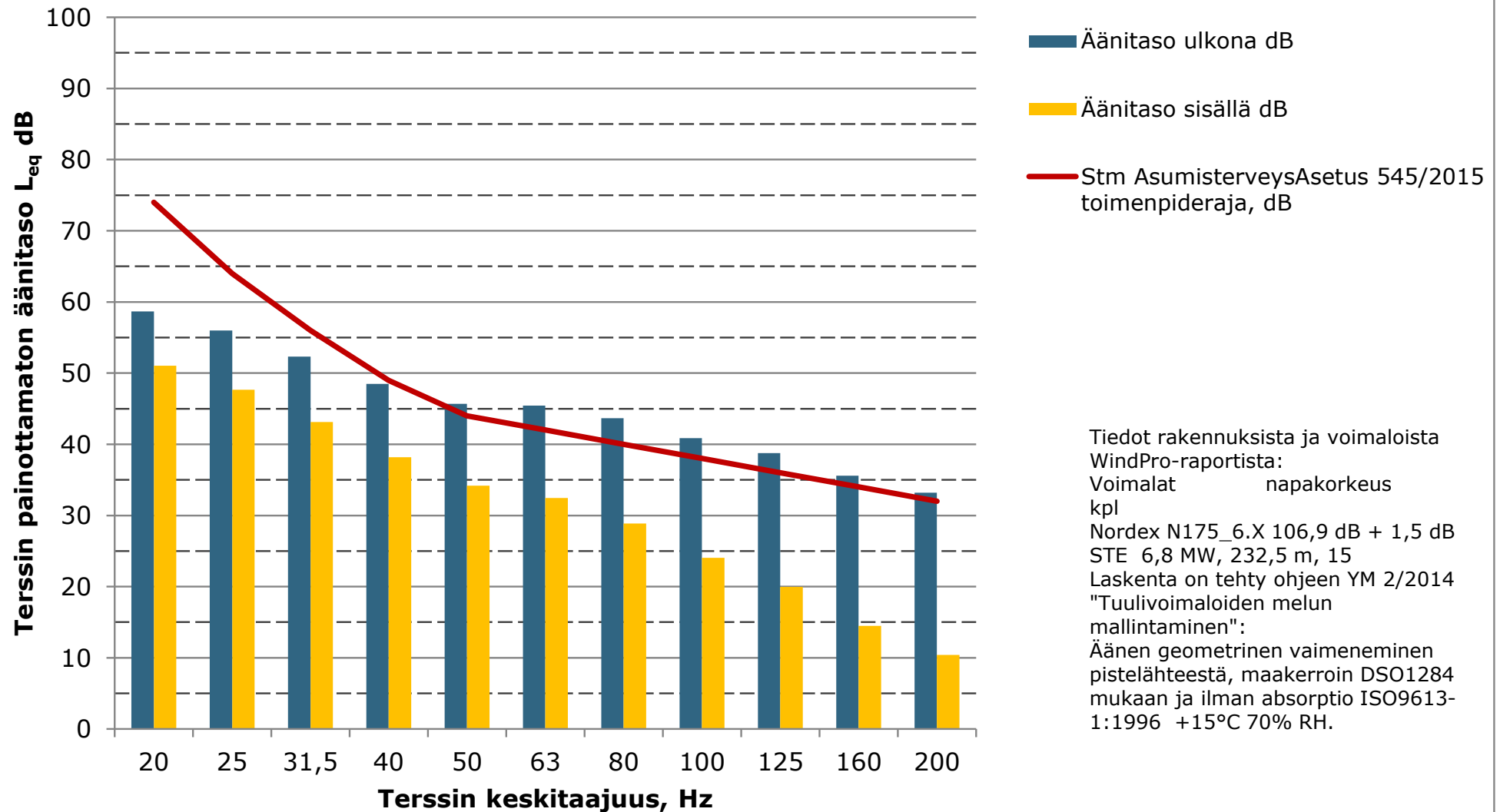




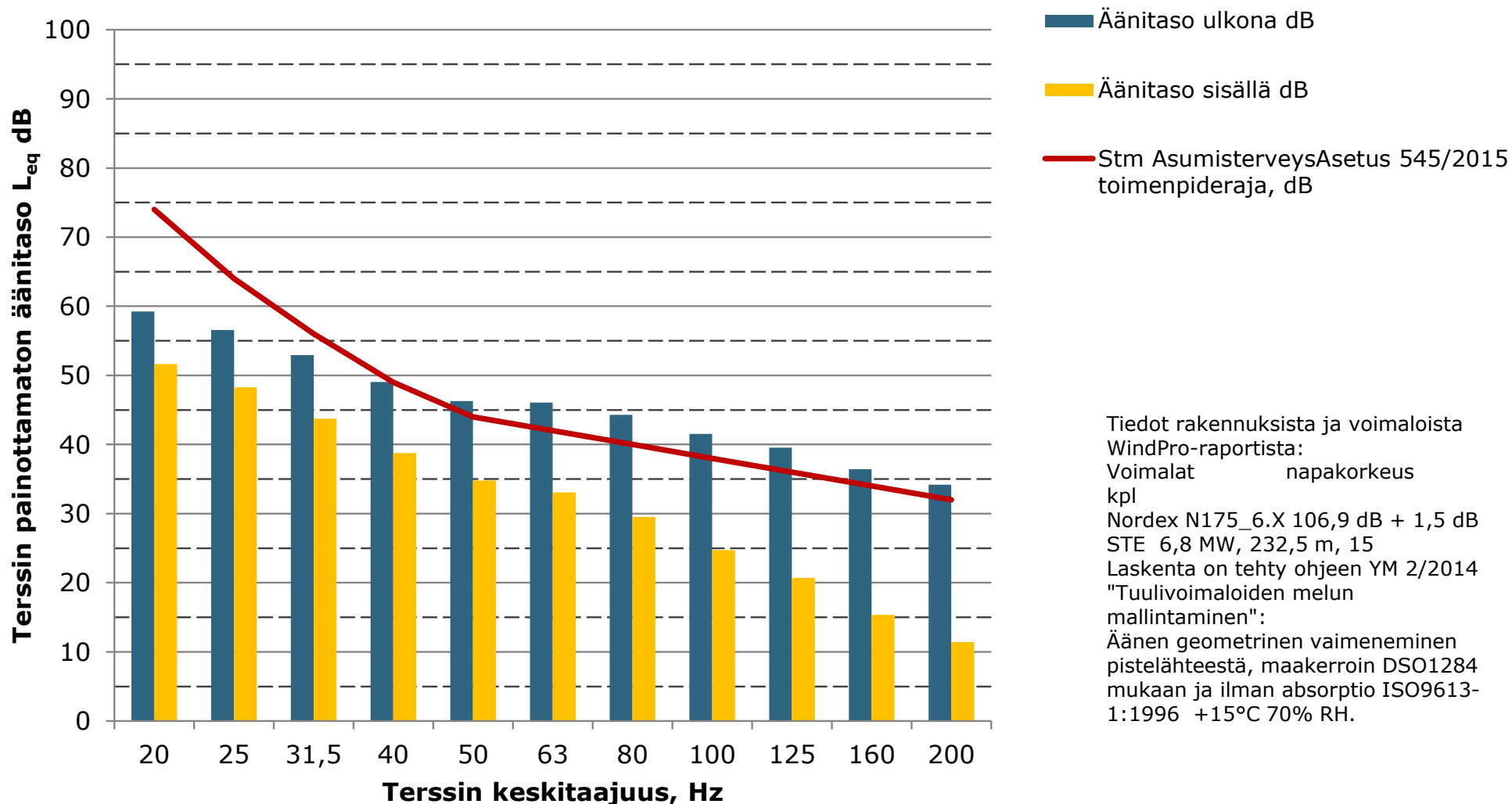
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



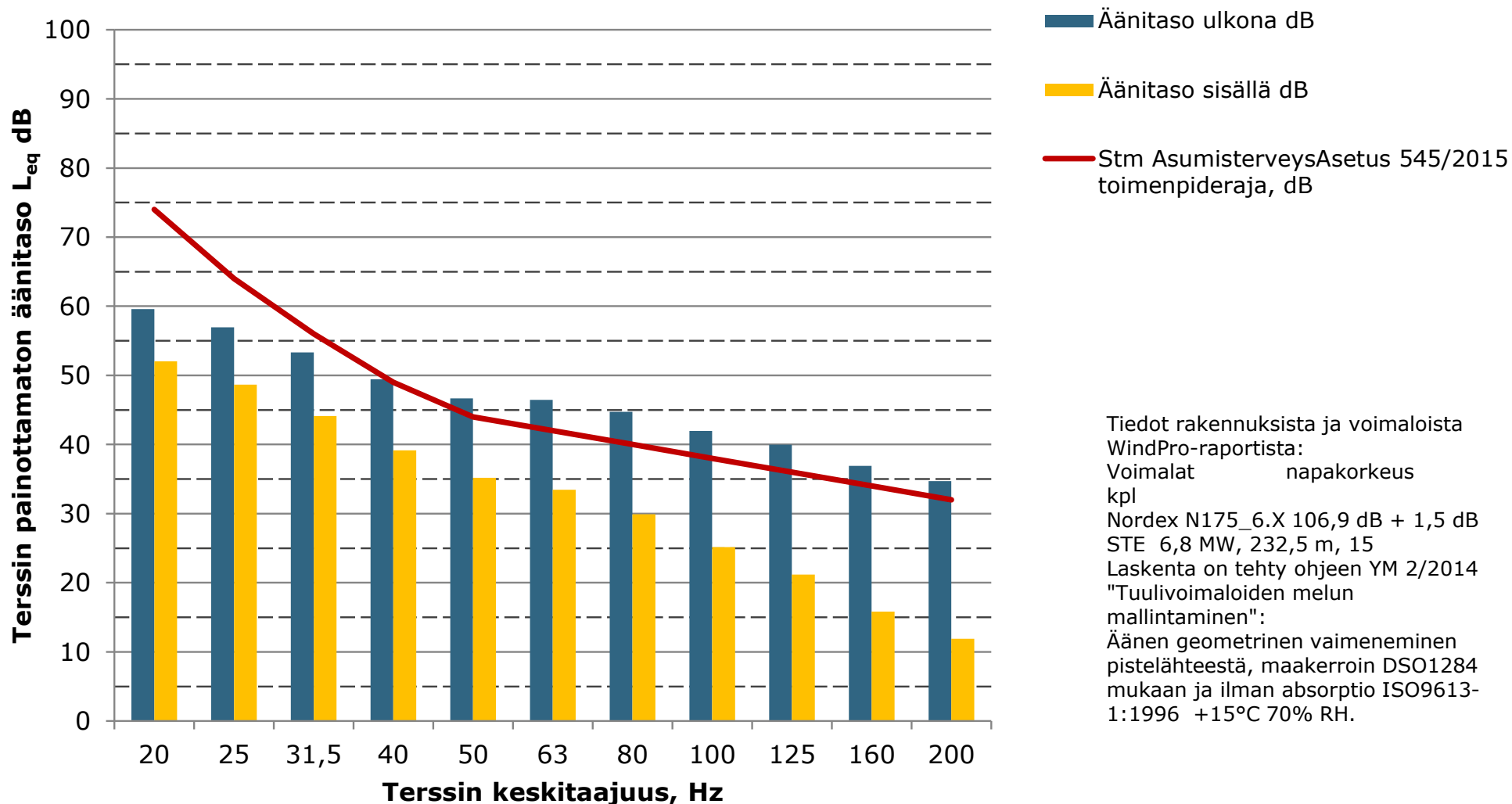
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_H (Karjaneva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



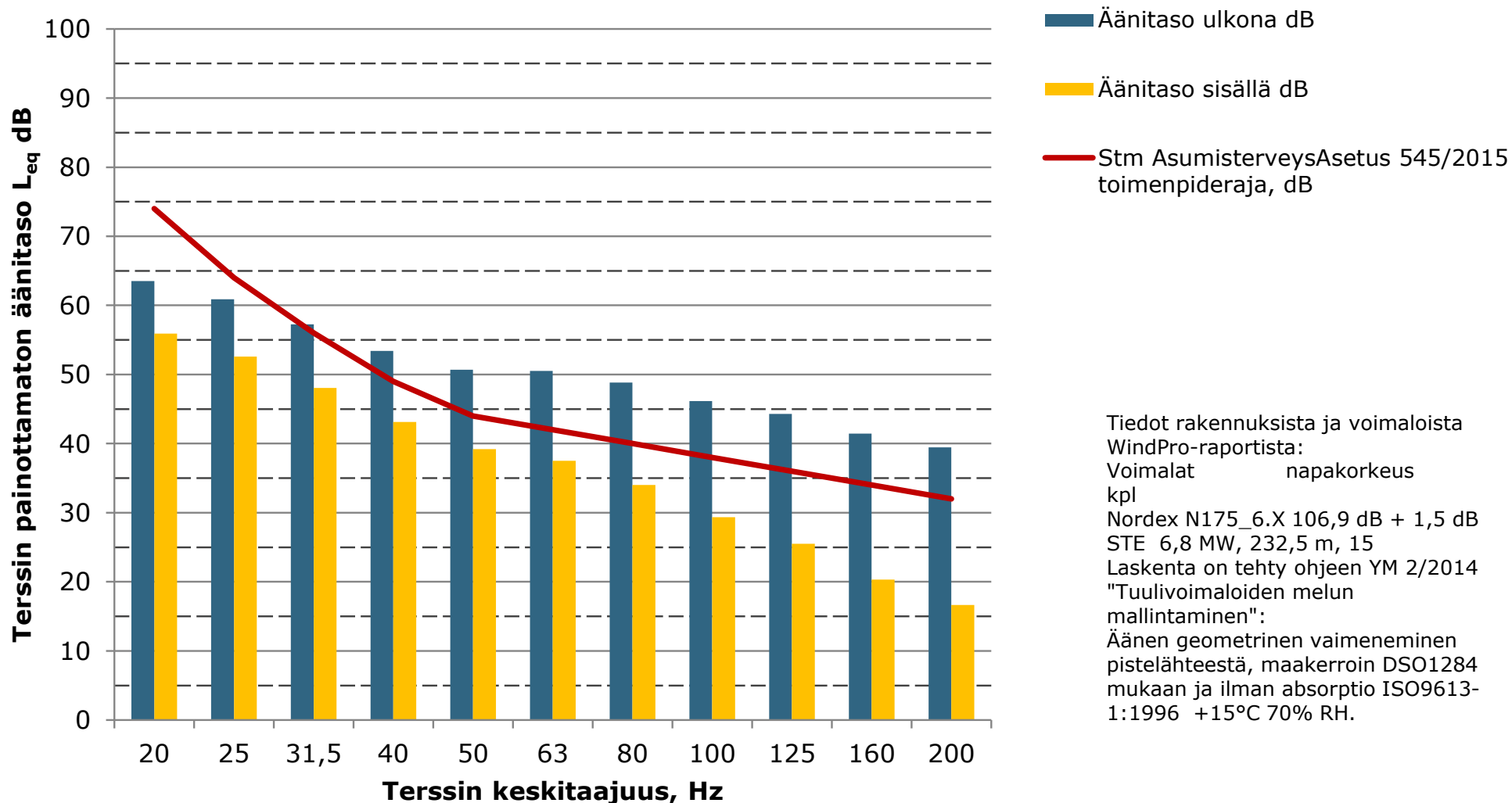
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



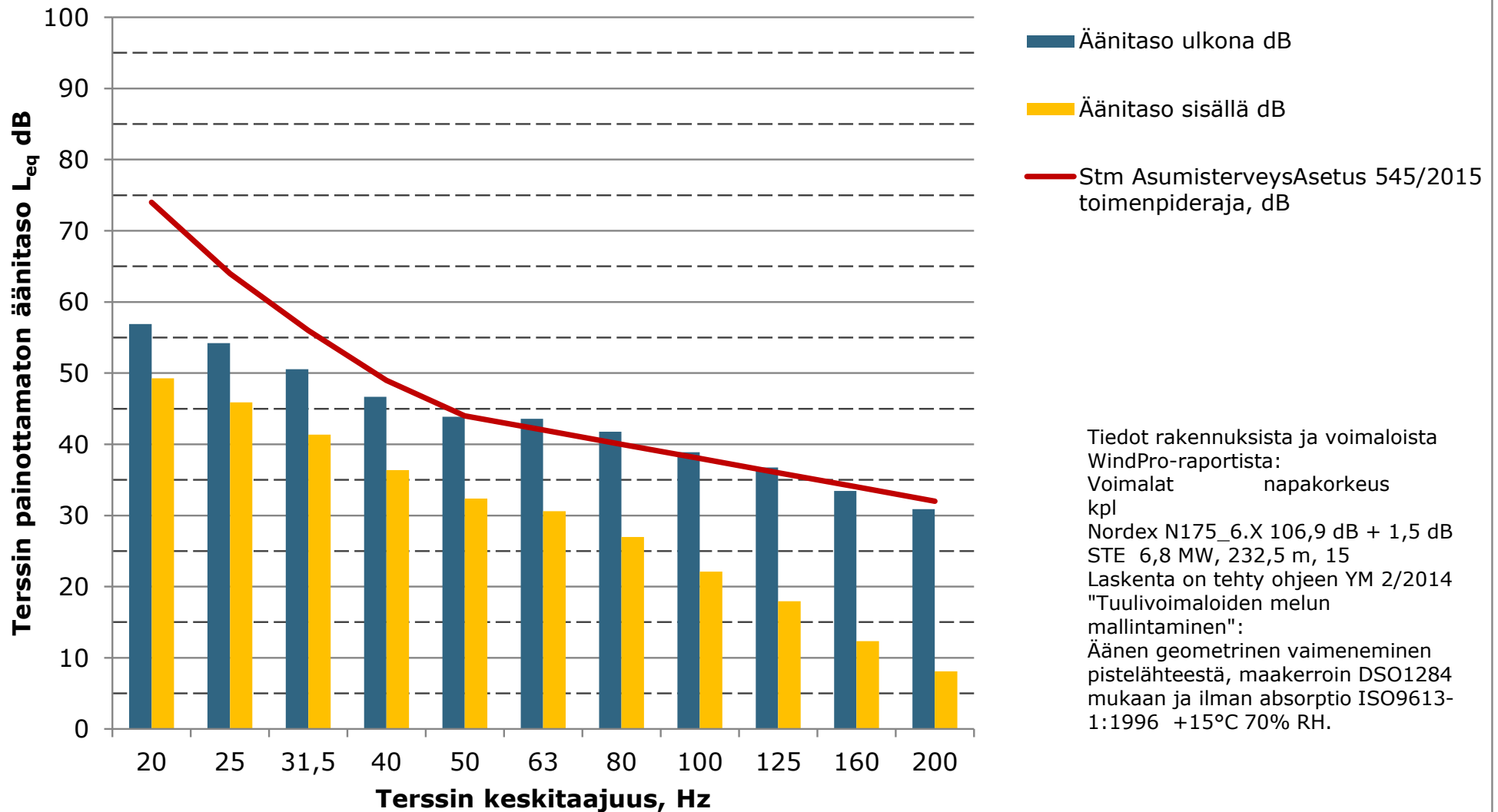
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

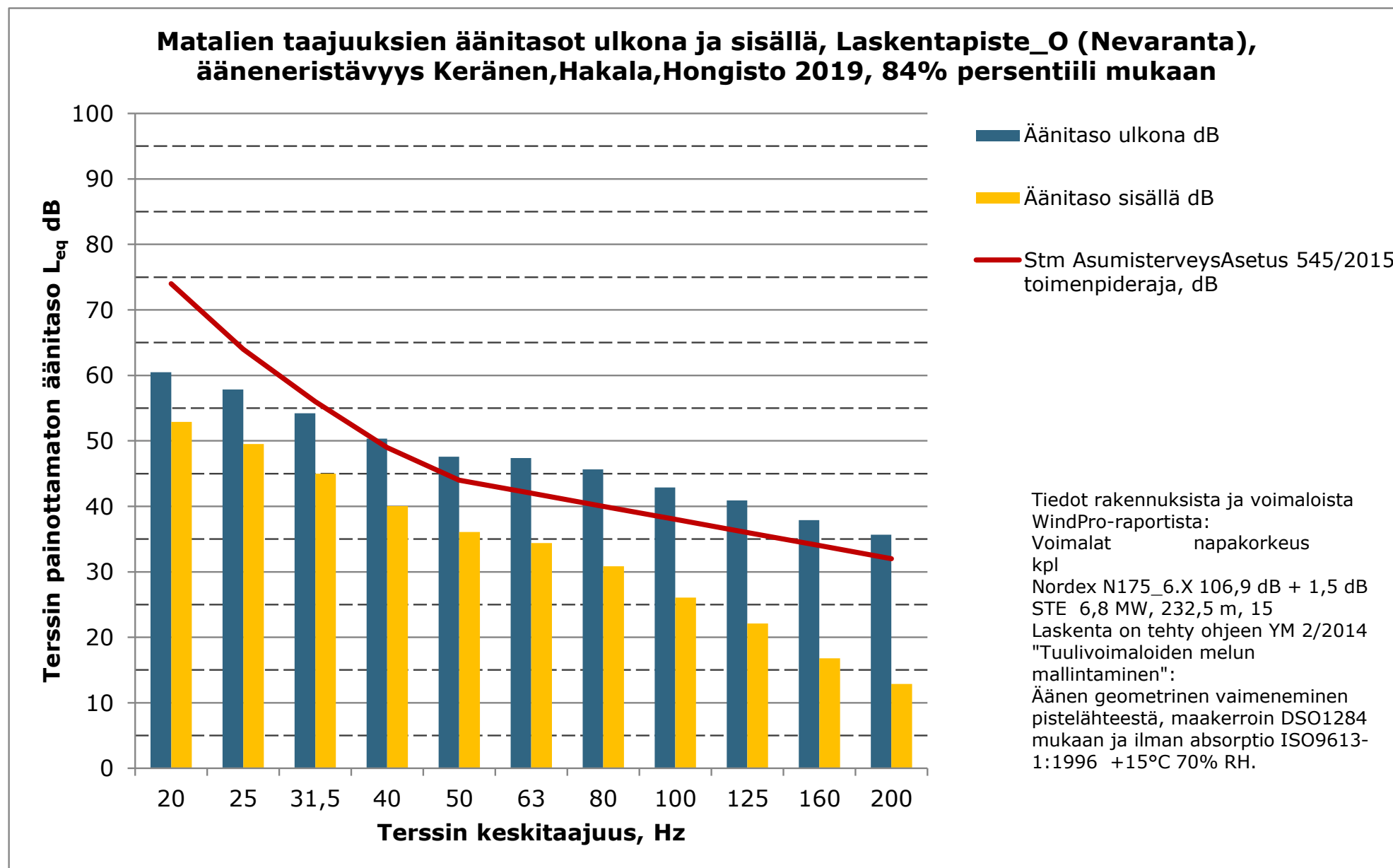


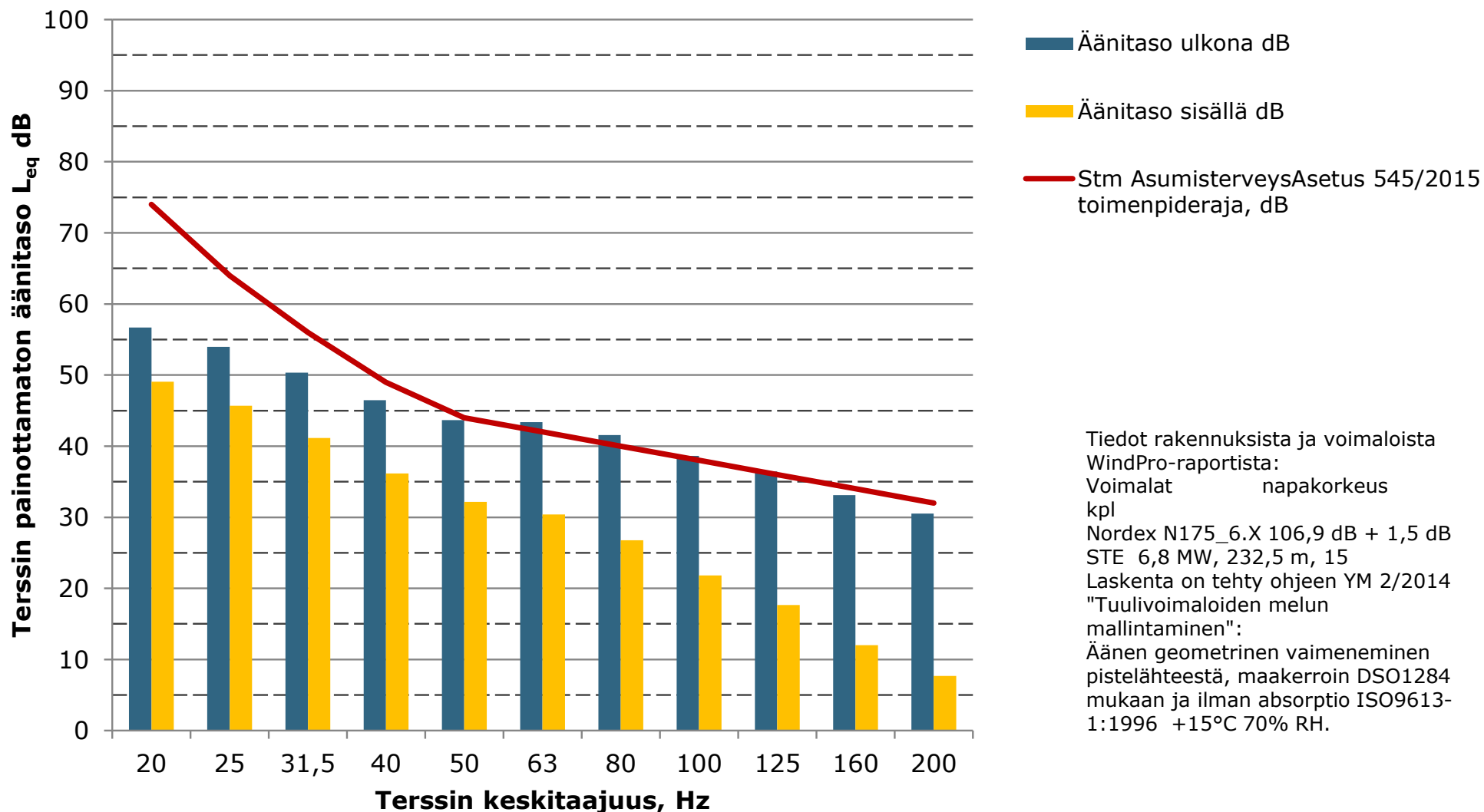
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

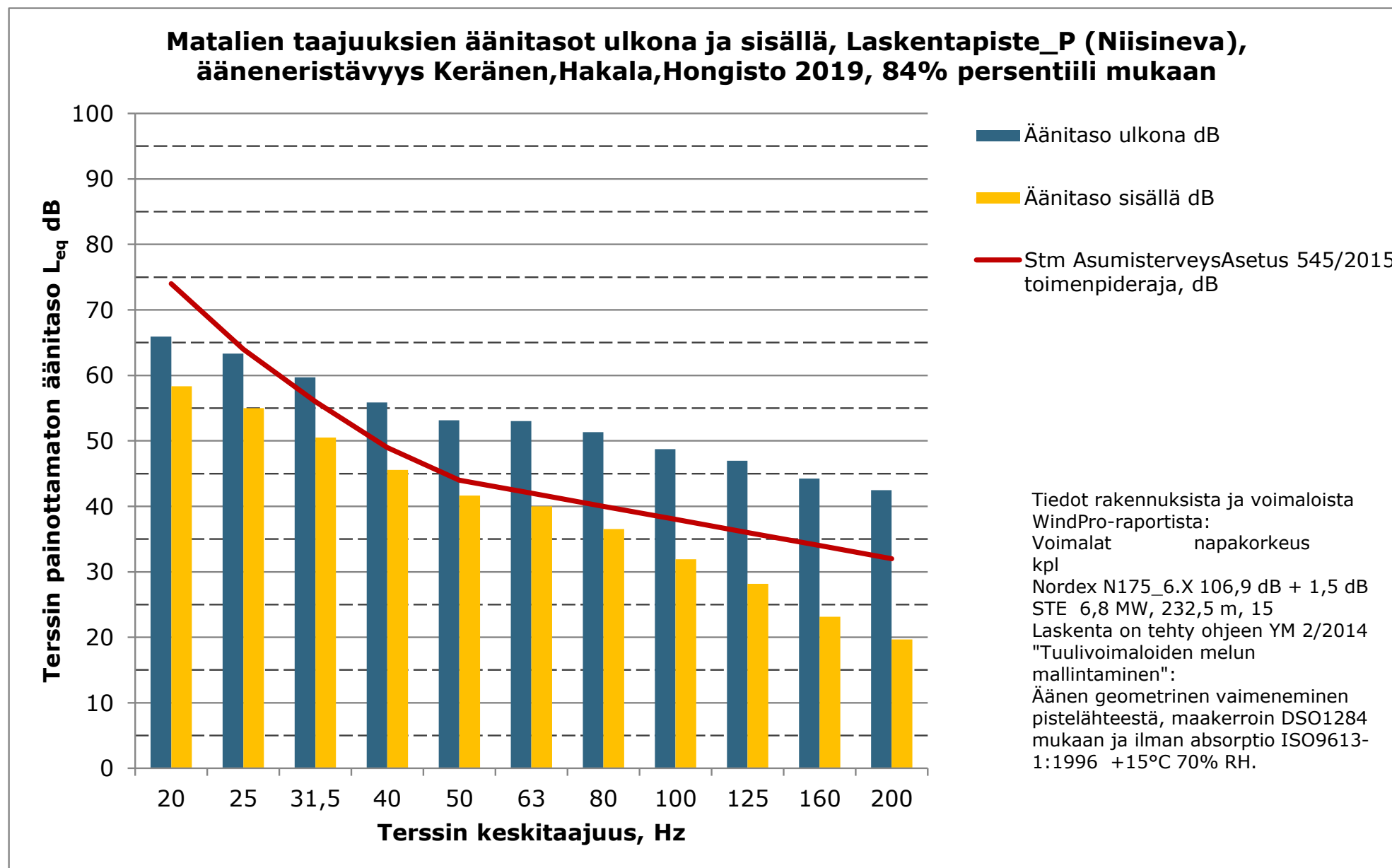


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

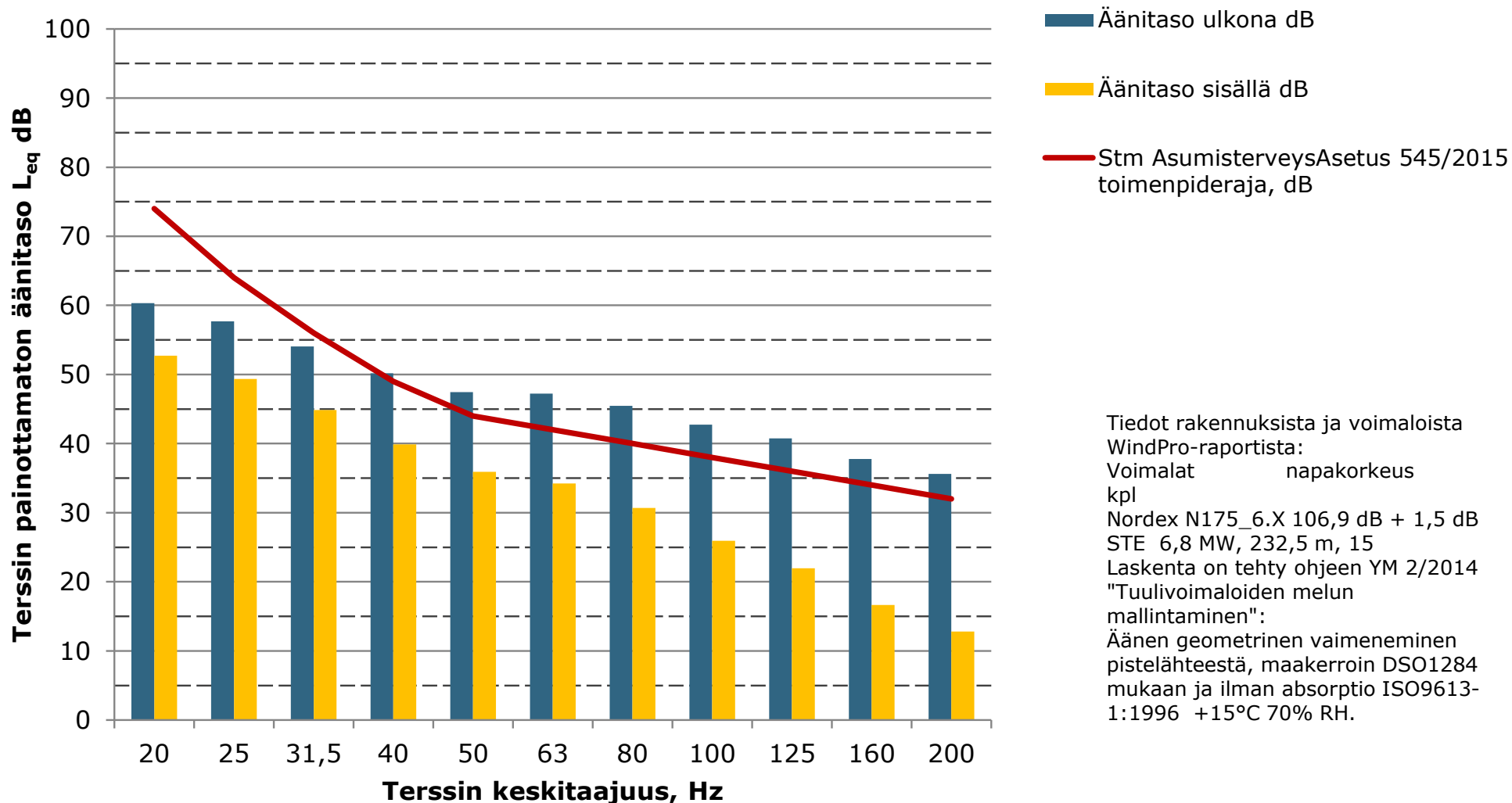




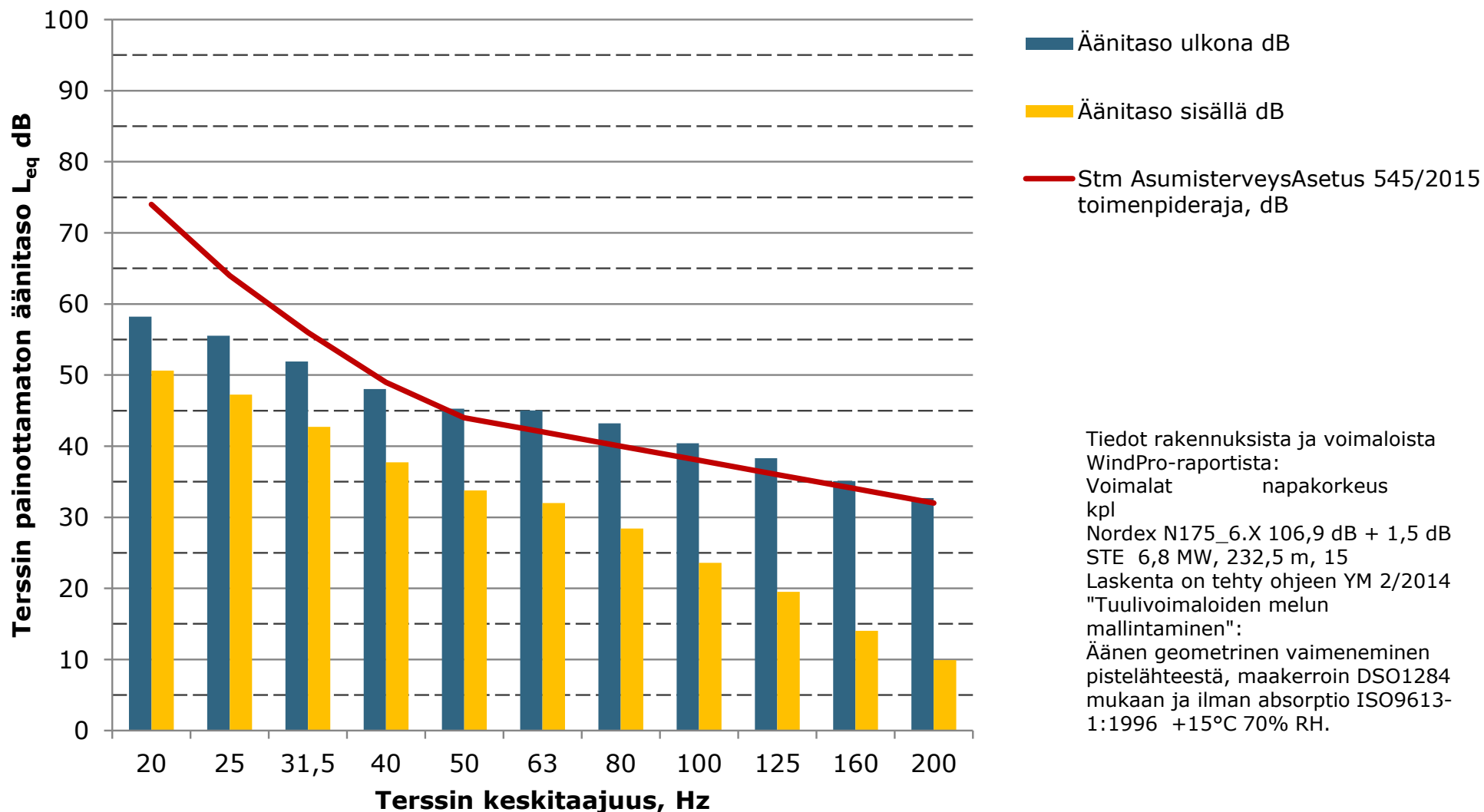
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

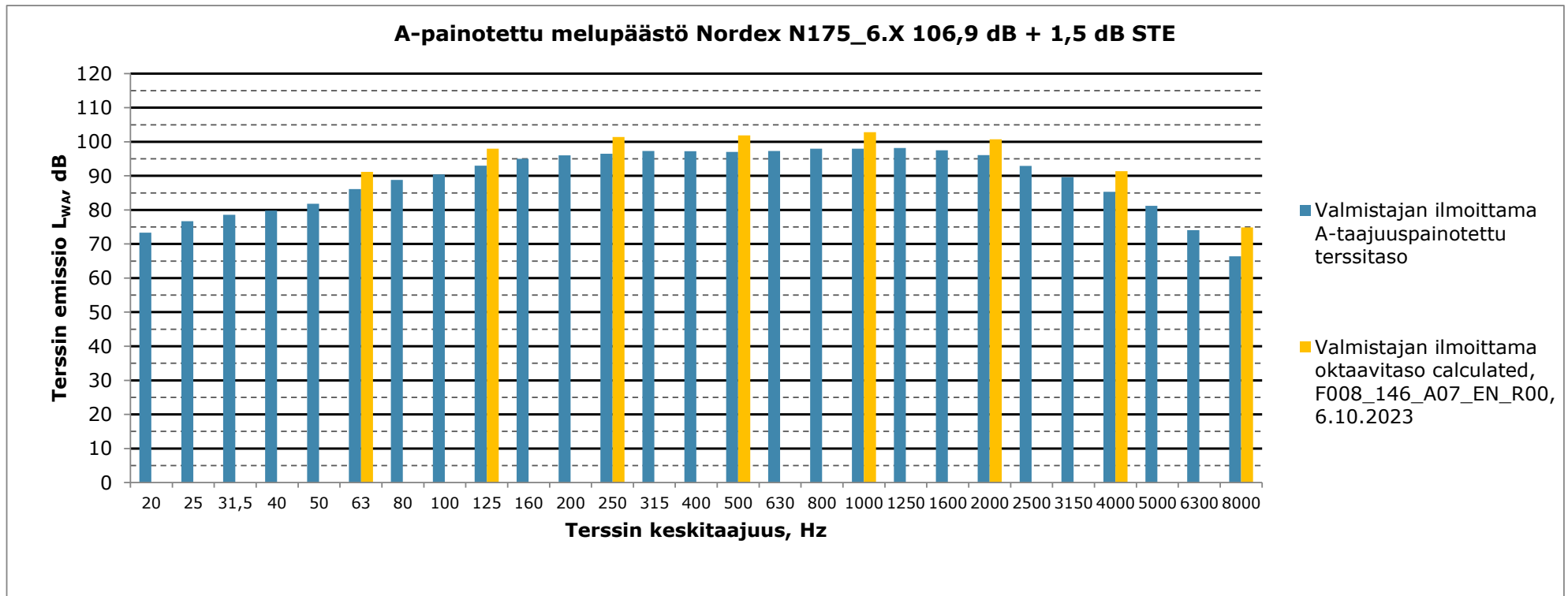


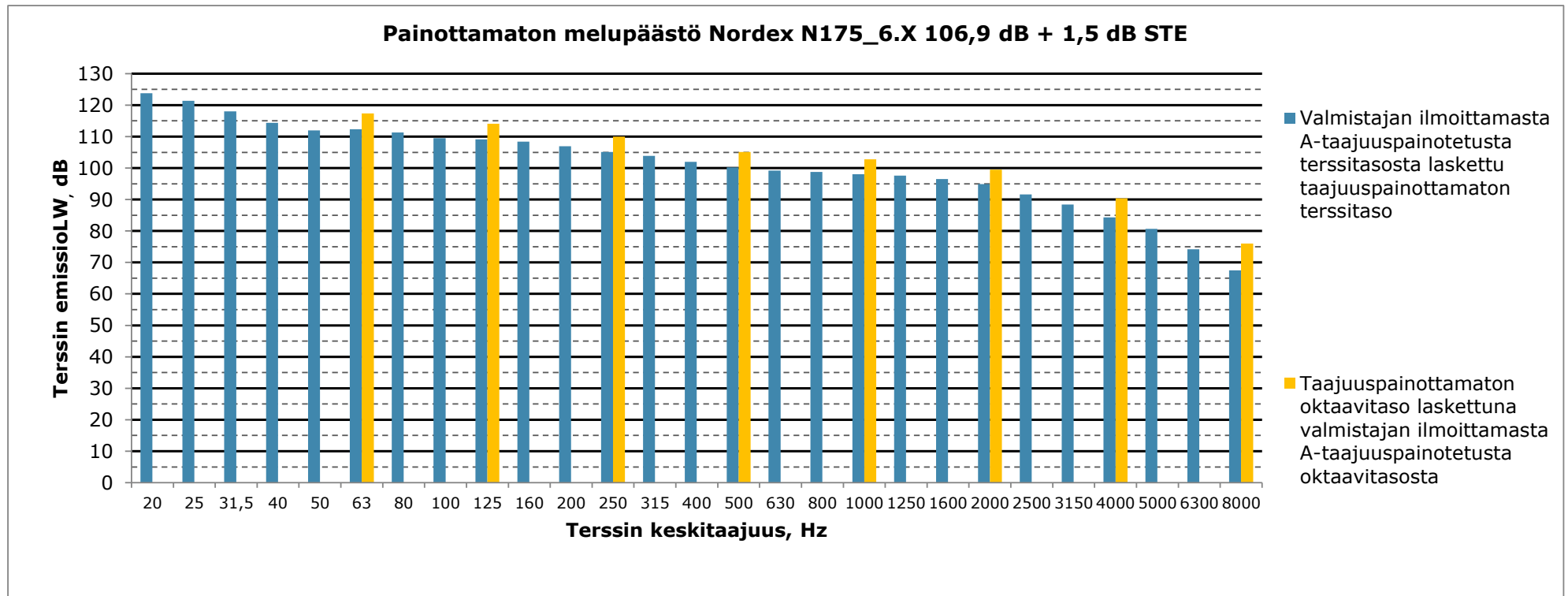
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



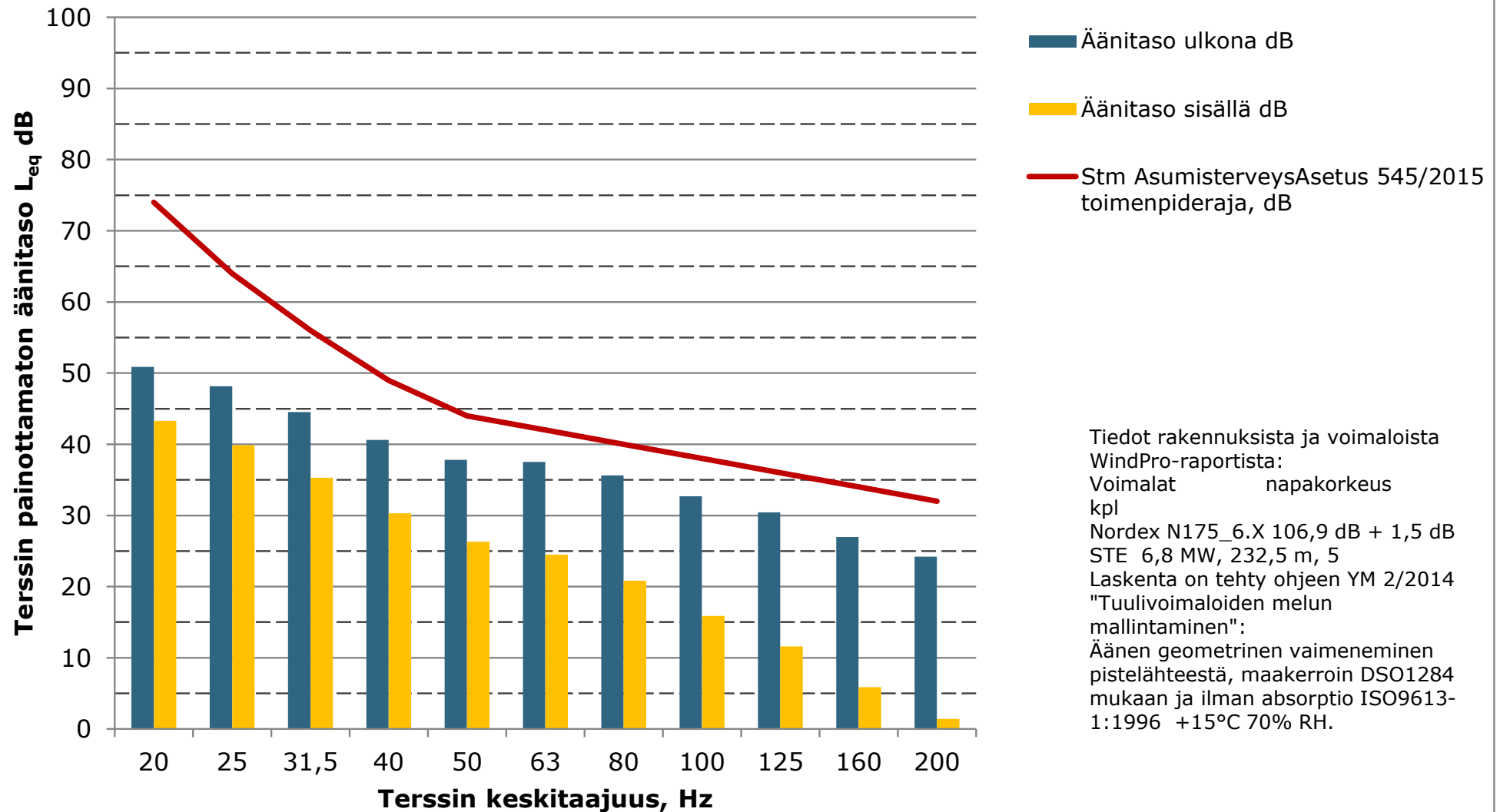
11.10.2023

Liite 12. Verkasalon tuulivoimahanke, Kalajoen alueella olevat voimalat – matalataajuisen melun rakennuskohtaiset arvot VE1 N175 - 6.8 MW.

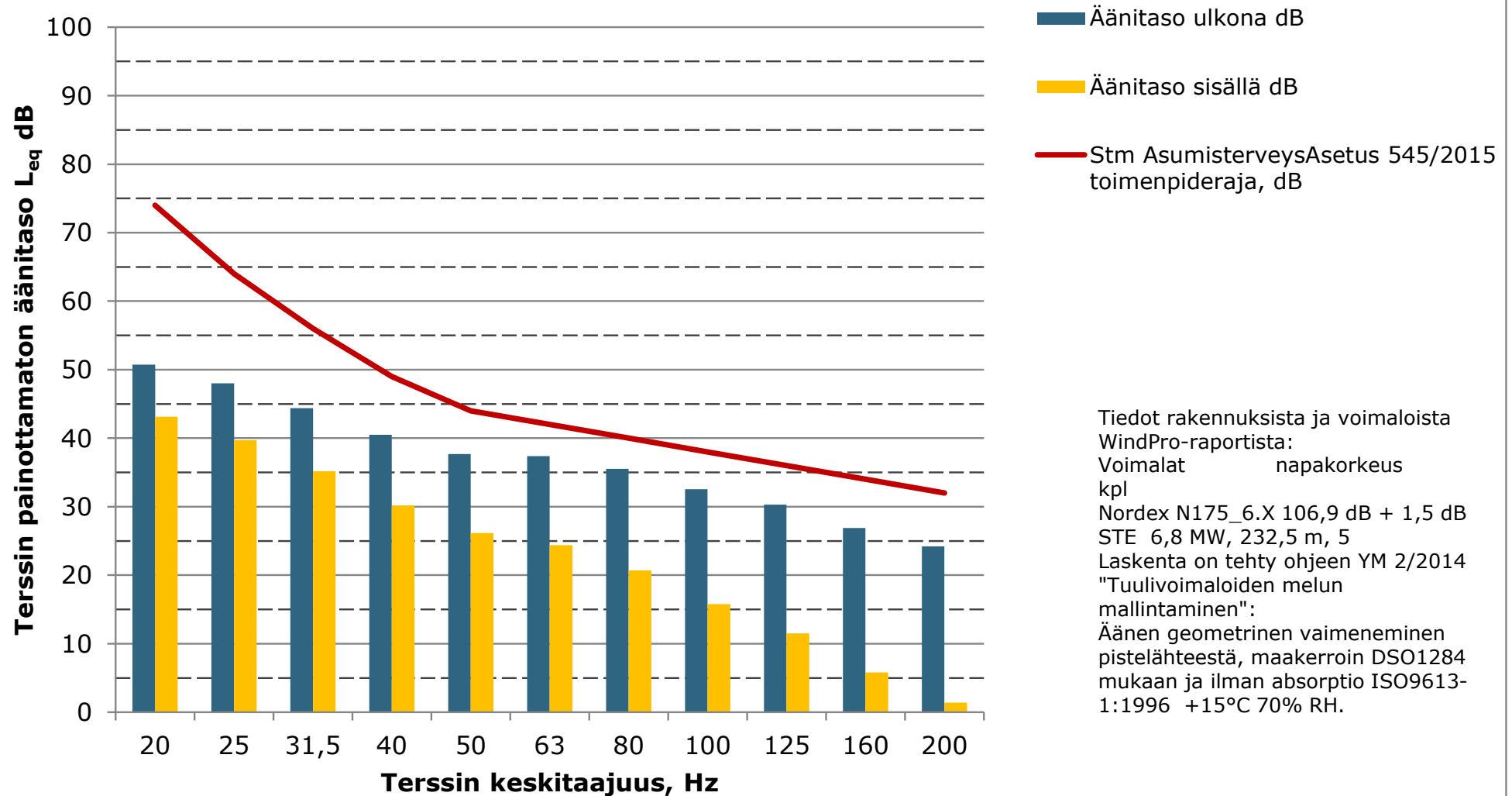




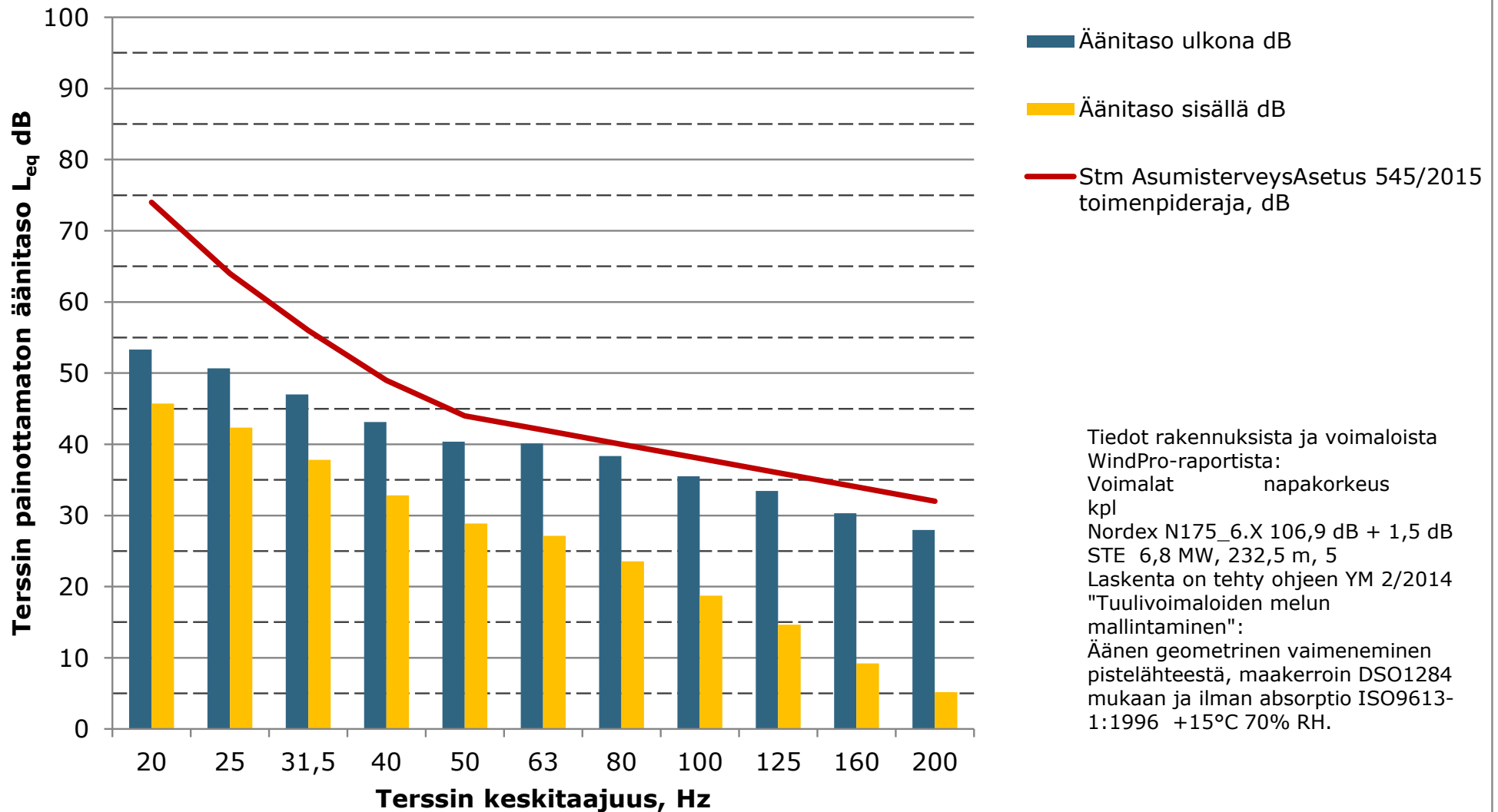
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

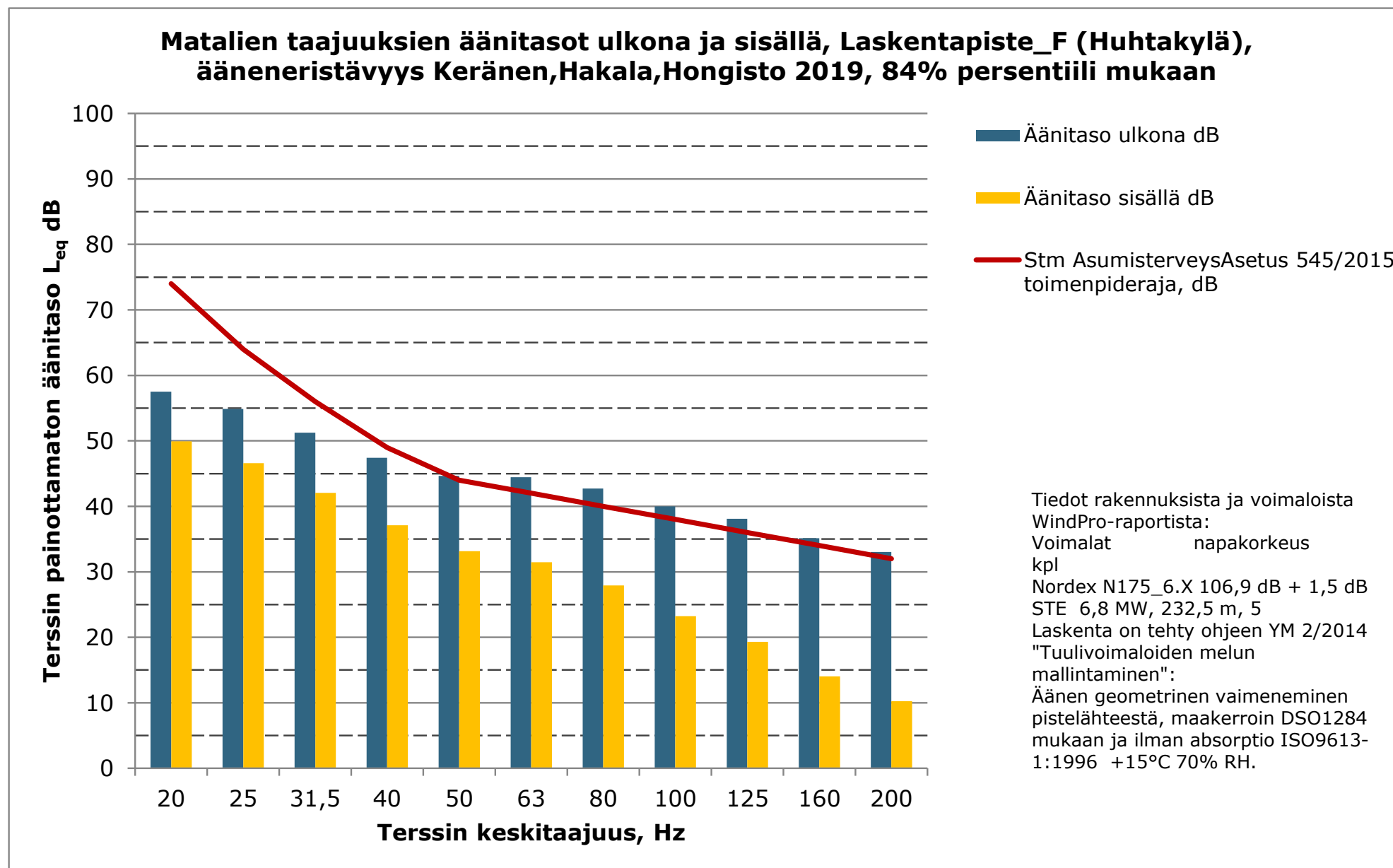


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

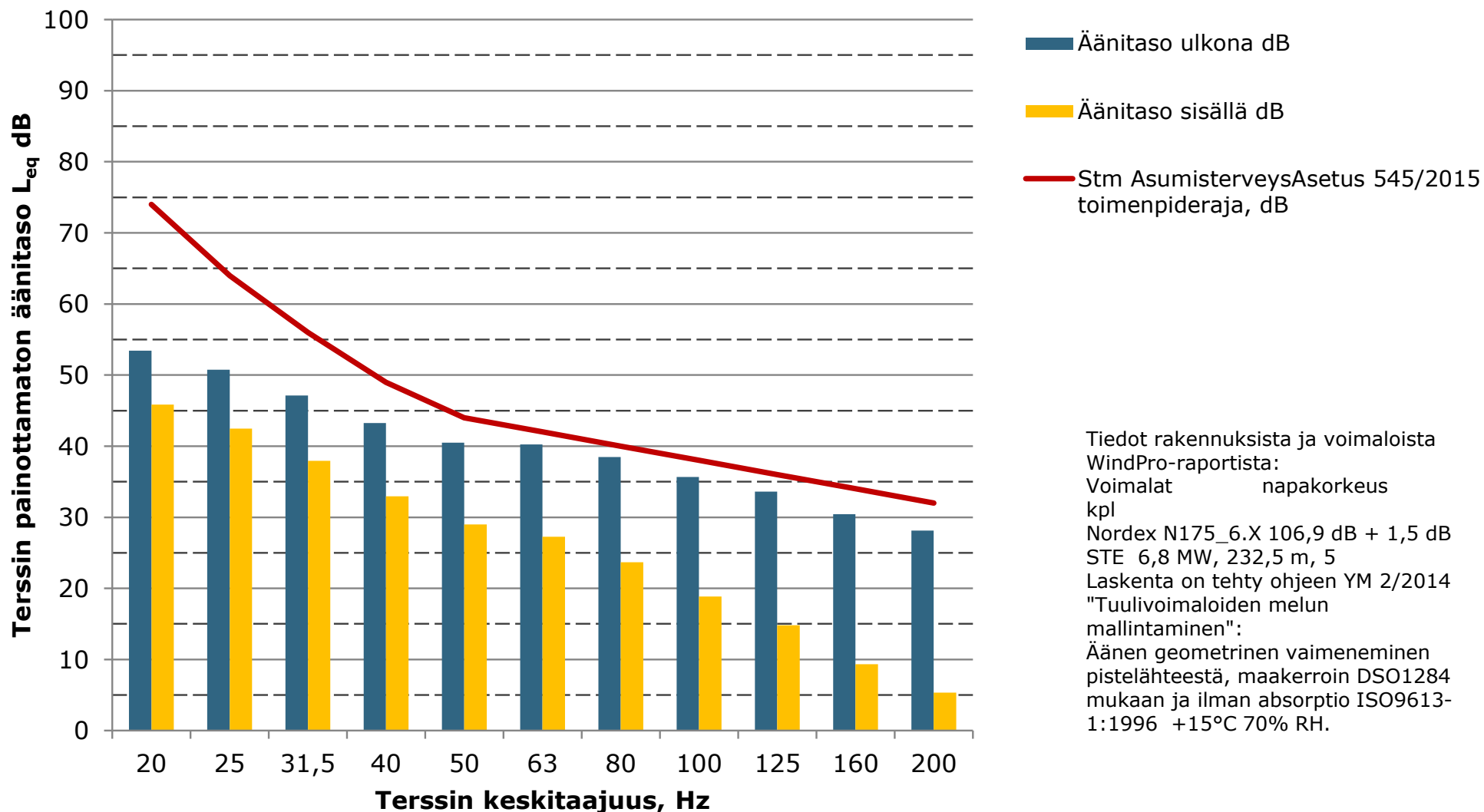


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

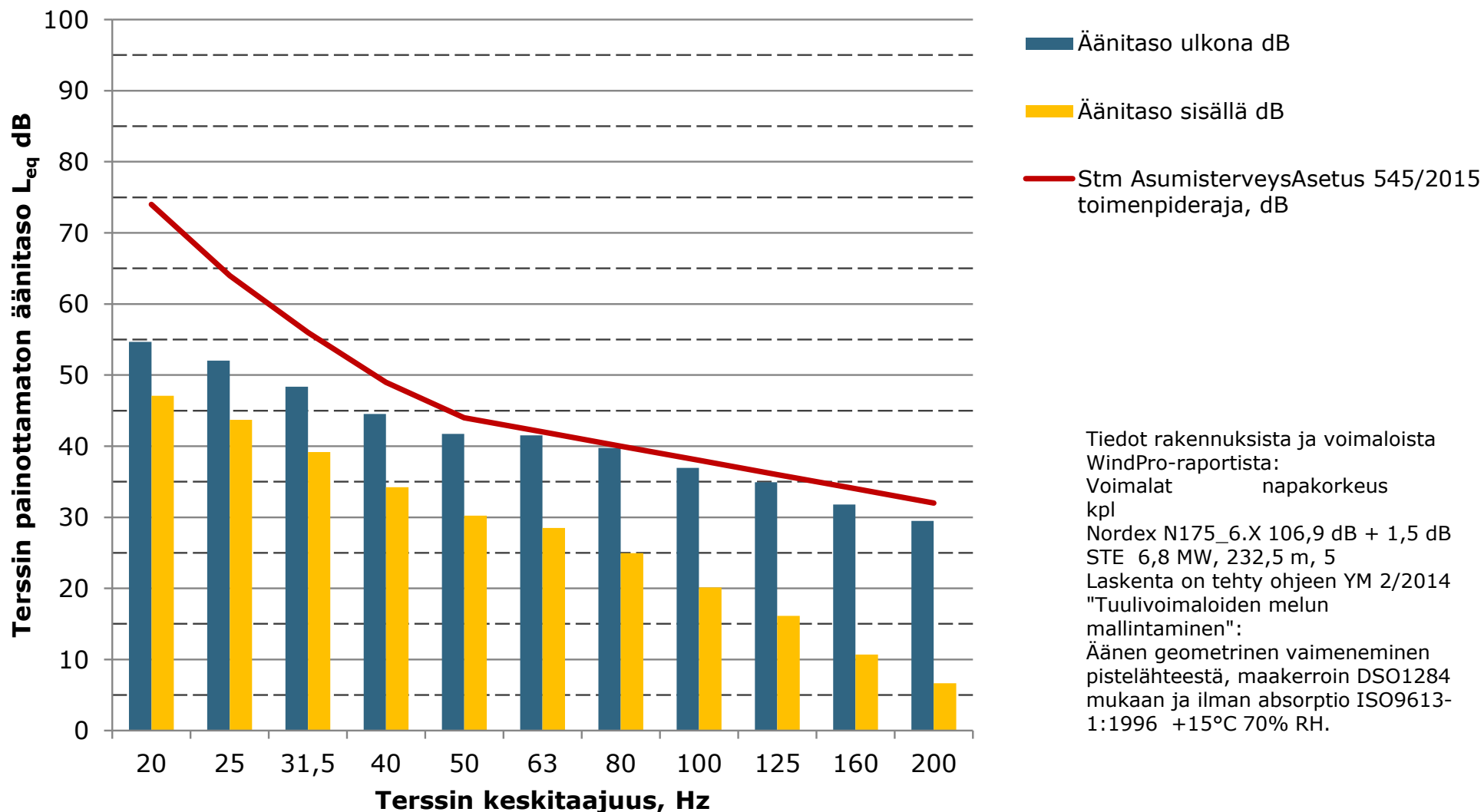


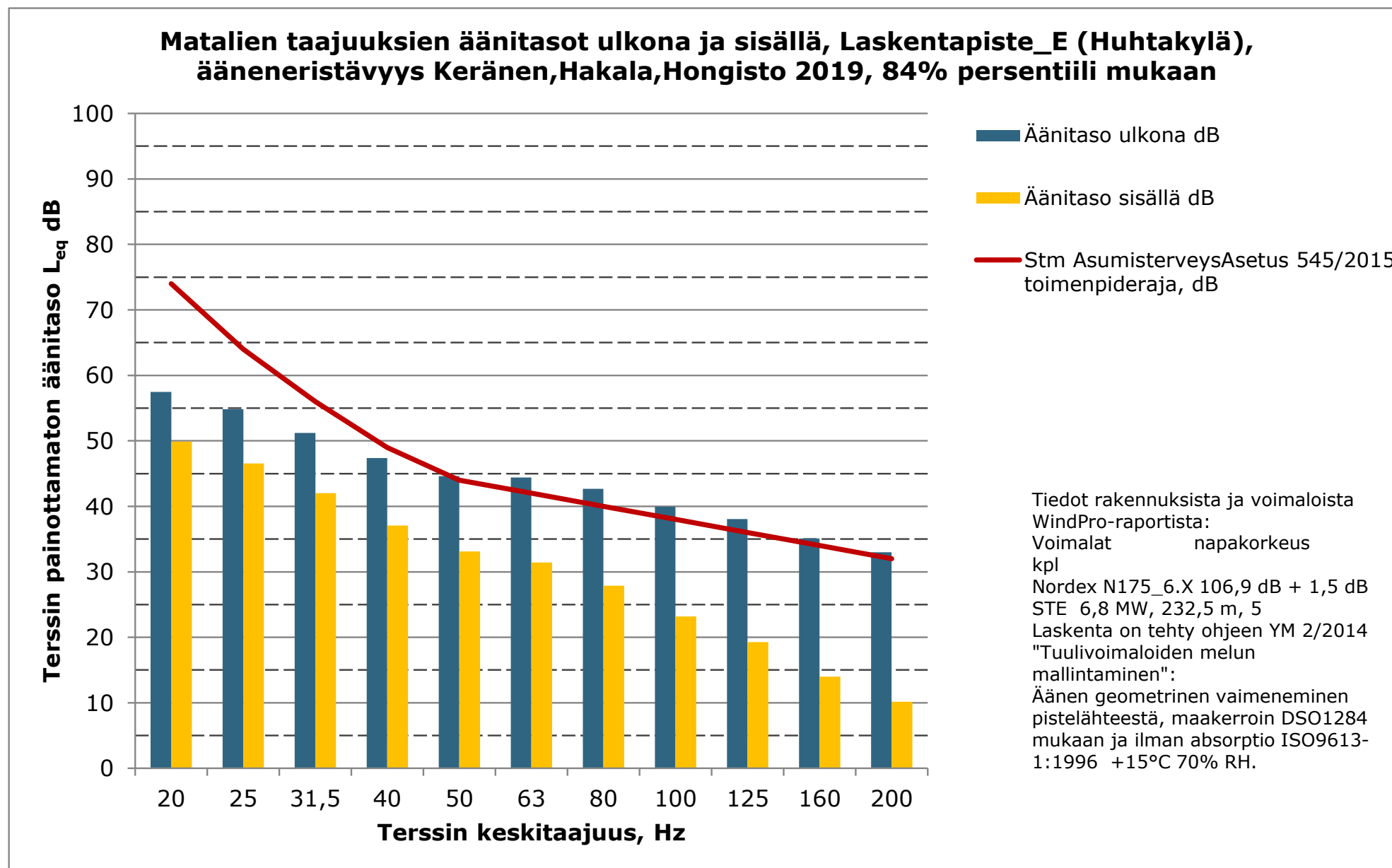


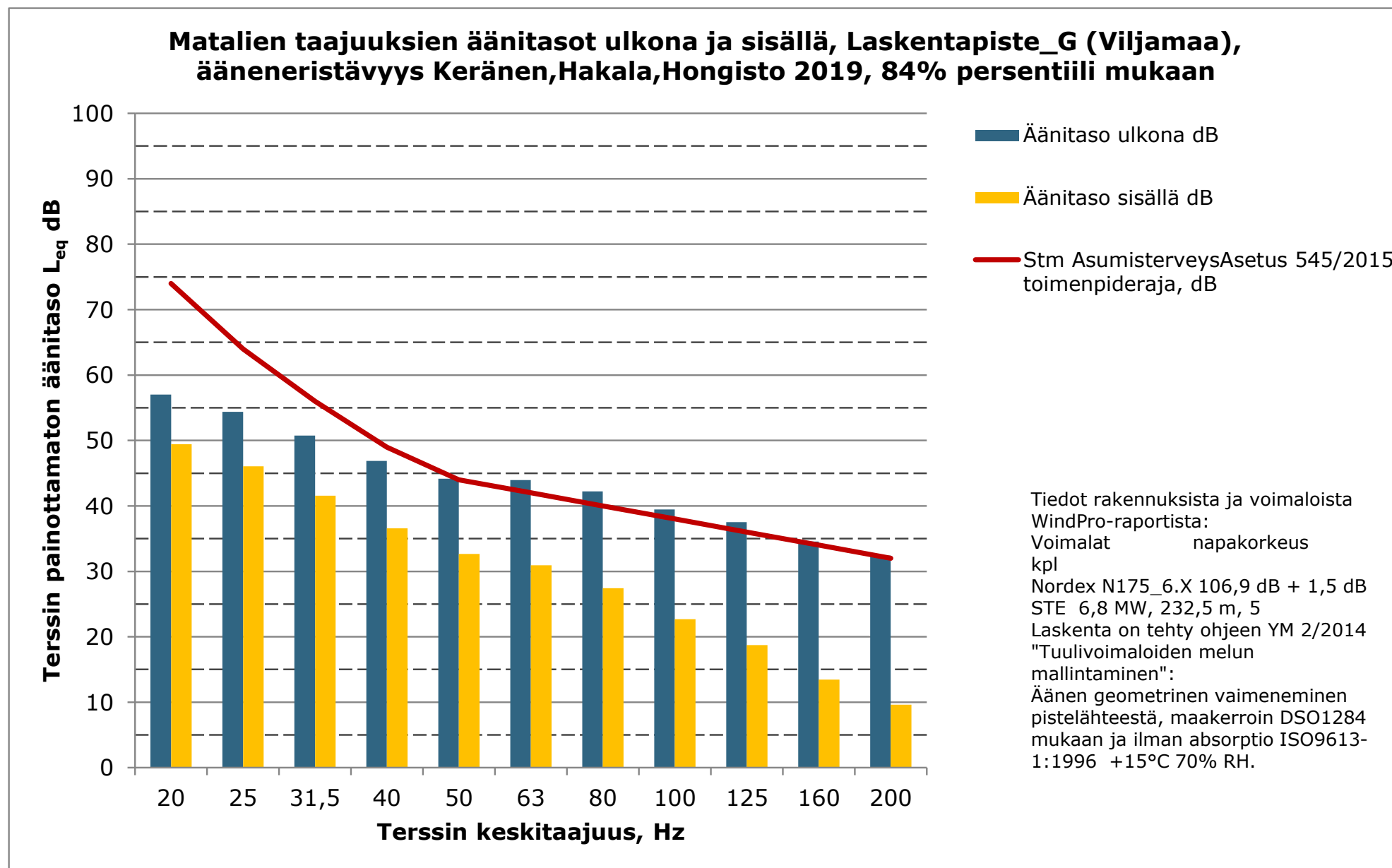
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

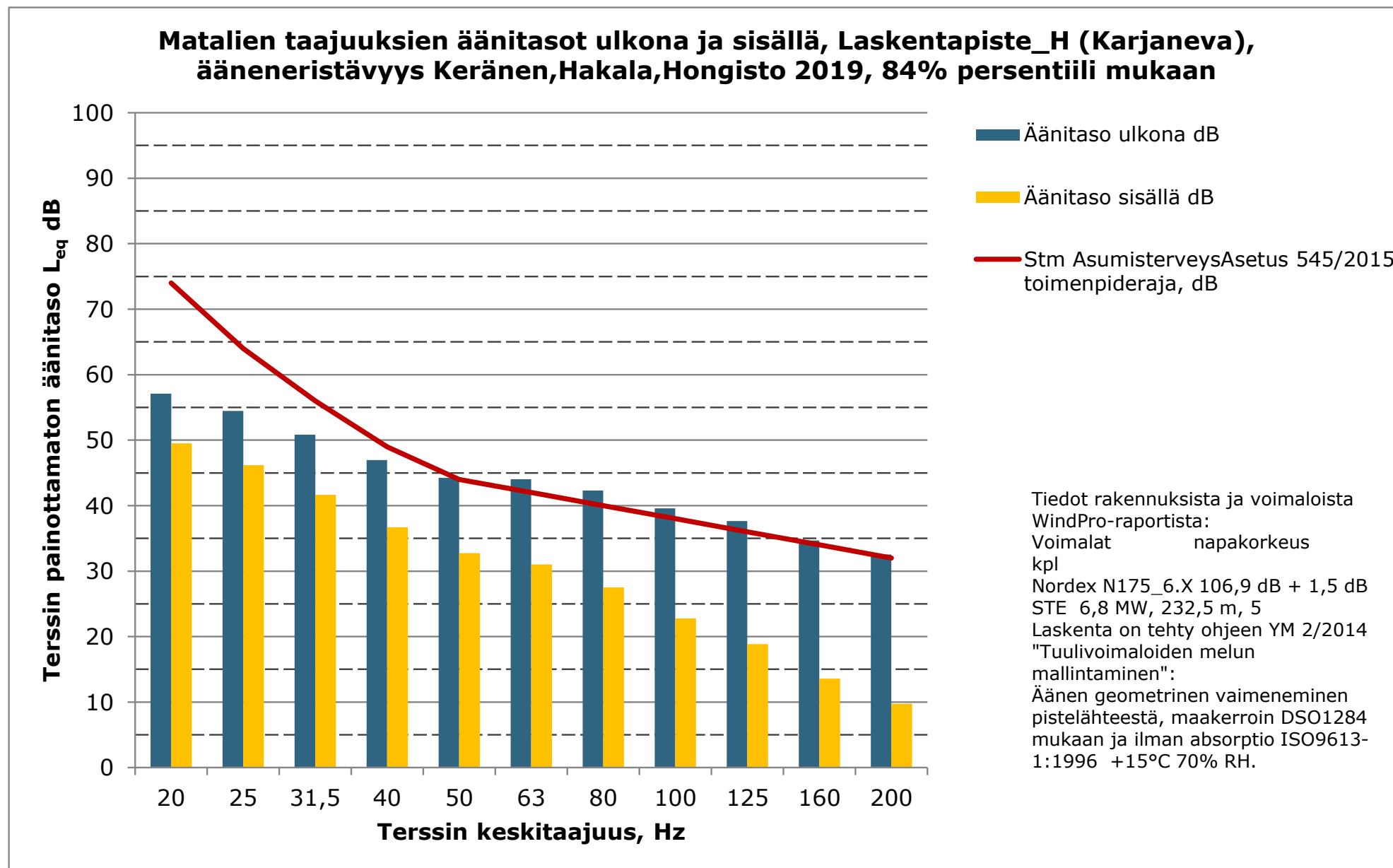


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

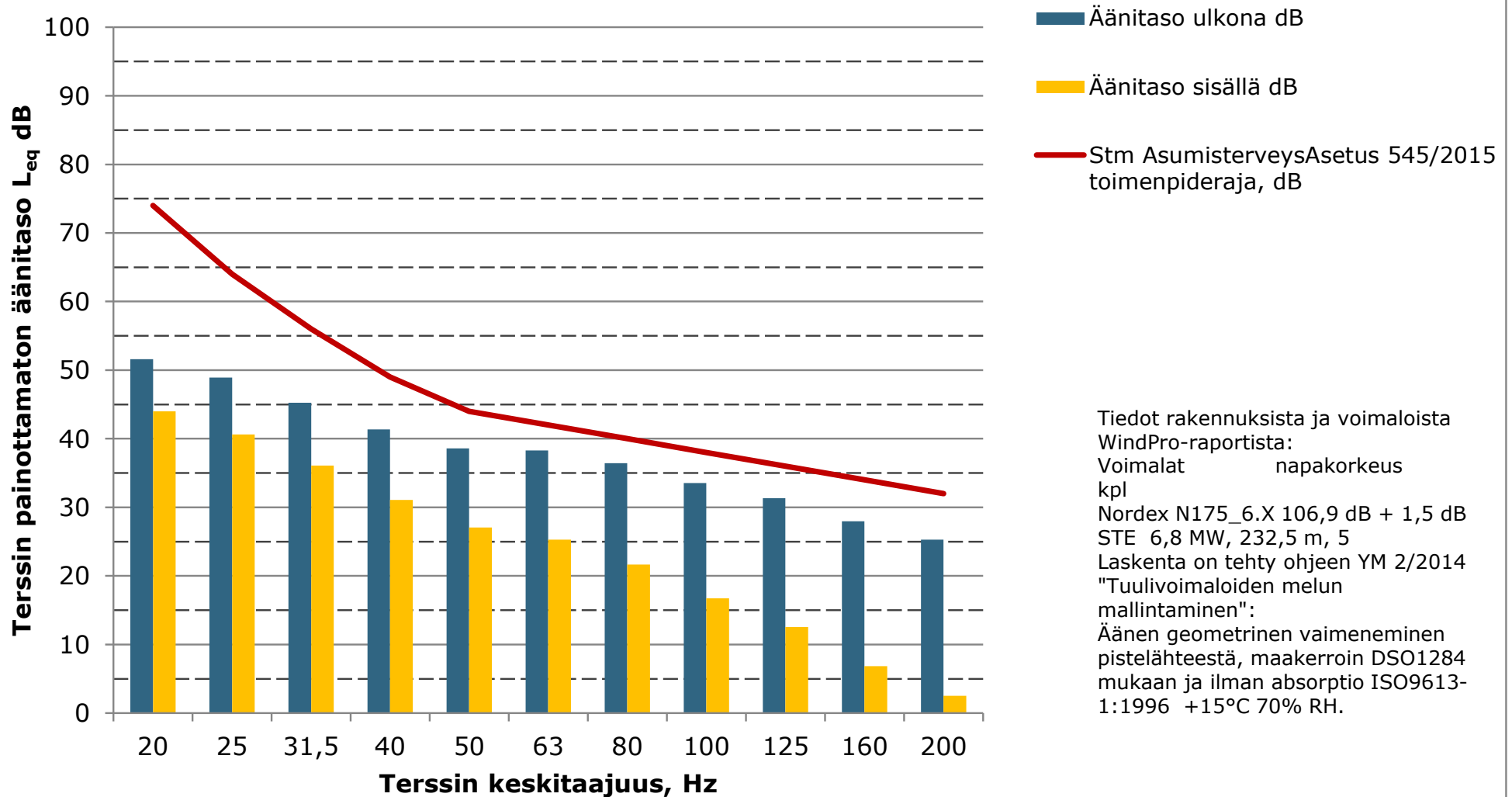




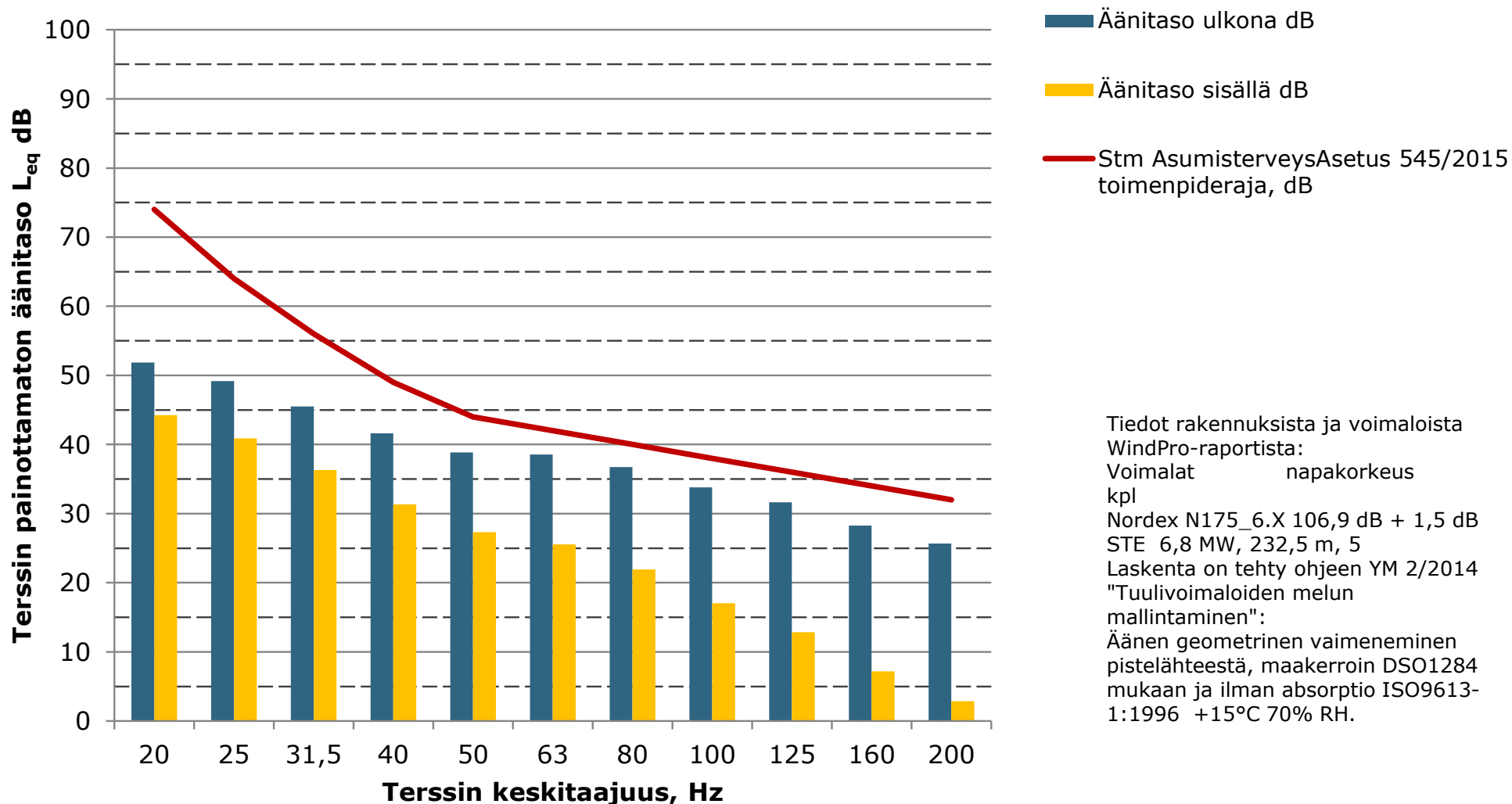




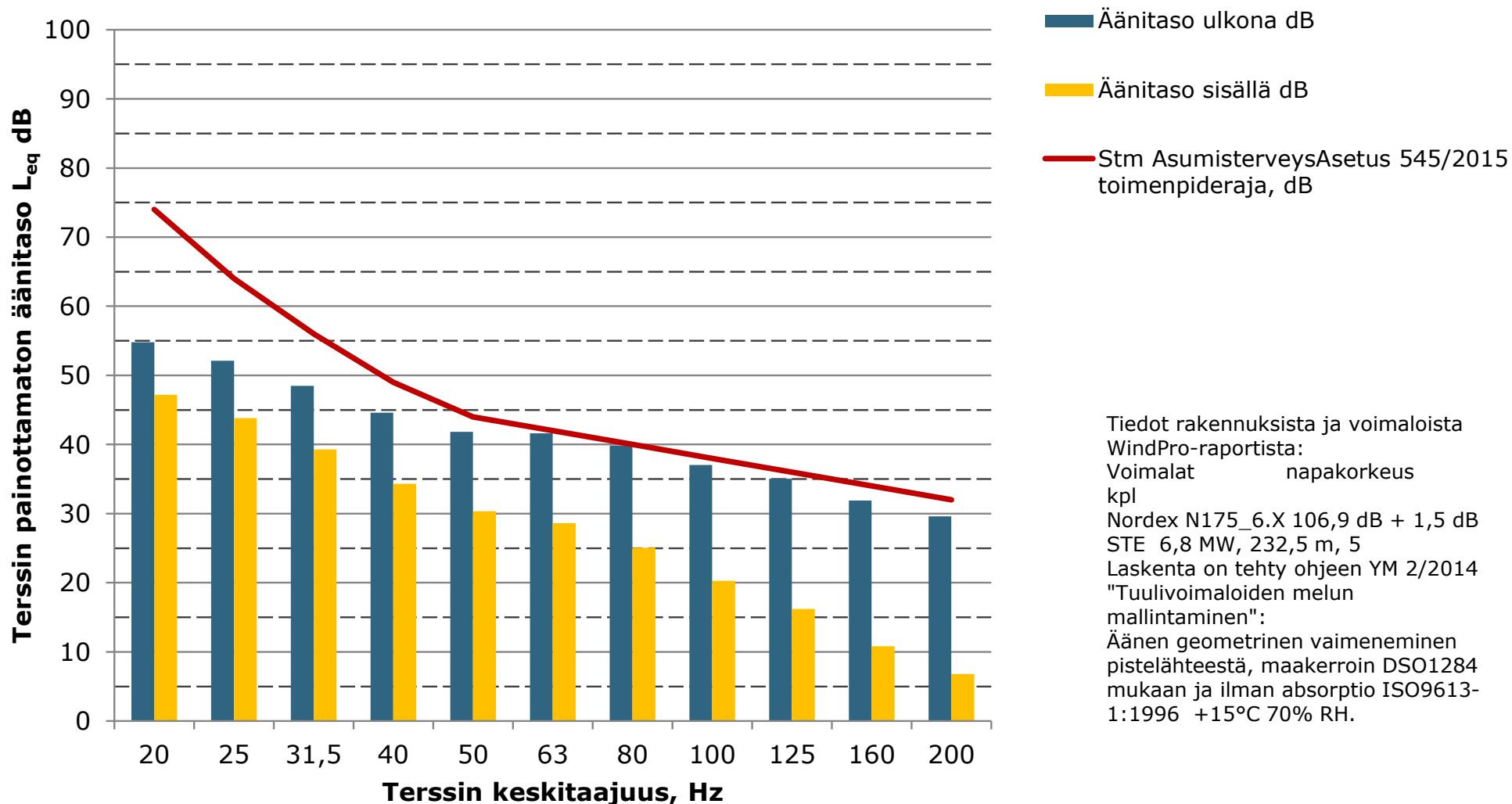
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



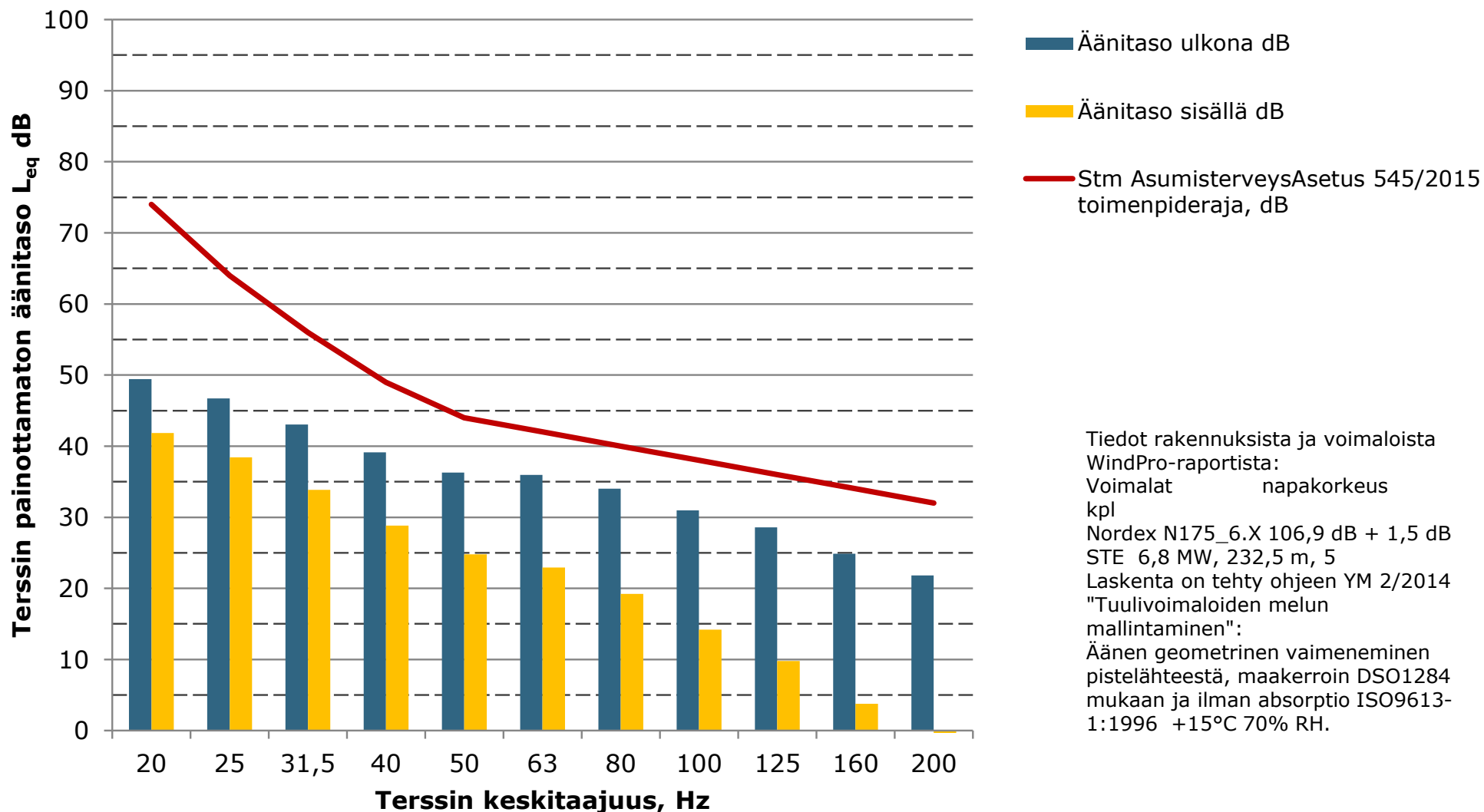
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



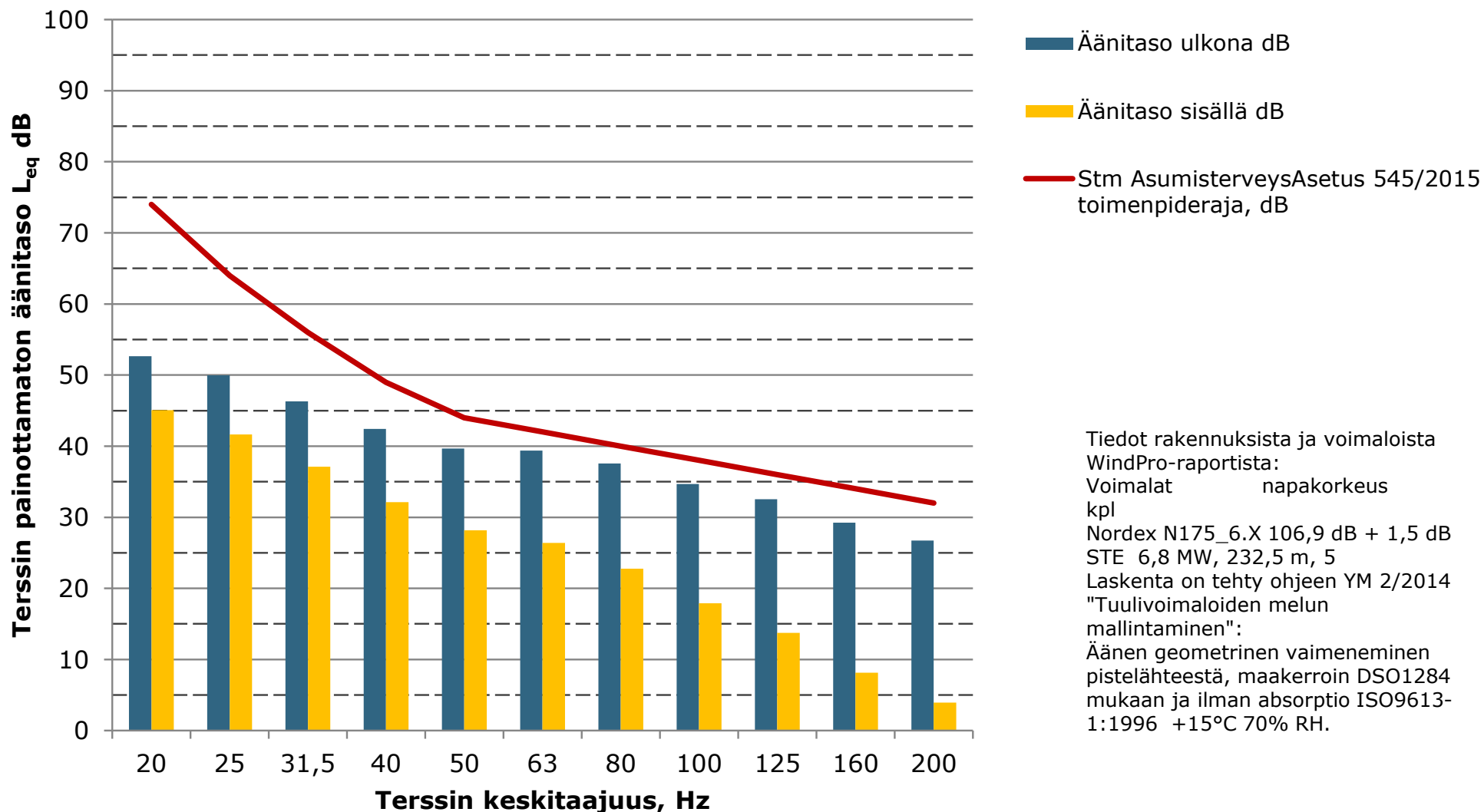
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



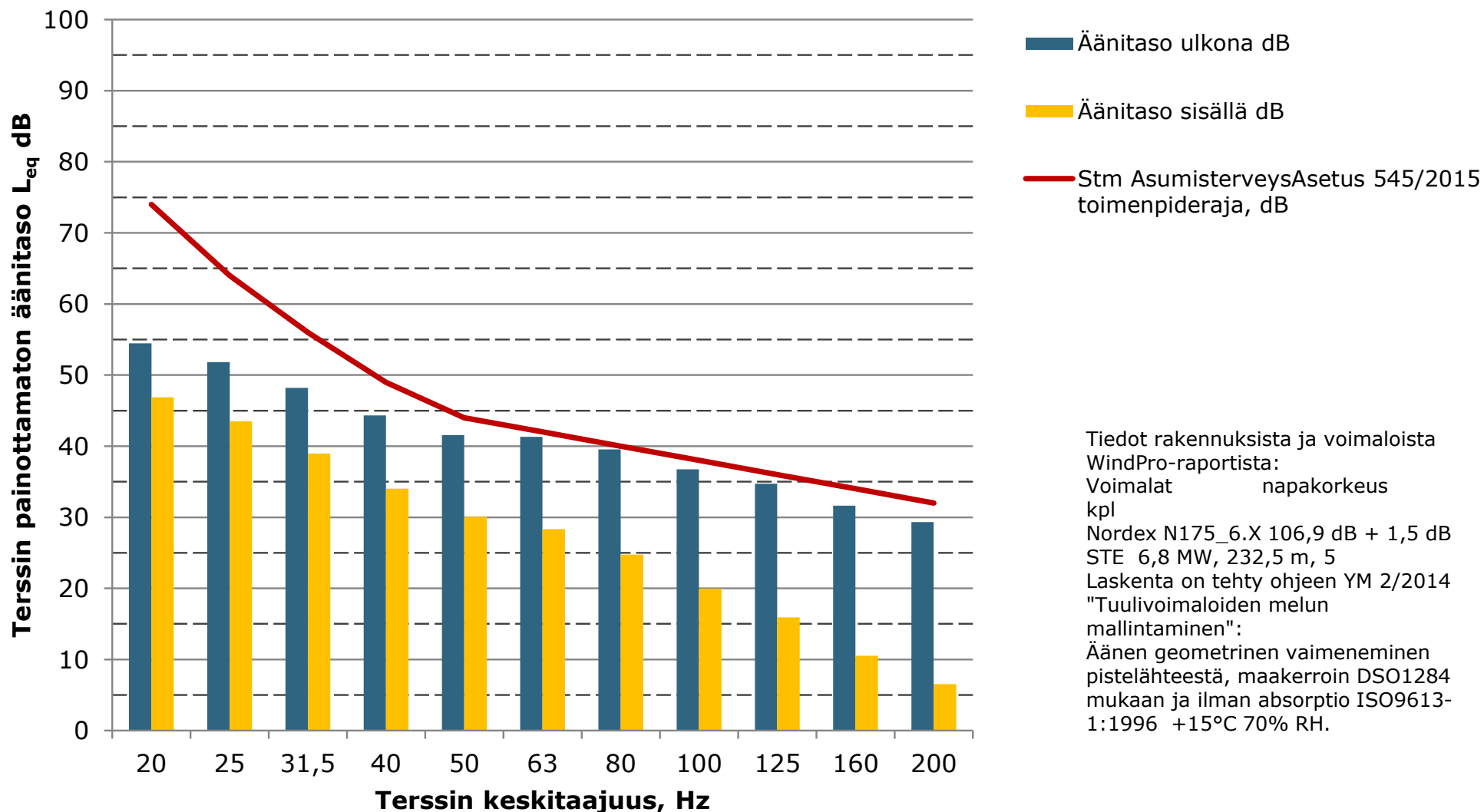
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



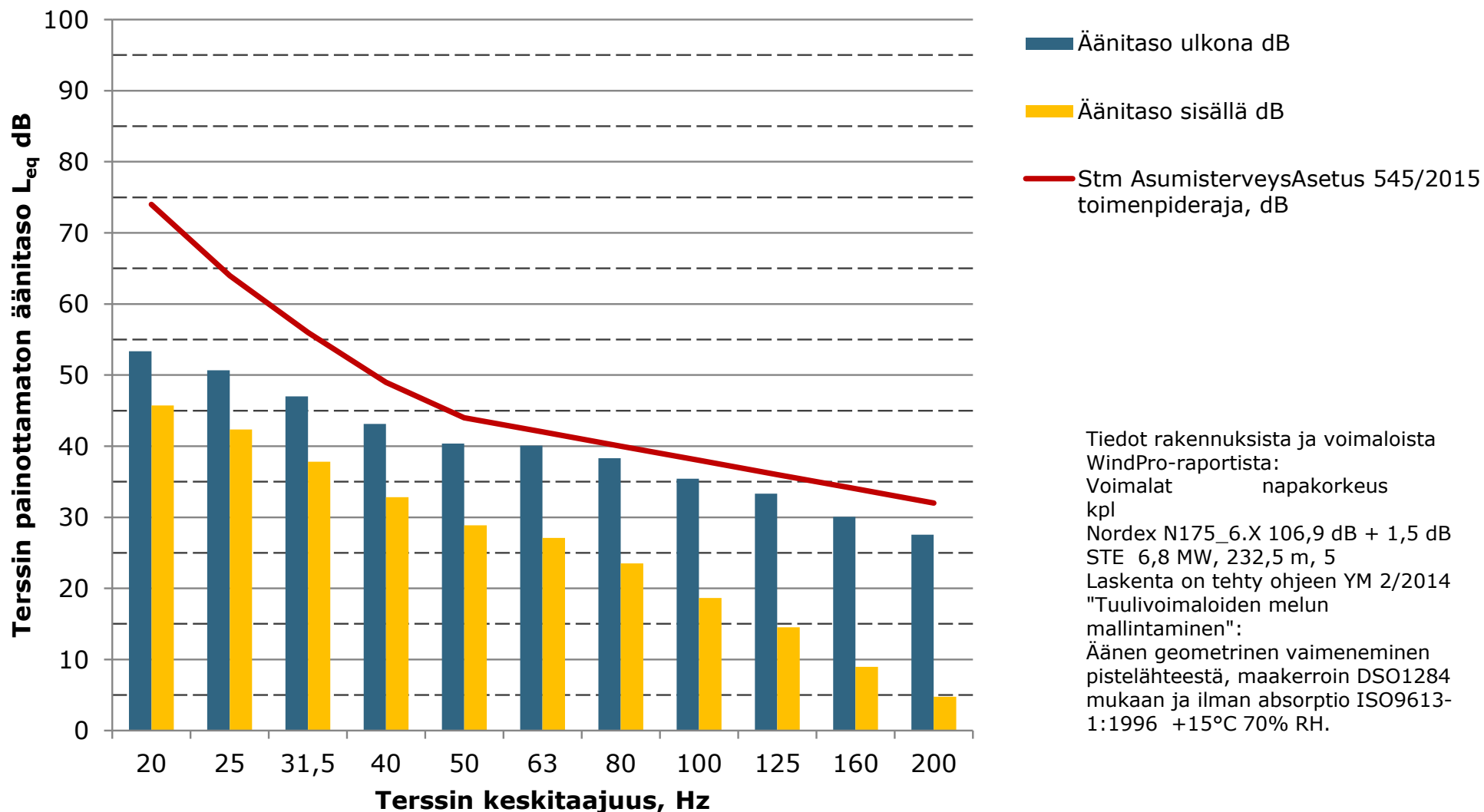
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_O (Nevaranta), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



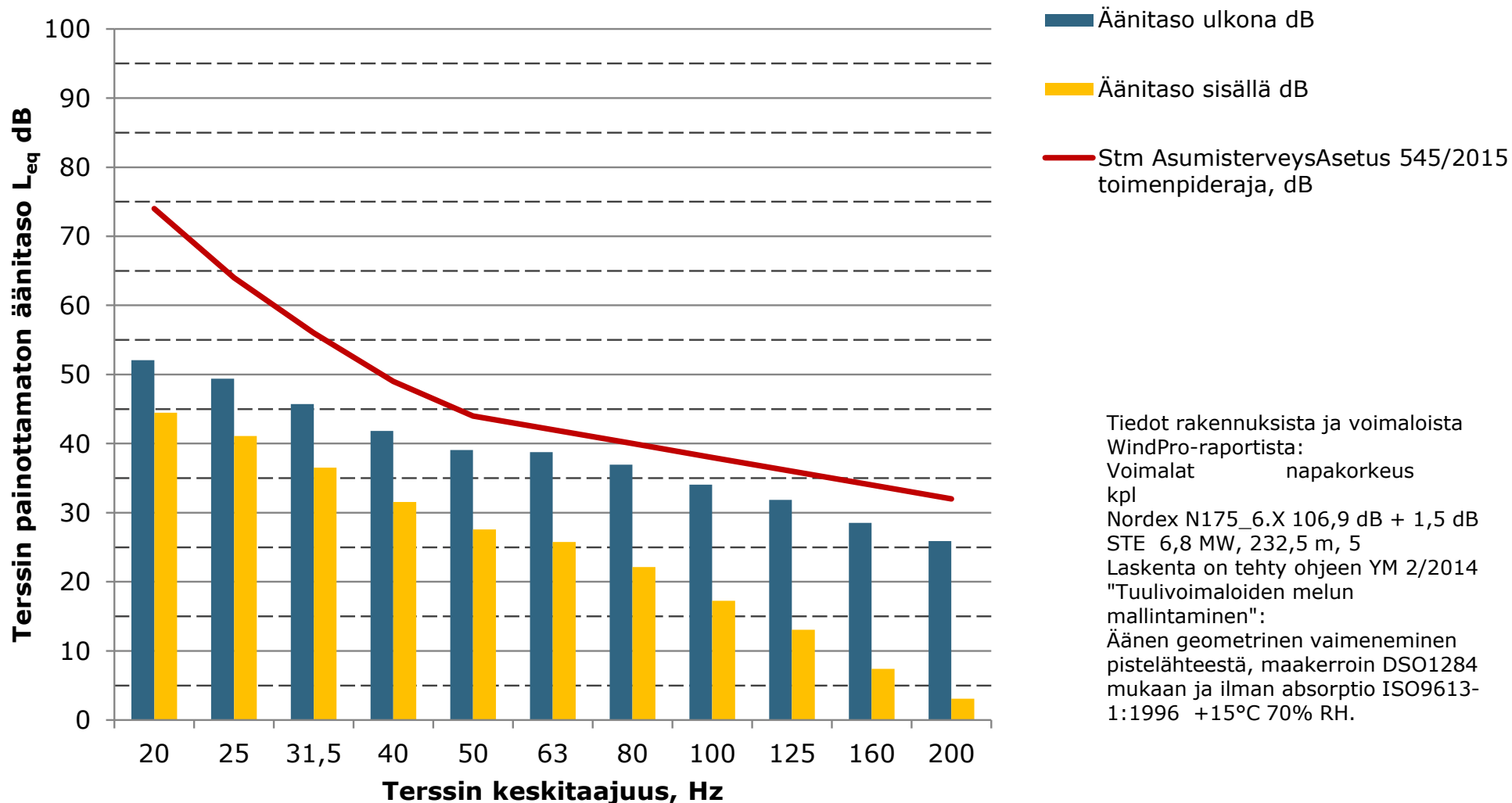
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

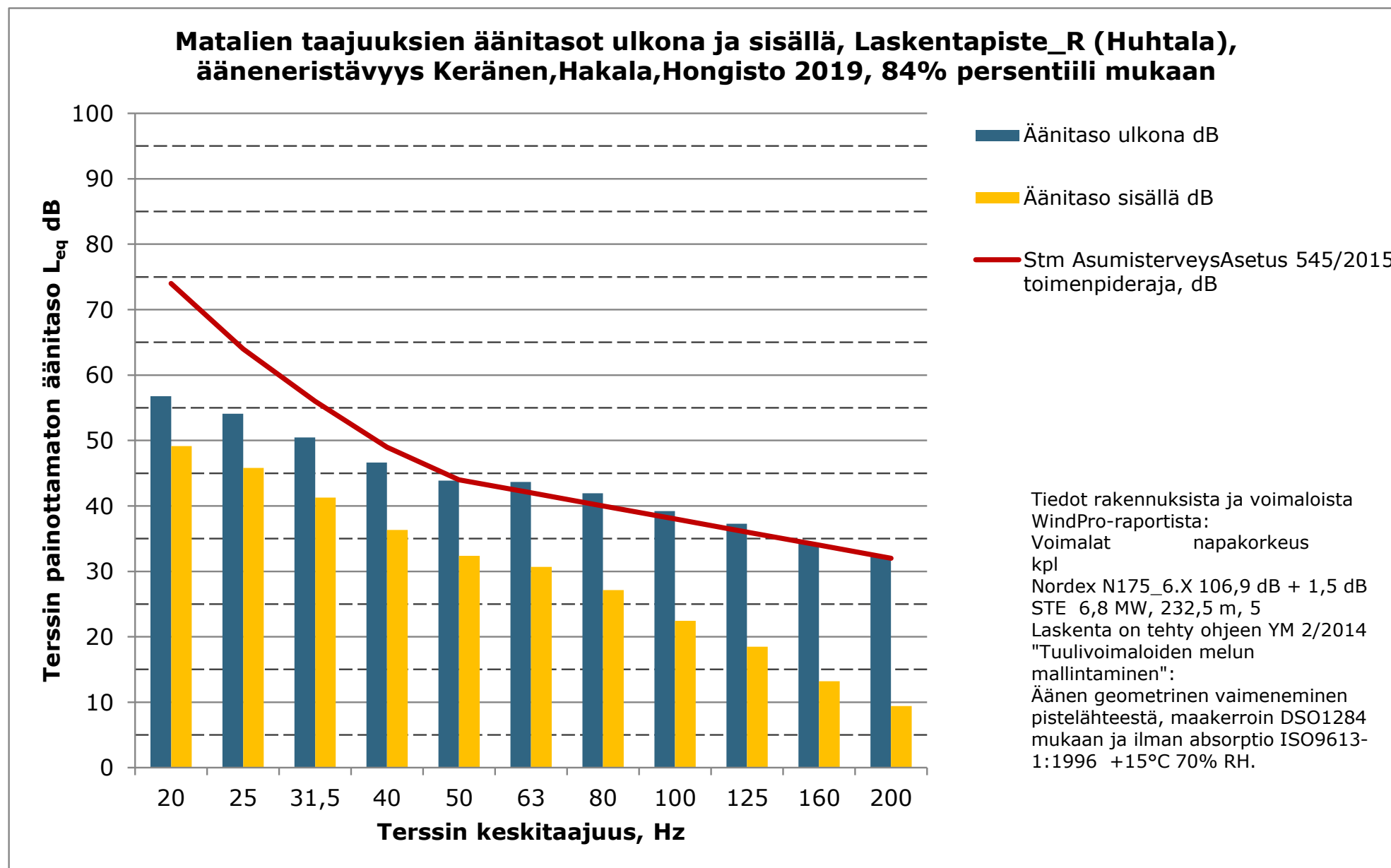


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_P (Niisineva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



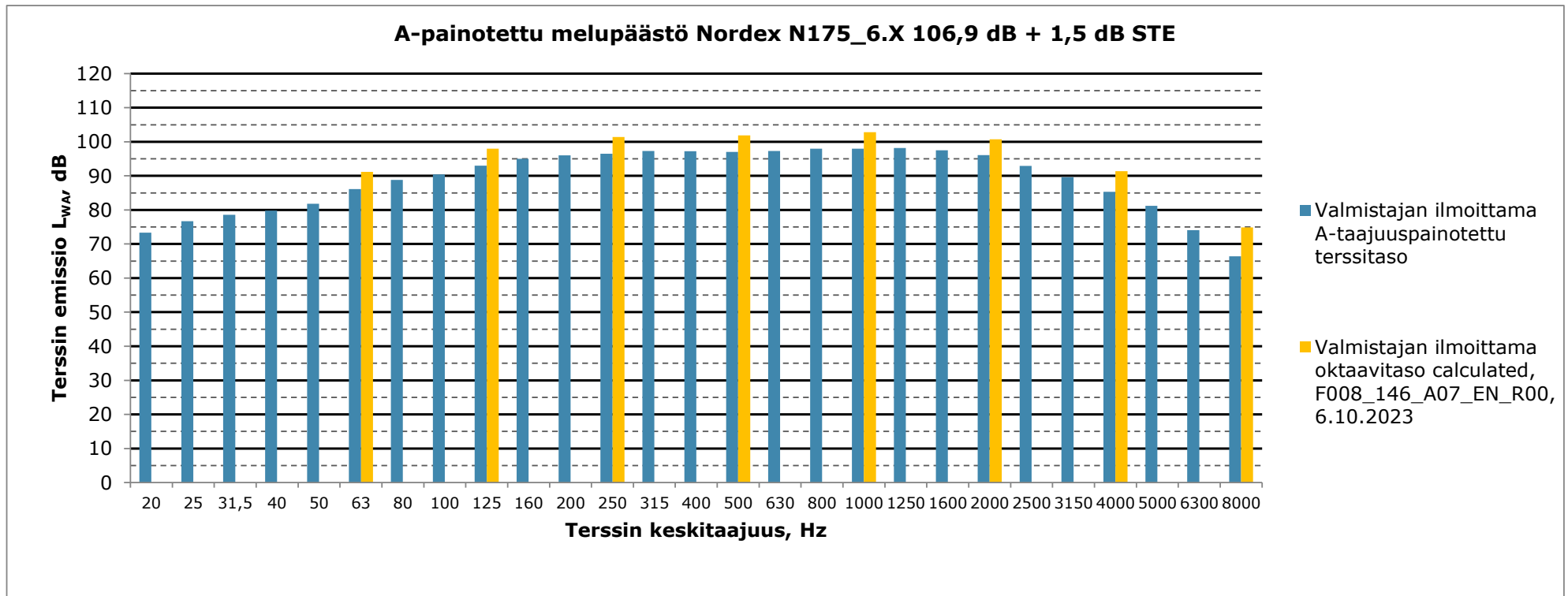
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

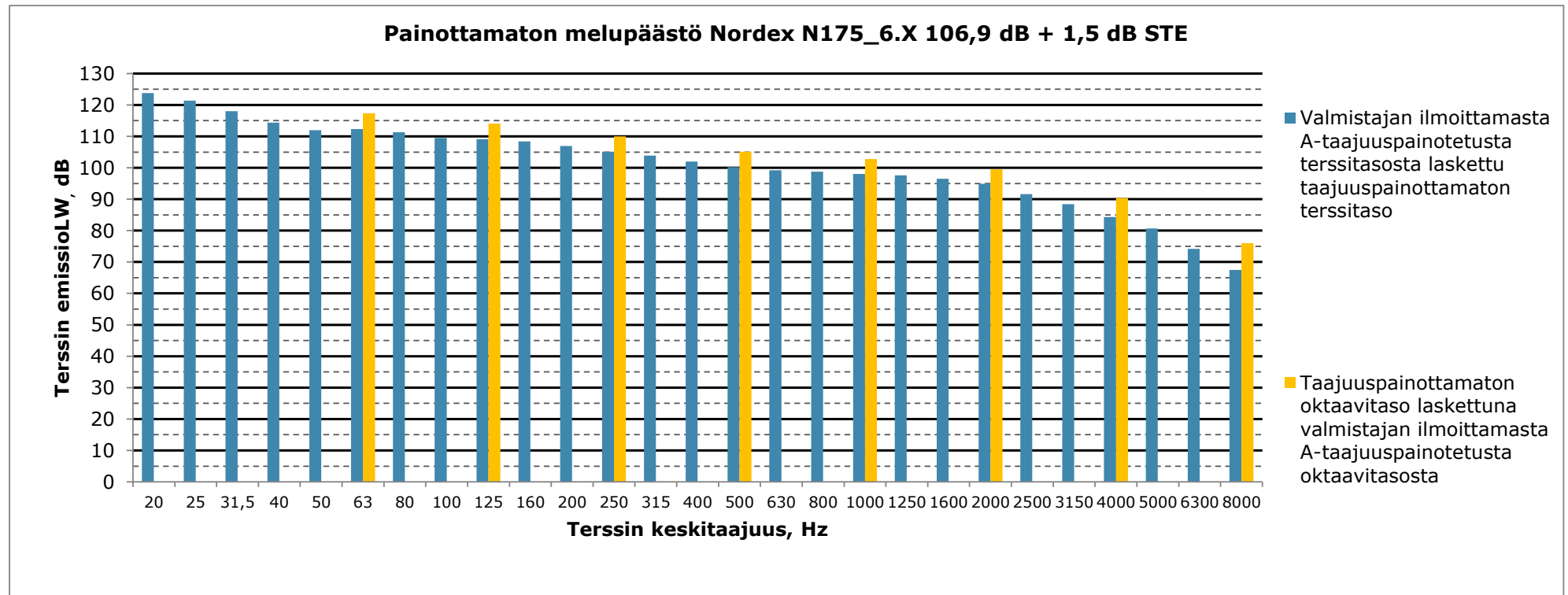




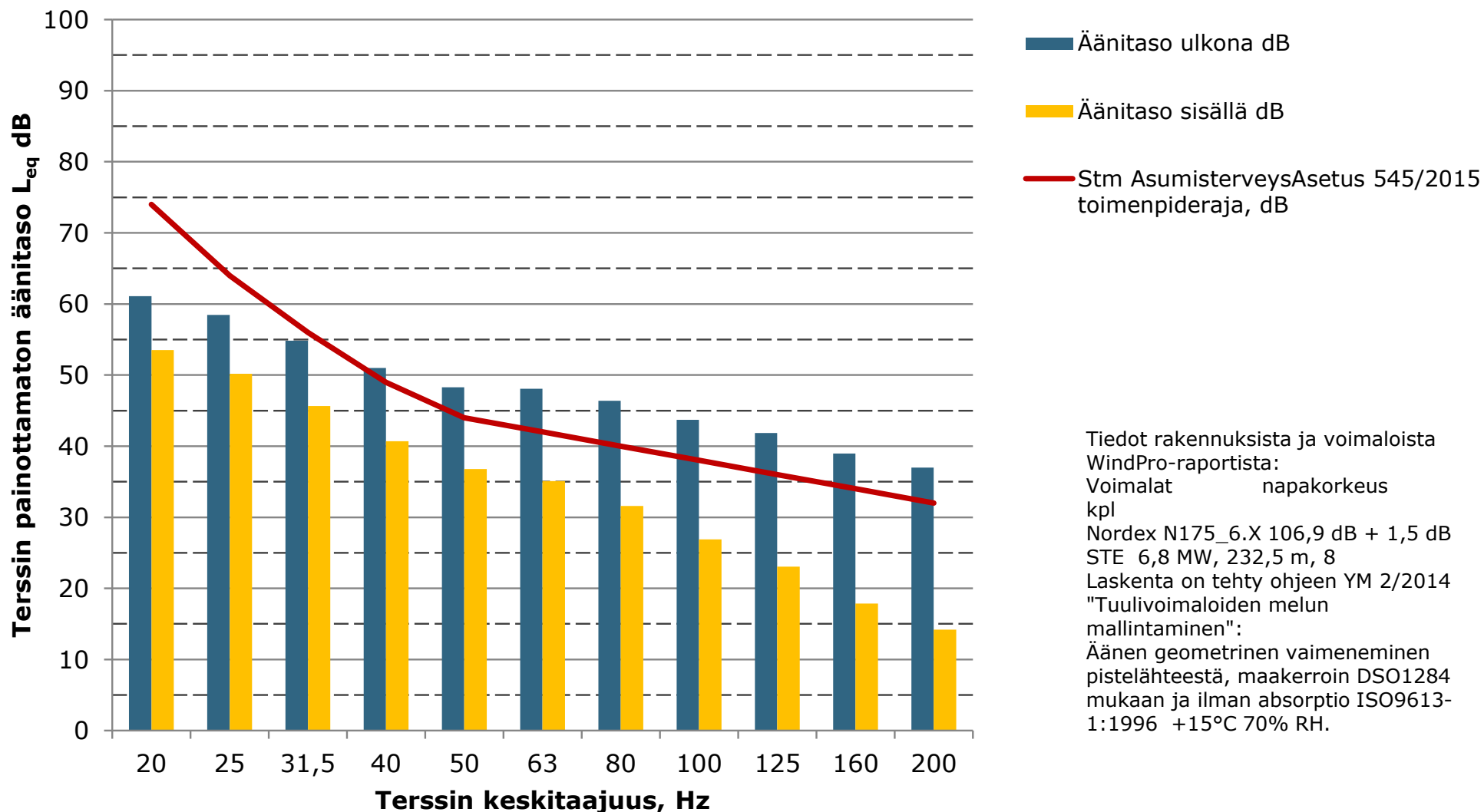
11.10.2023

Liite 13. Verkasalon tuulivoimahanke, Ylivieskan alueella olevat voimalat – matalataajuisen melun rakennuskohtaiset arvot VE1 N175 - 6.8 MW.

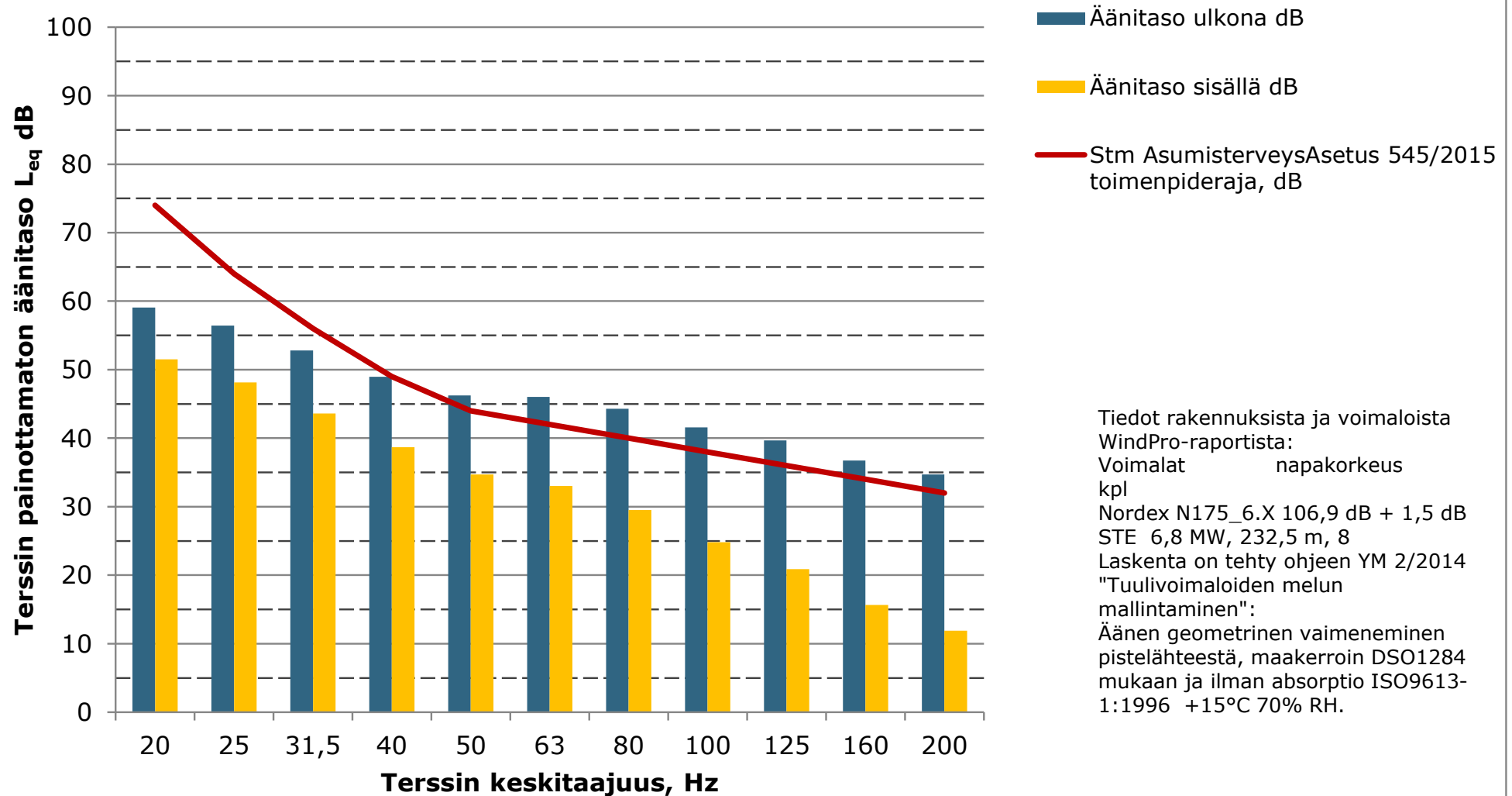


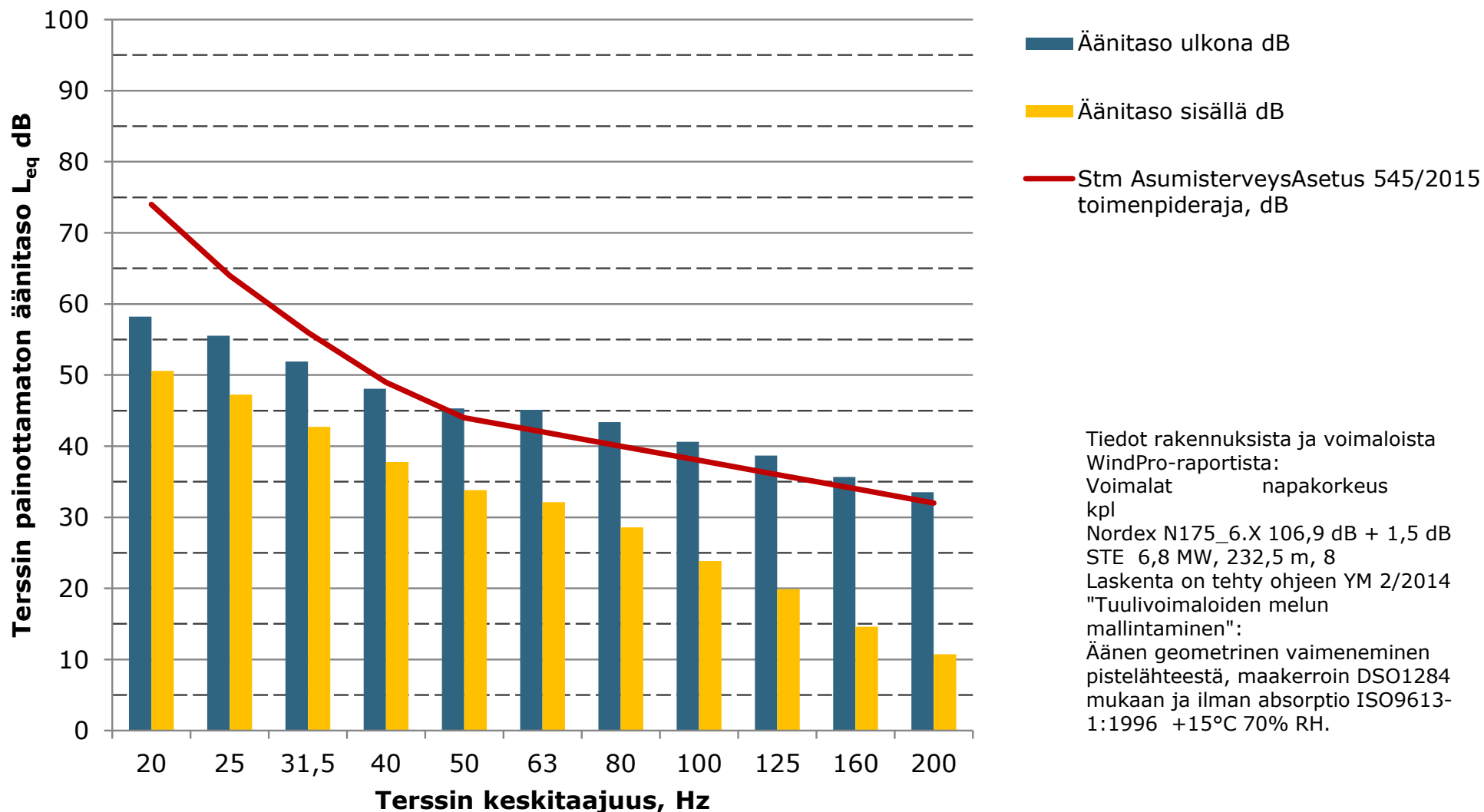


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

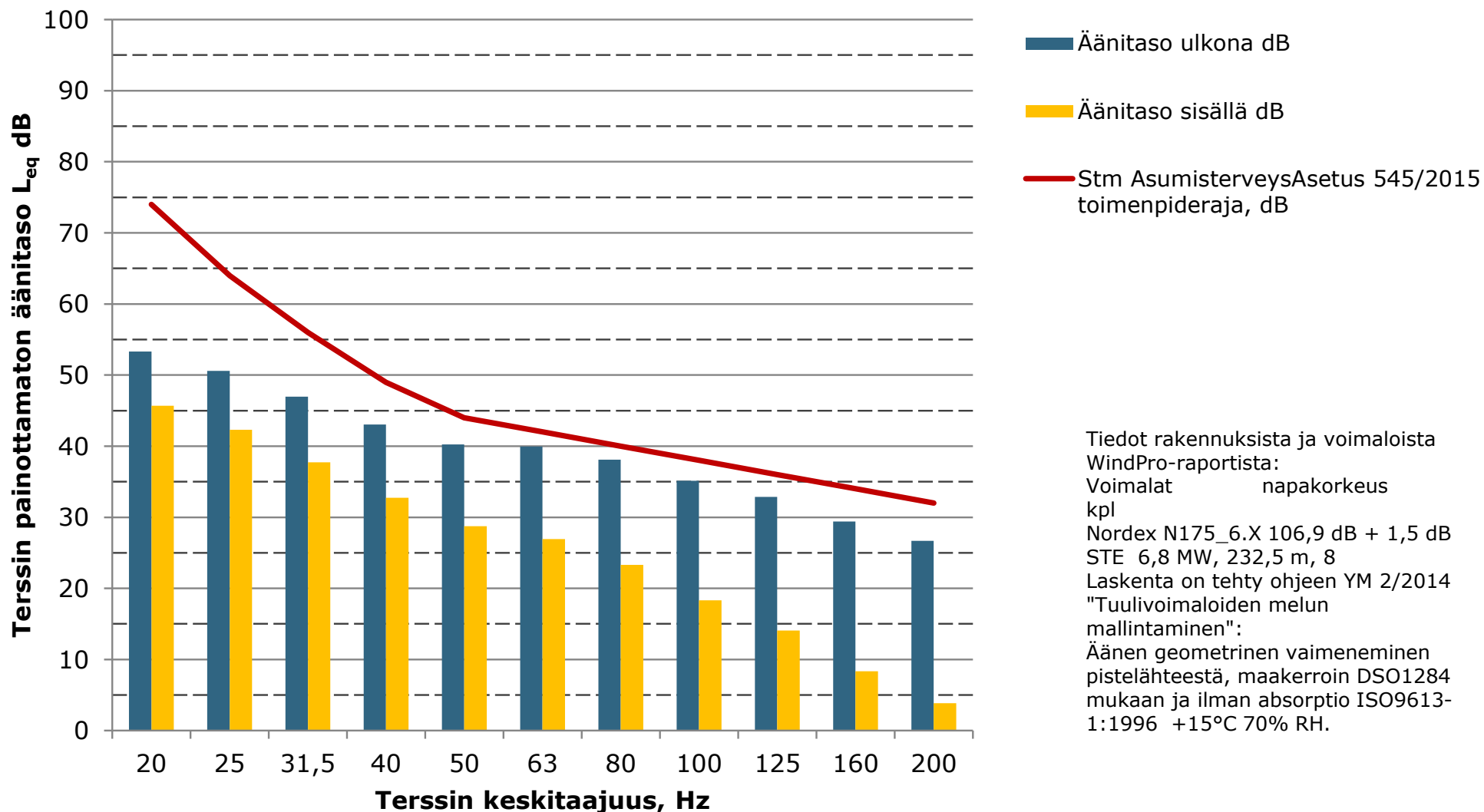


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

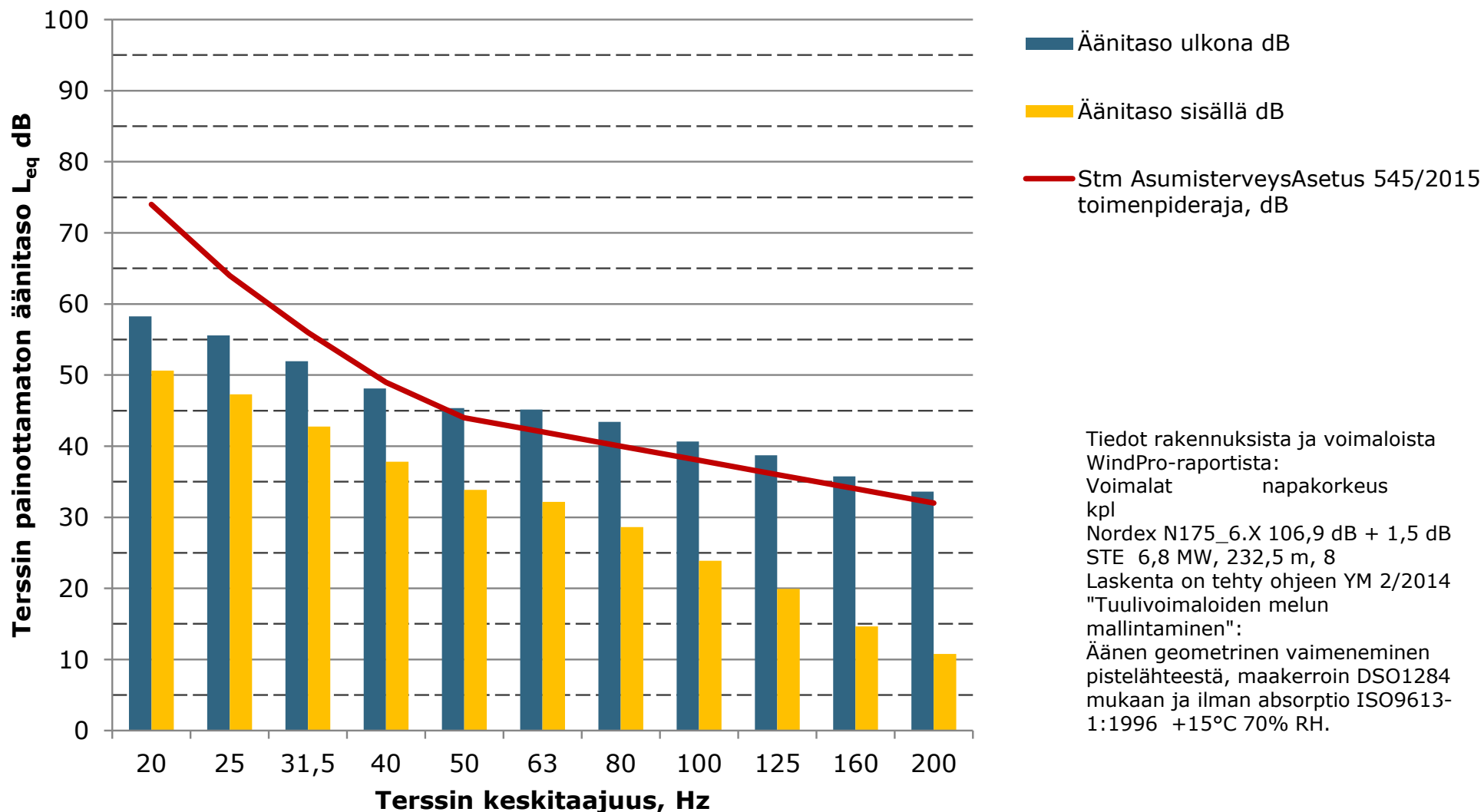


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

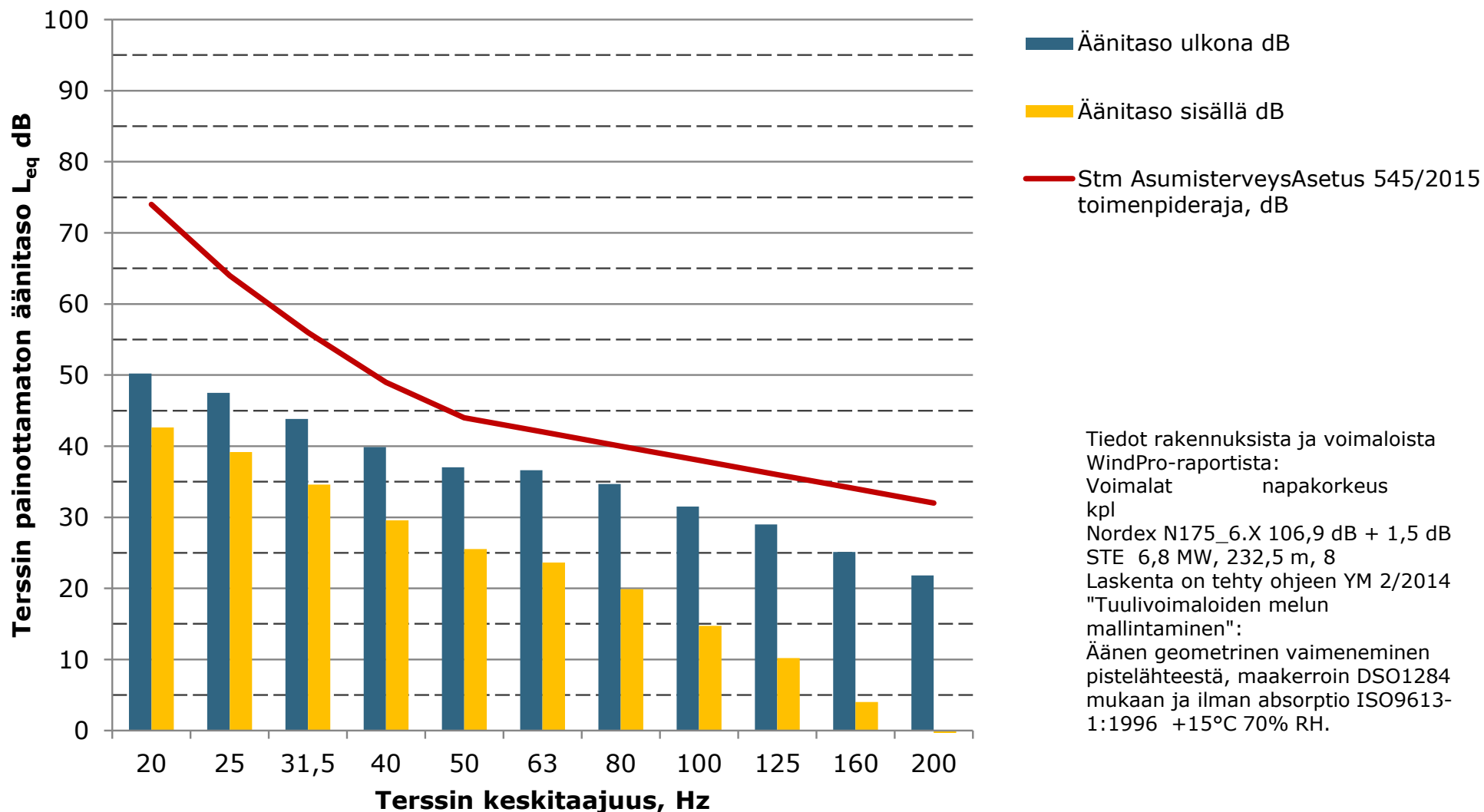
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_F (Huhtakylä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

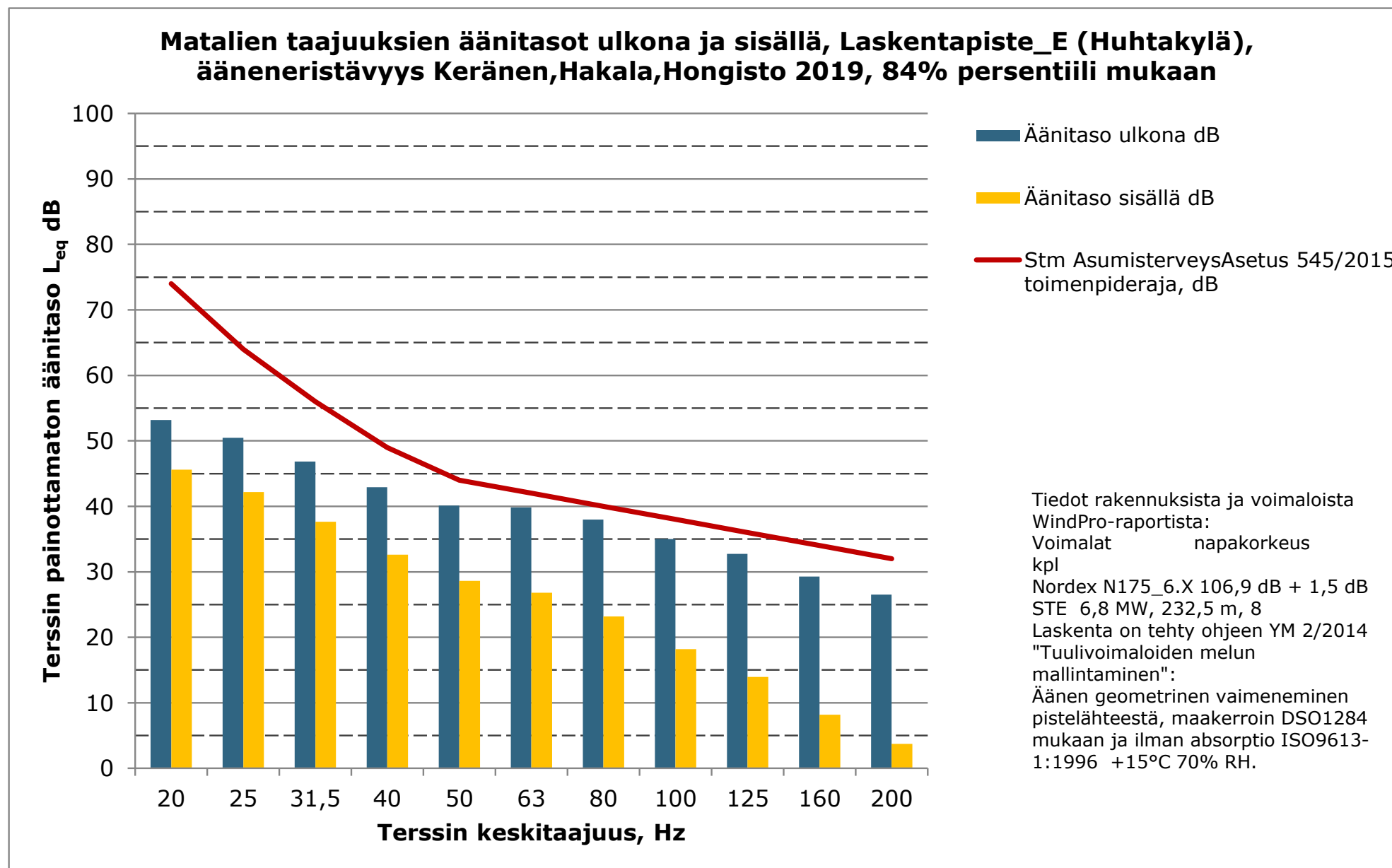


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

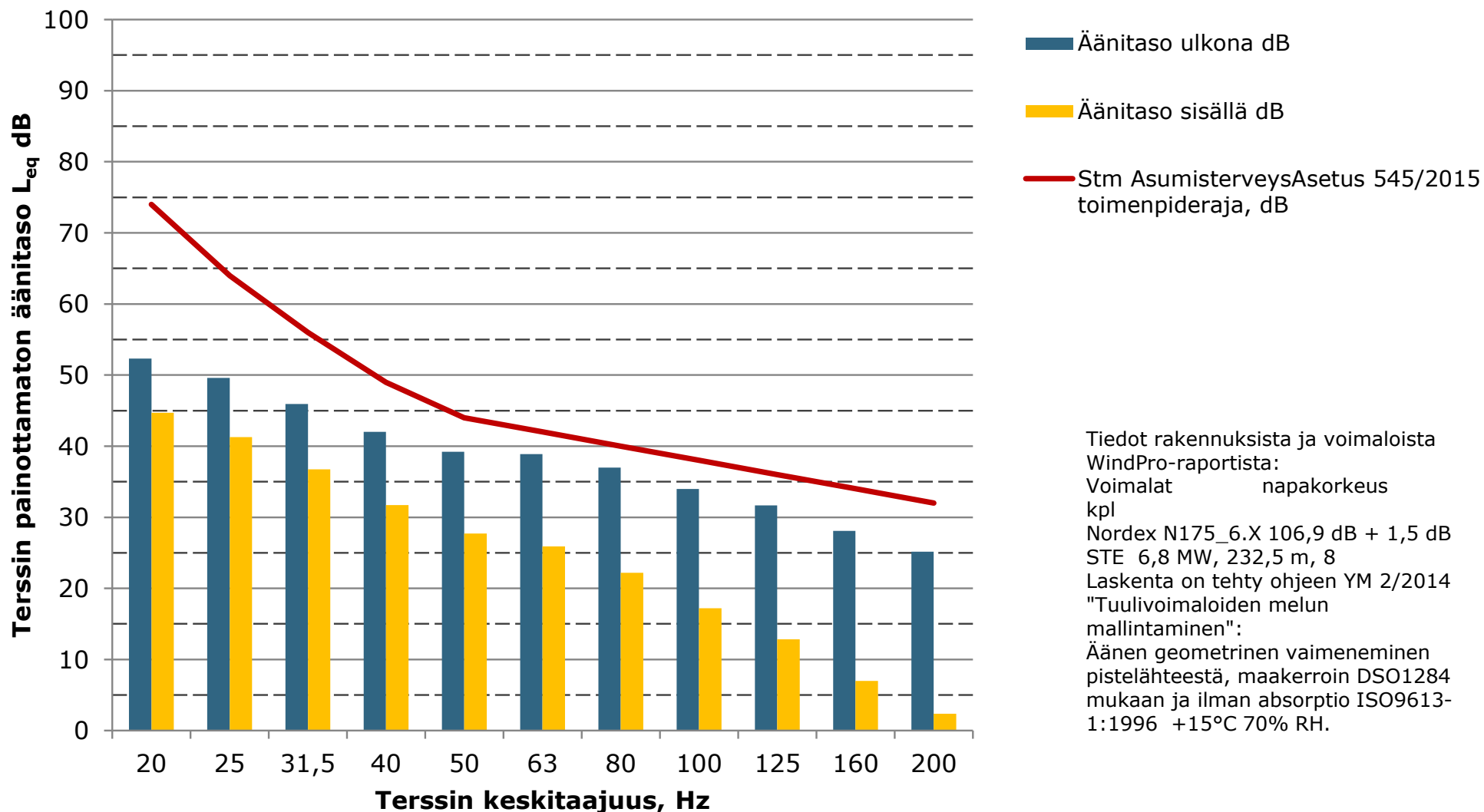


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

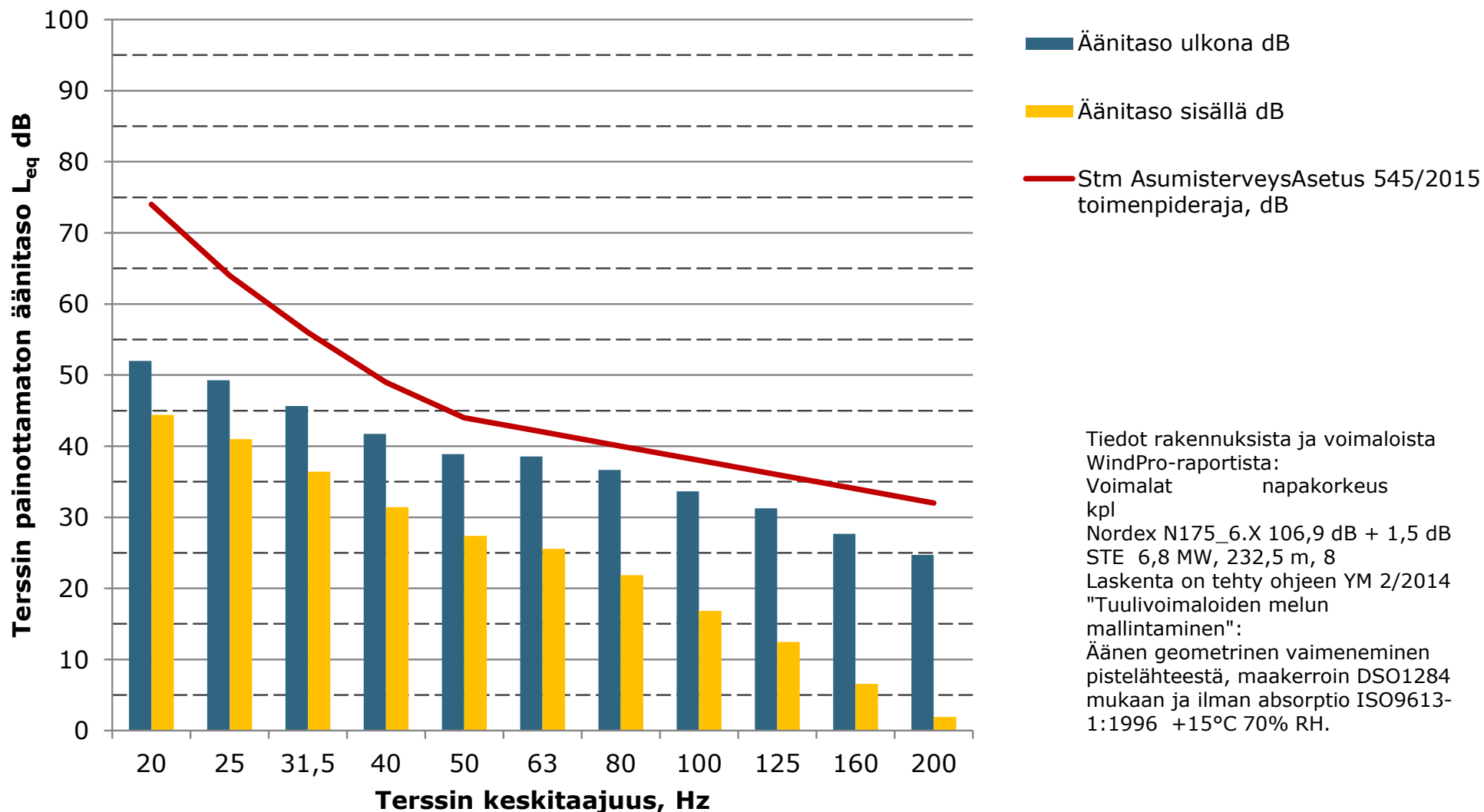




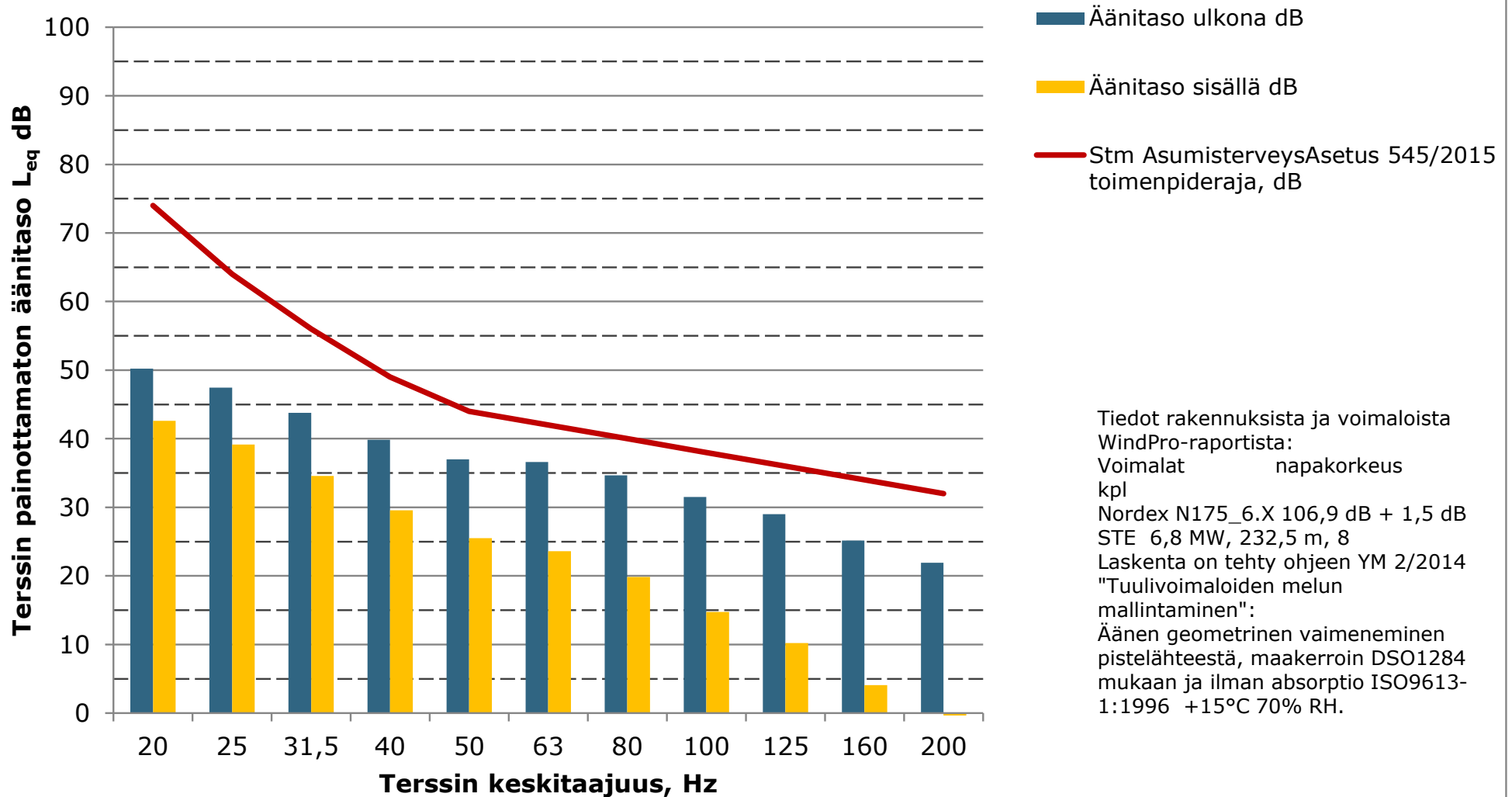
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



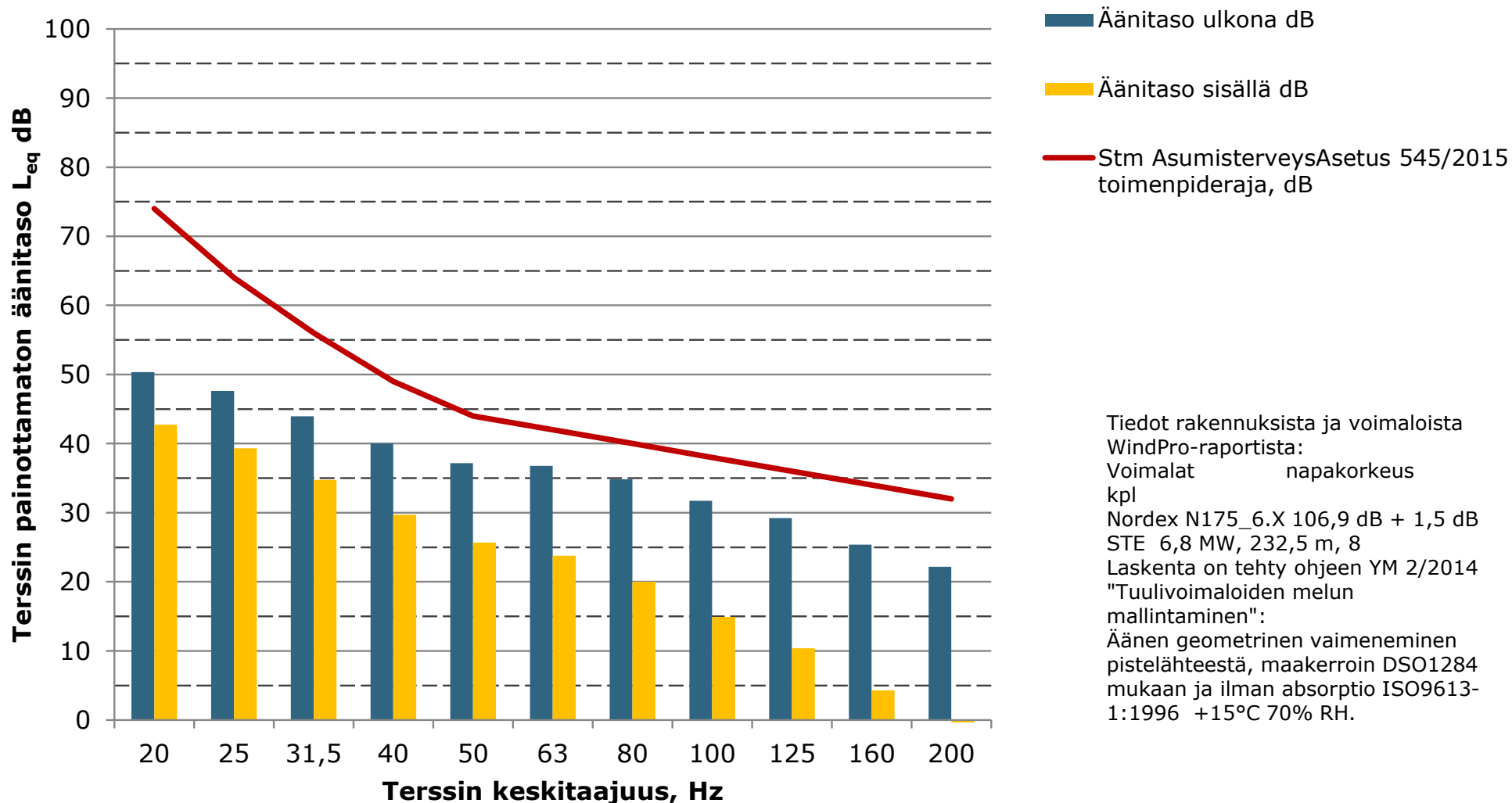
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_H (Karjaneva), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



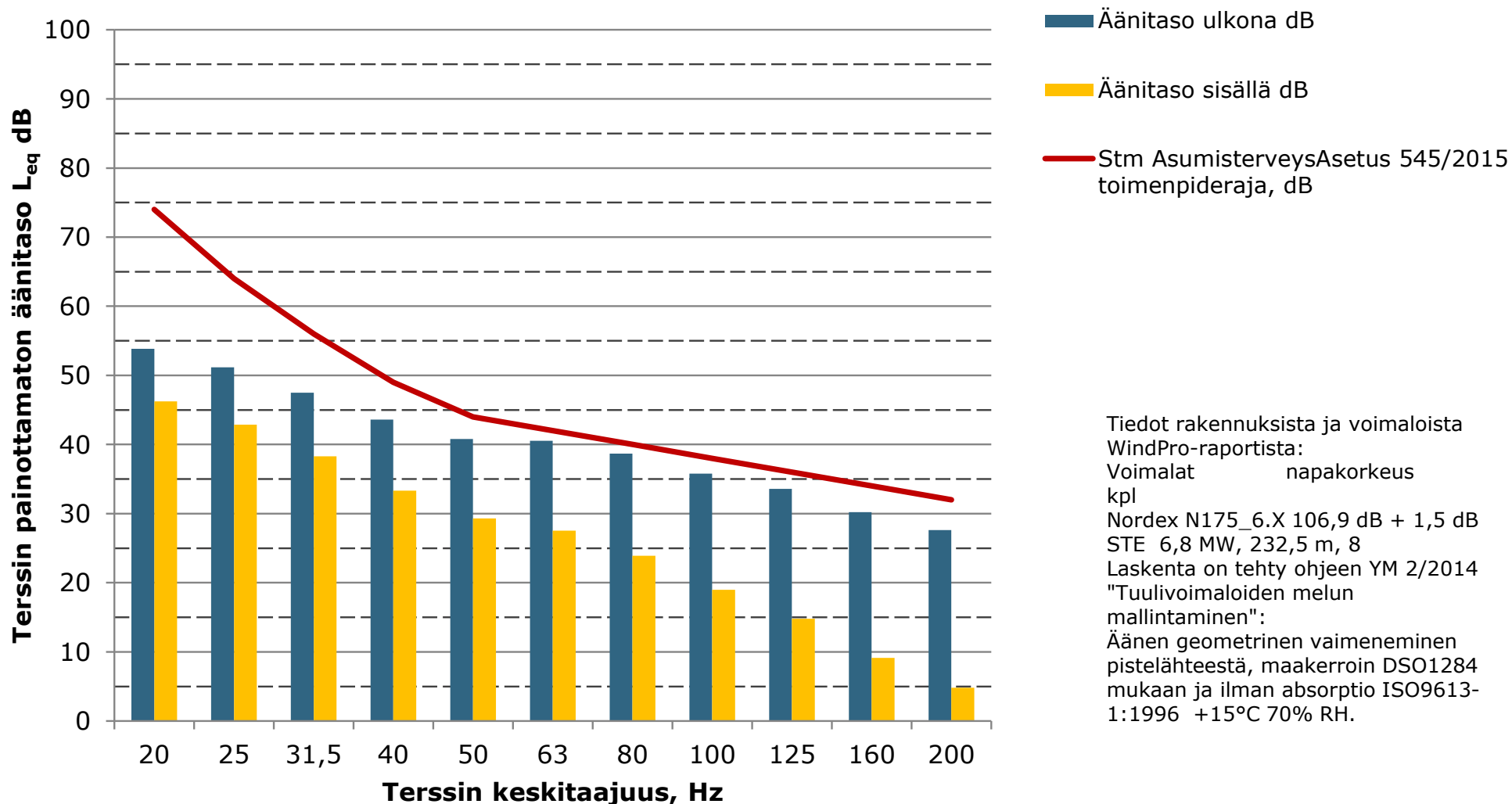
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



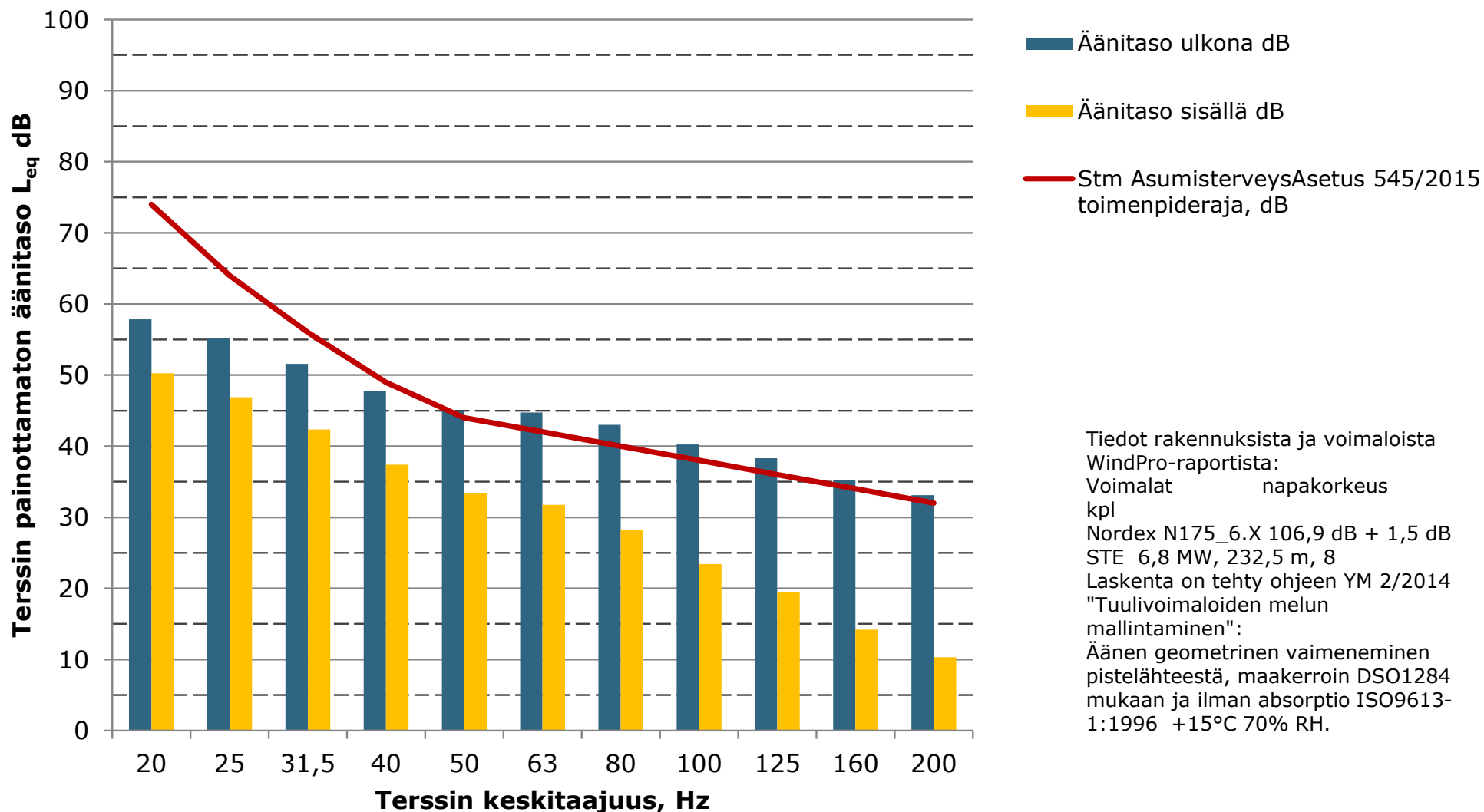
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

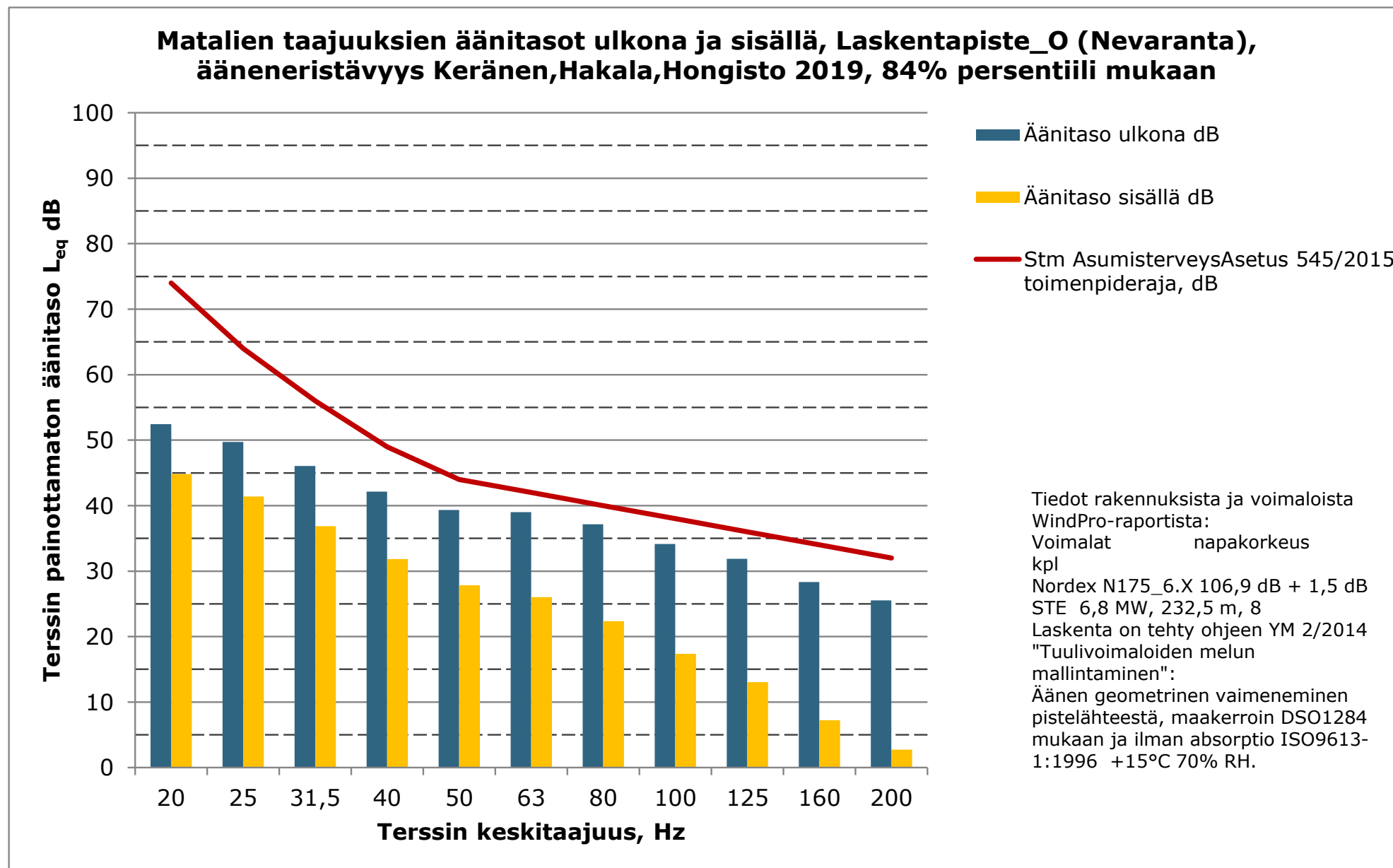


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

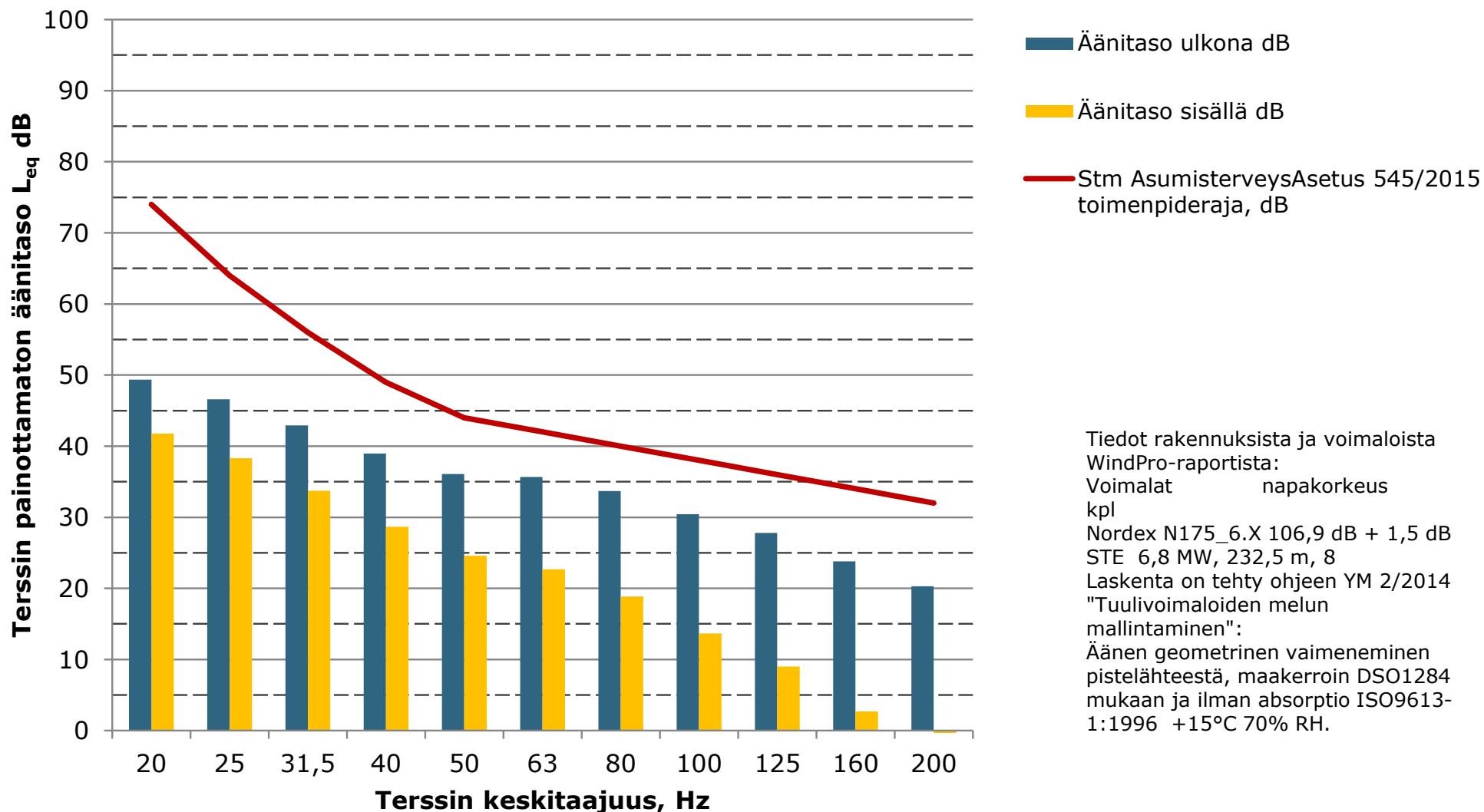


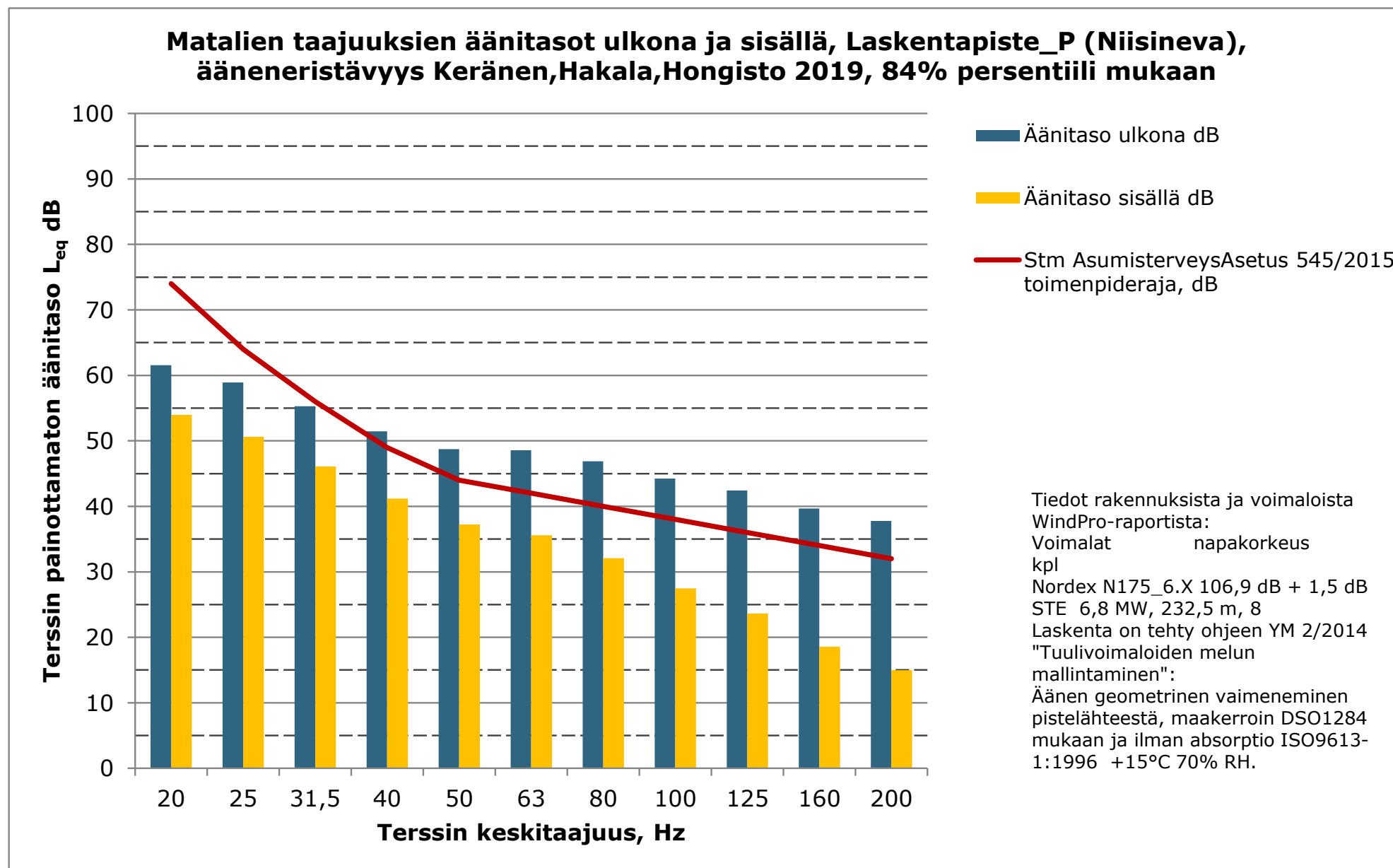
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



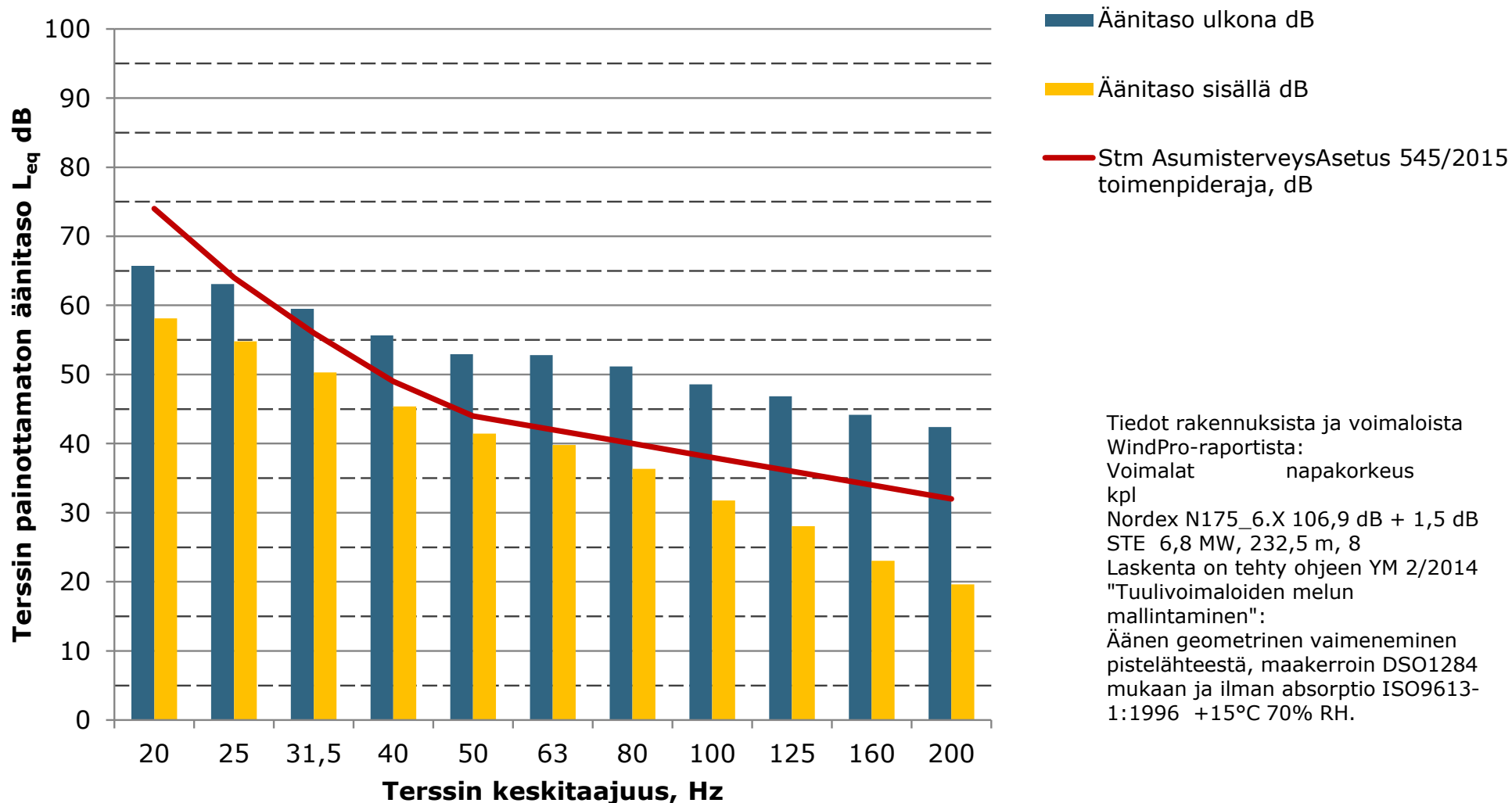


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

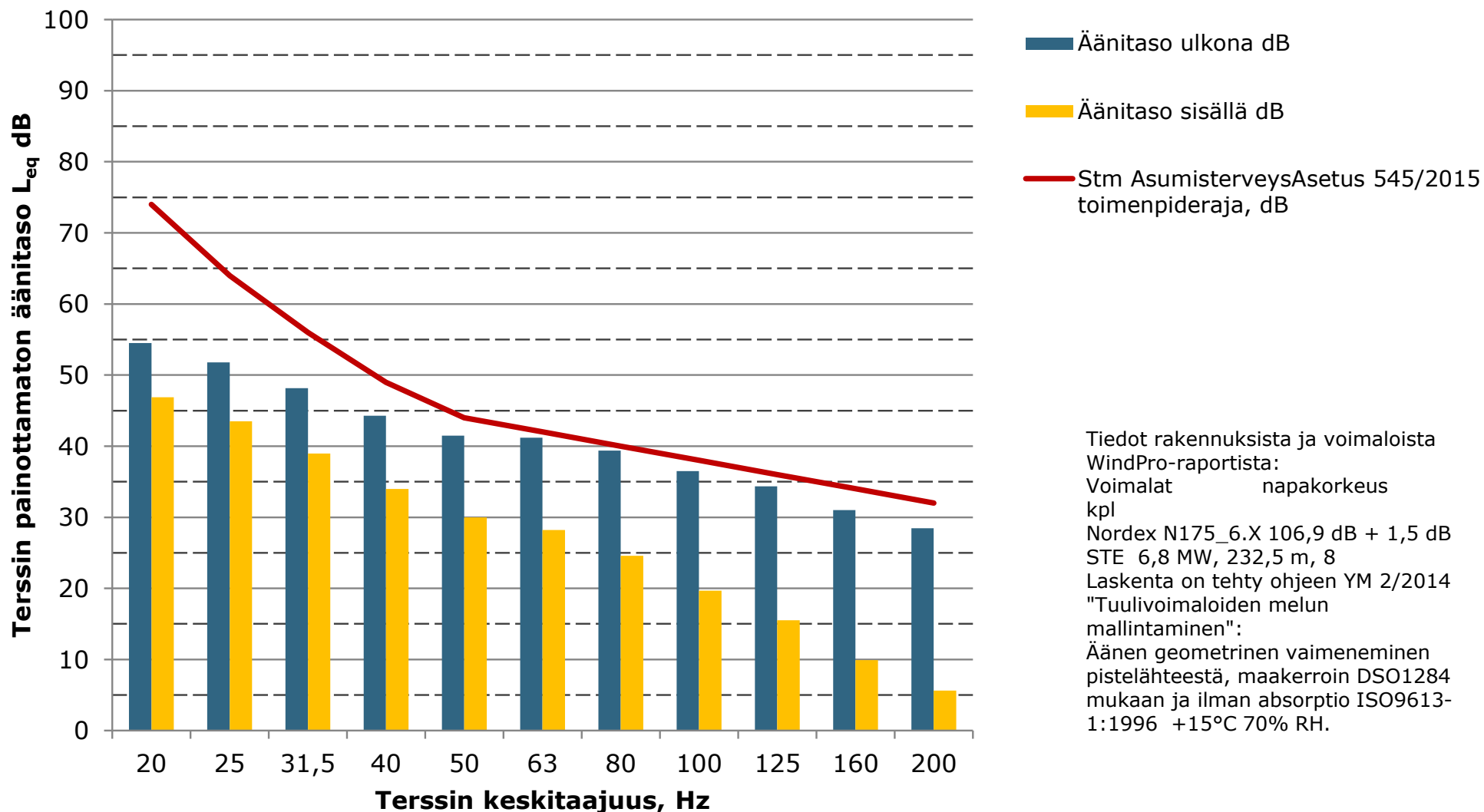




Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

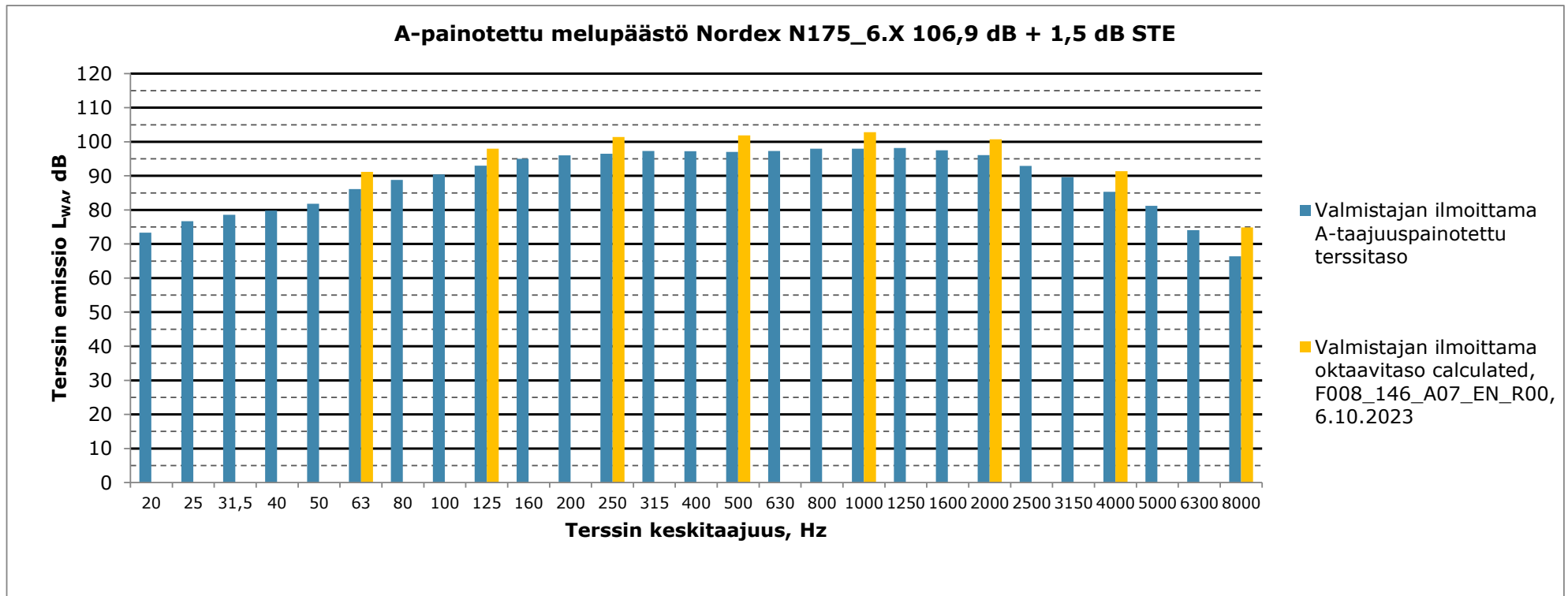


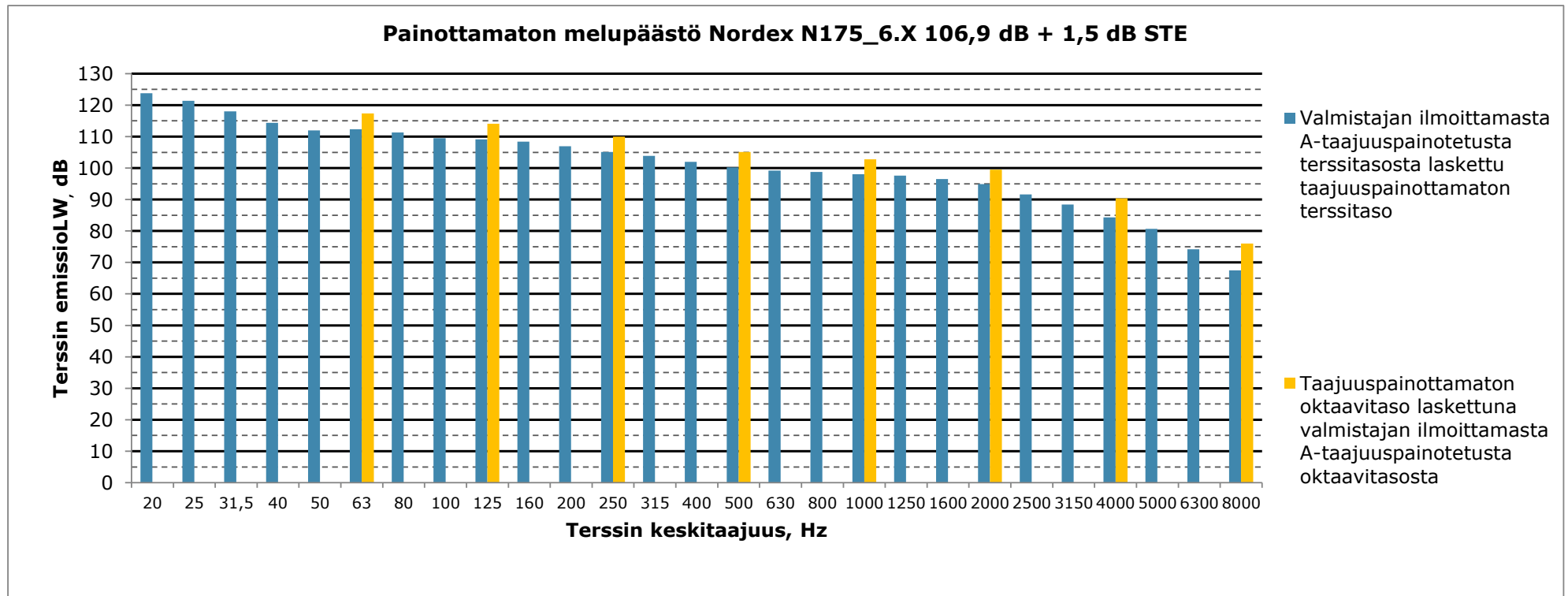
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



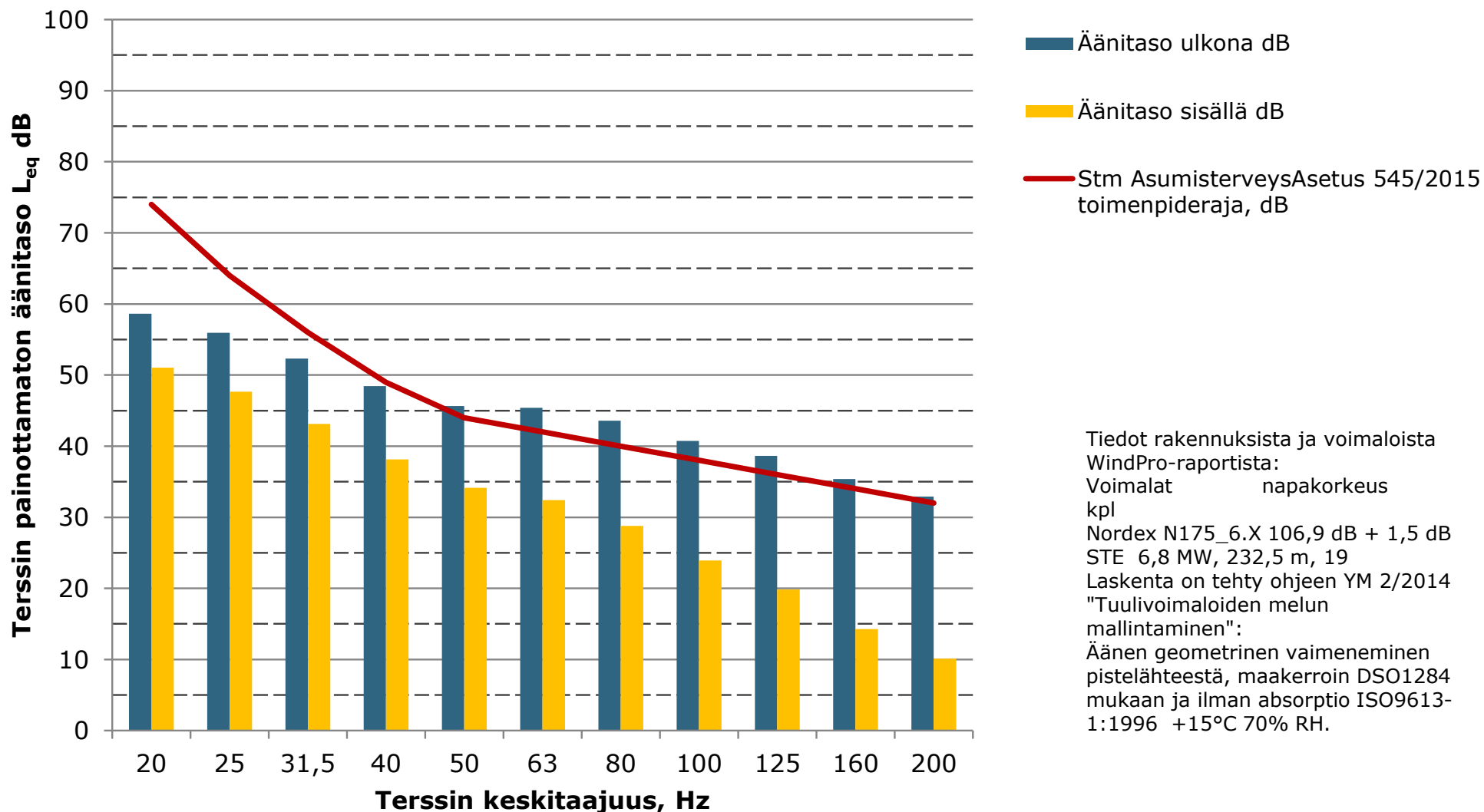
11.10.2023

Liite 14. Verkasalon tuulivoimahanke, Alavieskan alueella olevat voimalat – matalataajuisen melun rakennuskohtaiset arvot VE2 N175 - 6.8 MW.

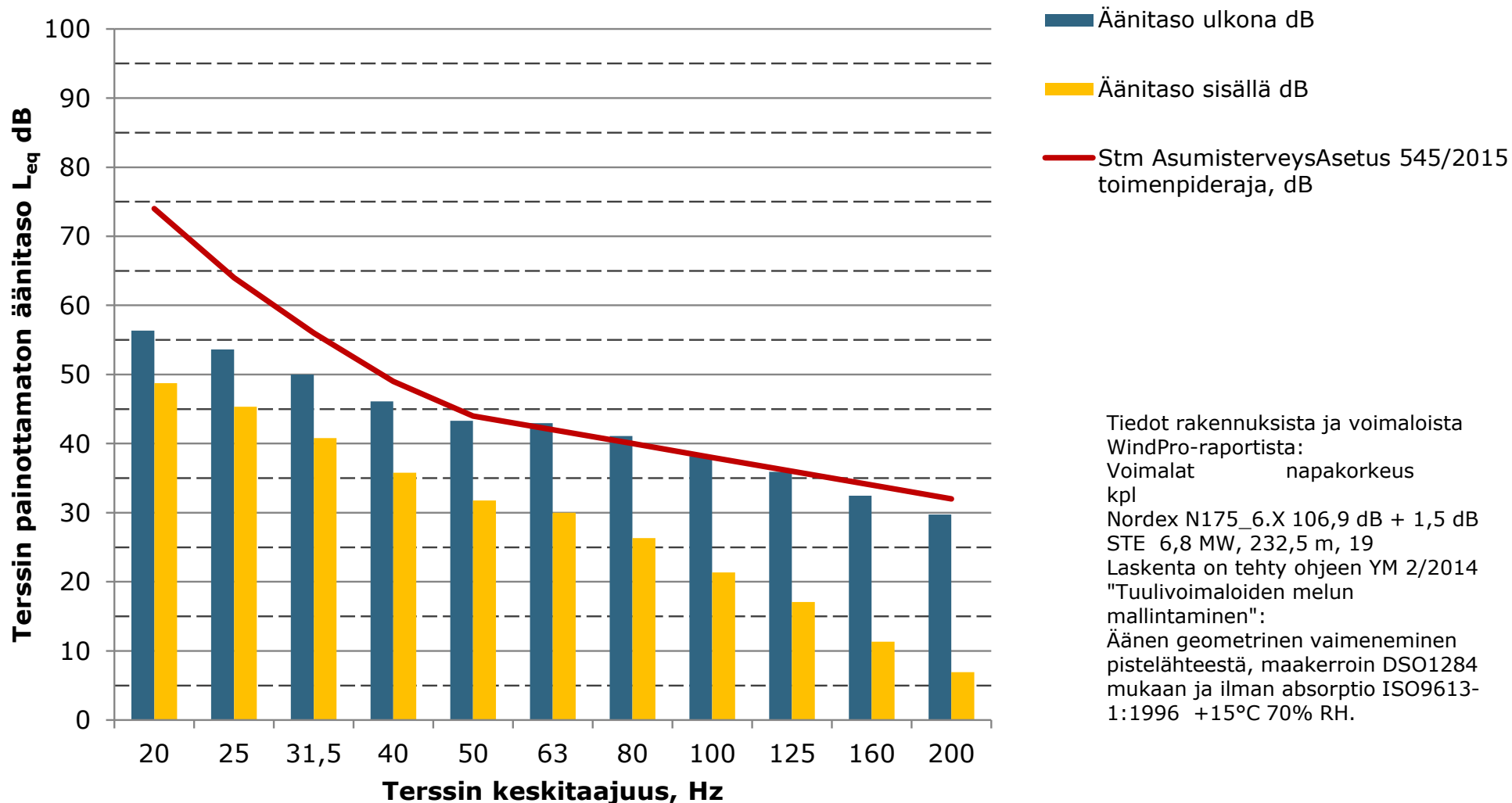


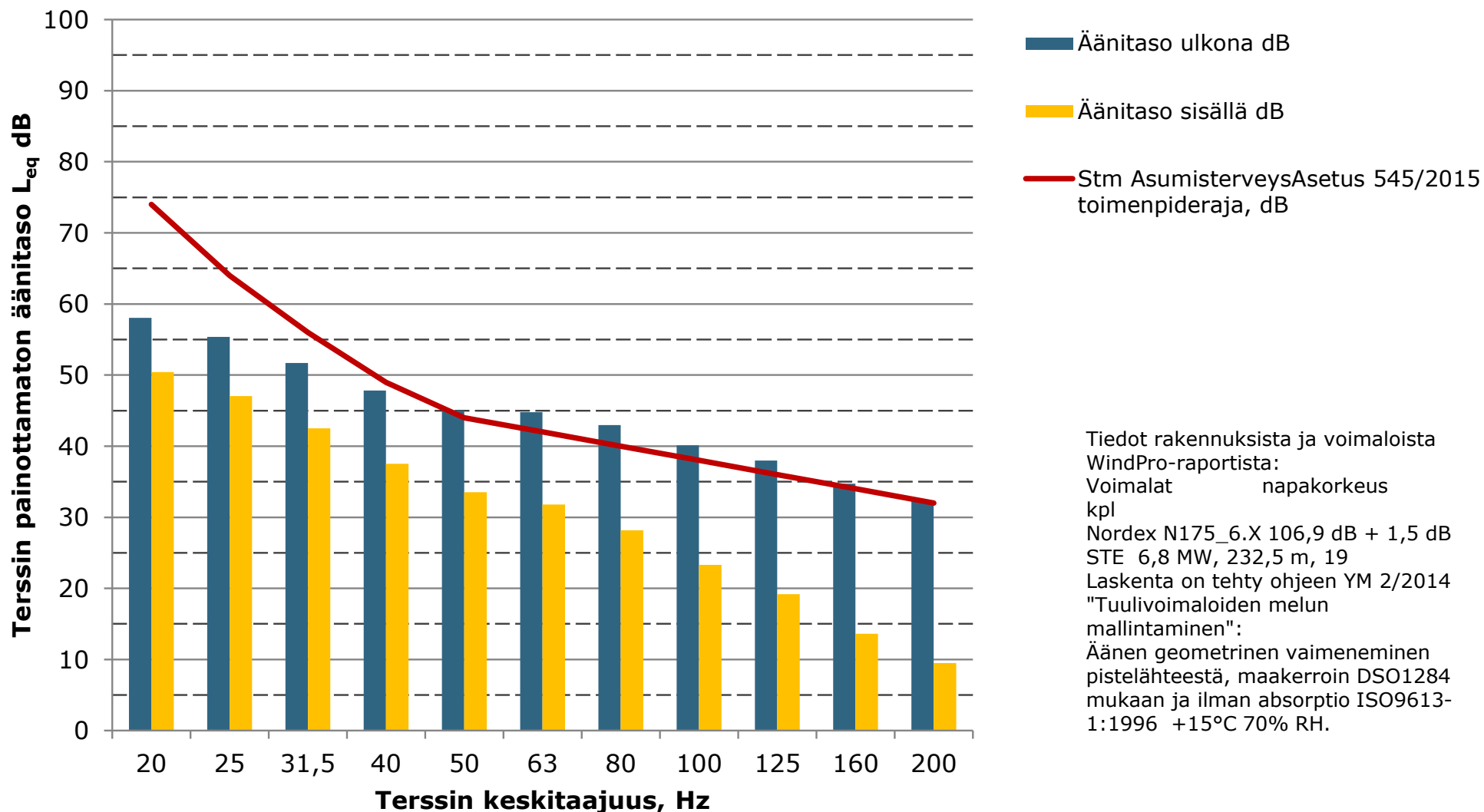


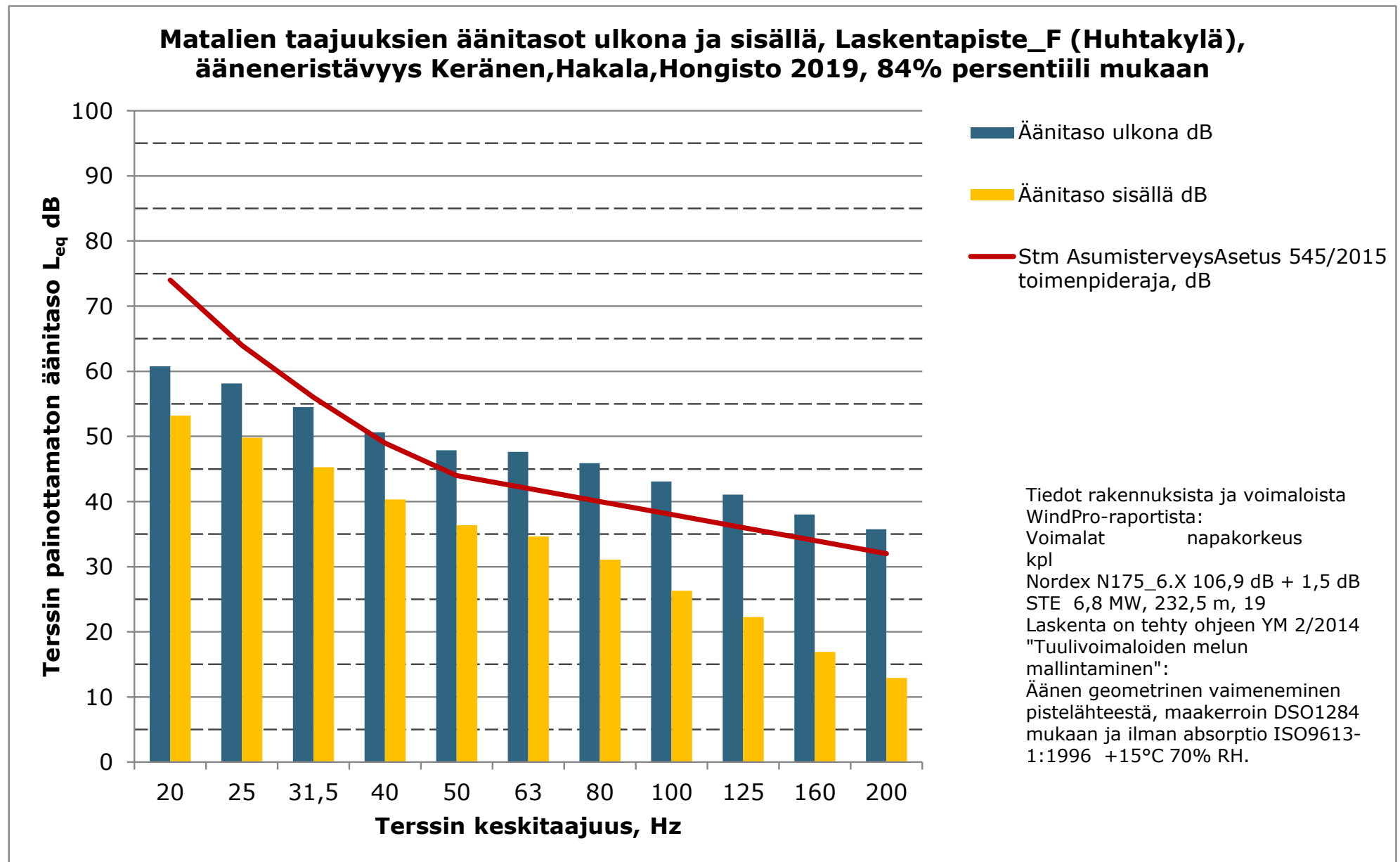
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



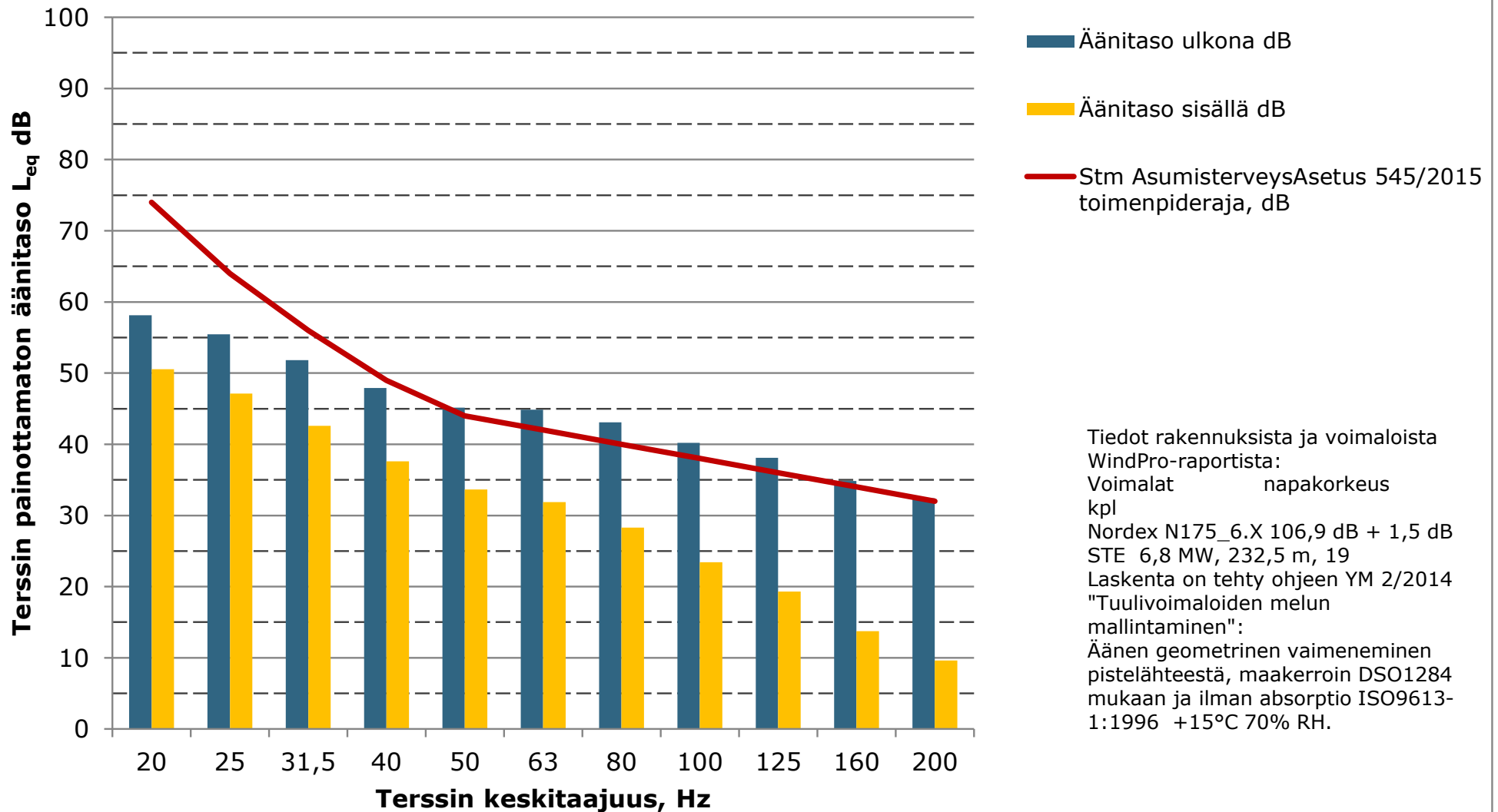
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

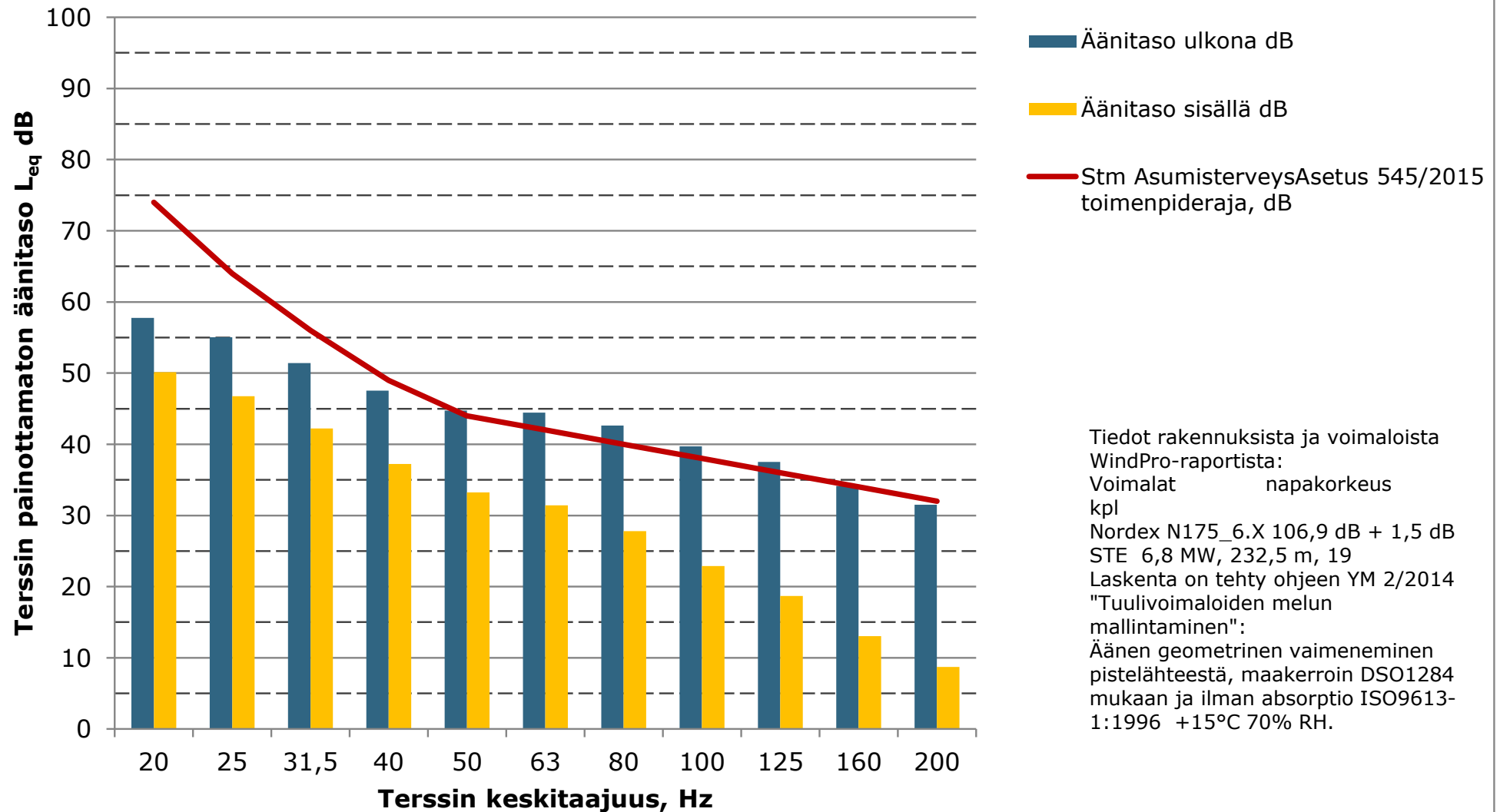


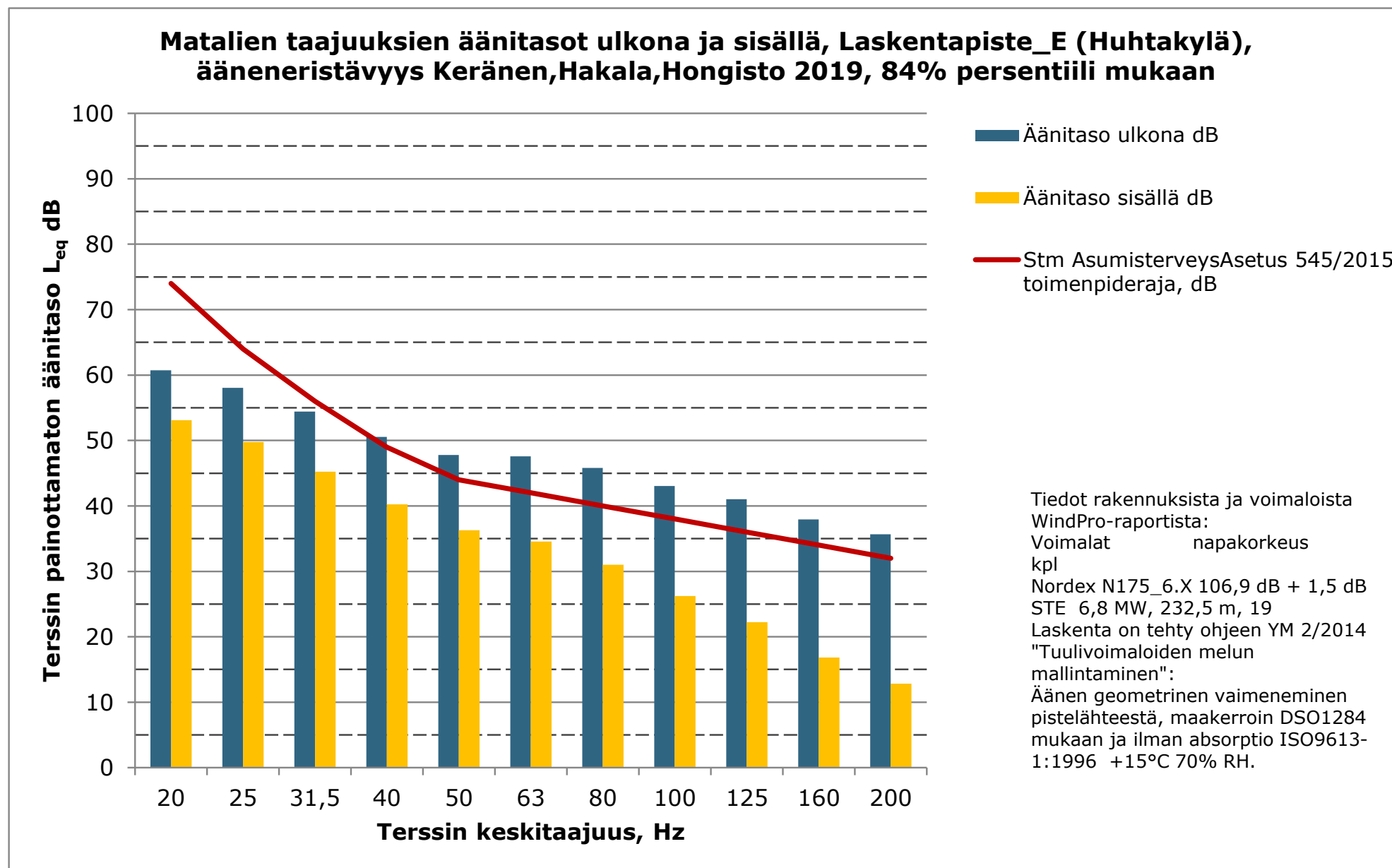
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



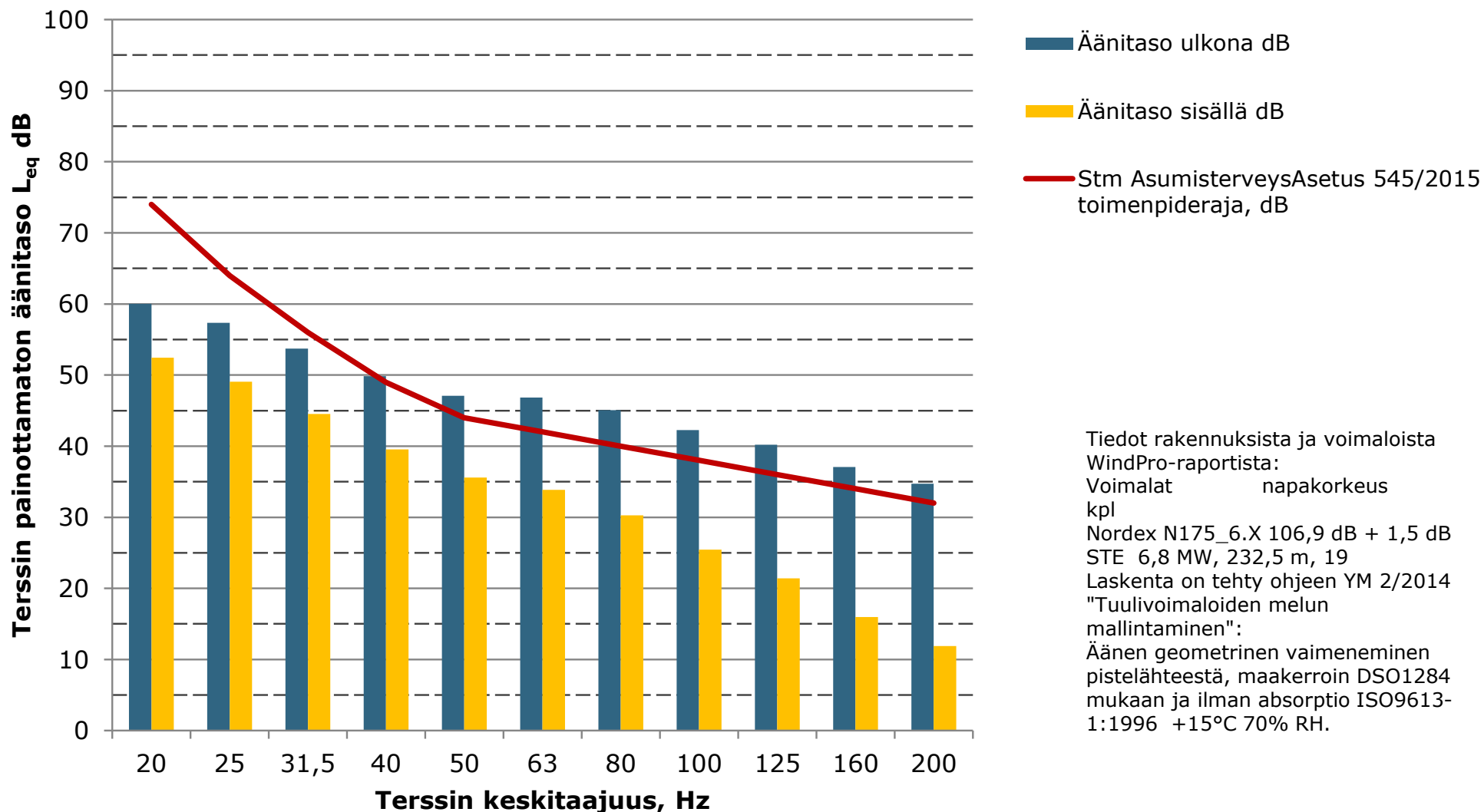
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

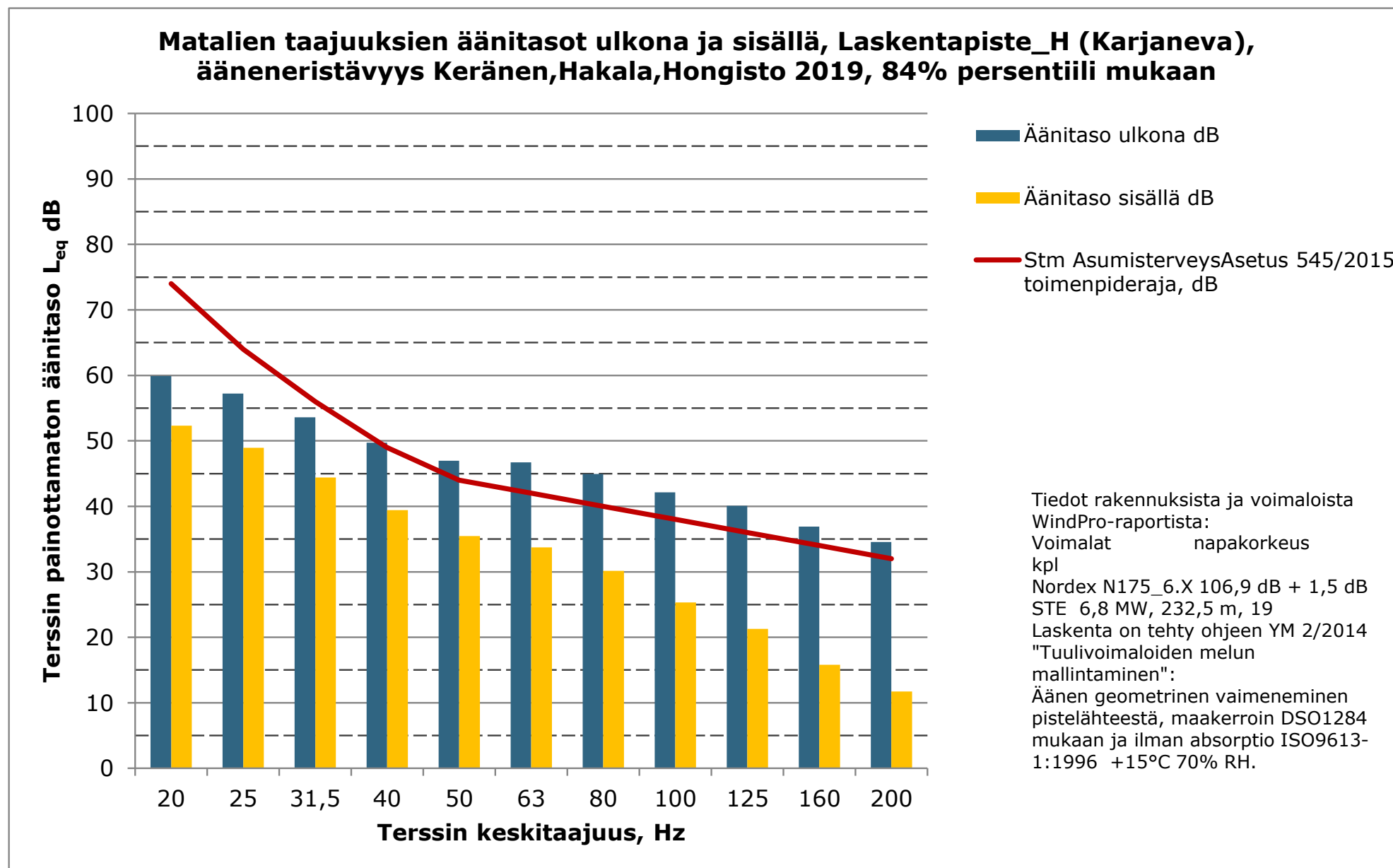


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

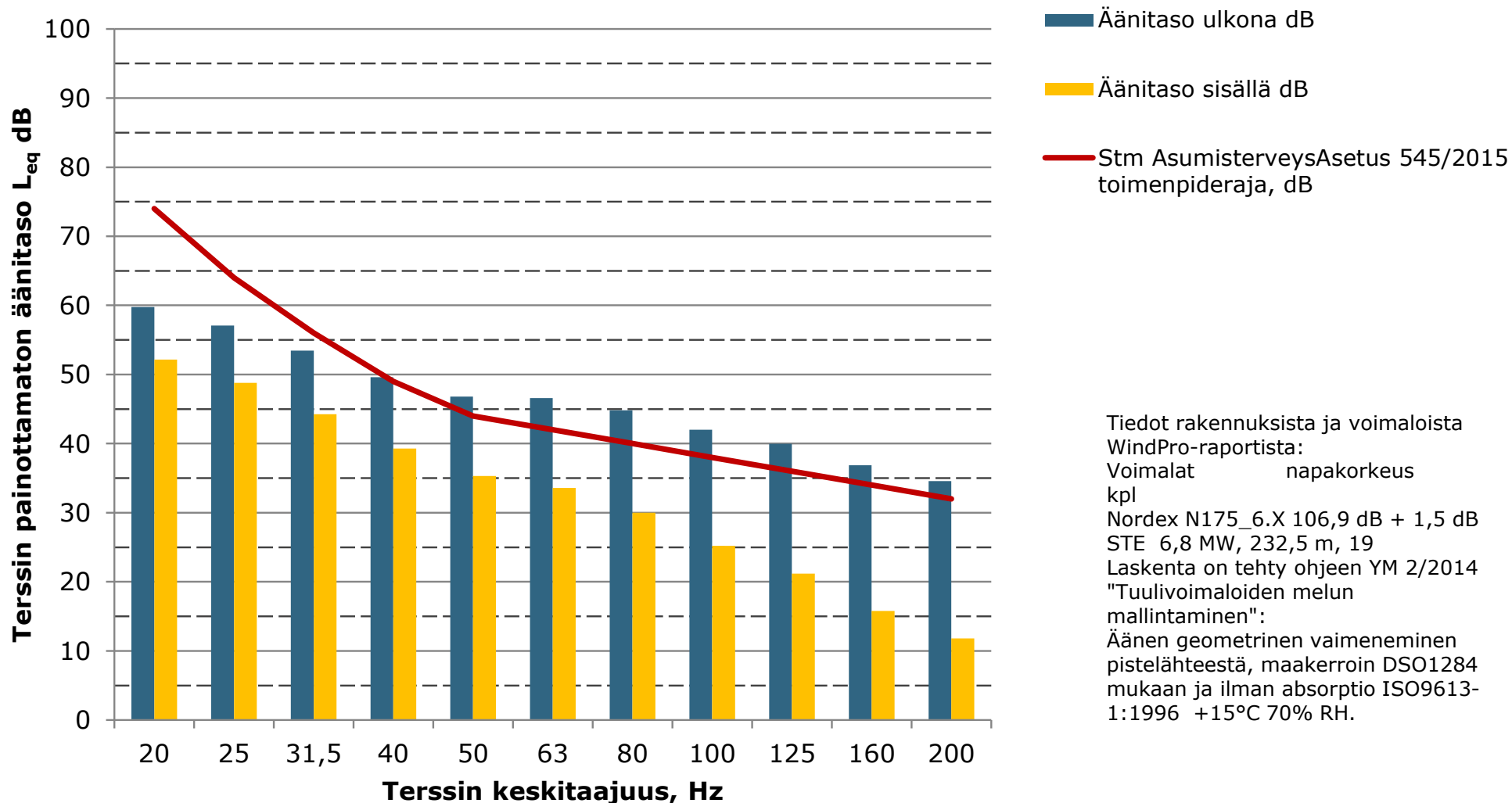


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

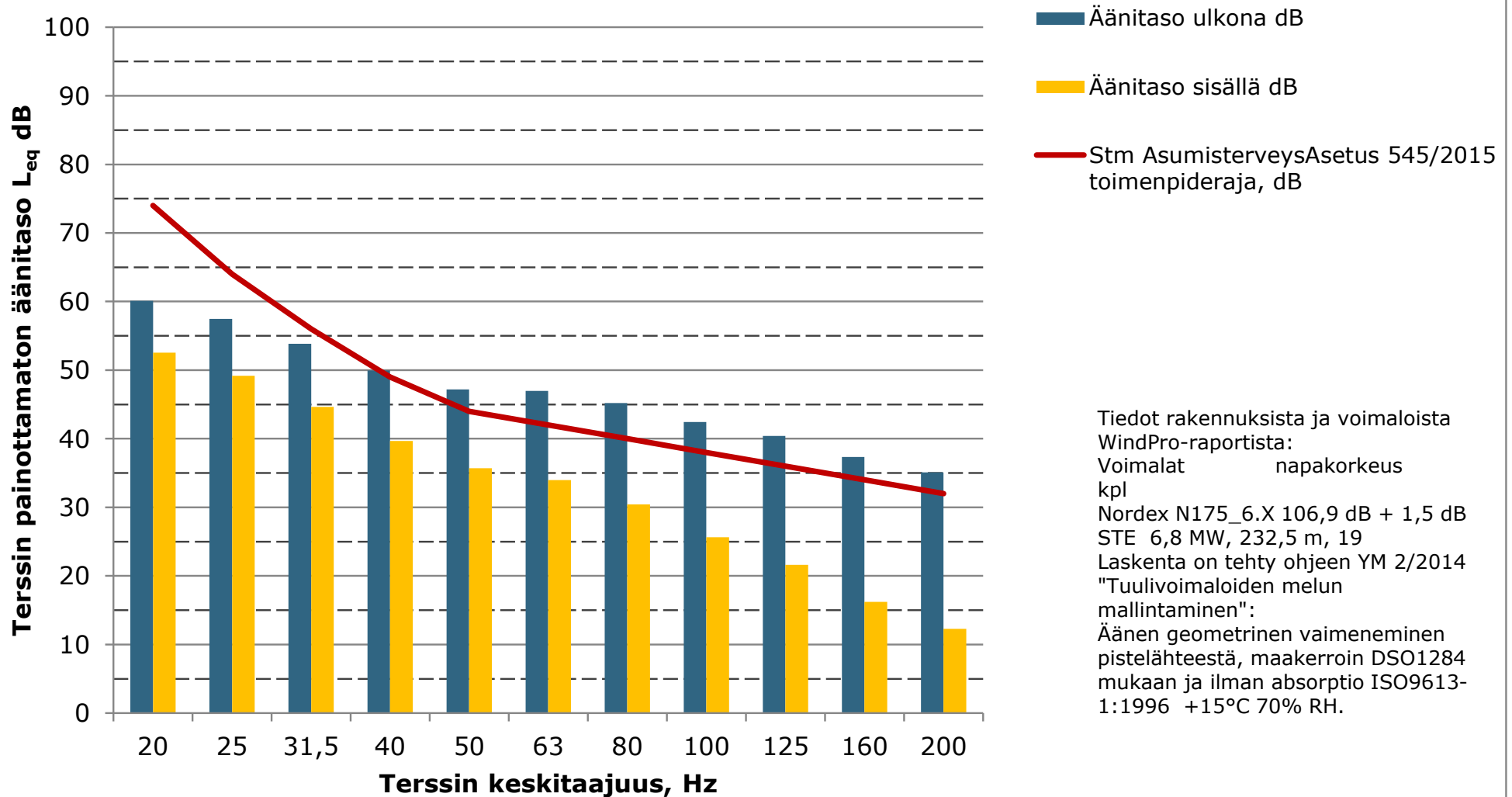




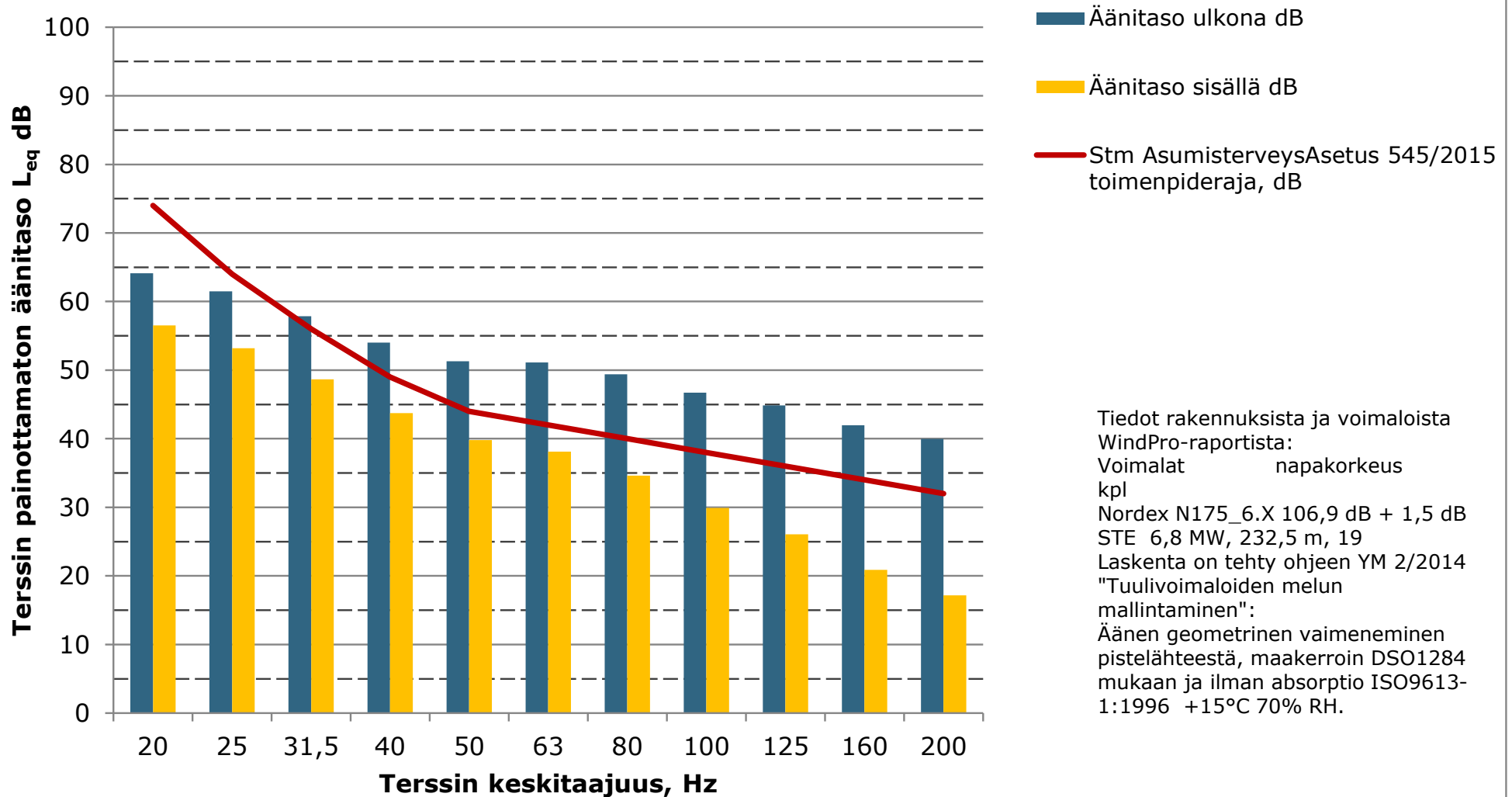
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



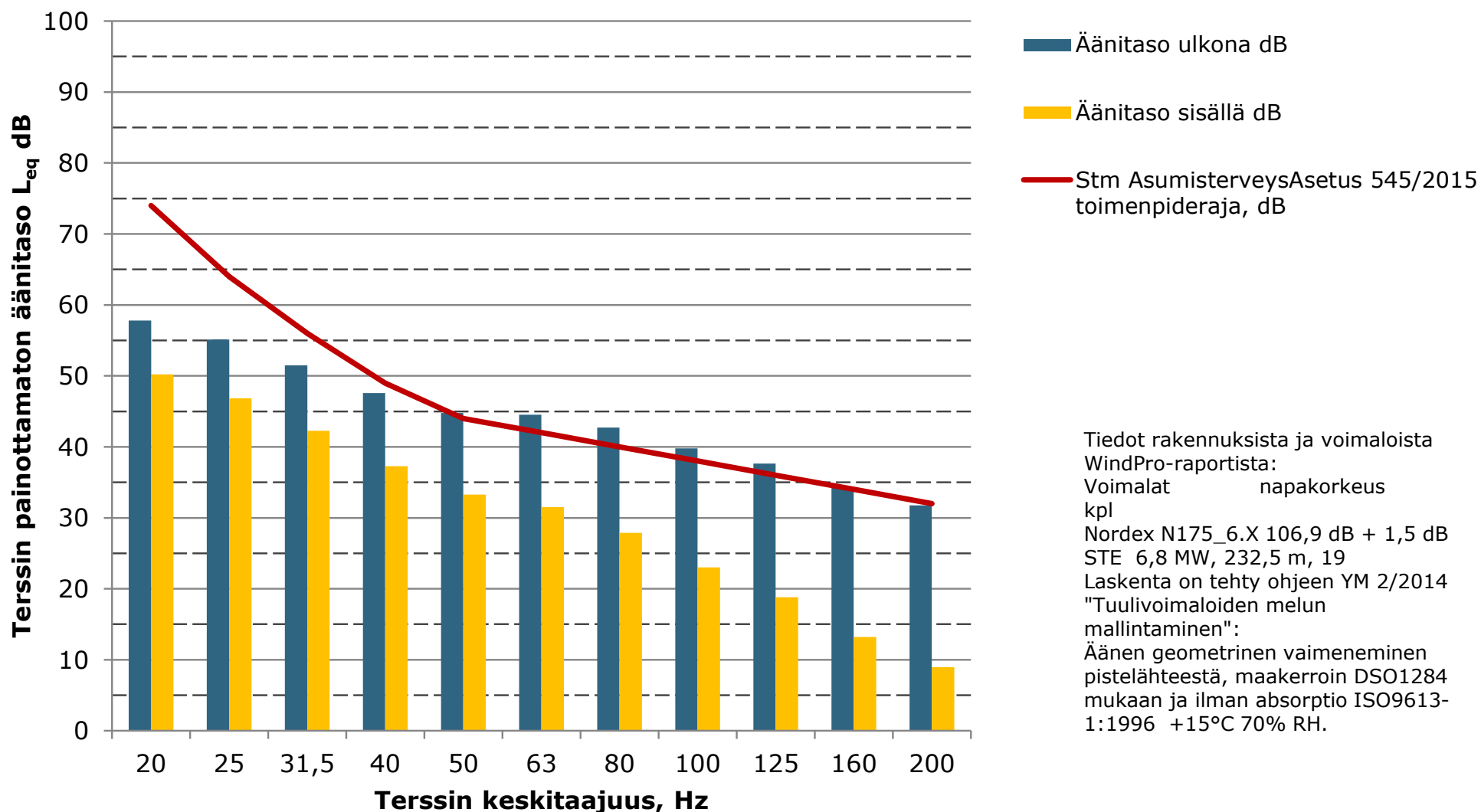
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

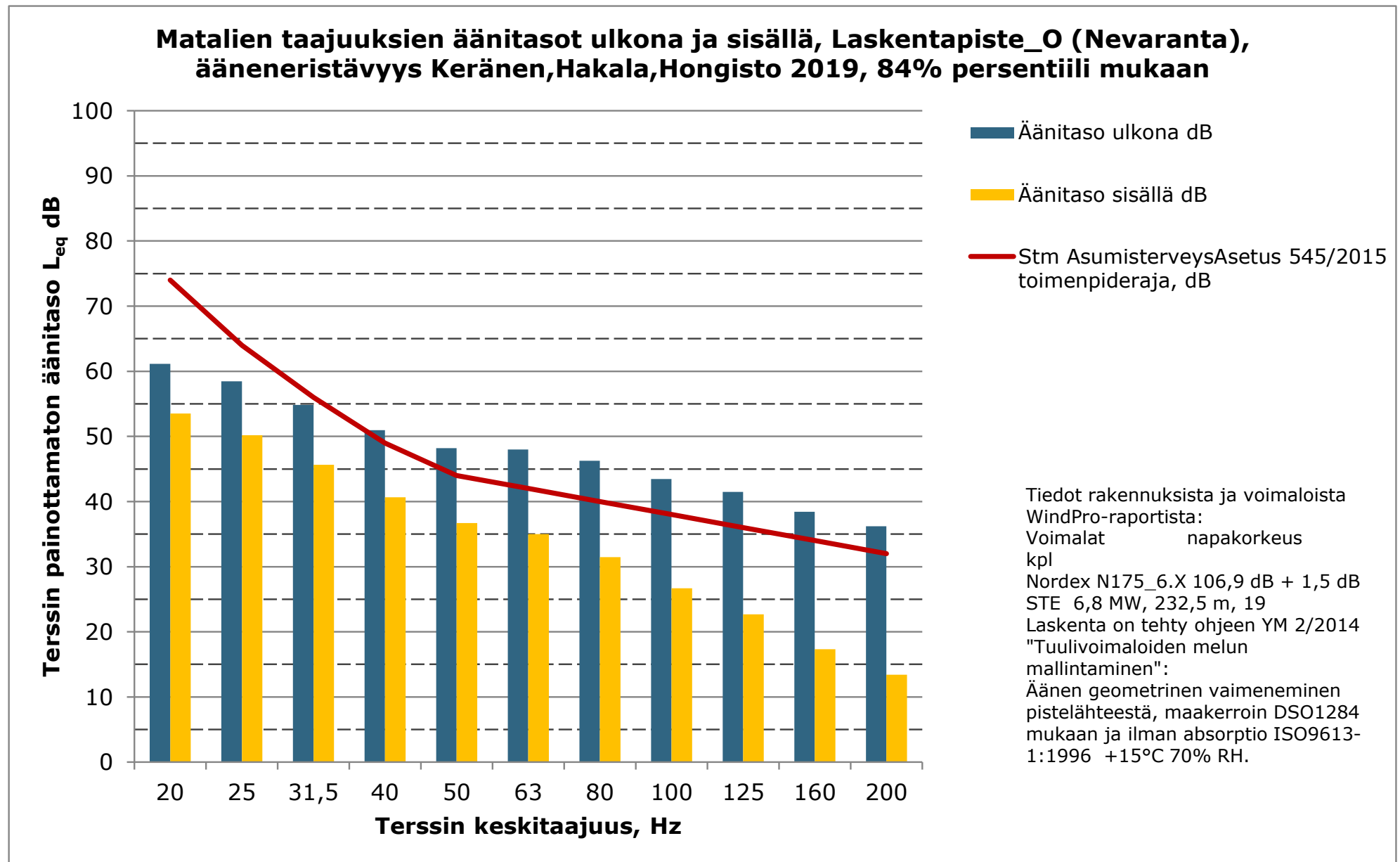


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

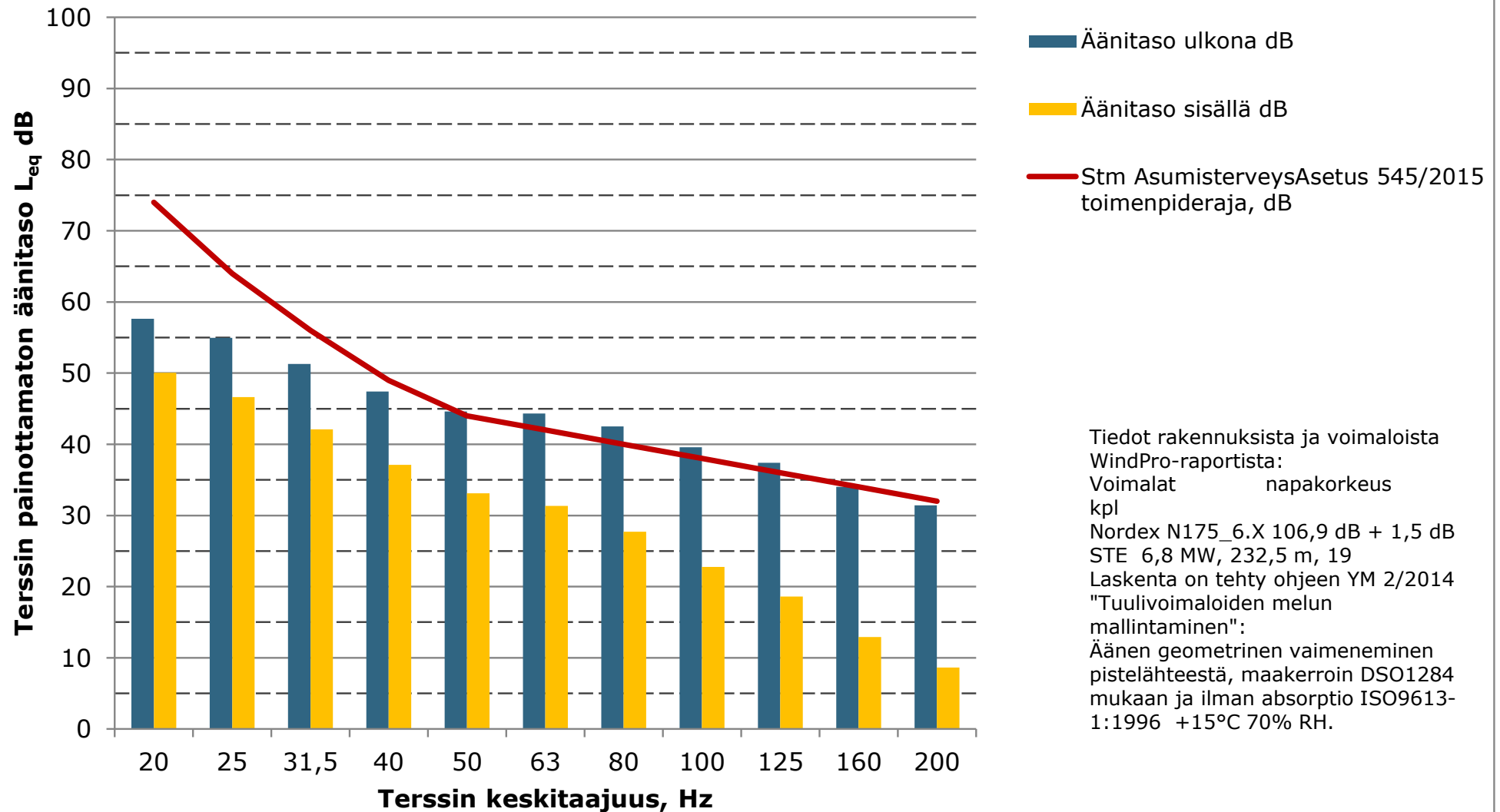


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

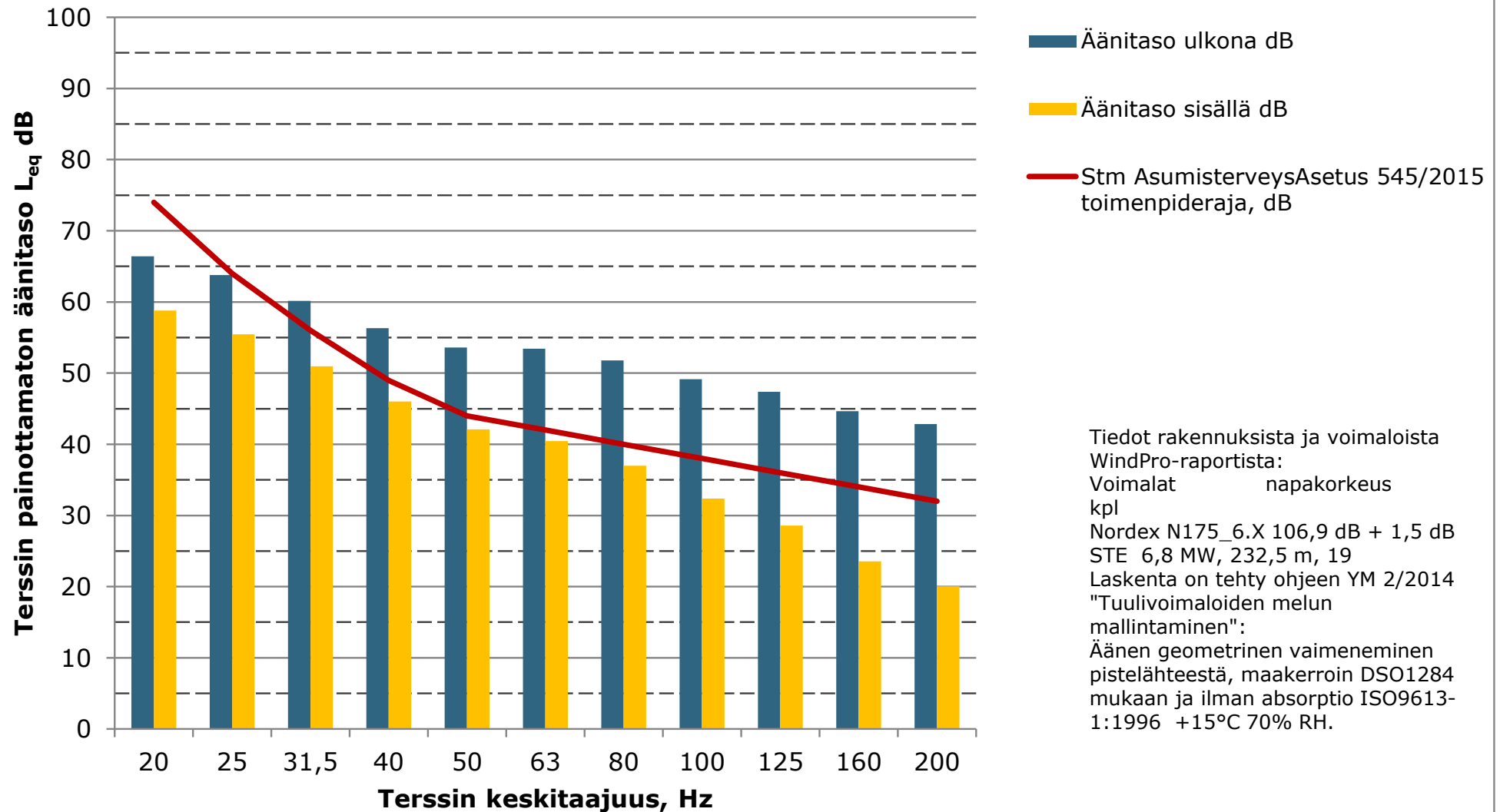




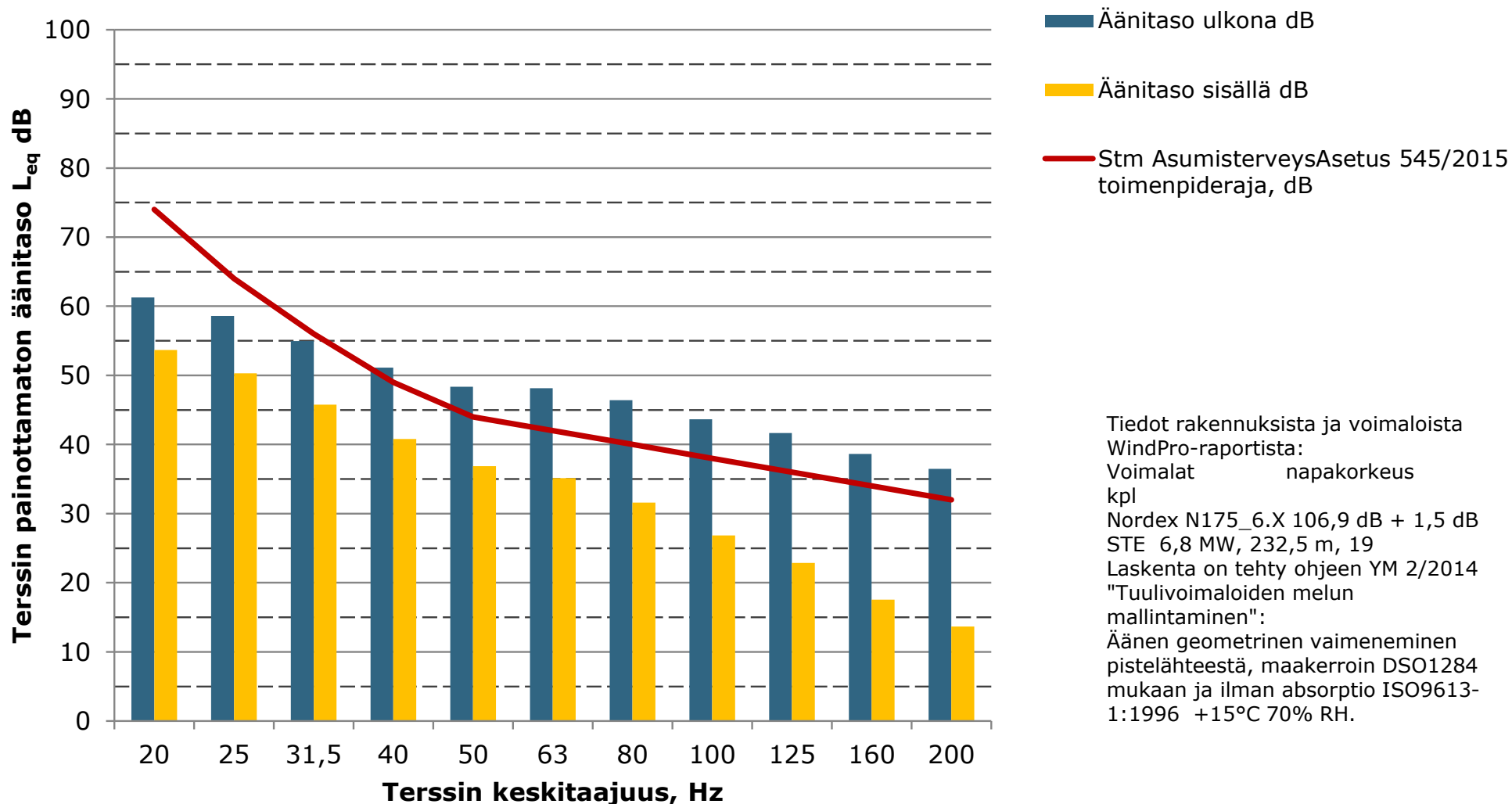
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

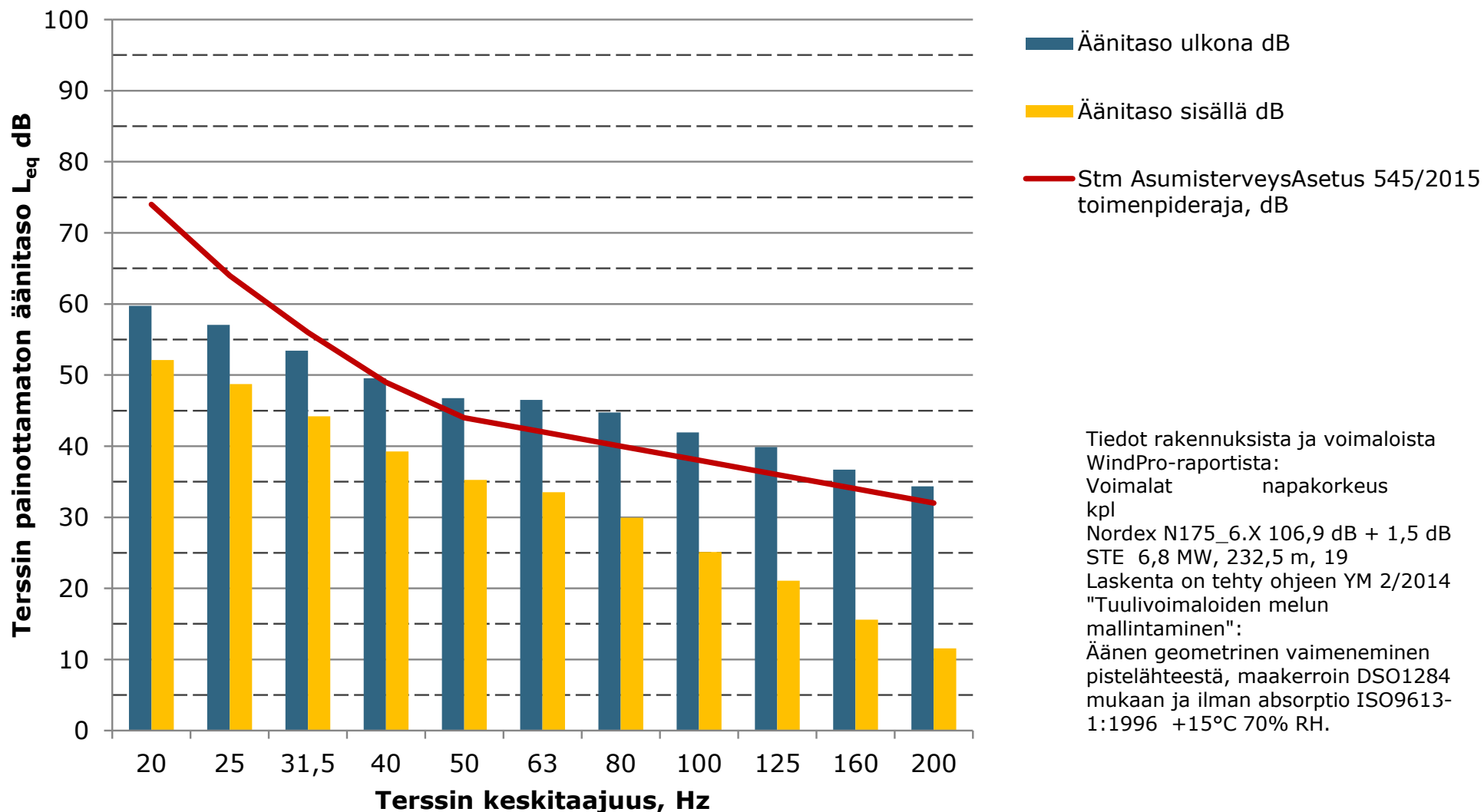


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_P (Niisineva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



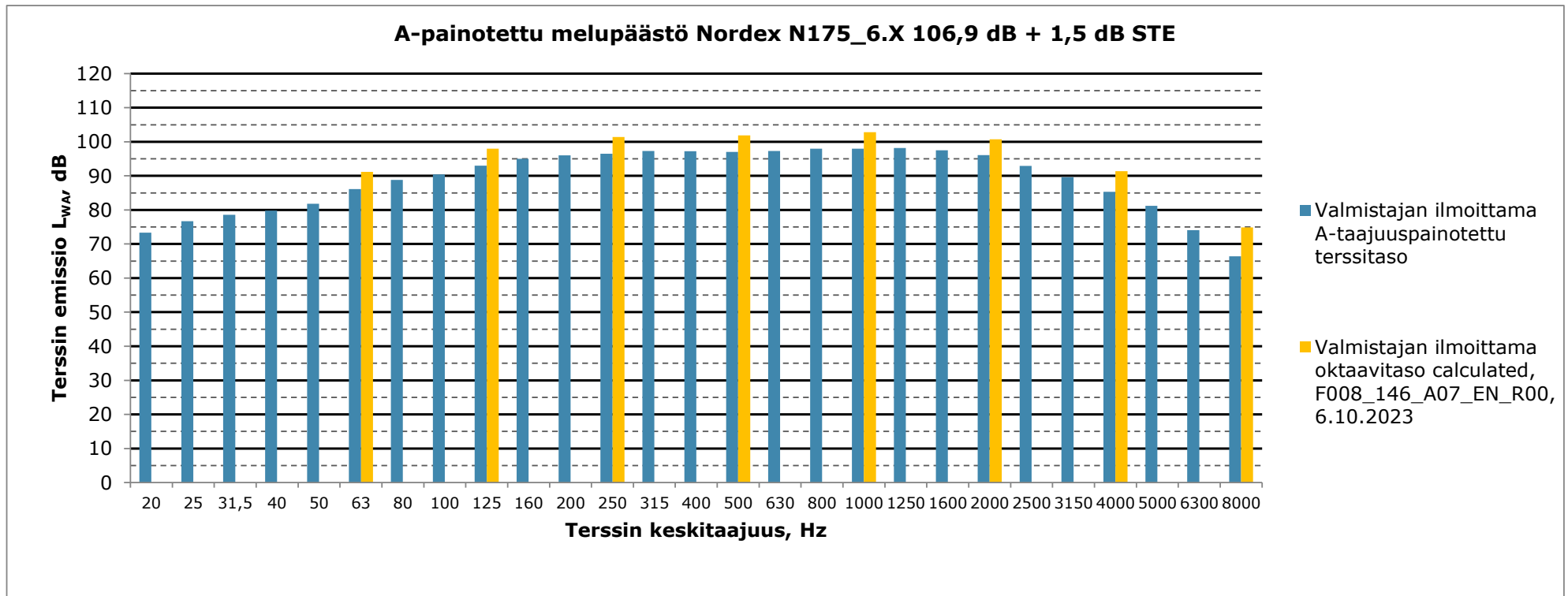
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

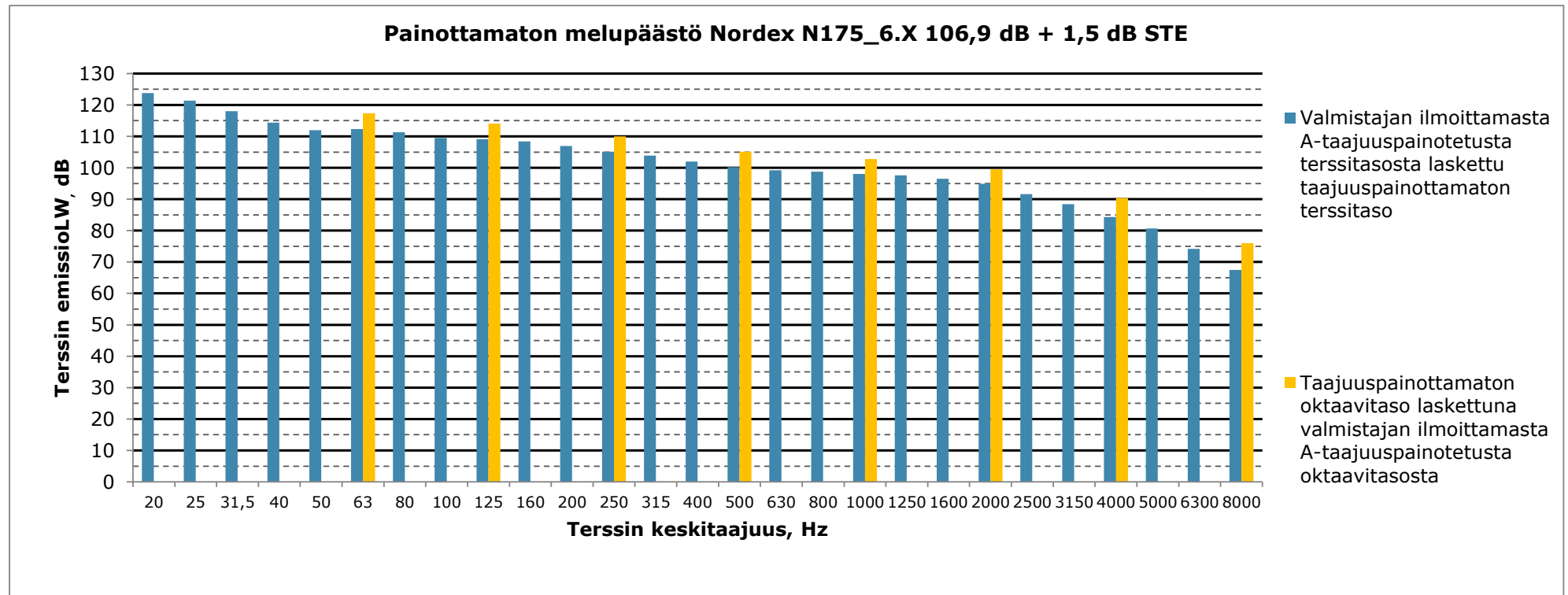


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

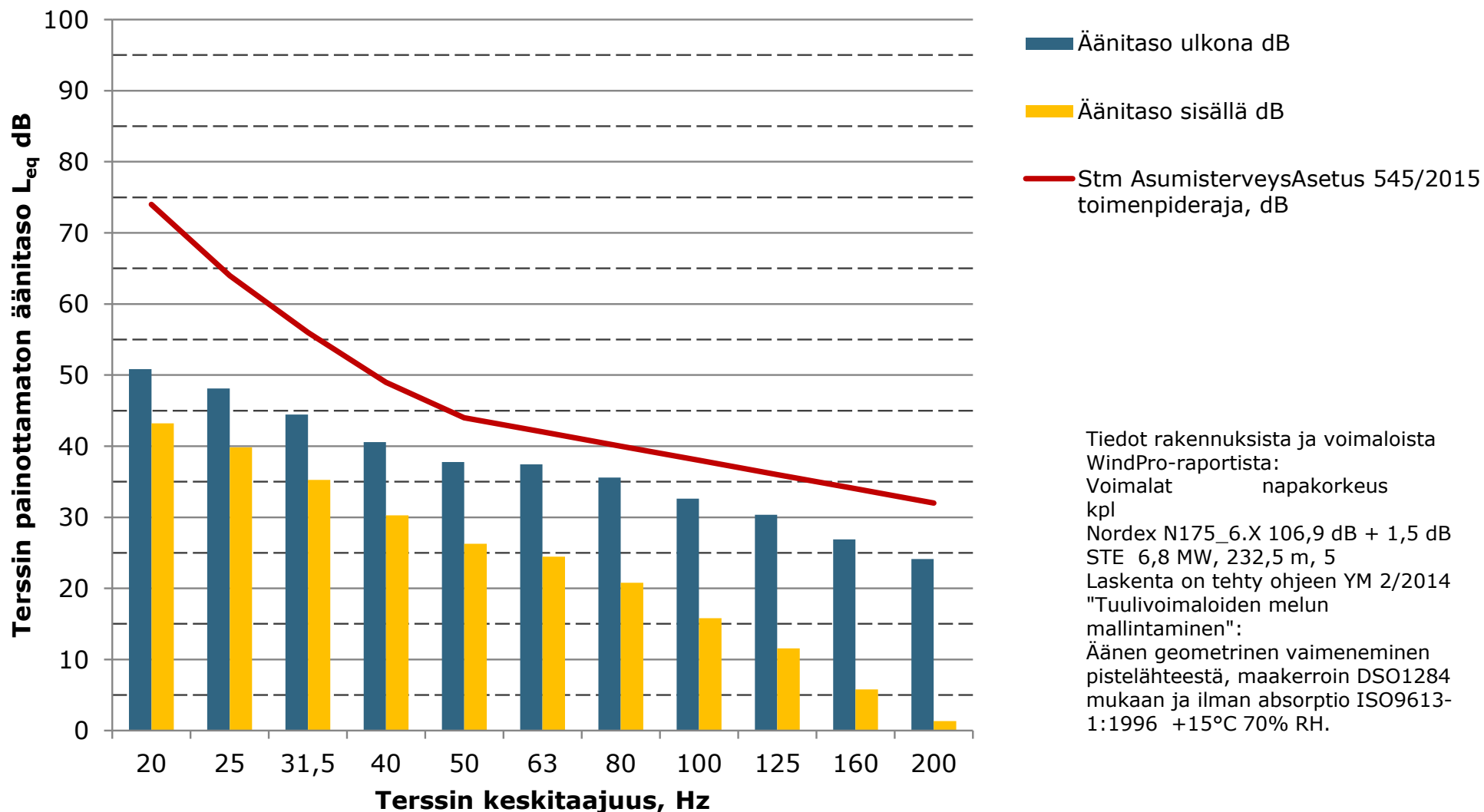
11.10.2023

Liite 15. Verkasalon tuulivoimahanke, Kalajoen alueella olevat voimalat – matalataajuisen melun rakennuskohtaiset arvot VE2 N175 - 6.8 MW.

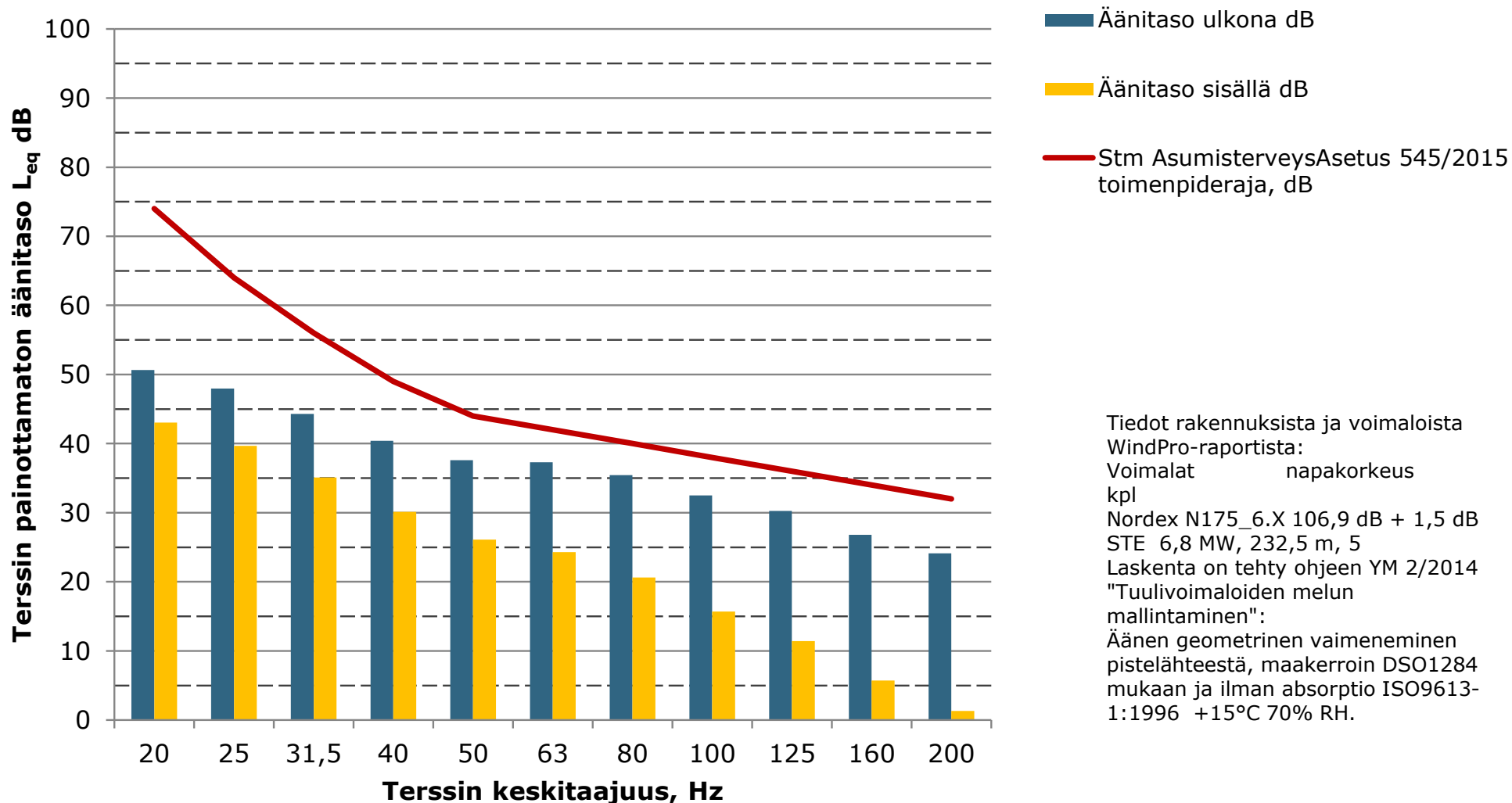




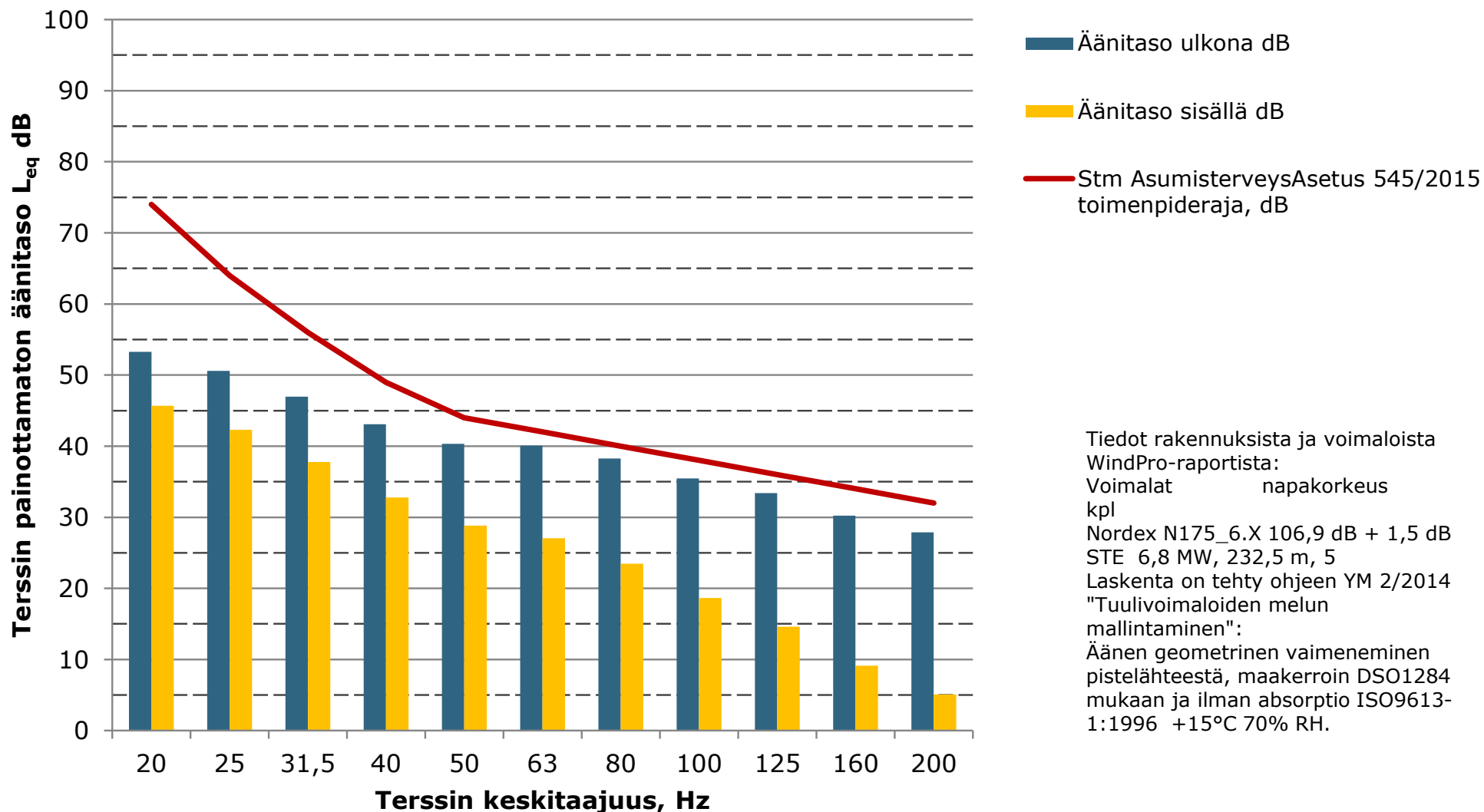
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

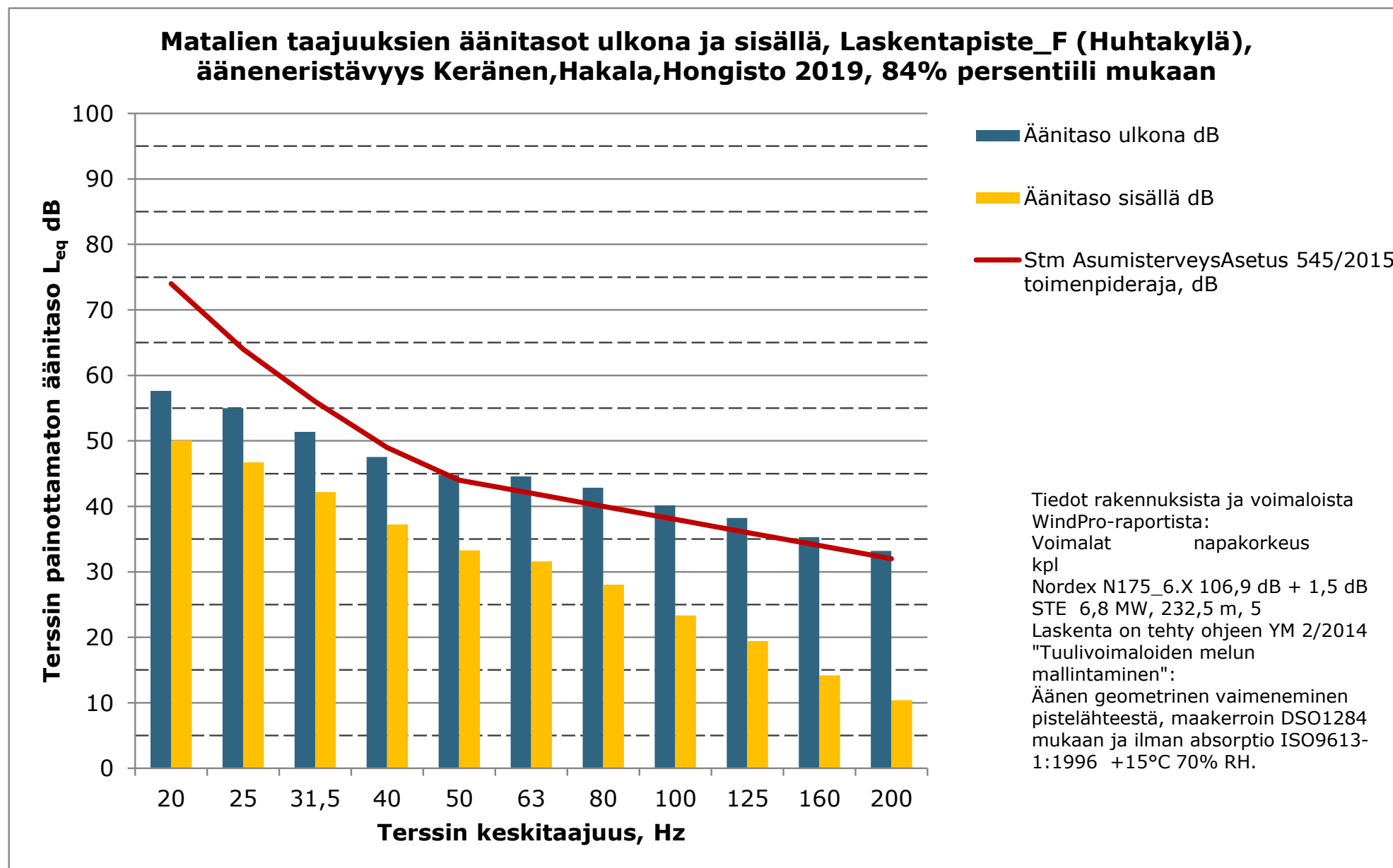


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

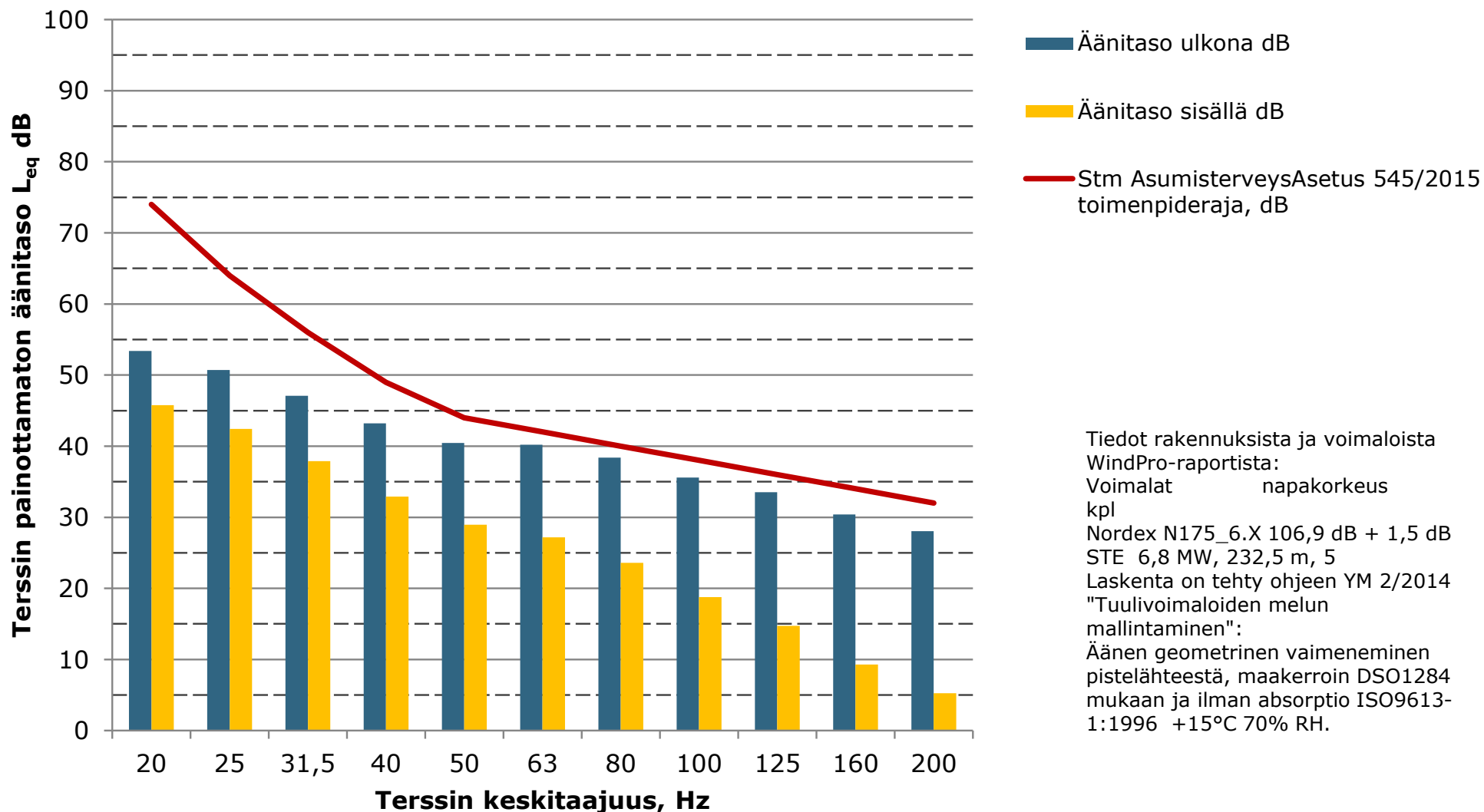


Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

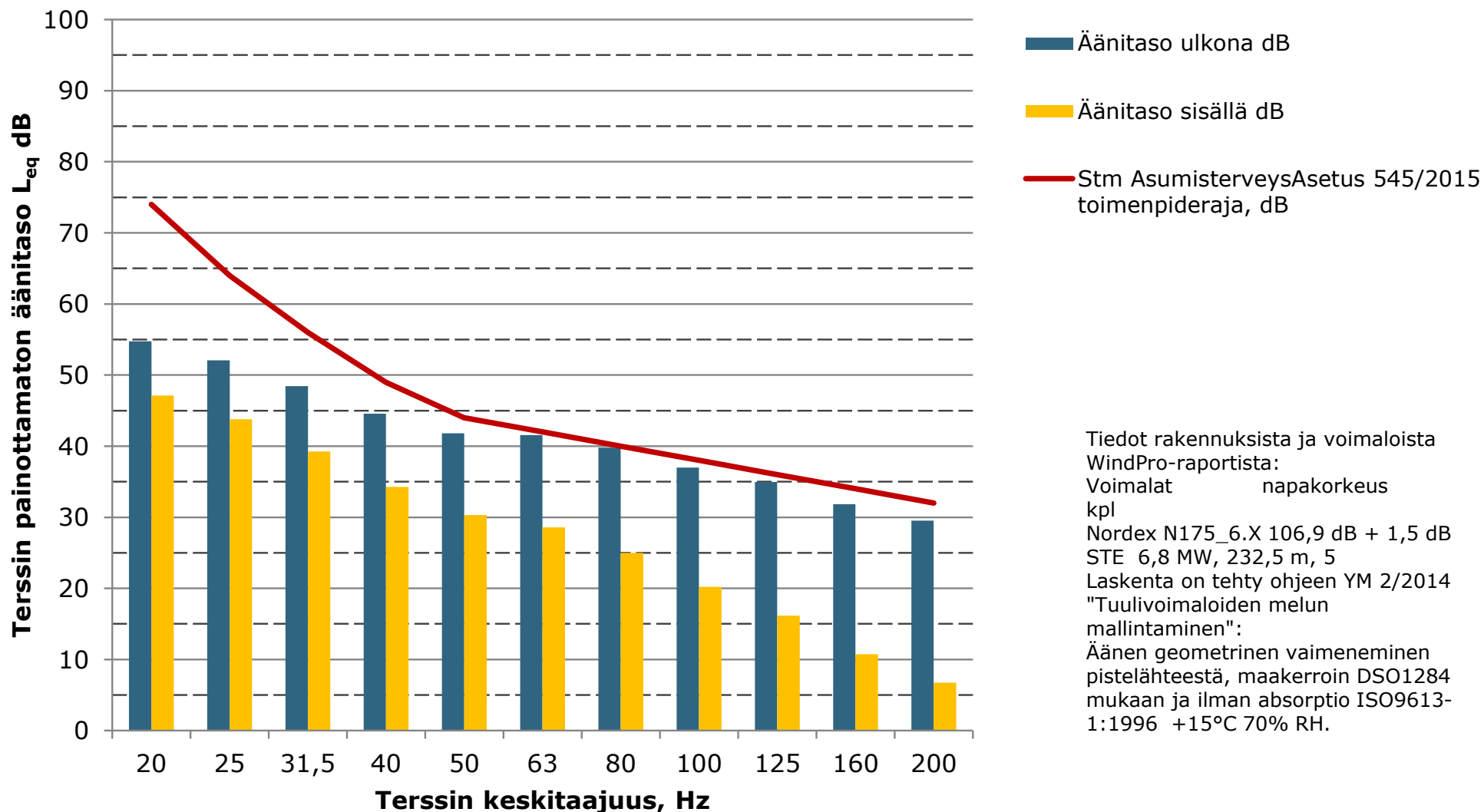




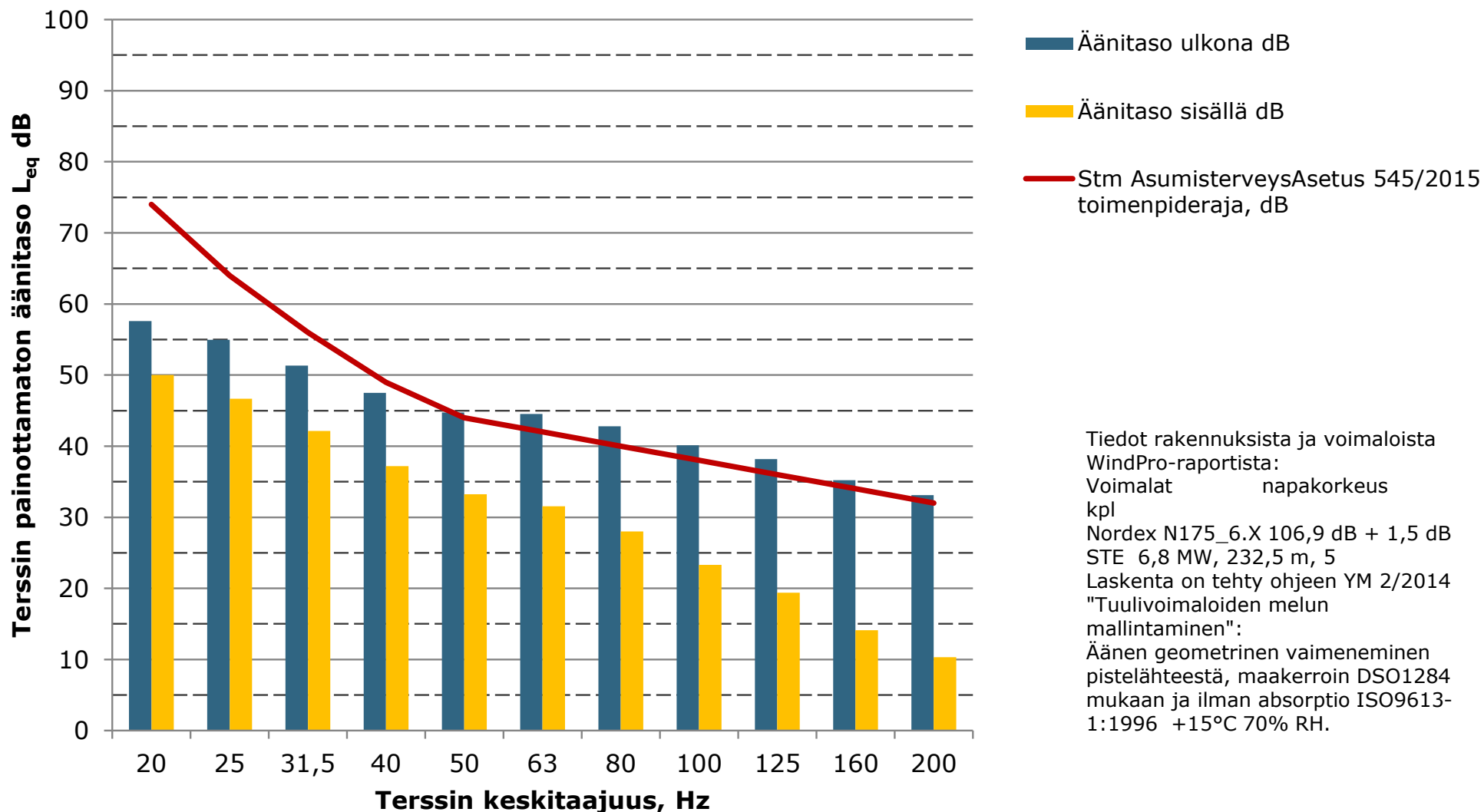
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

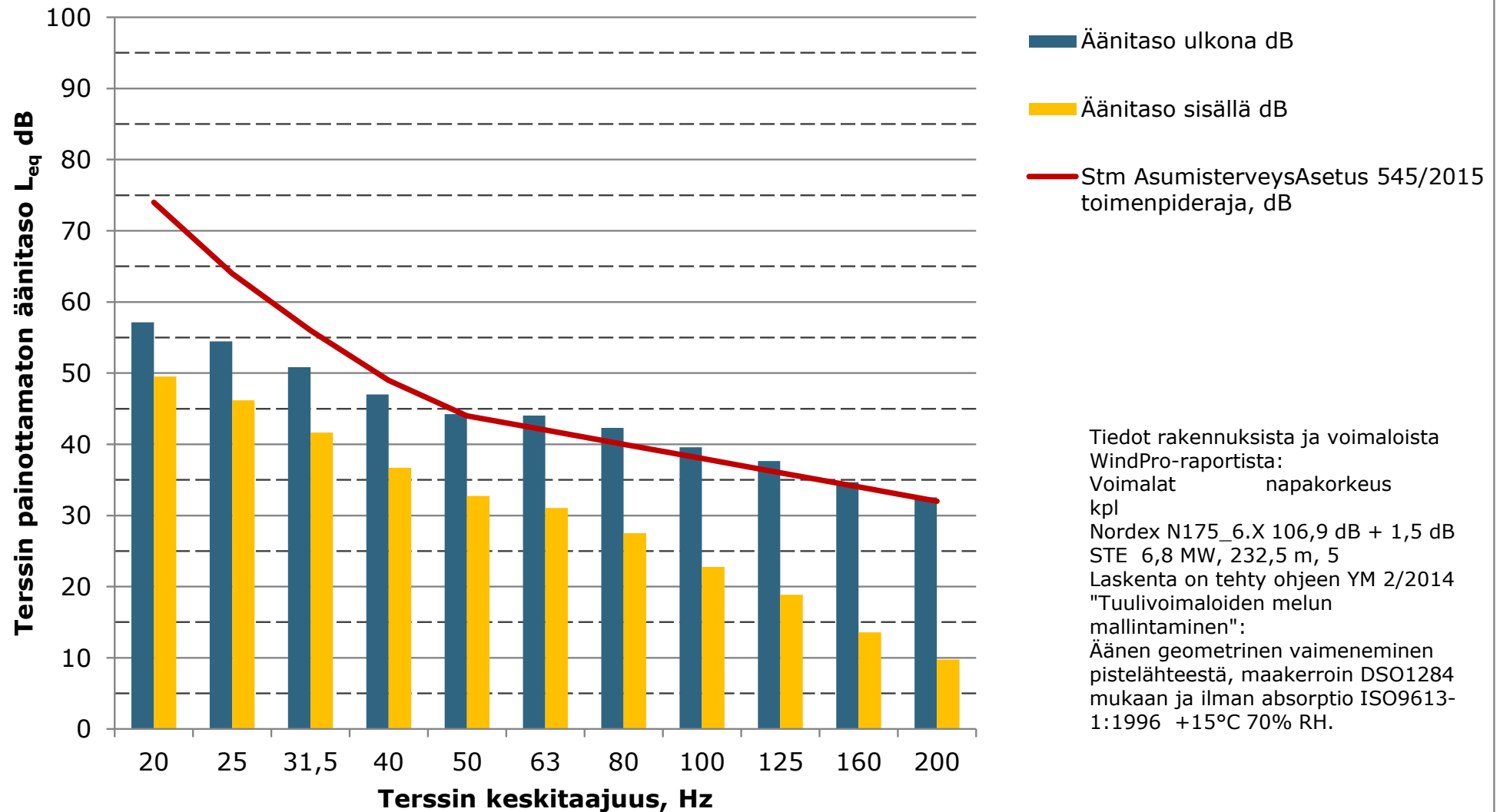


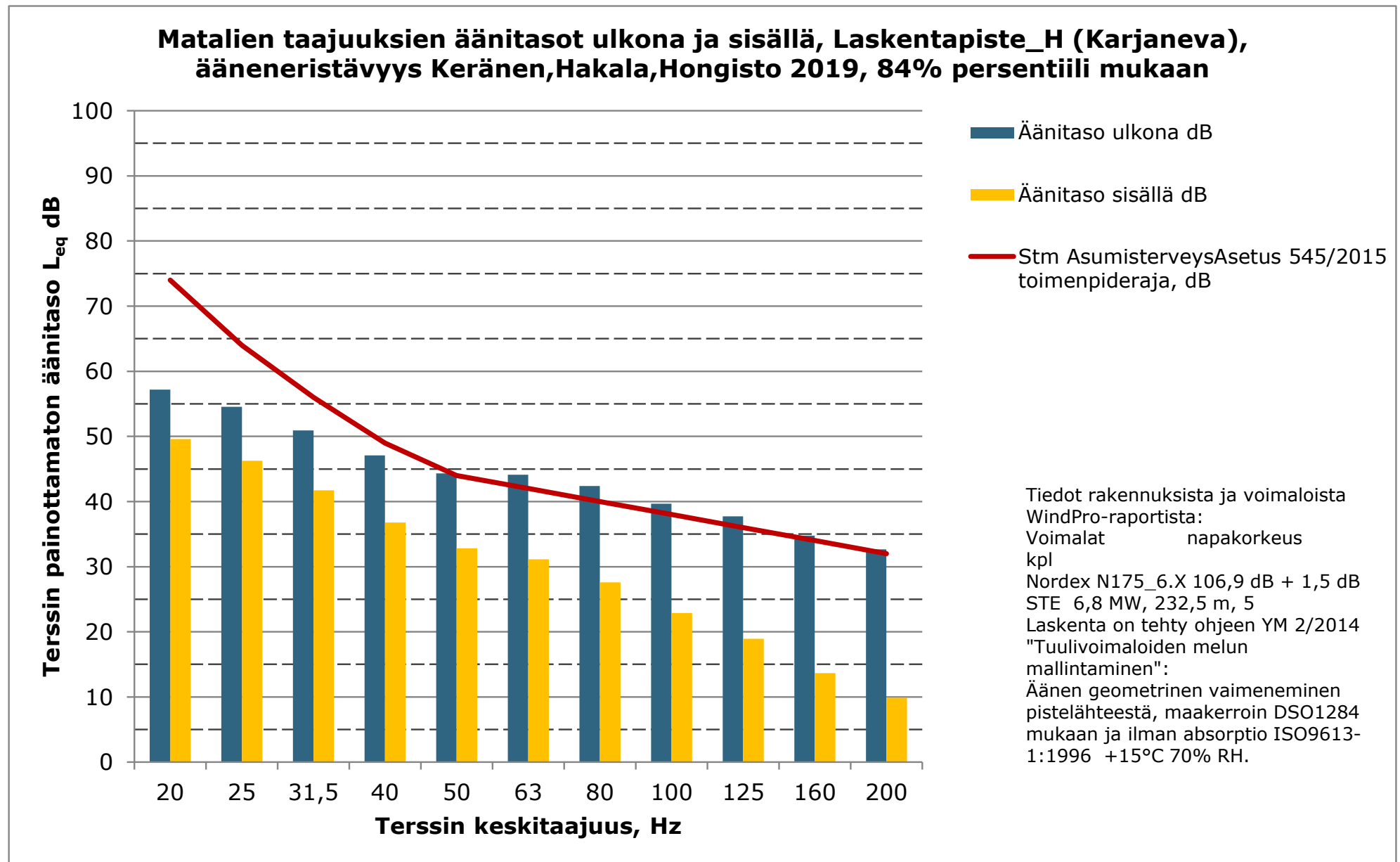
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



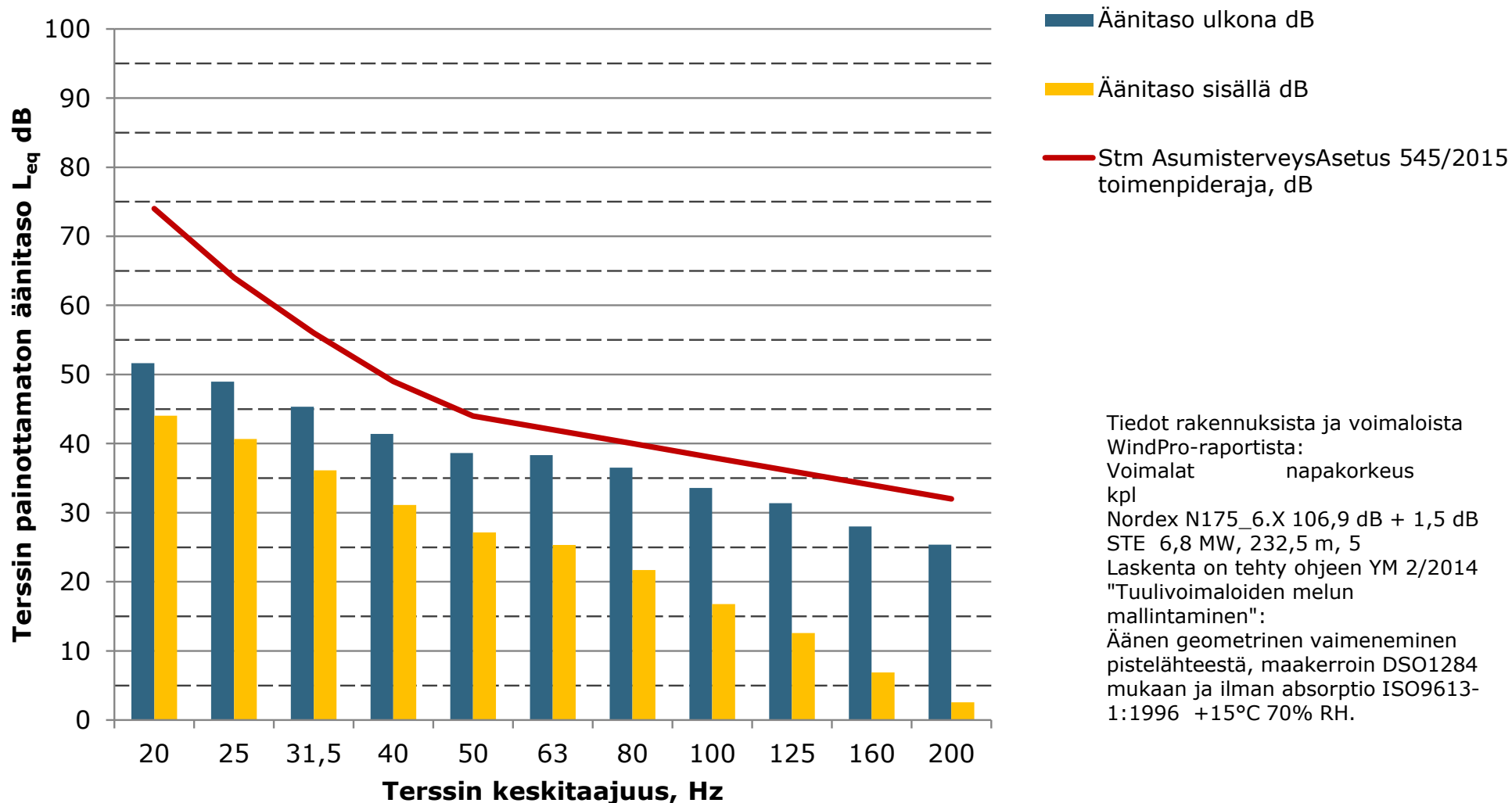
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_E (Huhtakylä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



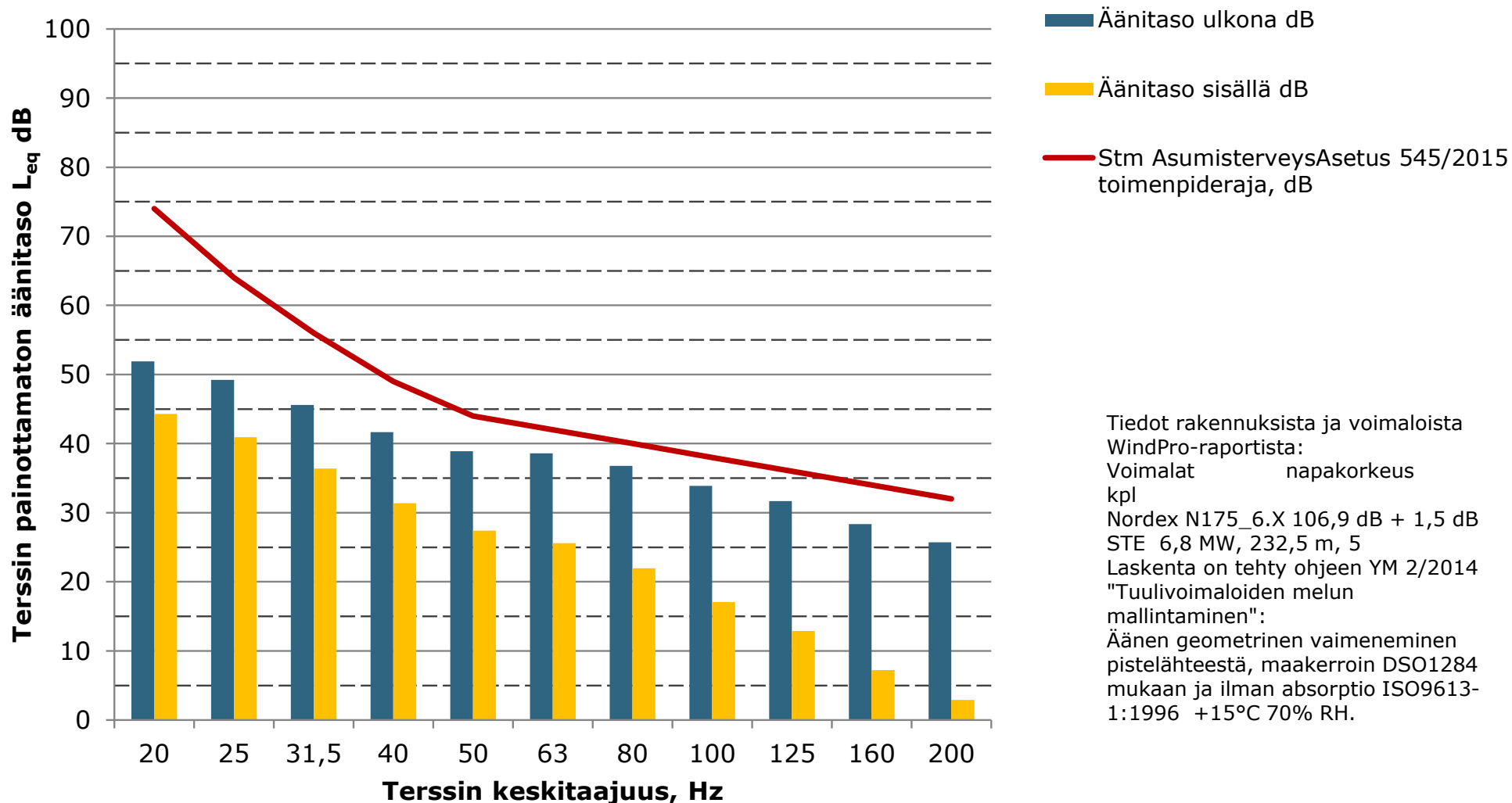
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



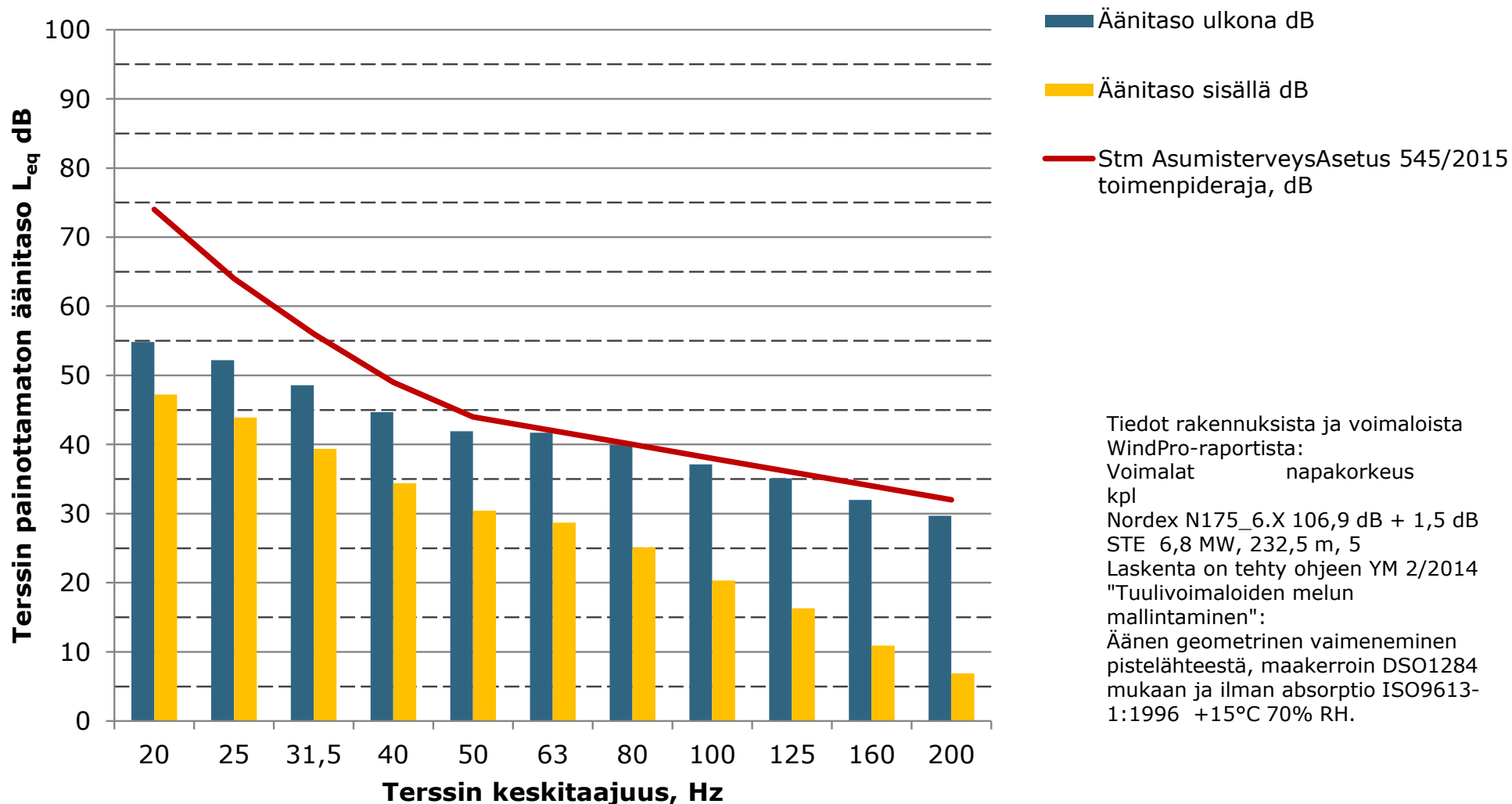
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



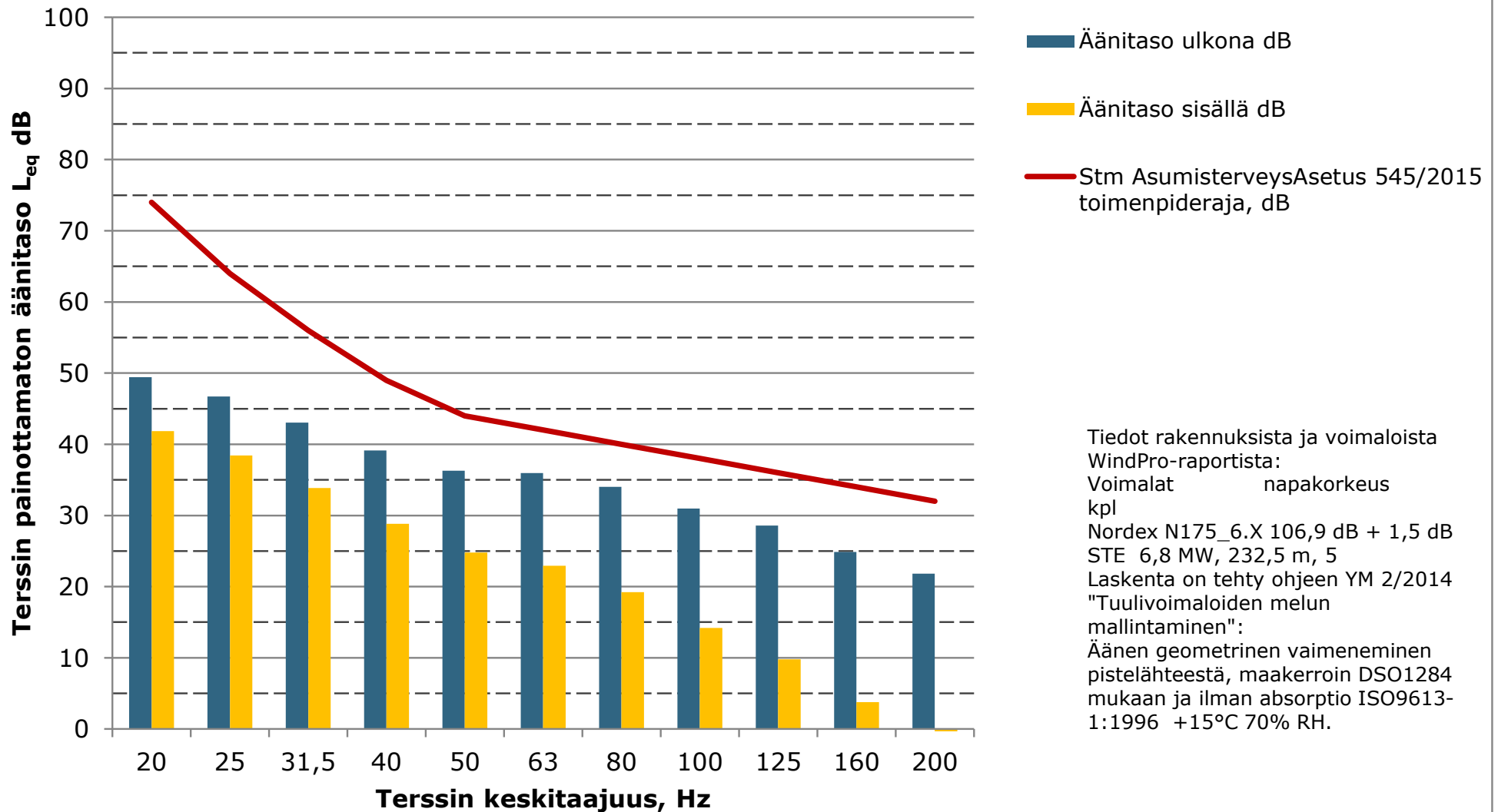
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

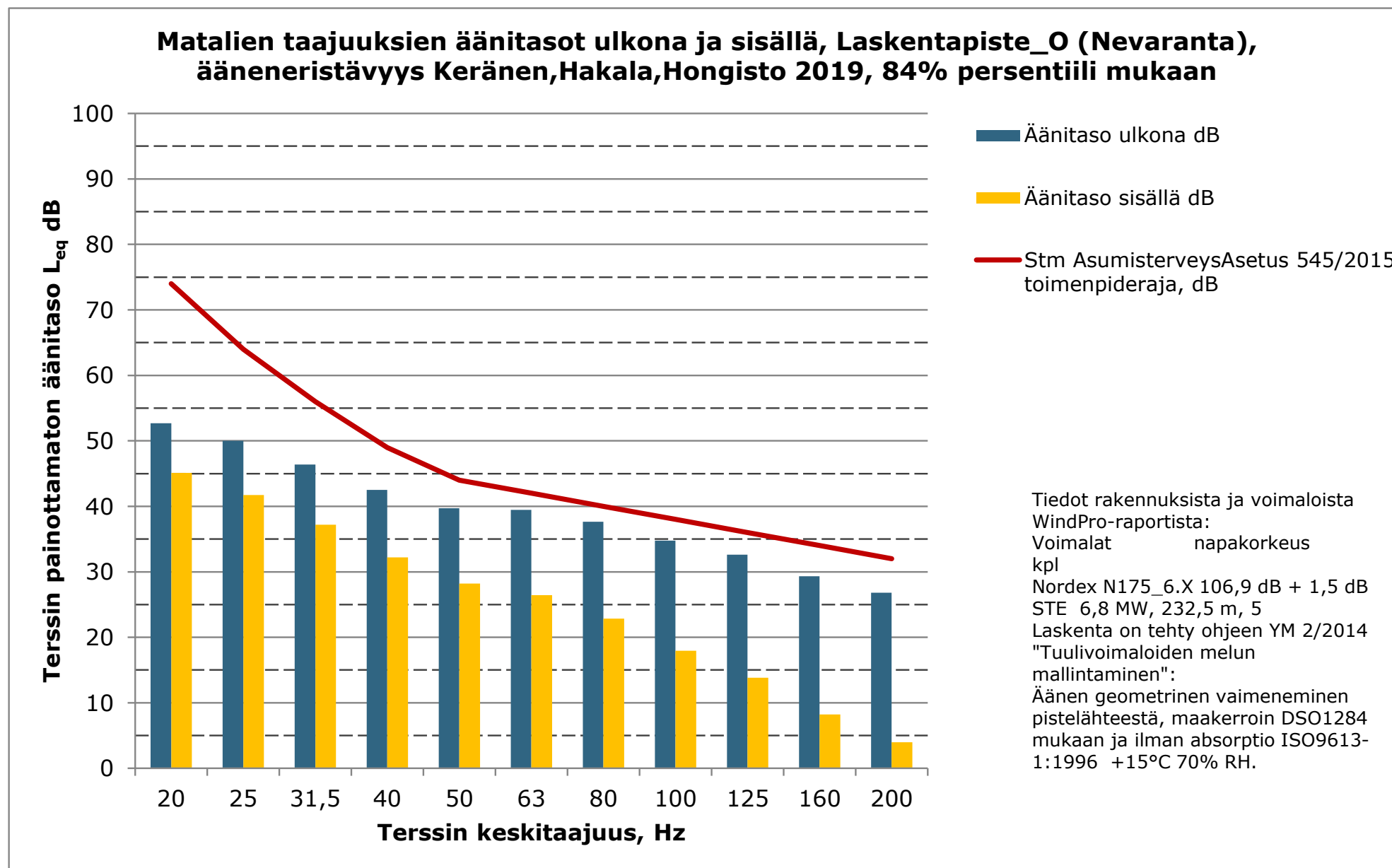


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

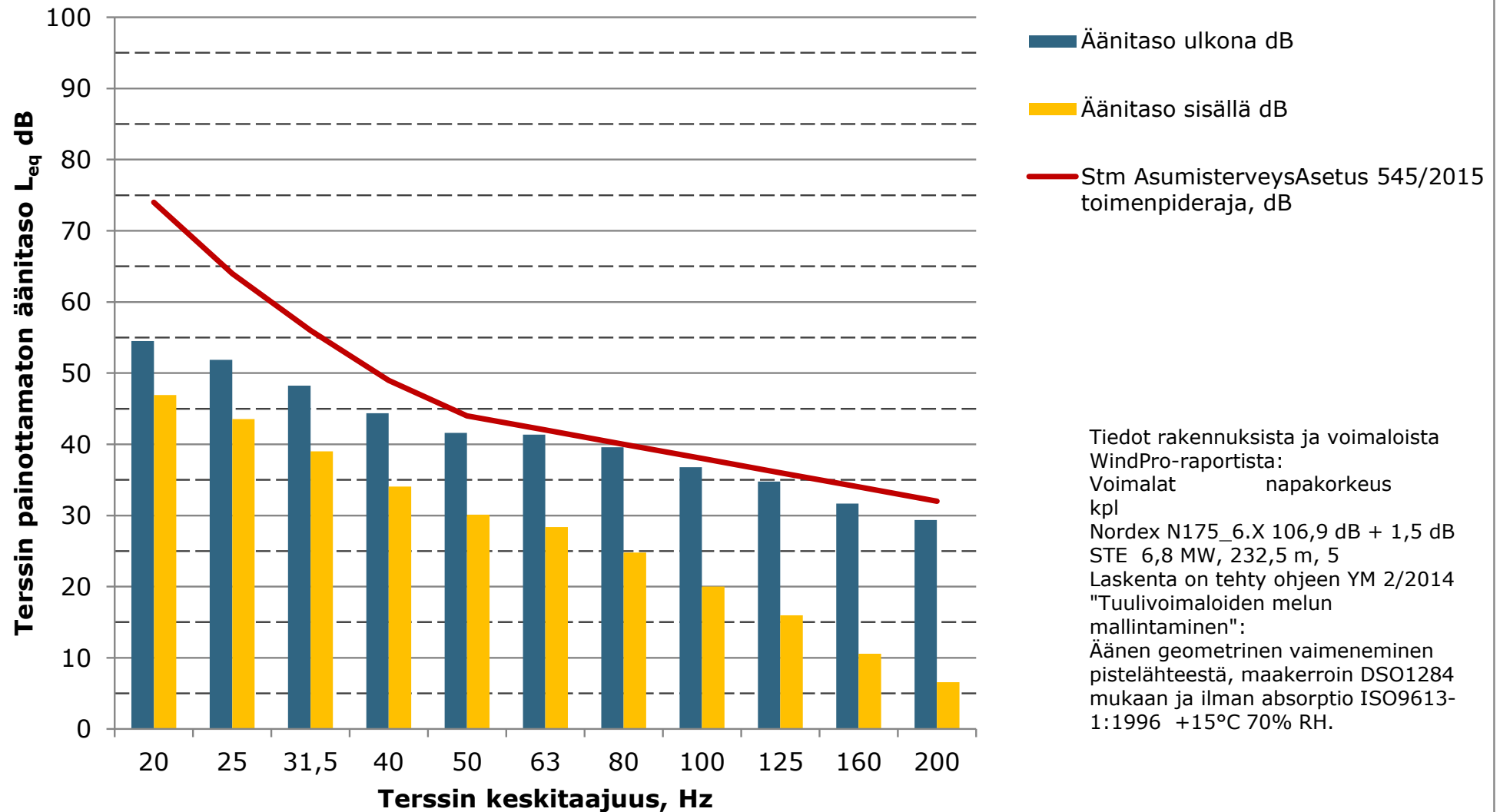


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_N (Mäntylä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

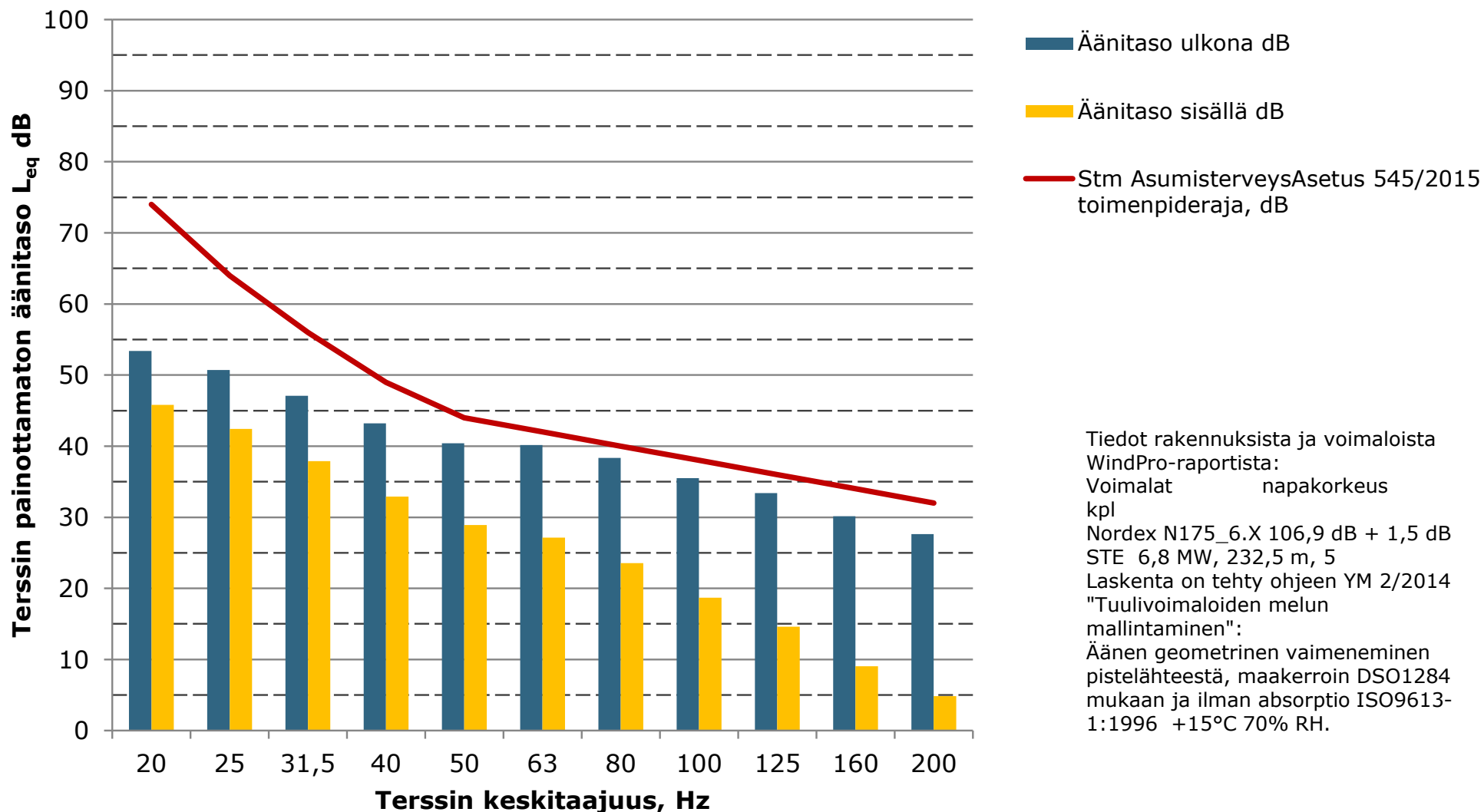




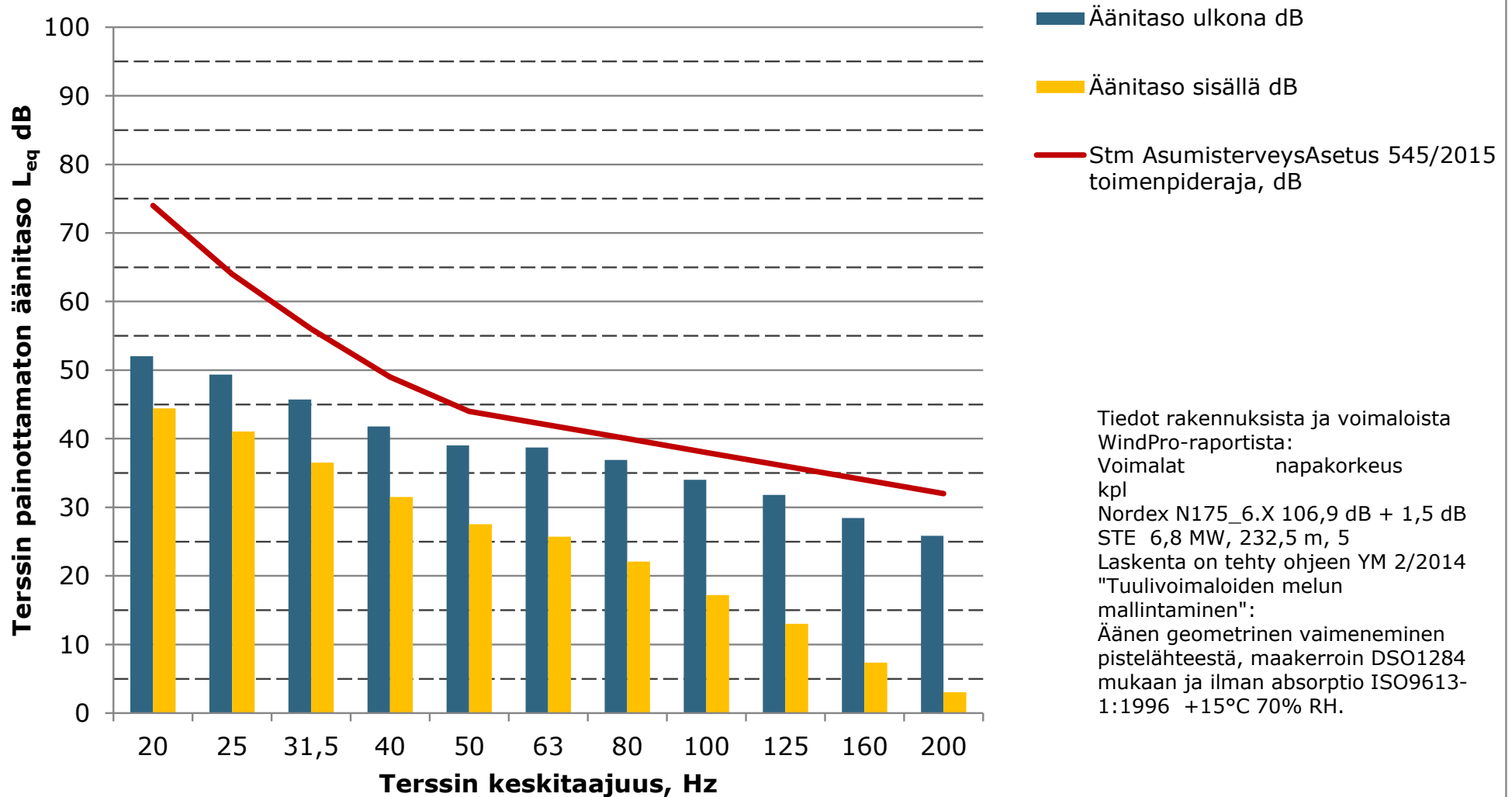
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



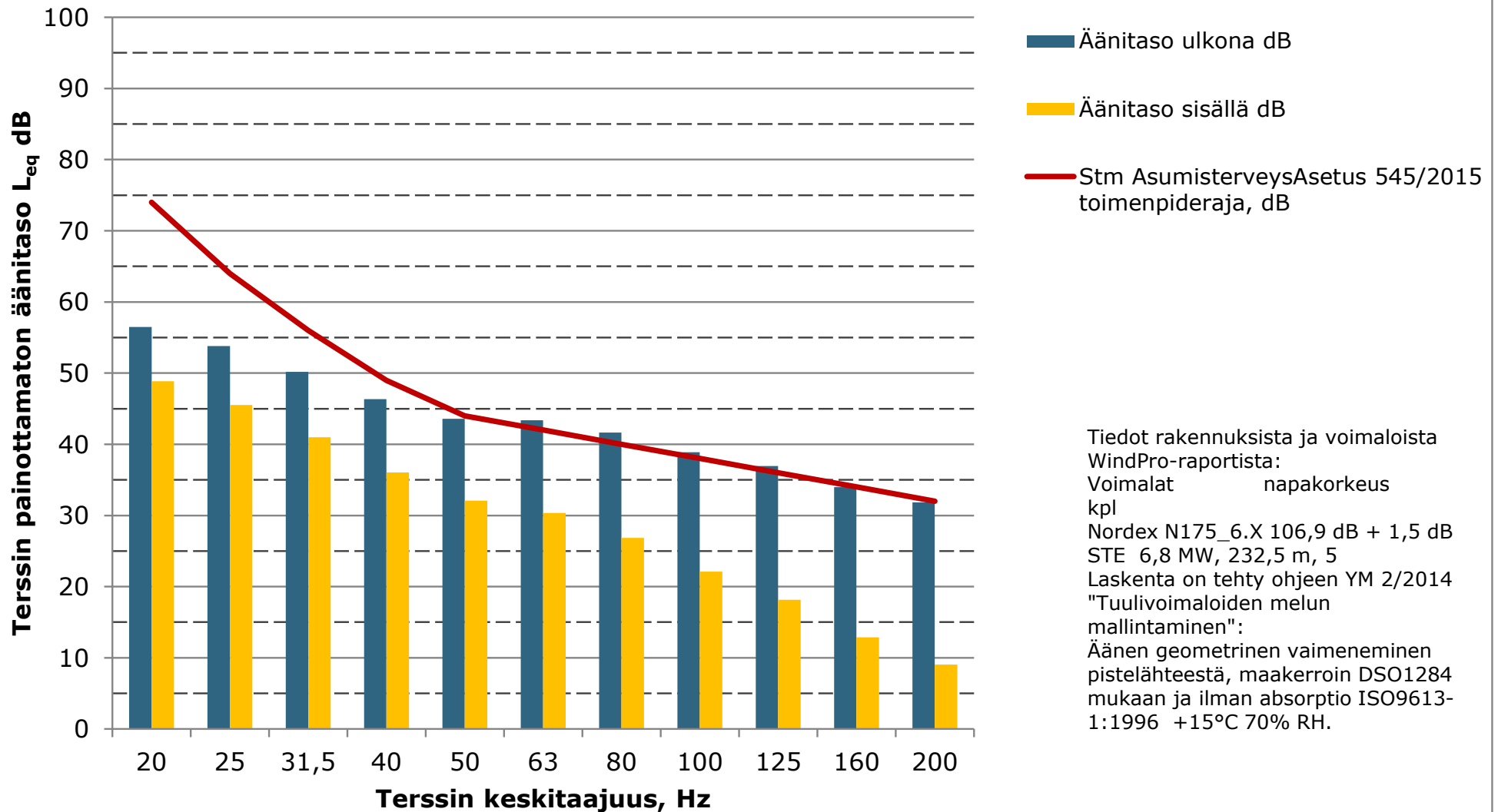
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_P (Niisineva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

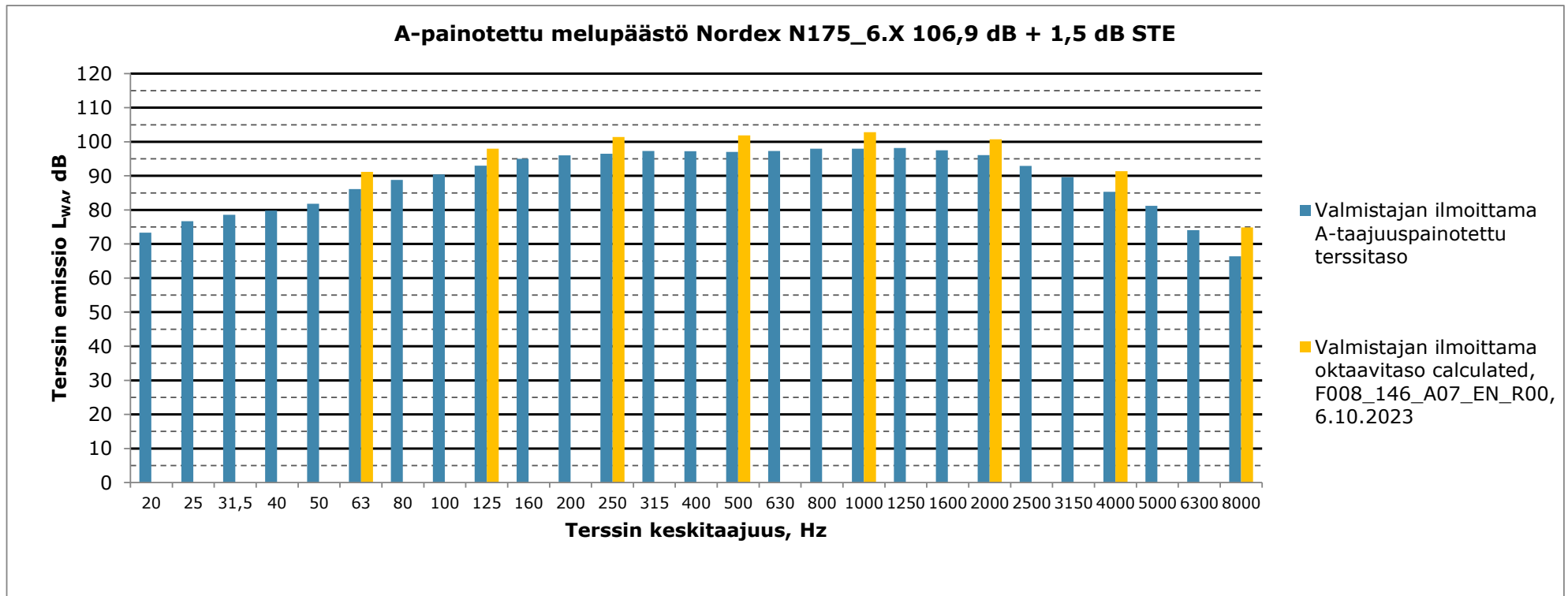


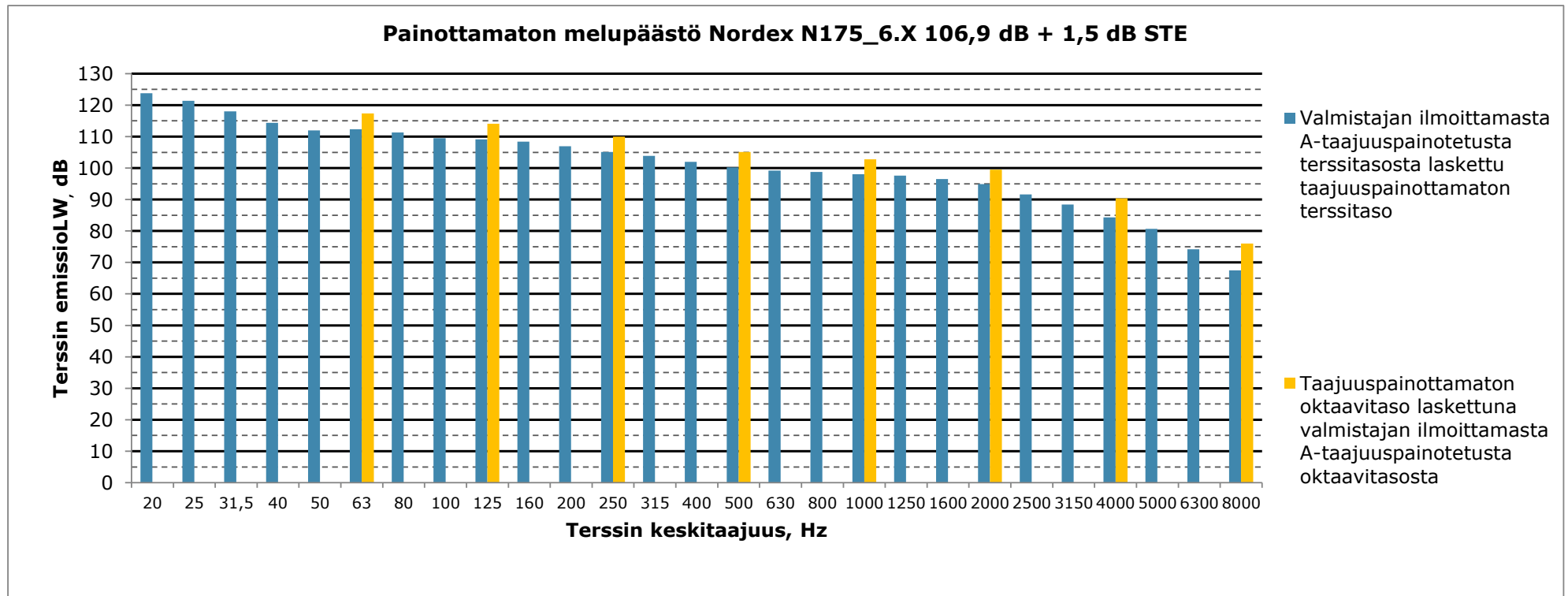
Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan

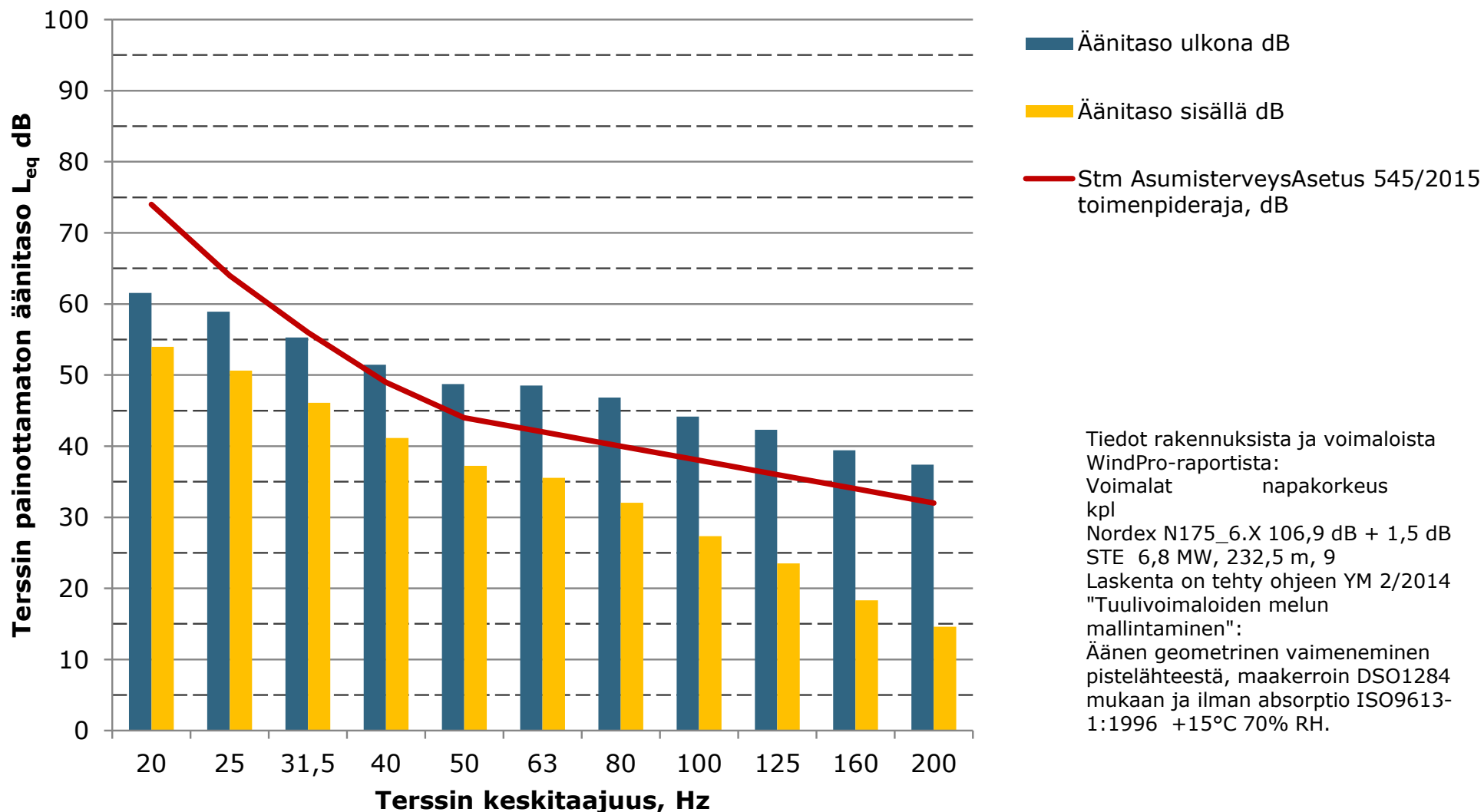


11.10.2023

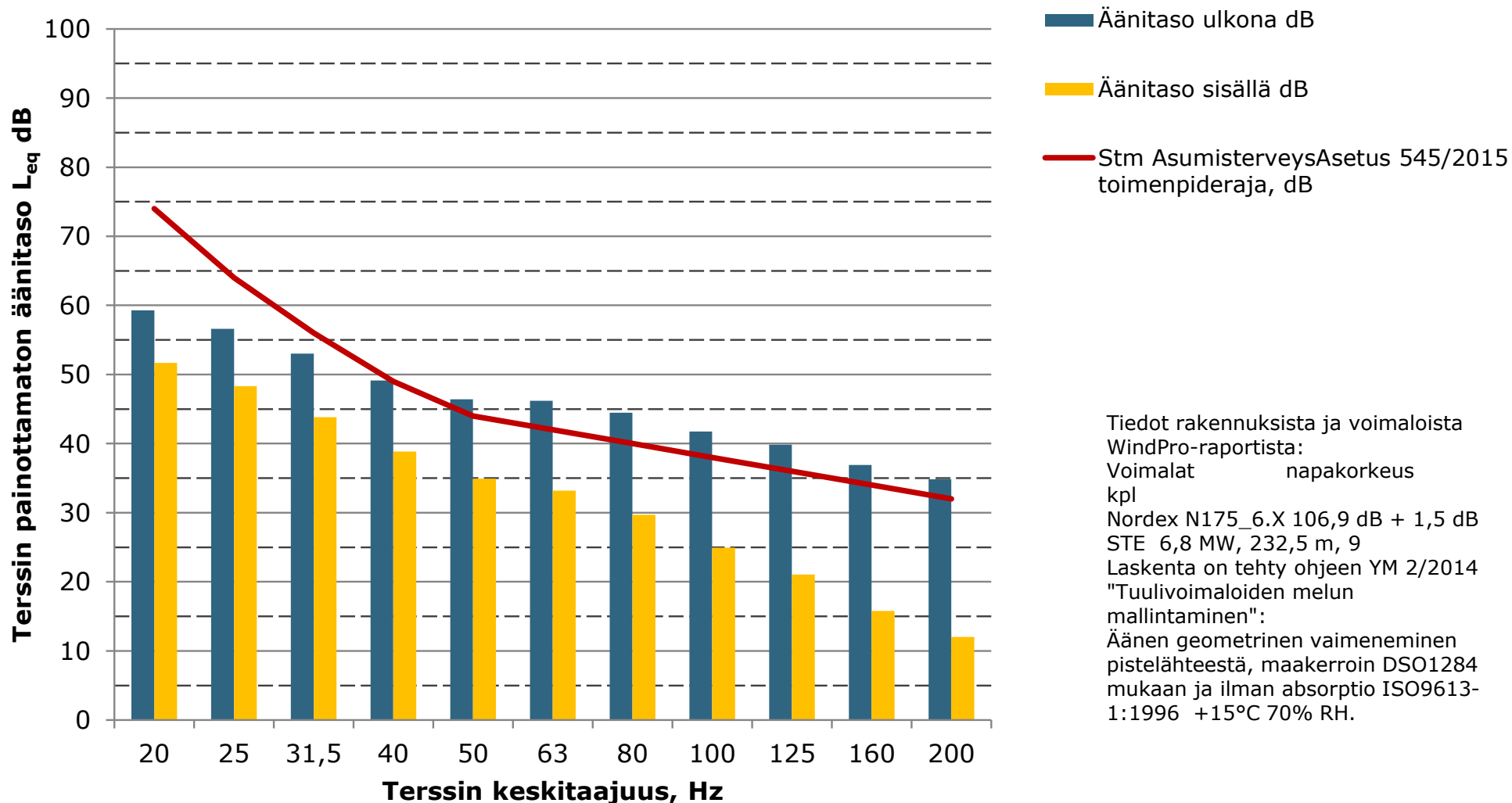
Liite 16. Verkasalon tuulivoimahanke, Ylivieskan alueella olevat voimalat – matalataajuisen melun rakennuskohtaiset arvot VE2 N175 - 6.8 MW.

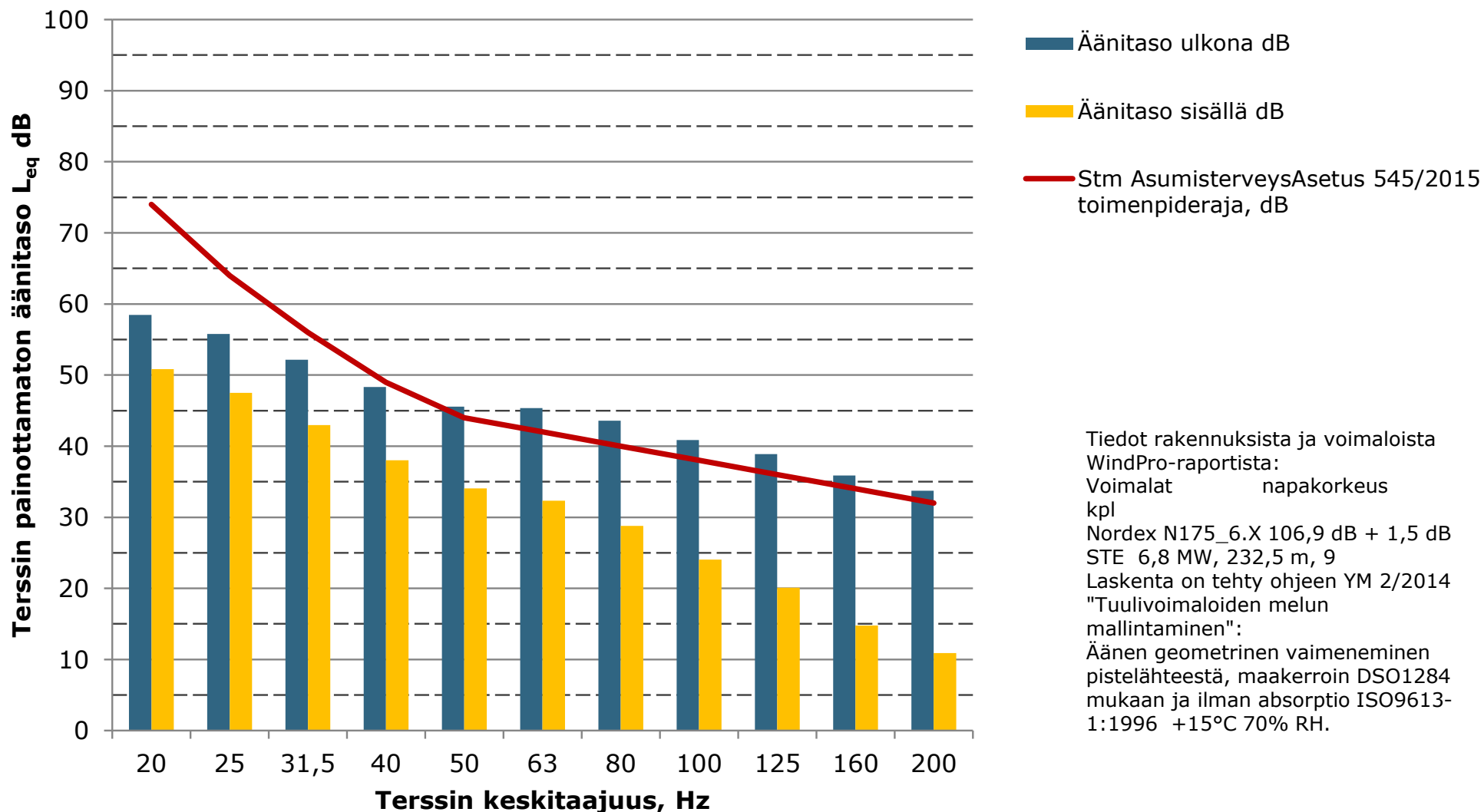


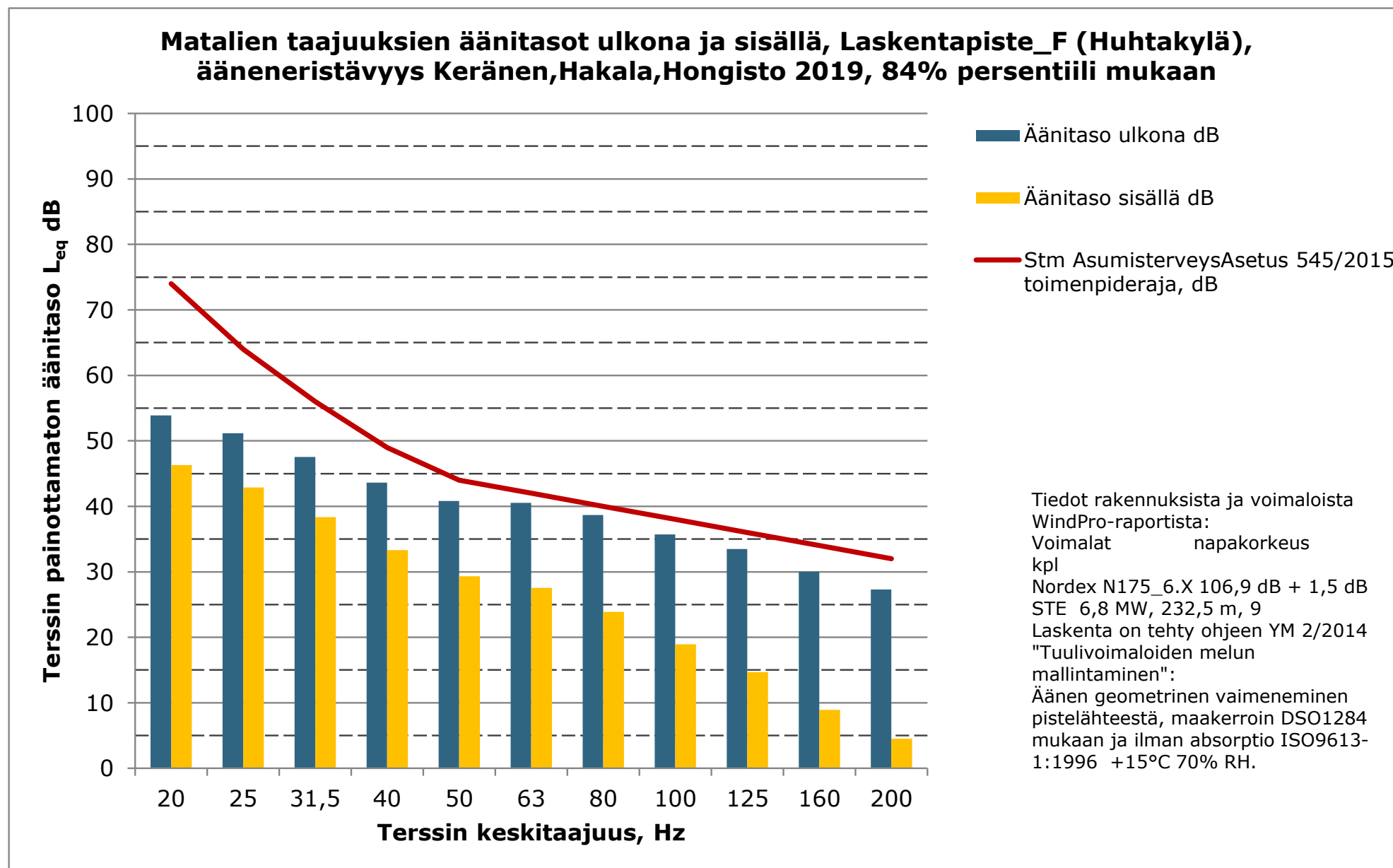


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_A (Oivo),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

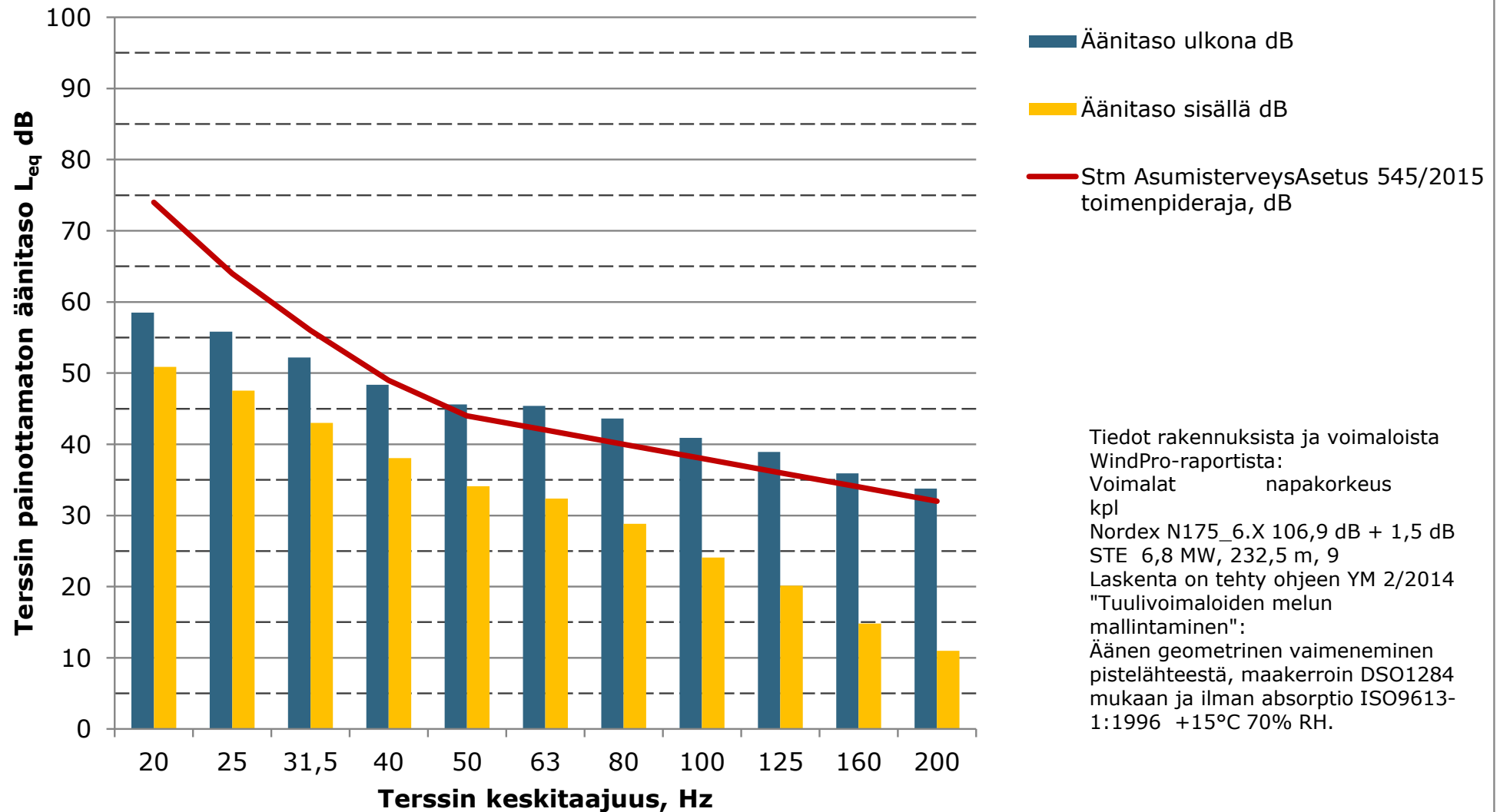
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_B
(Järviojanniittu), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



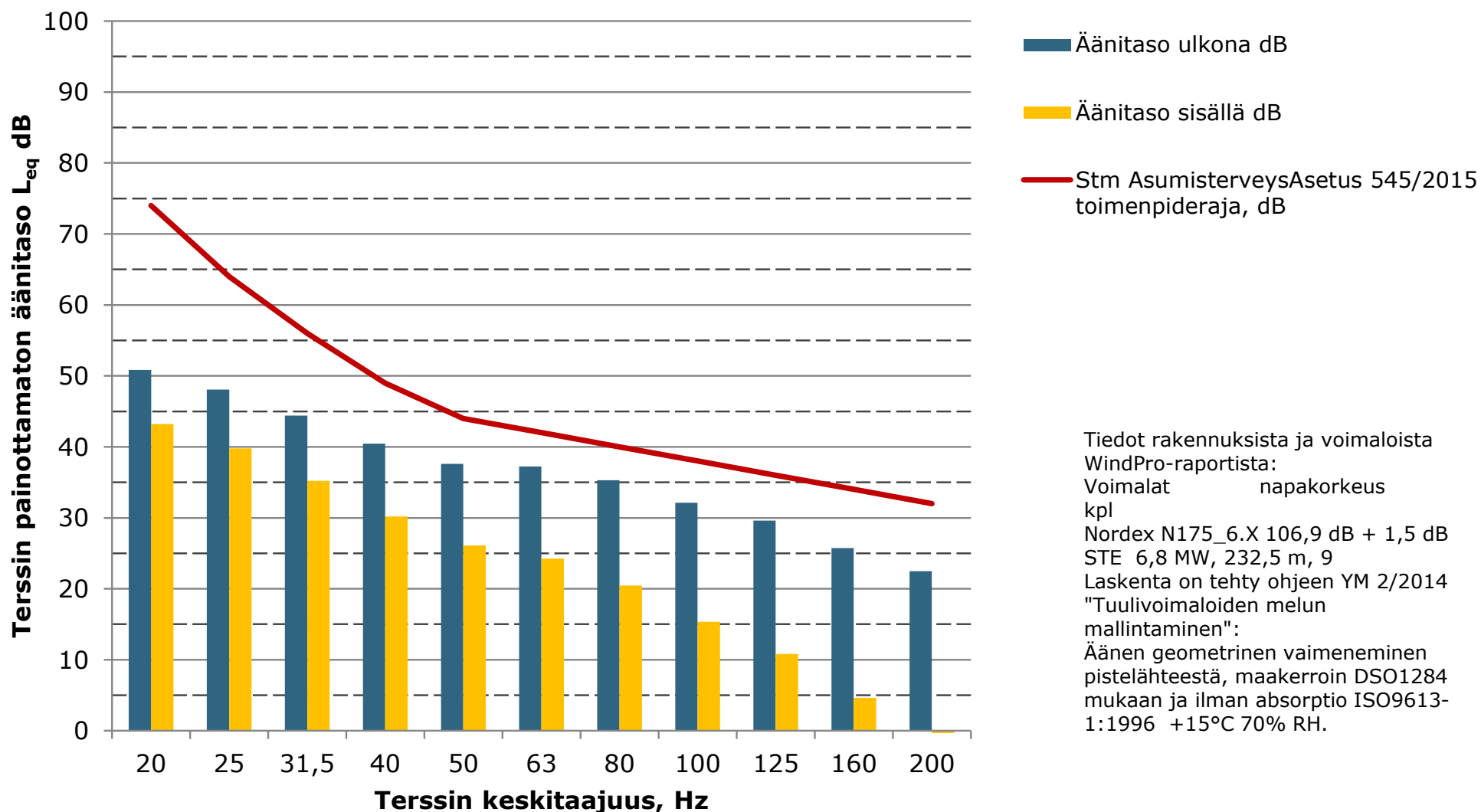
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_C (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



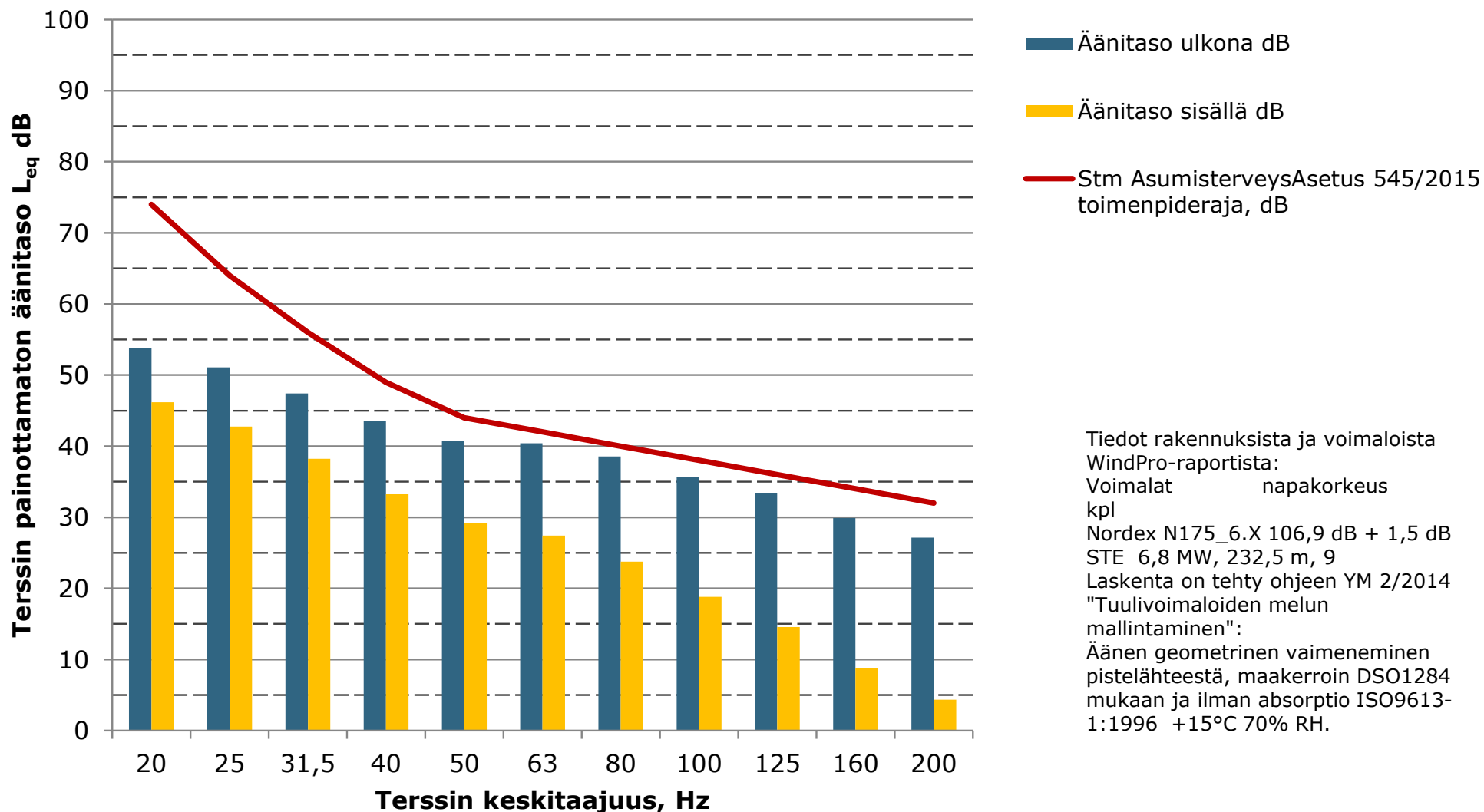
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_D (Sorvari),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



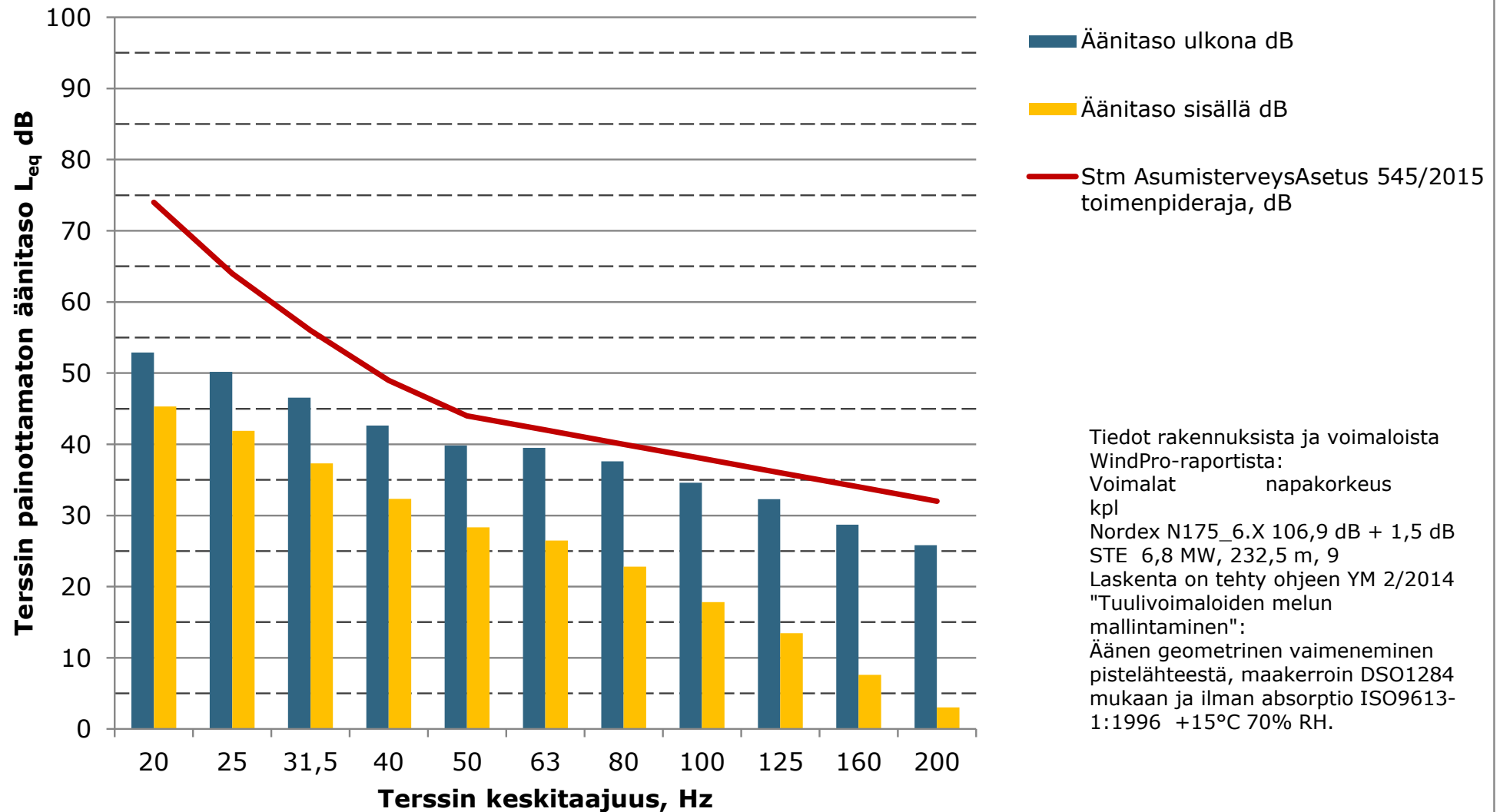
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_J (Pöllä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

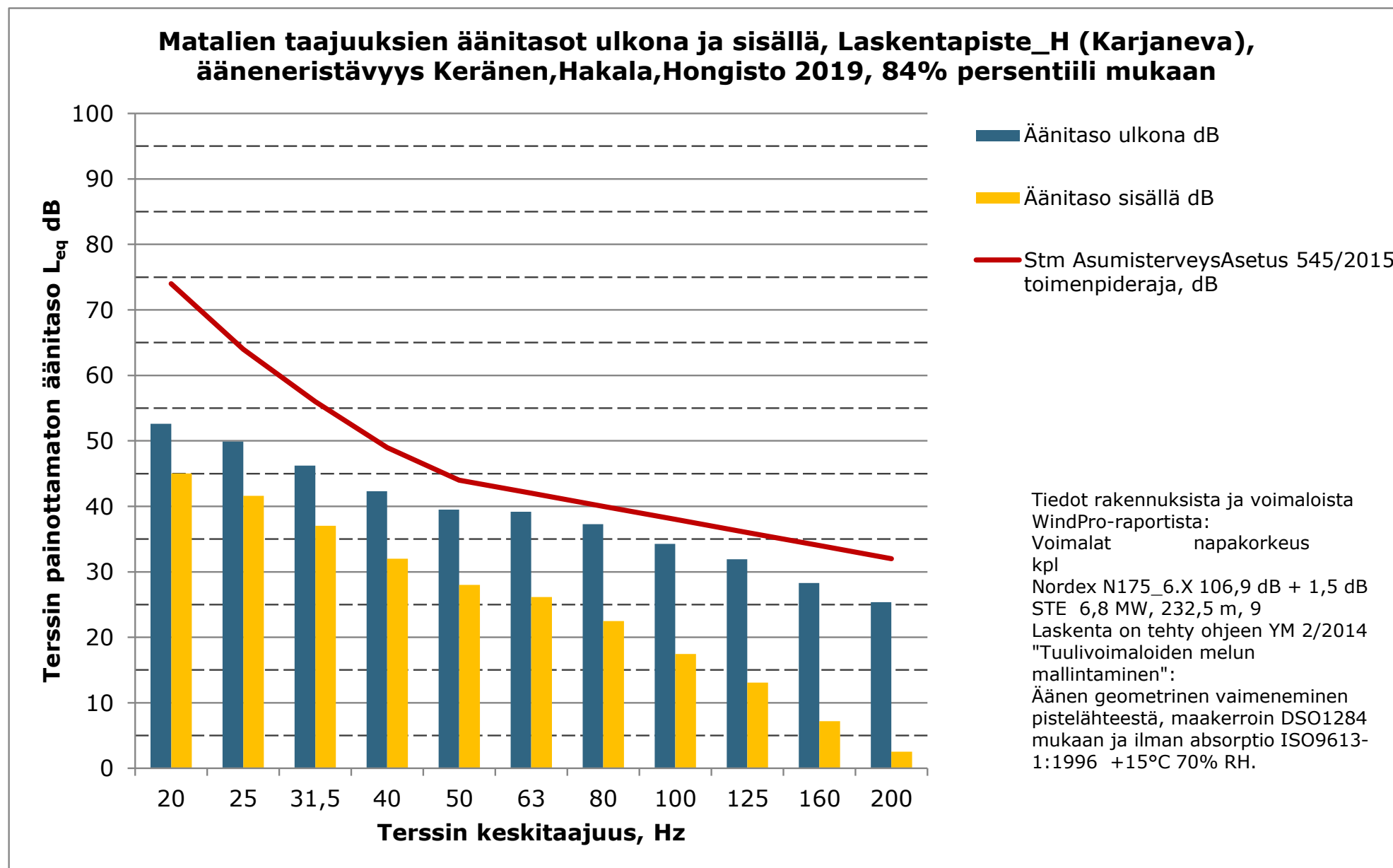


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_E (Huhtakylä),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

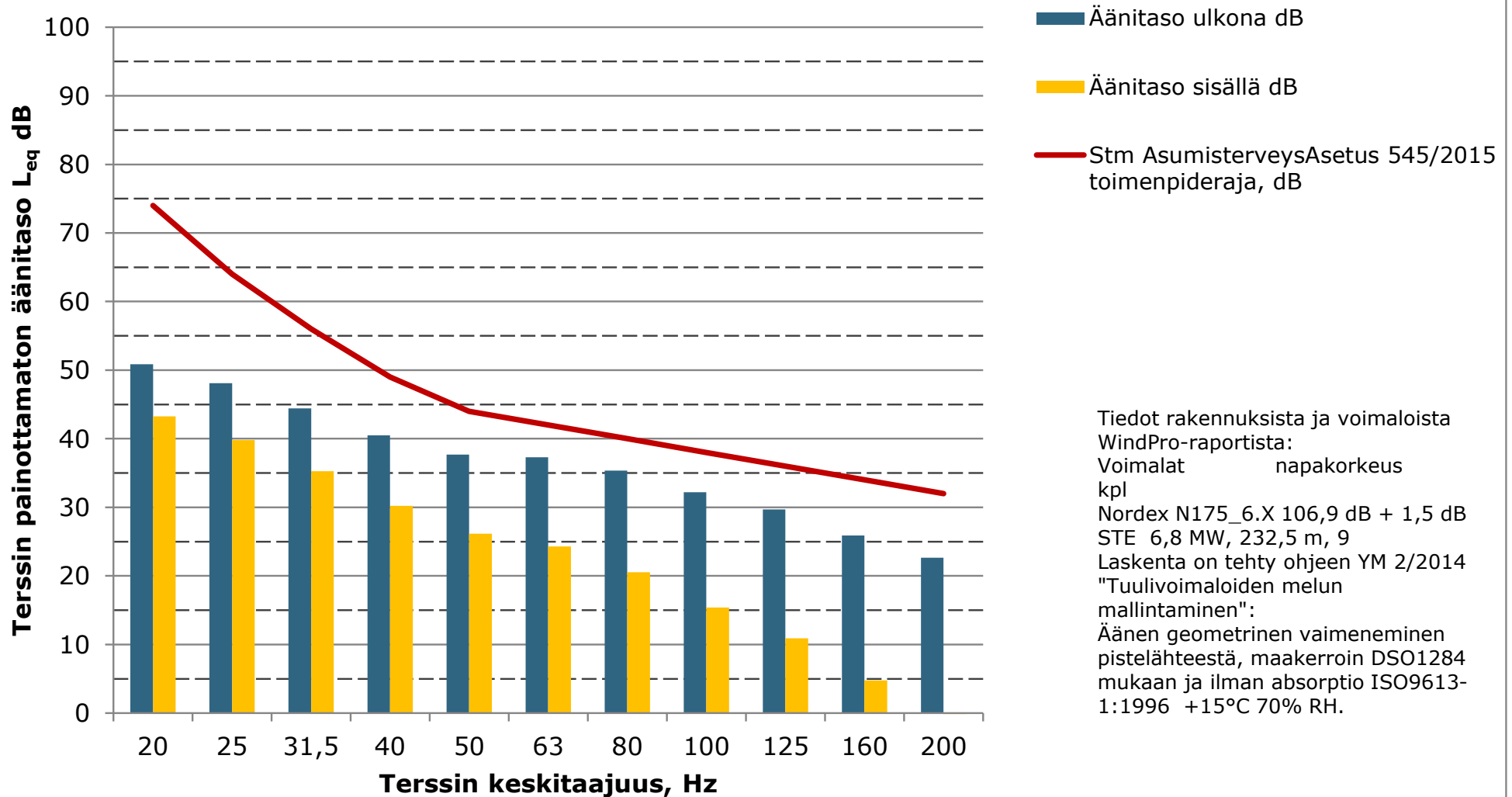


**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_G (Viljamaa),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**

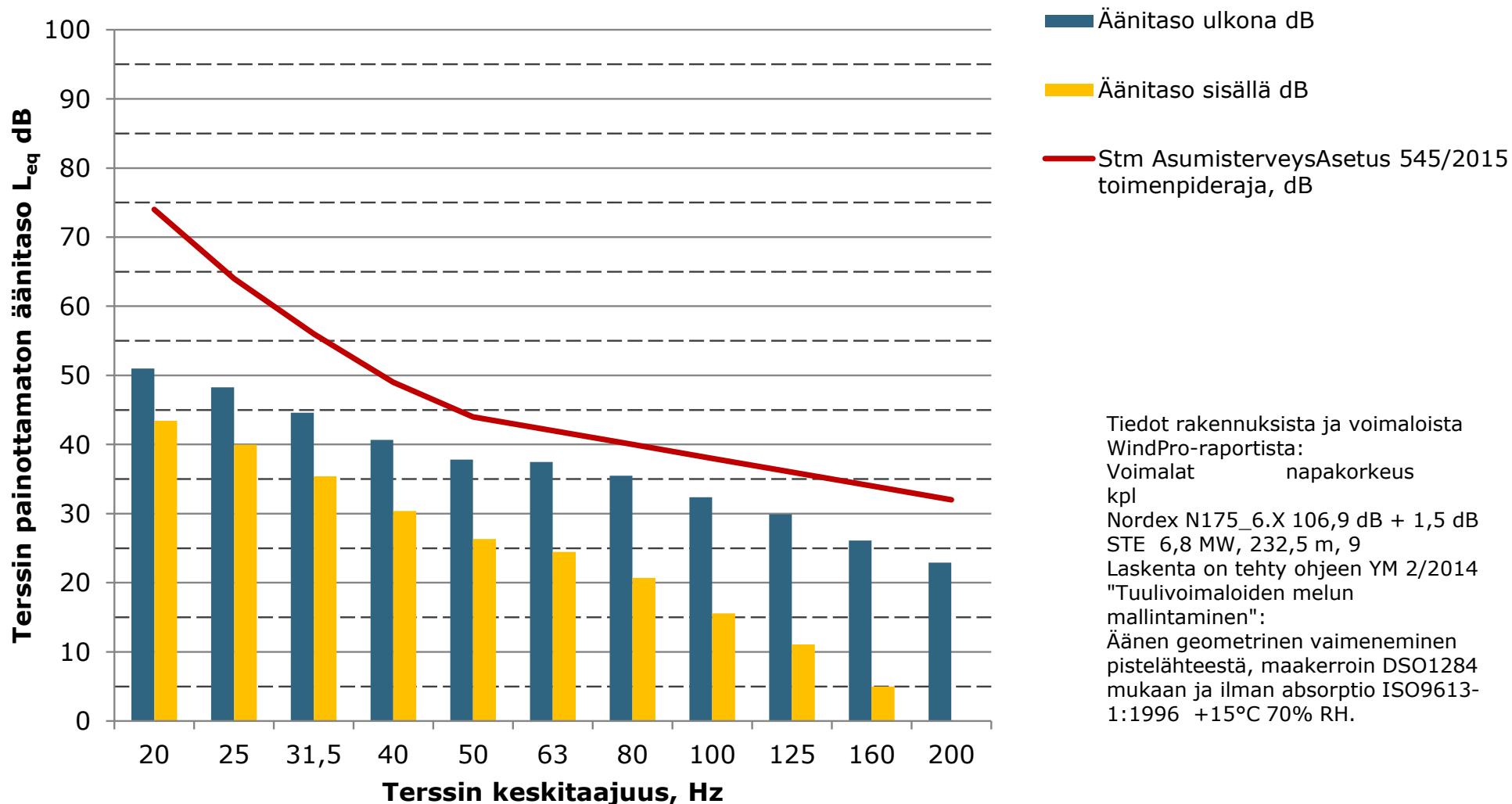




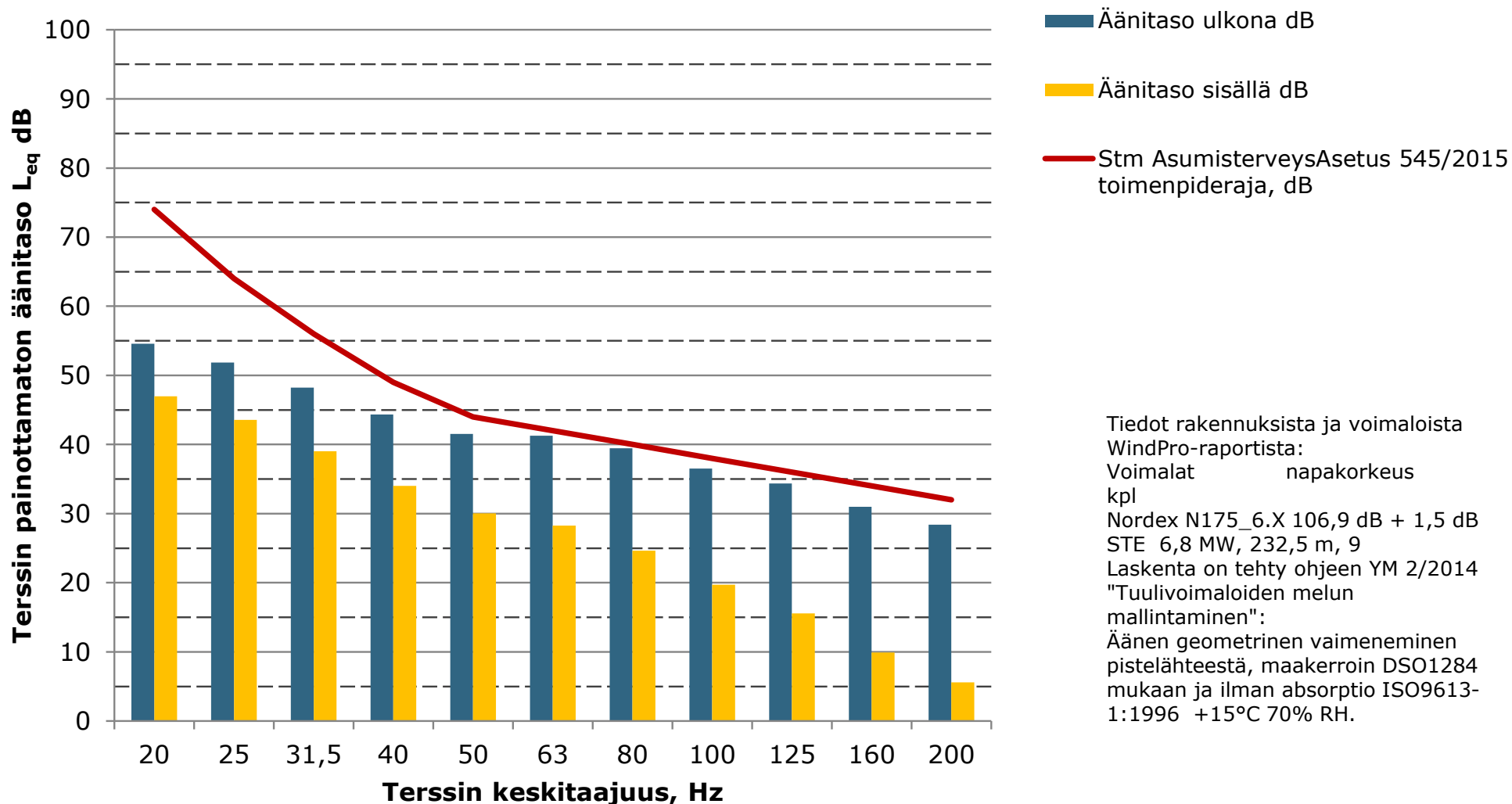
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_K
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**

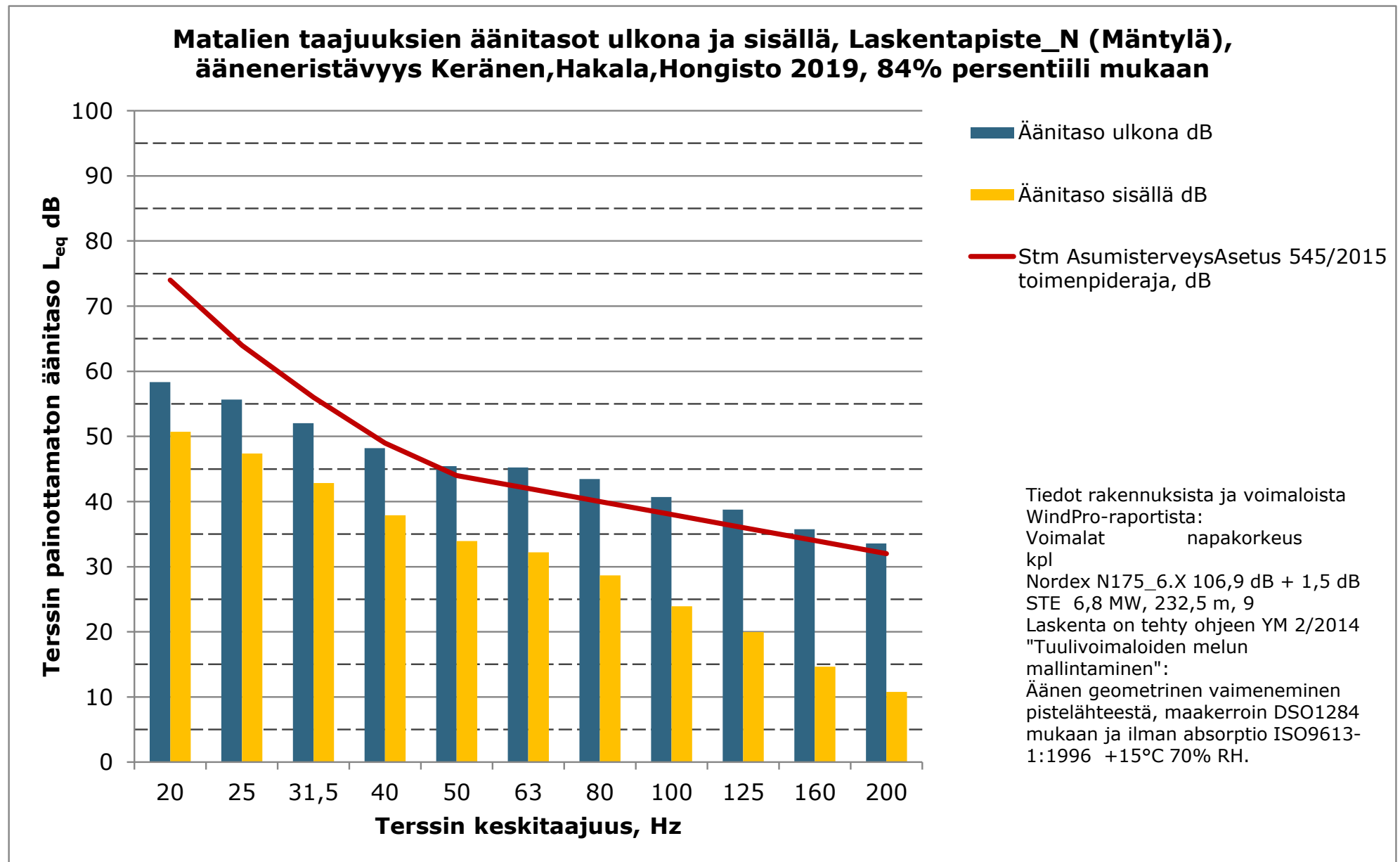


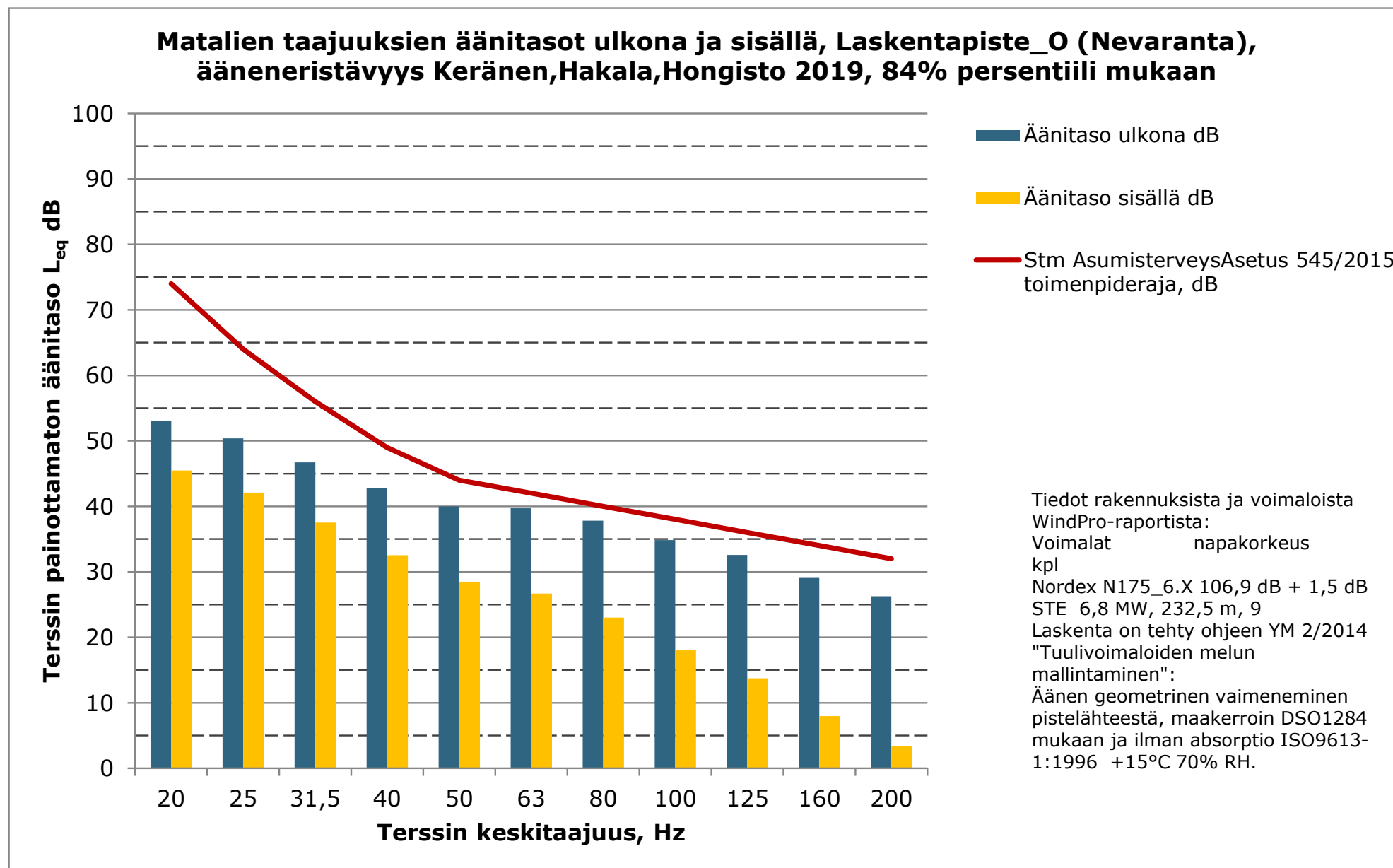
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_L
(Mattilanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



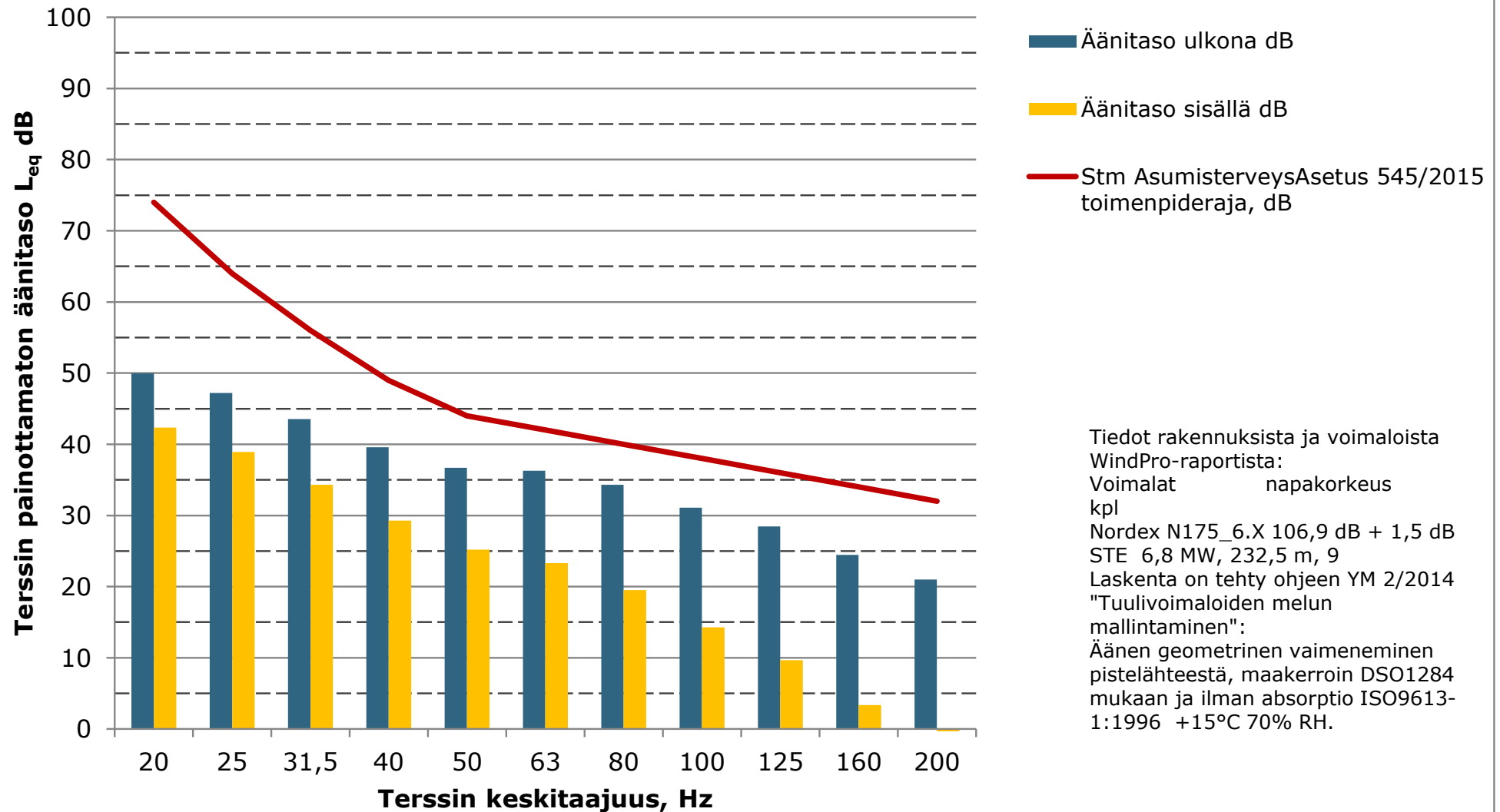
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_M
(Tiennevanperä), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84%
persentiili mukaan**



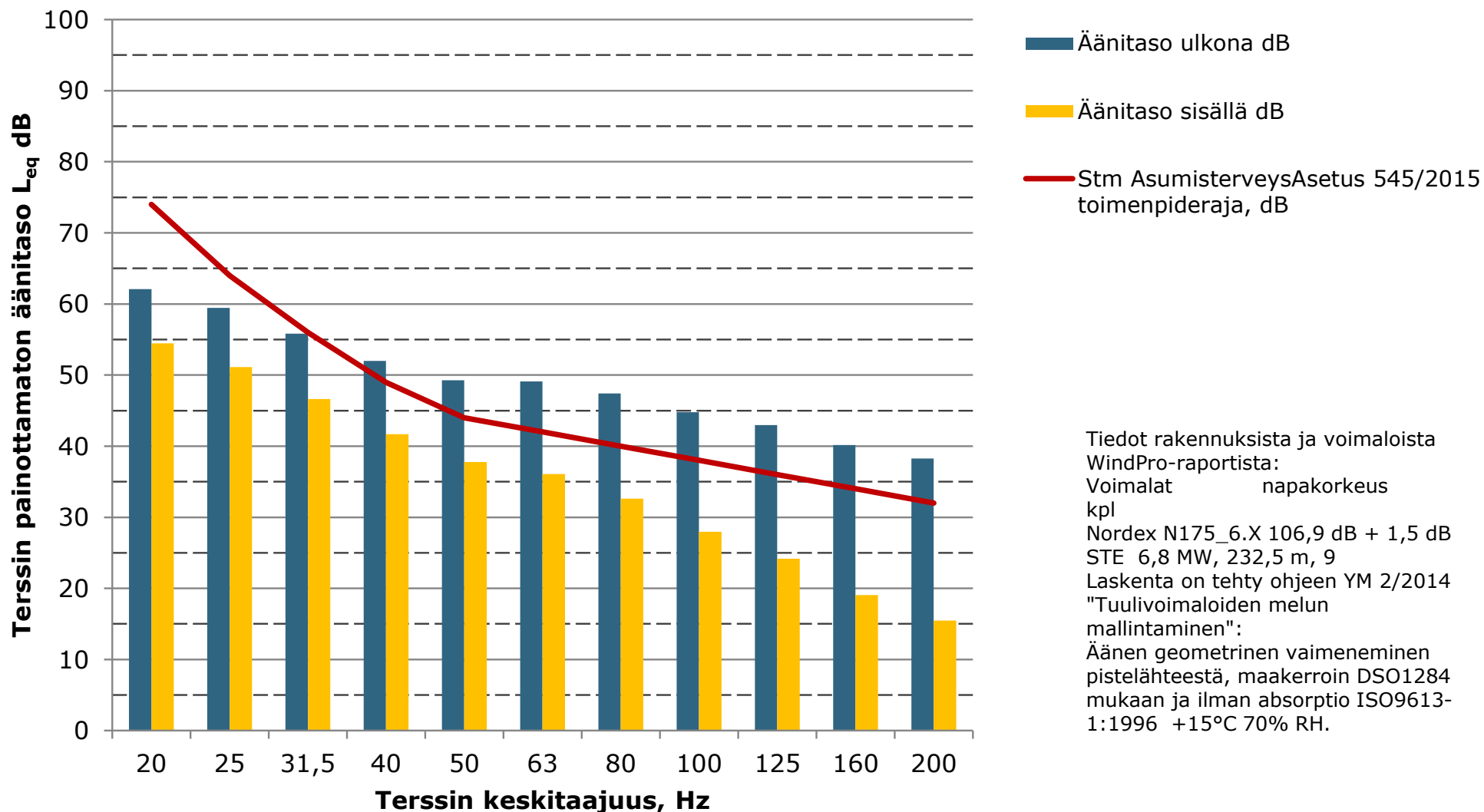




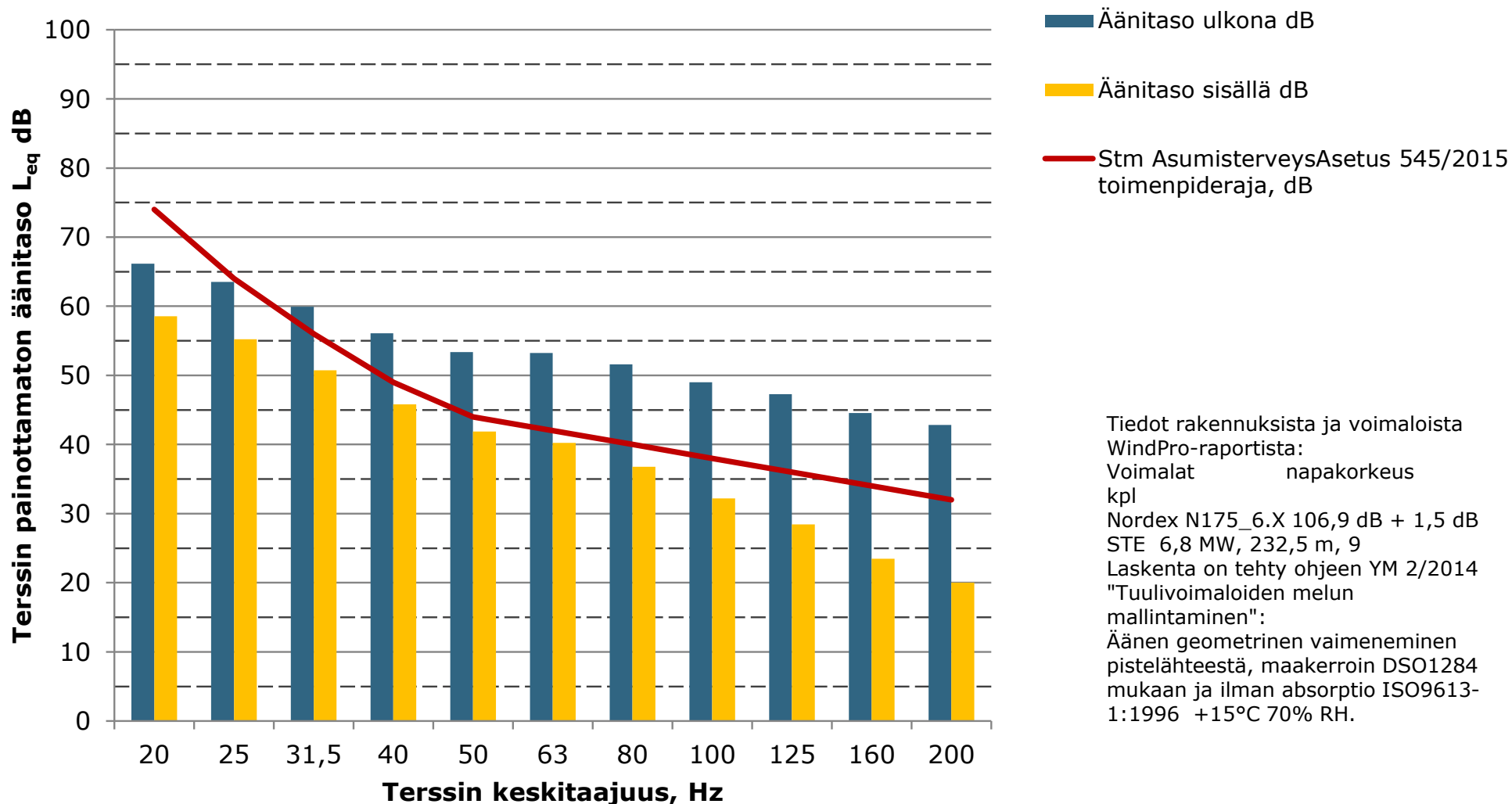
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_I (Rautio),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



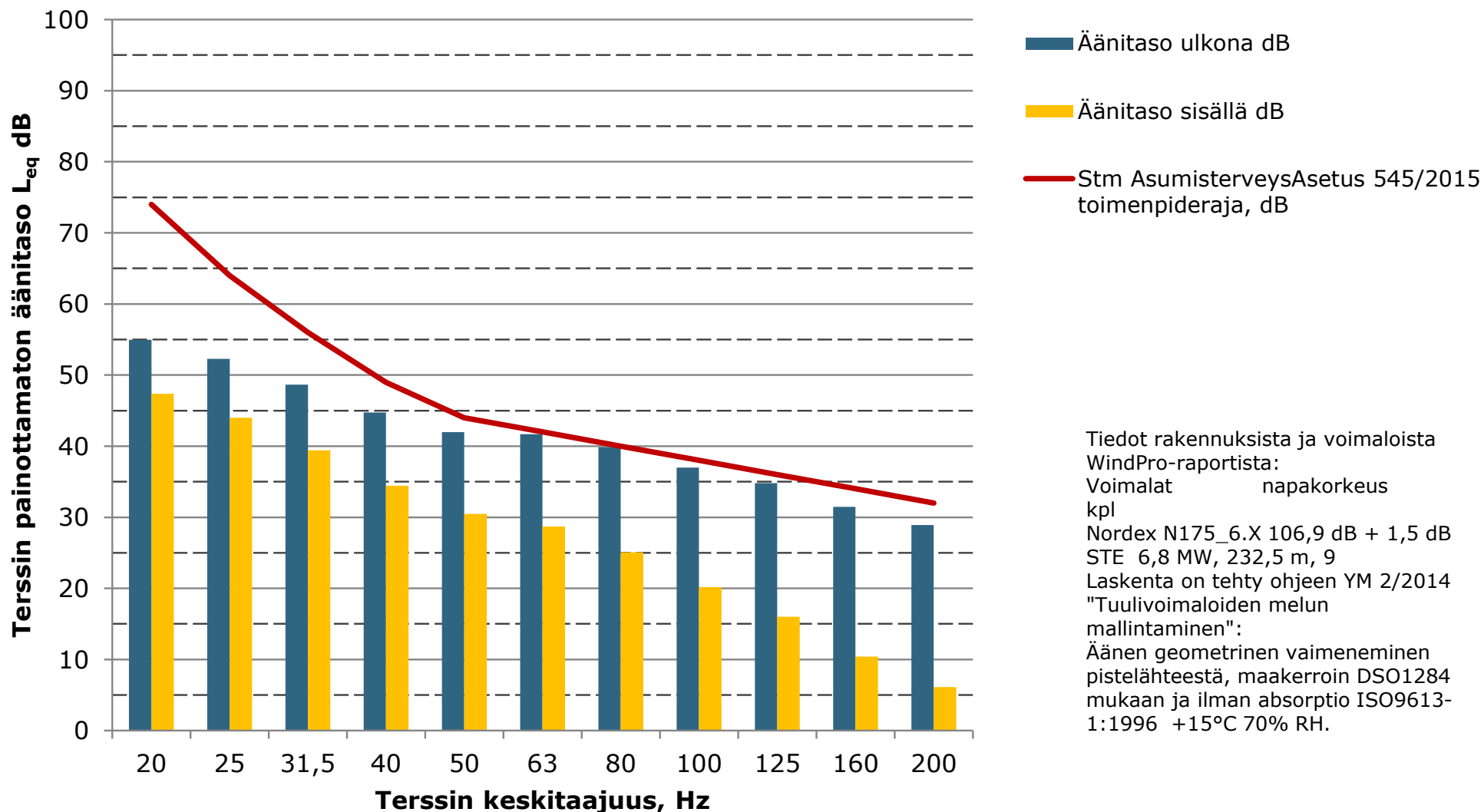
**Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_P (Niisineva),
ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan**



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_Q (Rinkkala-Kähtävä metsätie), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



Matalien taajuuksien äänitasot ulkona ja sisällä, Laskentapiste_R (Huhtala), ääneneristävyys Keränen,Hakala,Hongisto 2019, 84% persentiili mukaan



11.10.2023

Liite 17. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, no forest” (VE1).

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

19.9.2023 12.20/3.6.355

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_20230626_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

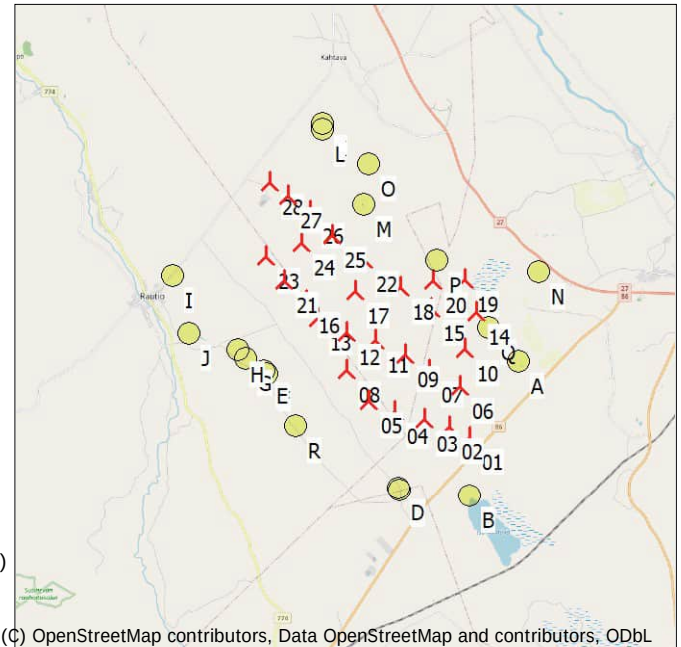
Idle start wind speed: Cut in wind speed from power curve

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

Scale 1:200 000

New WTG

Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 485	7 105 301	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	368 920	7 106 101	71,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	370 503	7 106 453	74,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	369 736	7 106 883	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	368 953	7 107 128	72,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	367 939	7 108 000	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	367 367	7 108 547	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	366 924	7 109 225	67,2	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	367 862	7 109 559	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_20230626_real case_no forest

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	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	12:03
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	5:50
D	Laskentapiste_D (Sorvari)	6:16
E	Laskentapiste_E (Huhtakylä)	9:11
F	Laskentapiste_F (Huhtakylä)	8:15
G	Laskentapiste_G (Viljamaa)	8:49
H	Laskentapiste_H (Karjaneva)	6:26
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	17:51
N	Laskentapiste_N (Mäntylä)	3:26
O	Laskentapiste_O (Nevaranta)	4:06
P	Laskentapiste_P (Niisineva)	45:44
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	25:04
R	Laskentapiste_R (Huhtala)	6:17

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

No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (423)	5:57
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (443)	3:05
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (445)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (436)	0:00
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (427)	2:39
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (429)	4:15
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (449)	2:54
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (432)	6:06
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (442)	1:09
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (435)	13:58
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (448)	0:00
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (424)	3:24
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (437)	11:50
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (440)	6:21
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (438)	8:09

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_20230626_real case_no forest

...continued from previous page

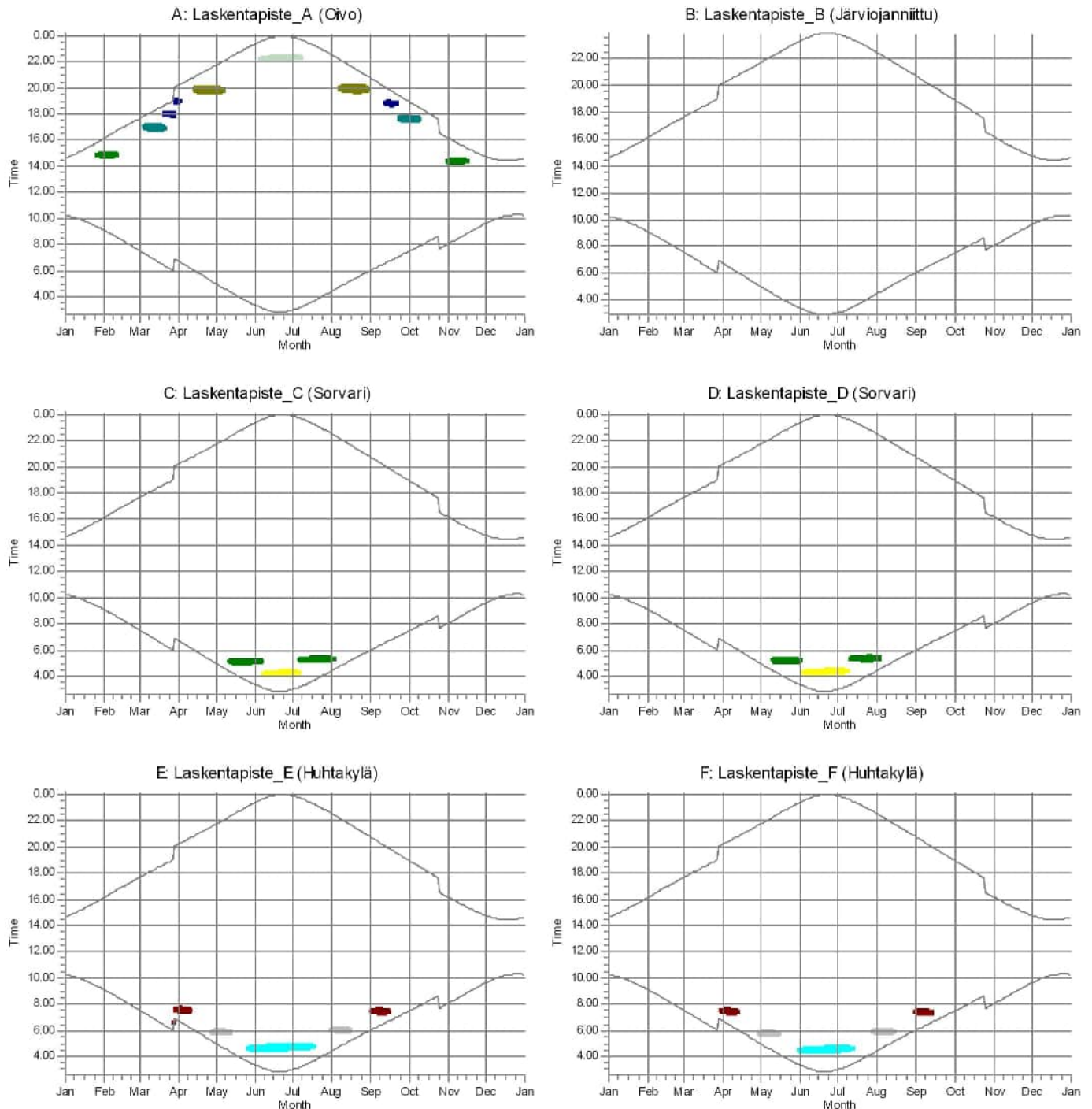
No.	Name	Expected [h/year]
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (428)	10:00
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (450)	2:25
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (431)	5:32
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (433)	10:46
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (441)	29:43
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (434)	0:00
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (426)	5:15
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (425)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (447)	1:39
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (430)	5:52
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (446)	6:44
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (444)	5:25
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (439)	2:21

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: Verkasalo_VE1_RD200x28xHH220_Valke_20230626_real case_no forest

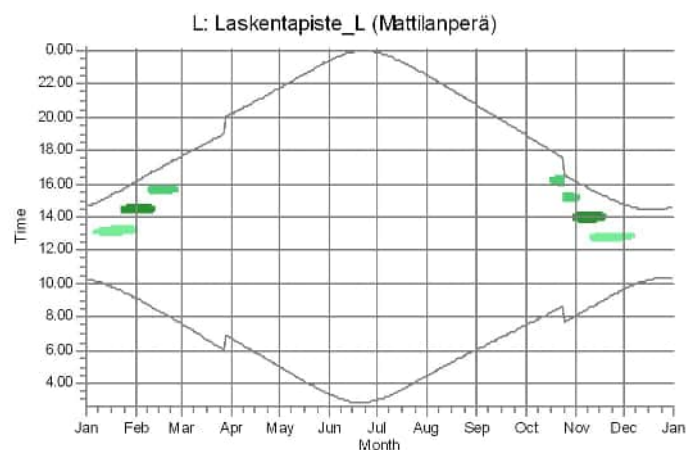
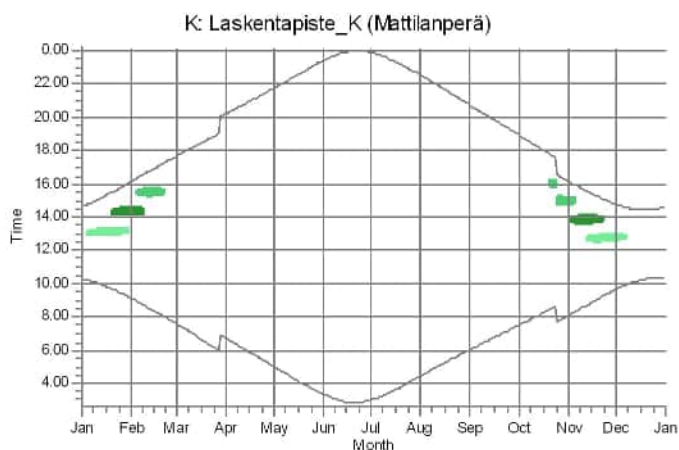
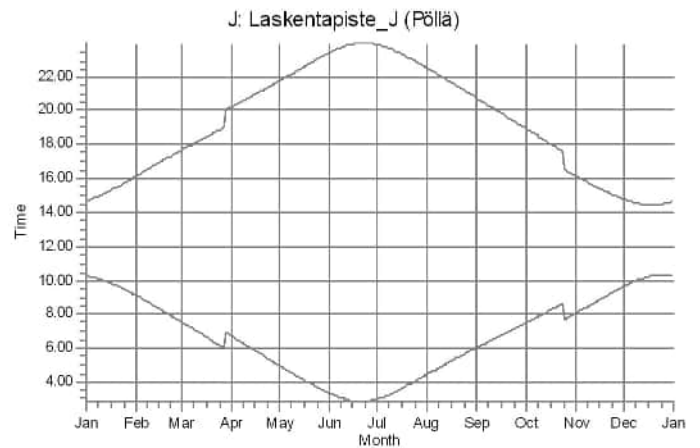
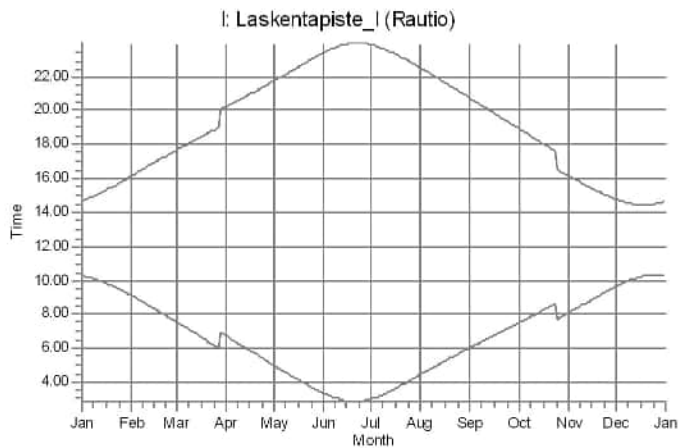
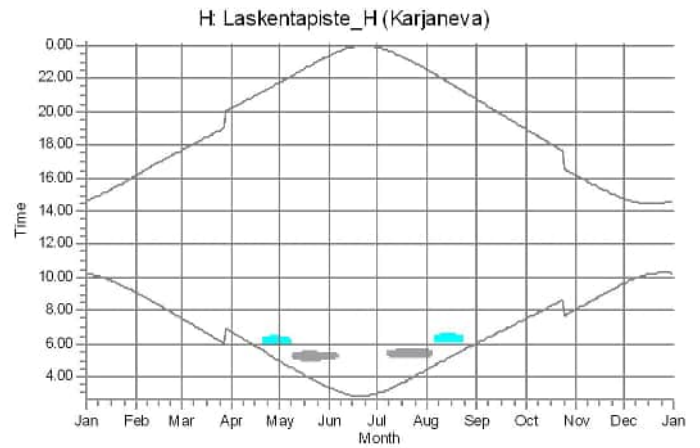
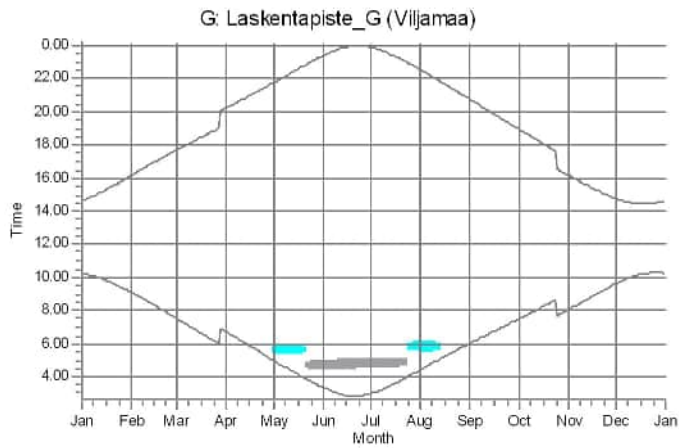


WTGs

01: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (423)	07: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (449)	12: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (424)
02: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (443)	08: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (432)	13: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (437)
06: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (429)	10: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (435)	14: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (440)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_20230626_real case_no forest



WTGs

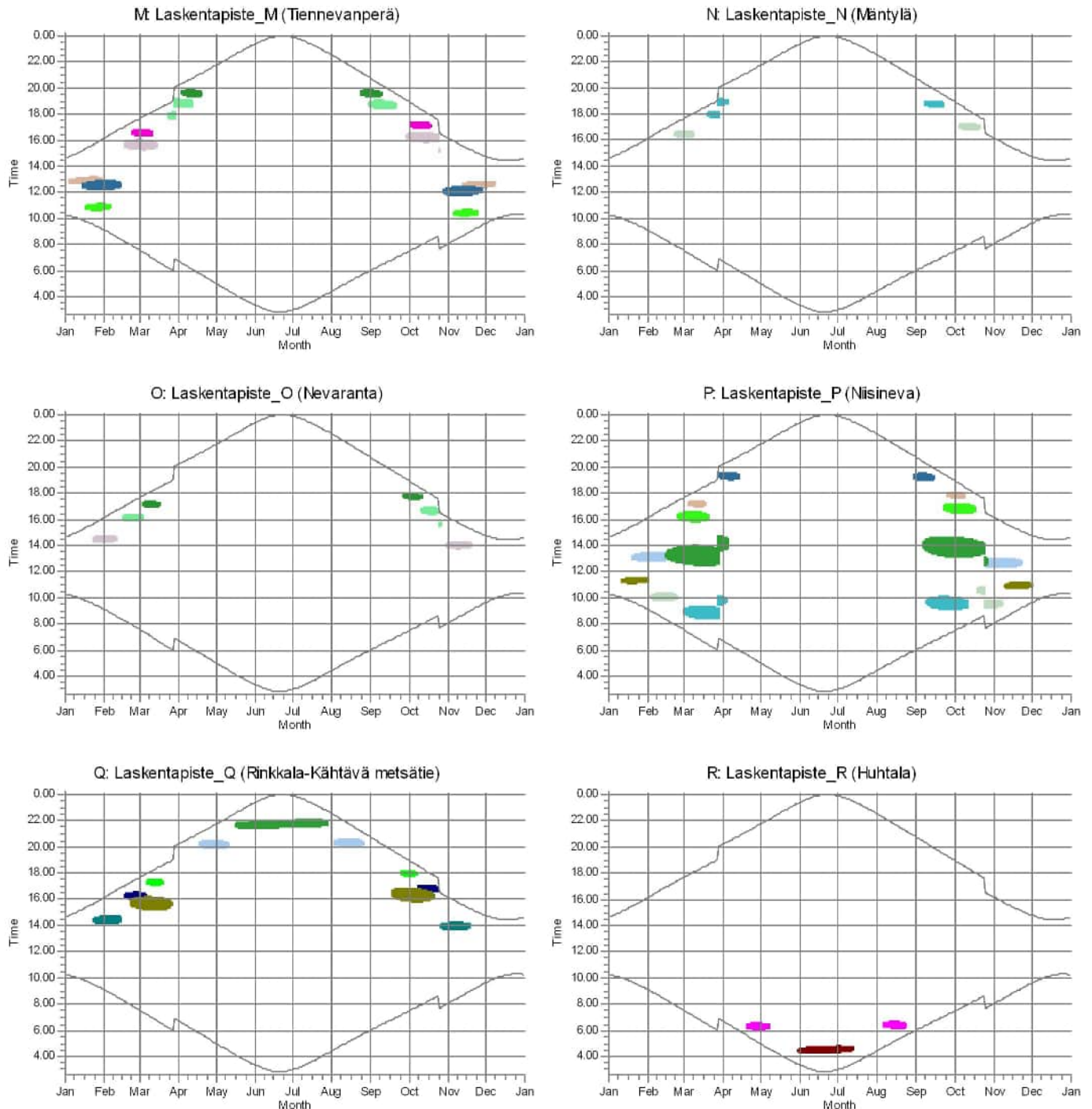
13: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (437)
 16: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (428)

26: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (446)
 27: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (444)

28: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (439)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_20230626_real case_no forest

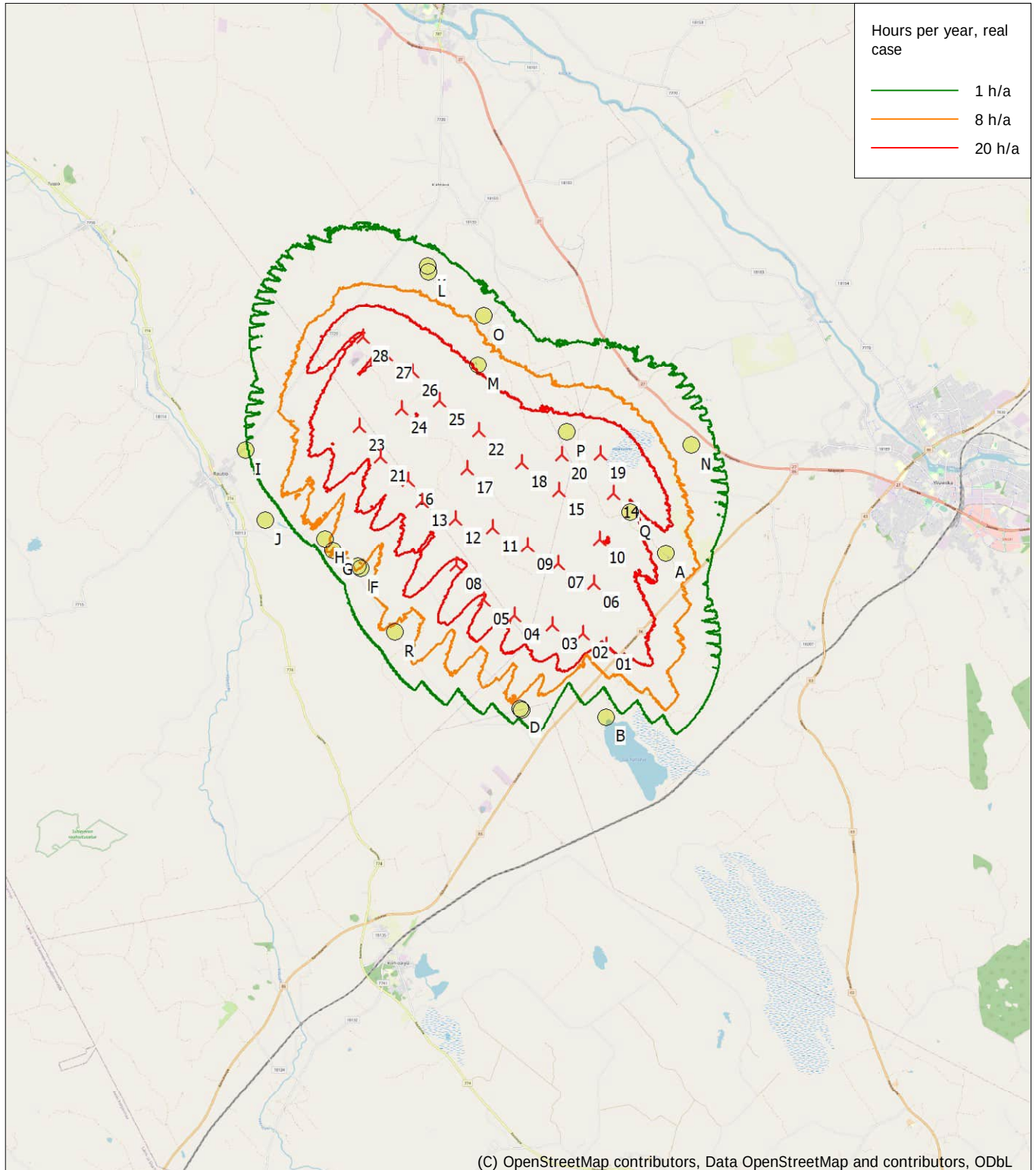


WTGs

05: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (427)	14: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (440)	22: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (426)
06: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (429)	15: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (438)	24: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (447)
07: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (449)	17: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (450)	25: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (430)
08: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (432)	18: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (431)	26: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (446)
09: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (442)	19: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (433)	27: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (444)
10: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (435)	20: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (441)	

SHADOW - Map

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_20230626_real case_no forest



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 18. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, no forest” (VE1). Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	426	388	391	554	792	1 006	1 143	936	672	564	618	8 086

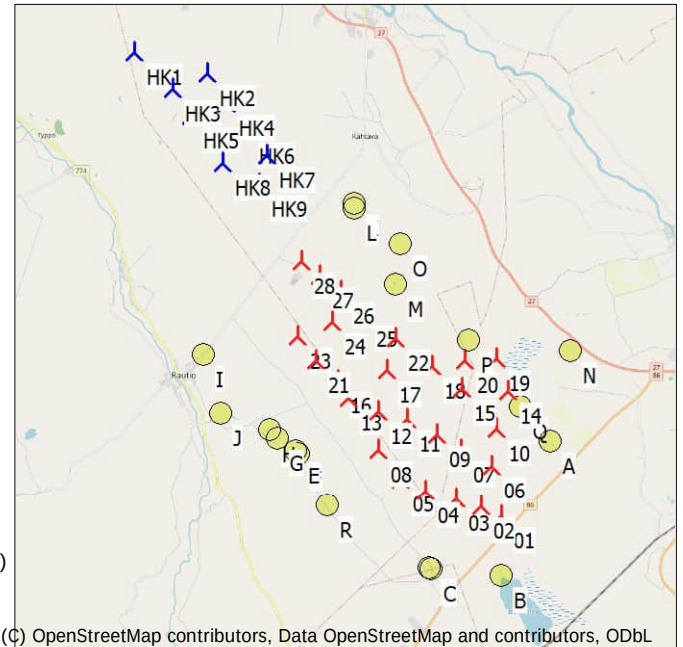
Idle start wind speed: Cut in wind speed from power curve

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

New WTG

Scale 1:200 000

Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 485	7 105 301	72,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	371 150	7 106 037	77,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	368 920	7 106 101	71,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	370 503	7 106 453	74,7	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220 7200 ...	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	369 736	7 106 883	72,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	368 953	7 107 128	72,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	368 227	7 107 519	68,6	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	372 422	7 107 527	67,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	371 227	7 107 652	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	367 939	7 108 000	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 253	7 108 202	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	370 442	7 108 273	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	372 176	7 108 397	63,7	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	371 335	7 108 402	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	367 367	7 108 547	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	369 525	7 109 029	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	366 924	7 109 225	67,2	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	367 862	7 109 559	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	368 702	7 109 705	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 126	7 110 369	63,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	367 574	7 110 777	62,8	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	367 096	7 111 177	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
HK1	362 925	7 116 909	50,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK2	364 851	7 116 247	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK3	363 880	7 115 898	53,1	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK4	365 316	7 115 435	55,6	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK5	364 350	7 115 141	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK6	365 790	7 114 681	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4

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SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest

...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]									[RPM]
HK7	366 307	7 114 024	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK8	365 140	7 113 868	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK9	366 091	7 113 264	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
				[m]	[m]	[m]				
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	12:02
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	5:49
D	Laskentapiste_D (Sorvari)	6:16
E	Laskentapiste_E (Huhtakylä)	9:11
F	Laskentapiste_F (Huhtakylä)	8:14
G	Laskentapiste_G (Viljamaa)	8:48
H	Laskentapiste_H (Karjaneva)	6:26
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	17:49
N	Laskentapiste_N (Mäntylä)	3:26
O	Laskentapiste_O (Nevaranta)	4:06
P	Laskentapiste_P (Niisineva)	45:40
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	25:01
R	Laskentapiste_R (Huhtala)	6:17

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

No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (423)	5:57
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (443)	3:05
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (445)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (436)	0:00
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (427)	2:39

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest

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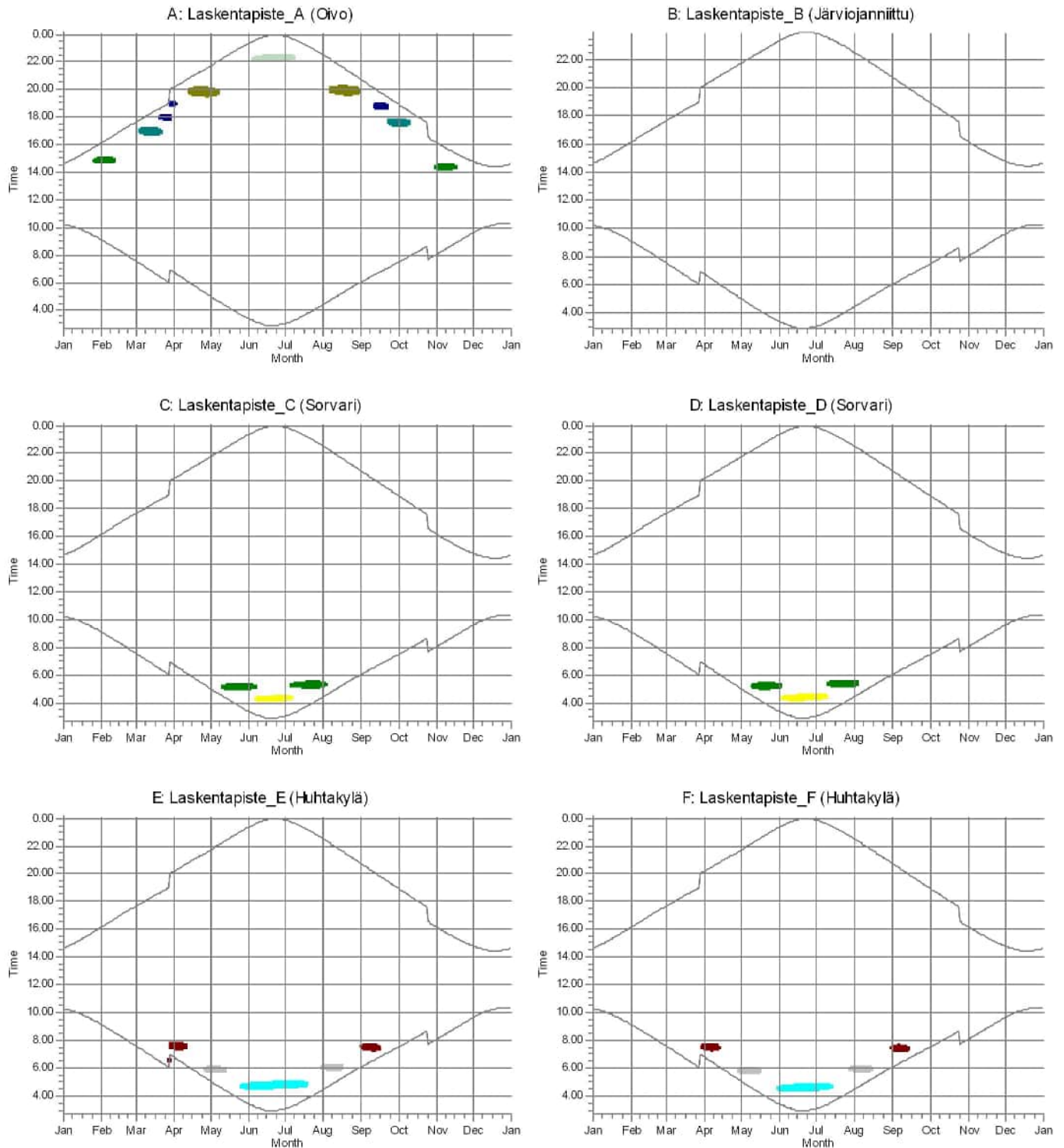
No.	Name	Expected [h/year]
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (429)	4:15
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (449)	2:54
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (432)	6:06
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (442)	1:09
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (435)	13:57
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (448)	0:00
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (424)	3:24
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (437)	11:49
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (440)	6:20
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (438)	8:08
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (428)	9:59
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (450)	2:25
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (431)	5:32
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (433)	10:45
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (441)	29:40
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (434)	0:00
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (426)	5:15
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (425)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (447)	1:39
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (430)	5:51
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (446)	6:43
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (444)	5:25
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (439)	2:21
HK1	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (414)	0:00
HK2	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (421)	0:00
HK3	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (415)	0:00
HK4	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (418)	0:00
HK5	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (416)	0:00
HK6	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (419)	0:00
HK7	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (420)	0:00
HK8	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (417)	0:00
HK9	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (422)	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: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest



WTGs

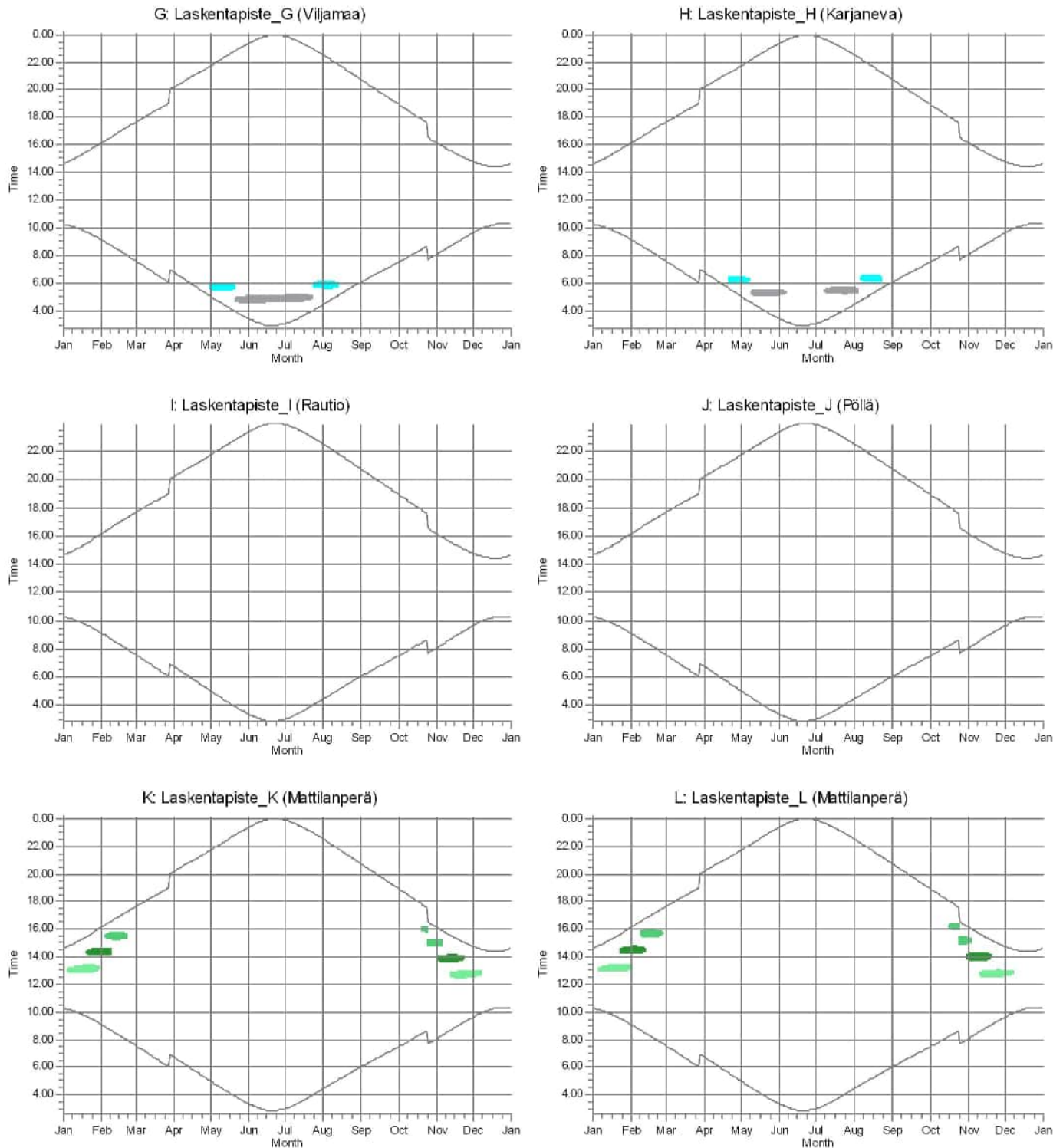
01: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (423)
 02: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (443)
 06: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (429)

07: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (449)
 08: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (432)
 10: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (435)

12: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (424)
 13: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (437)
 14: Generic RD200 HH220 7200 200.0 lOI hub: 220.0 m (TOT: 320.0 m) (440)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest

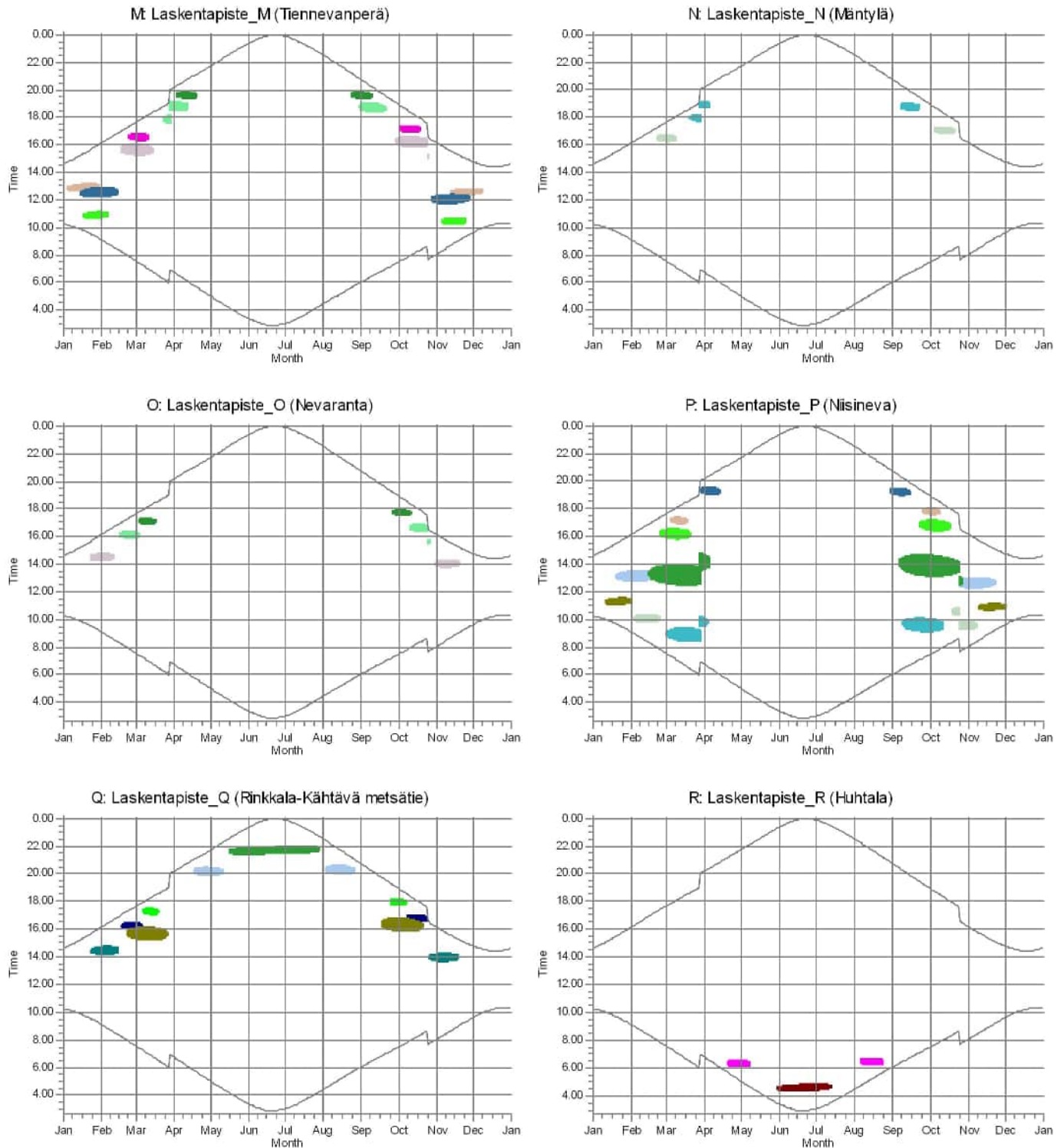


WTGs

13: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (437)	26: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (446)	28: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (439)
16: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (428)	27: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (444)	

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest



WTGs

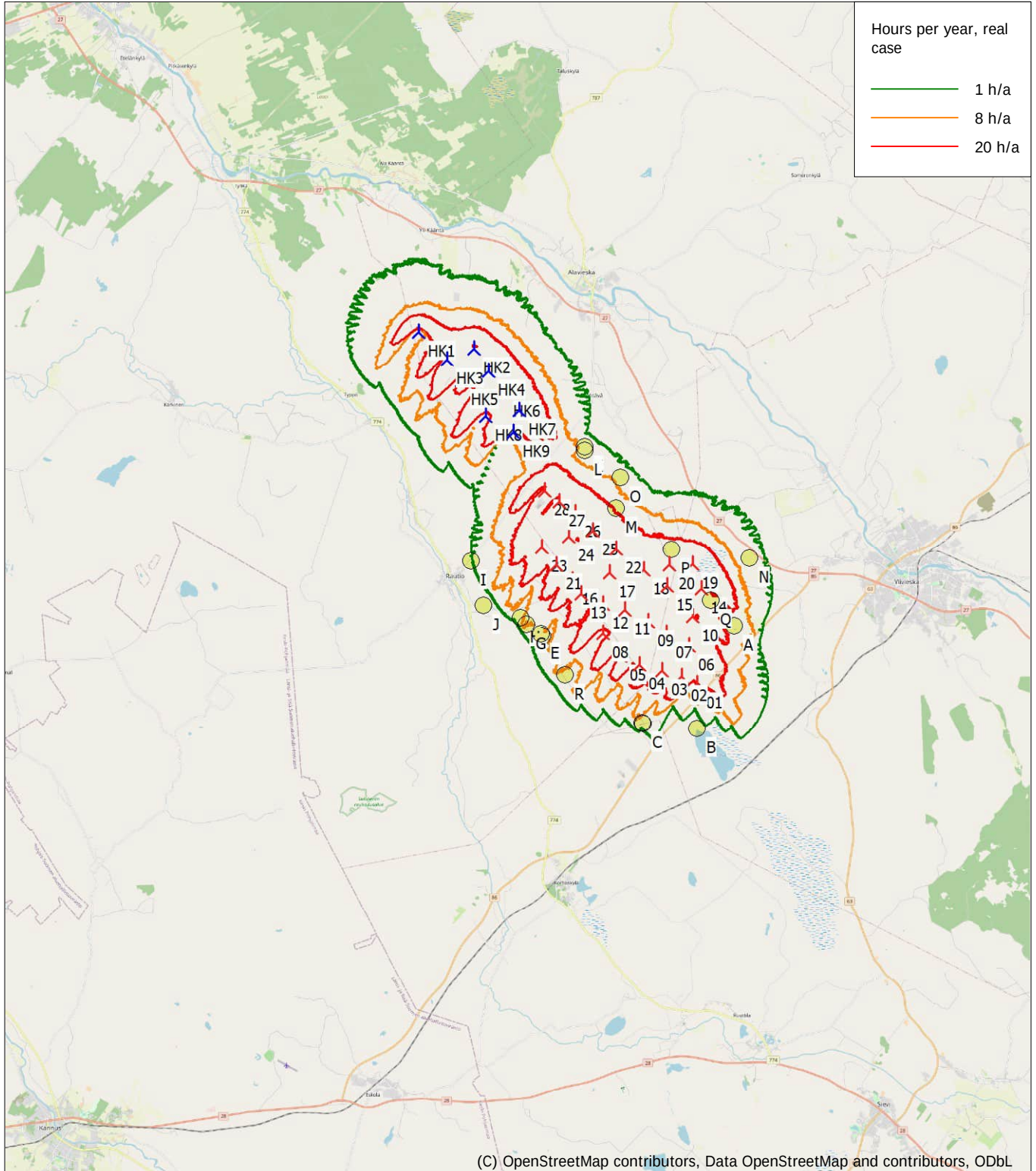
05: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (427)	14: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (440)	22: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (426)
06: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (429)	15: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (438)	24: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (447)
07: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (449)	17: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (450)	25: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (430)
08: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (432)	18: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (431)	26: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (446)
09: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (442)	19: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (433)	27: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (444)
10: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (435)	20: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (441)	

Project:
Verkasalo

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Calculated:
19.9.2023 12.47/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest



Map: EMD OpenStreetMap , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 366 940 North: 7 108 640
New WTG Shadow receptor
Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 19. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, no forest” (VE2).

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_20230626_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

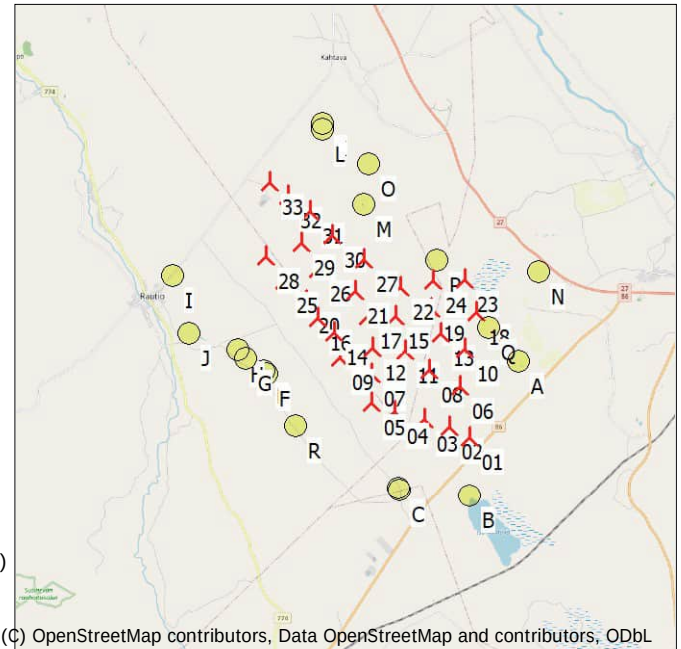
Idle start wind speed: Cut in wind speed from power curve

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

Scale 1:200 000

New WTG

Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 541	7 105 227	72,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	369 591	7 105 980	71,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	368 764	7 106 453	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	370 521	7 106 556	73,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	369 636	7 106 678	75,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	371 464	7 106 967	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	368 628	7 107 123	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	370 306	7 107 506	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 568	7 107 523	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	367 939	7 108 000	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	367 367	7 108 547	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 250	7 108 818	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	366 924	7 109 225	67,2	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
29	367 862	7 109 559	67,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
30	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
31	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
32	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
33	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_20230626_real case_no forest

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	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	14:23
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	5:50
D	Laskentapiste_D (Sorvari)	6:16
E	Laskentapiste_E (Huhtakylä)	11:09
F	Laskentapiste_F (Huhtakylä)	10:32
G	Laskentapiste_G (Viljamaa)	10:28
H	Laskentapiste_H (Karjaneva)	6:26
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	19:16
N	Laskentapiste_N (Mäntylä)	3:26
O	Laskentapiste_O (Nevaranta)	4:06
P	Laskentapiste_P (Niisineva)	50:23
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	31:04
R	Laskentapiste_R (Huhtala)	5:24

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

No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (380)	5:57
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (400)	3:05
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (402)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (393)	0:00
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (384)	2:26
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (386)	4:15
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (411)	2:58
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (406)	2:54
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (389)	3:24
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (392)	13:58
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (399)	1:14
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (405)	0:00
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (409)	8:31
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (381)	7:17
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (412)	3:16

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_20230626_real case_no forest

...continued from previous page

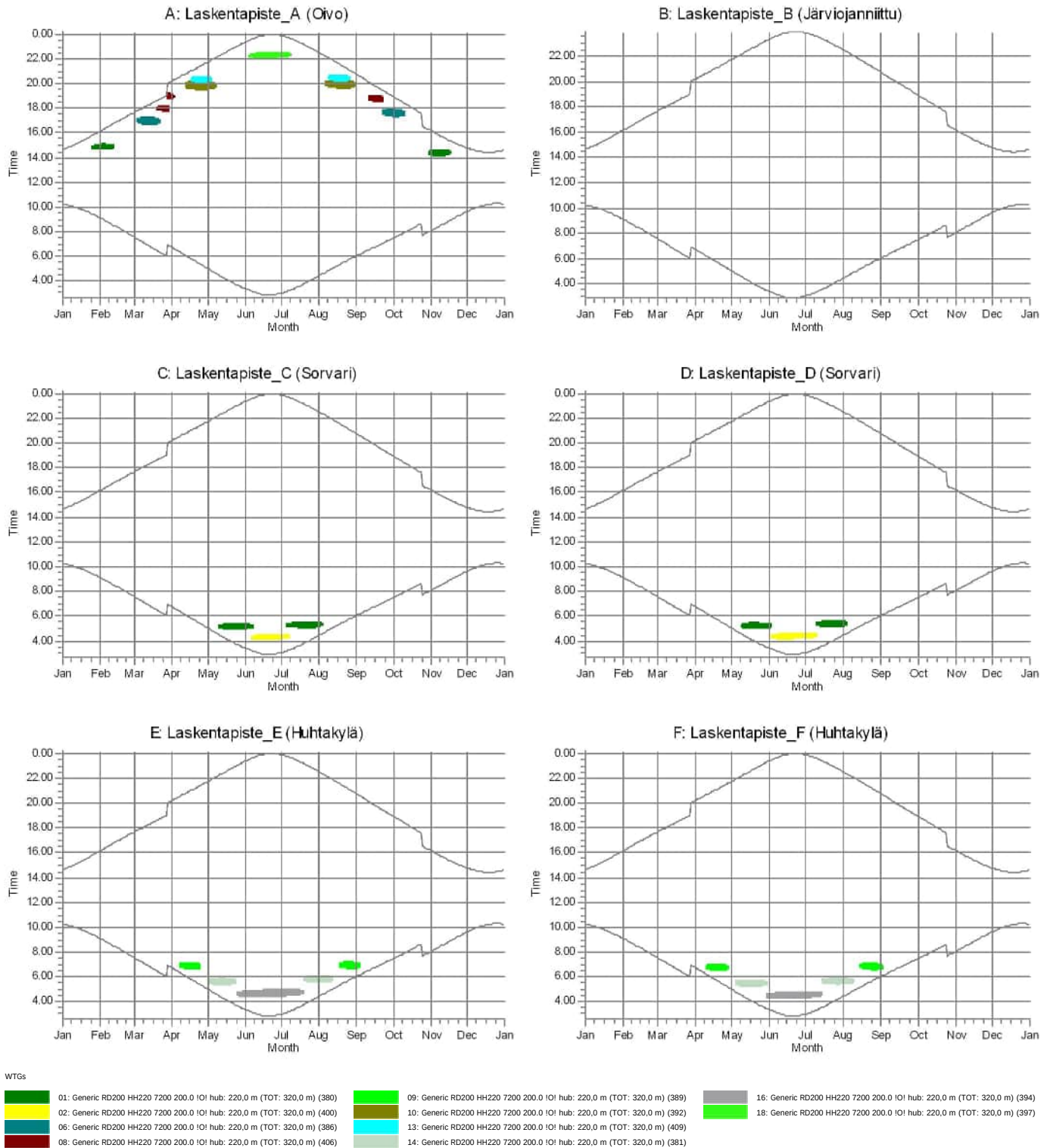
No.	Name	Expected [h/year]
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (394)	11:50
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (408)	1:06
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (397)	6:21
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (395)	8:09
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (385)	10:00
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (407)	2:25
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (388)	5:32
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (390)	10:46
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (398)	29:43
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (391)	0:00
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (410)	1:25
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (383)	5:15
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (382)	0:00
29	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (404)	1:39
30	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (387)	5:52
31	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (403)	6:44
32	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (401)	5:25
33	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (396)	2:21

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.

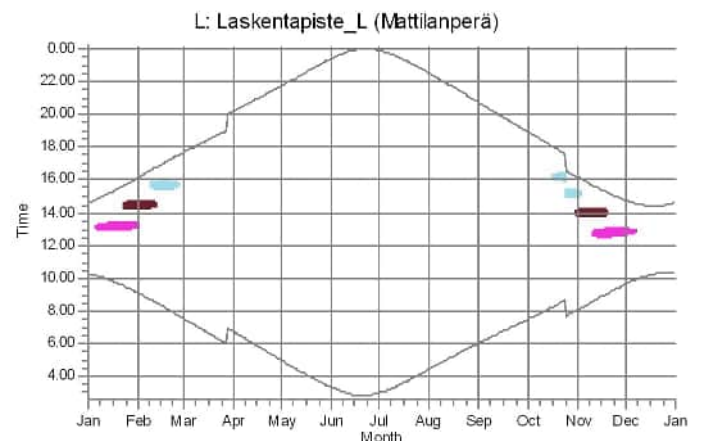
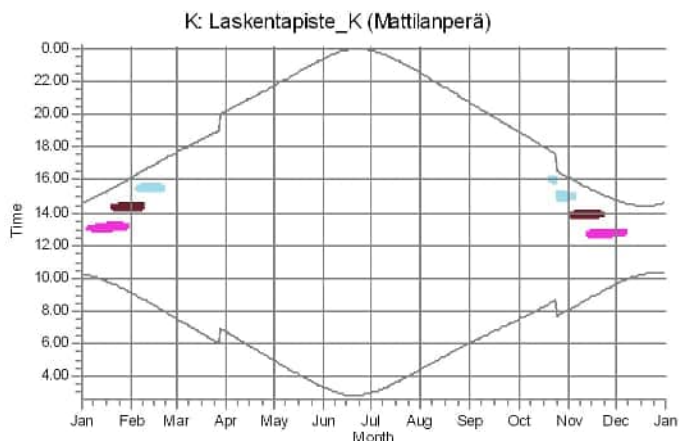
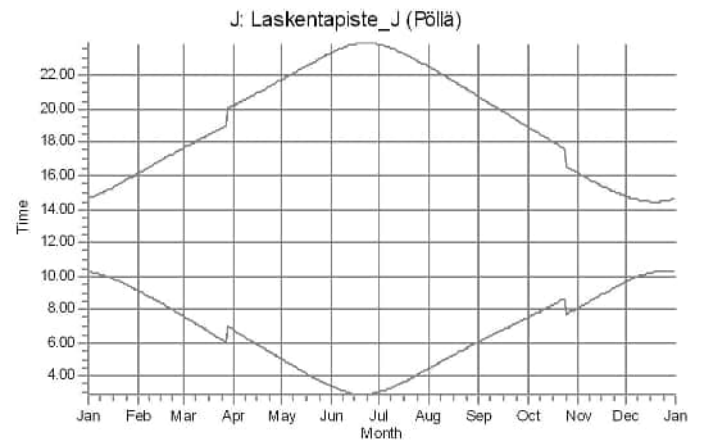
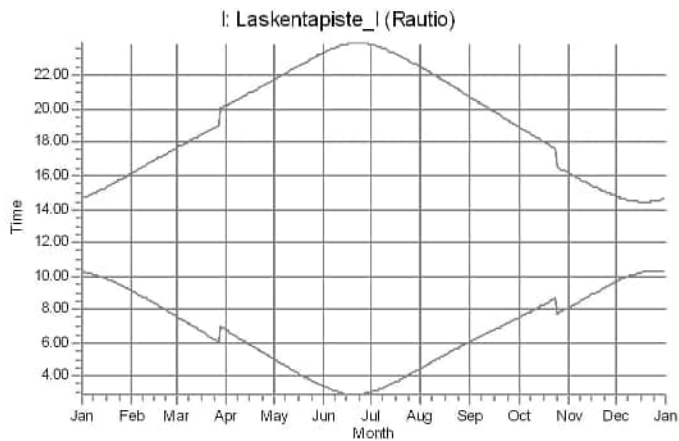
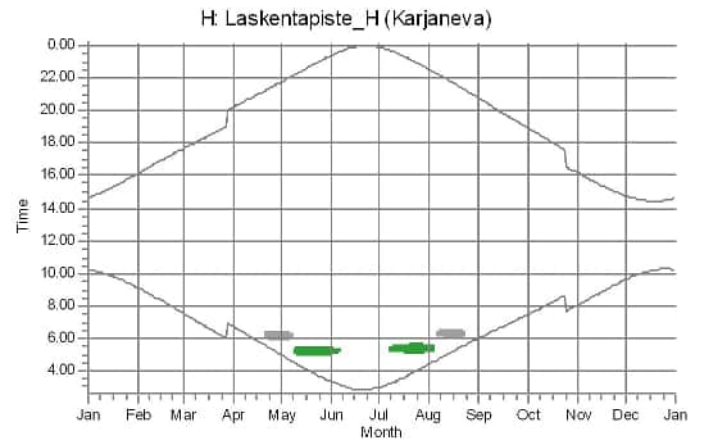
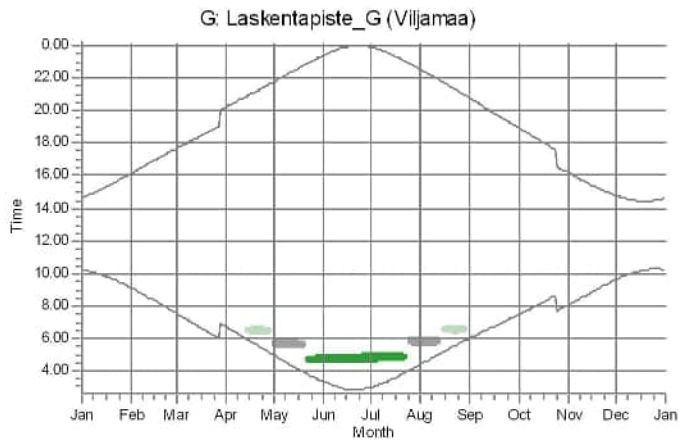
SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_20230626_real case_no forest



SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_20230626_real case_no forest

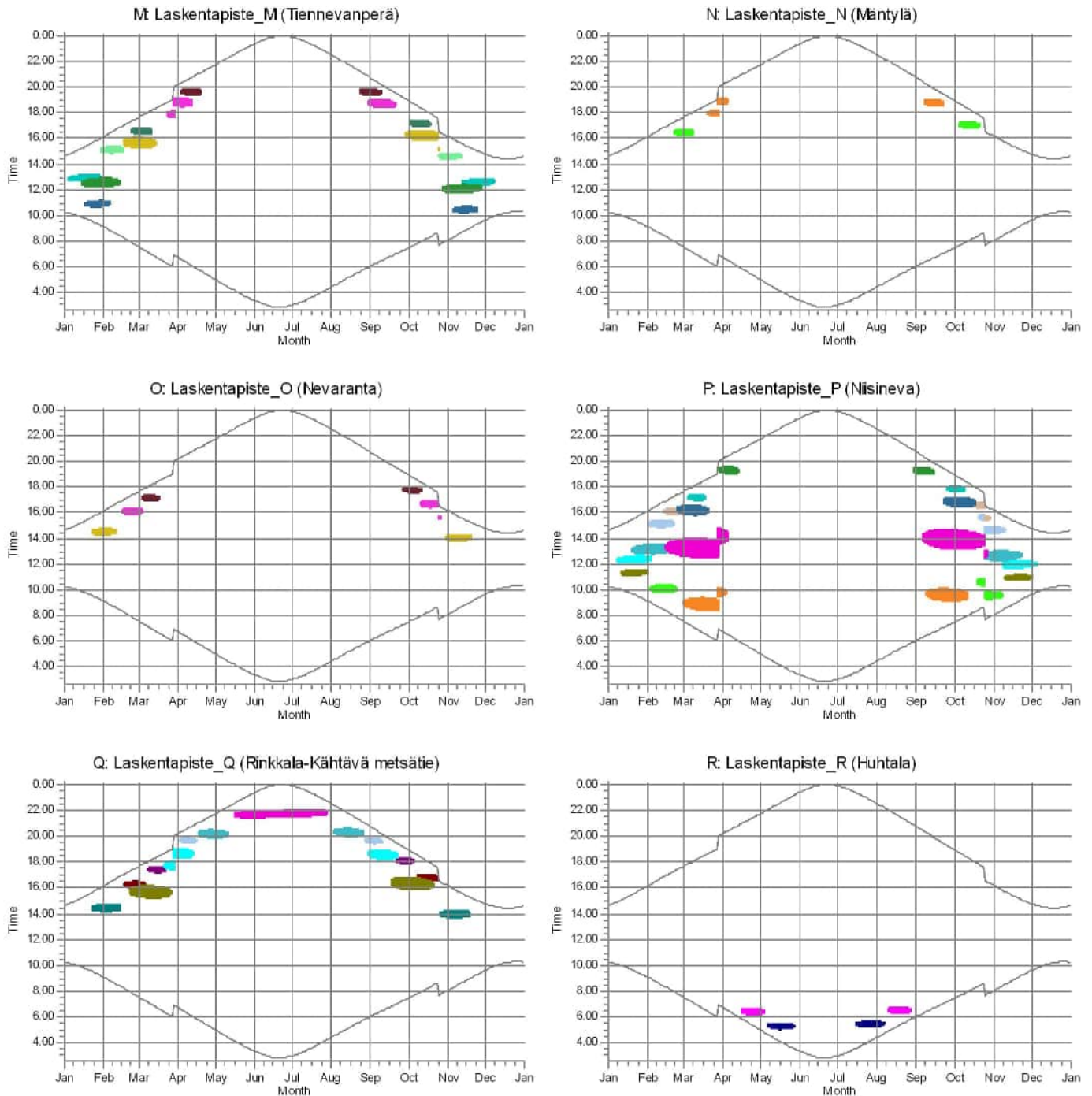


WTGs

14: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (381)	20: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (385)	32: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (401)
16: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (394)	31: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (403)	33: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (396)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_20230626_real case_no forest

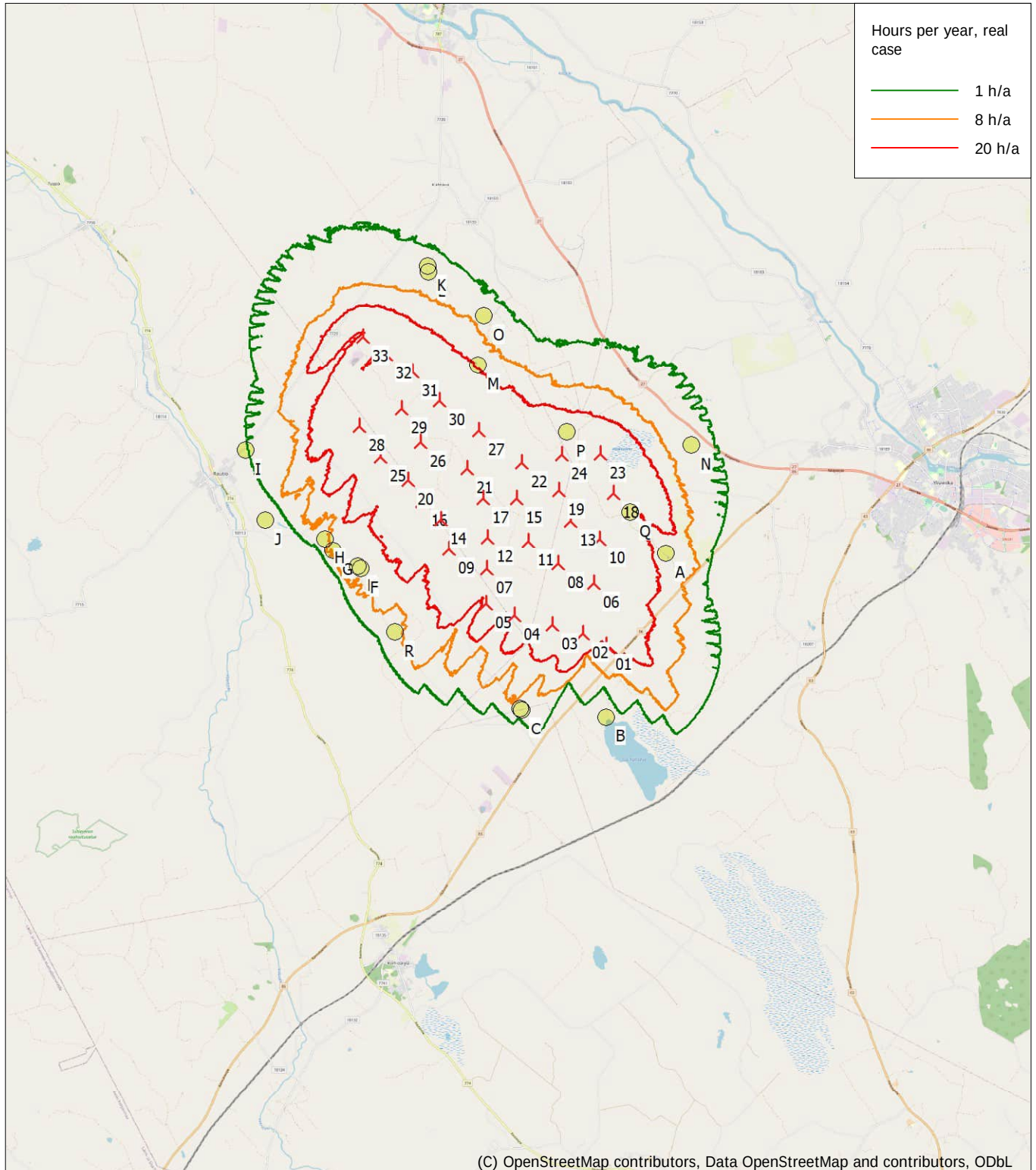


WTGs

05: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (384)	15: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (412)	24: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (398)
06: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (386)	17: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (408)	26: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (410)
07: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (411)	18: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (397)	27: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (383)
08: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (406)	19: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (395)	29: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (404)
10: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (392)	21: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (407)	30: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (387)
11: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (399)	22: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (388)	31: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (403)
13: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (409)	23: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (390)	32: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (401)

SHADOW - Map

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_20230626_real case_no forest



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 20. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, no forest” (VE2). Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	426	388	391	554	792	1 006	1 143	936	672	564	618	8 087

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

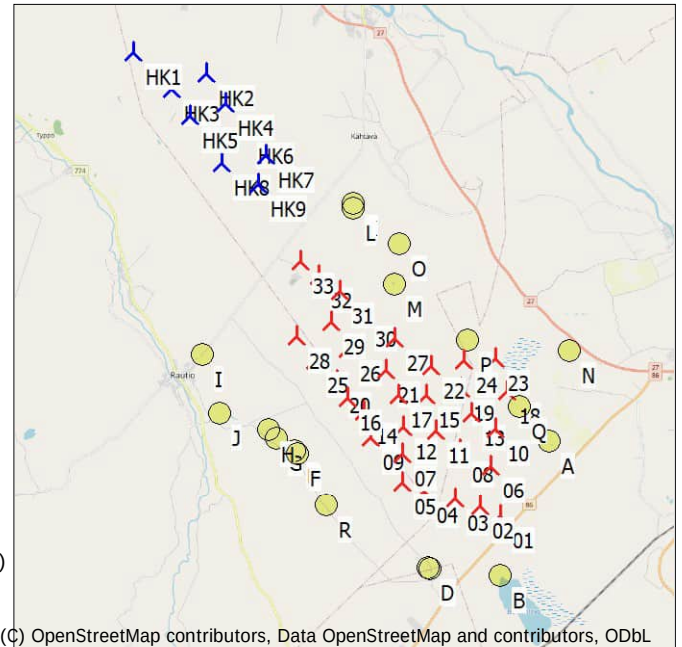
All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 541	7 105 227	72,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	369 591	7 105 980	71,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	371 150	7 106 037	77,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	368 764	7 106 453	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	370 521	7 106 556	73,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	369 636	7 106 678	75,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	371 464	7 106 967	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	368 628	7 107 123	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	370 306	7 107 506	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	368 227	7 107 519	68,6	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 568	7 107 523	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	372 422	7 107 527	67,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	371 227	7 107 652	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	367 939	7 108 000	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	369 253	7 108 202	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	370 442	7 108 273	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	372 176	7 108 397	63,7	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	371 335	7 108 402	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	367 367	7 108 547	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 250	7 108 818	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	369 525	7 109 029	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	366 924	7 109 225	67,2	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
29	367 862	7 109 559	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
30	368 702	7 109 705	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
31	368 126	7 110 369	63,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
32	367 574	7 110 777	62,8	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
33	367 096	7 111 177	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
HK1	362 925	7 116 909	50,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4

To be continued on next page...



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Scale 1:200 000
 New WTG
 Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest

...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]									[RPM]
HK2	364 851	7 116 247	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK3	363 880	7 115 898	53,1	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK4	365 316	7 115 435	55,6	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK5	364 350	7 115 141	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK6	365 790	7 114 681	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK7	366 307	7 114 024	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK8	365 140	7 113 868	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK9	366 091	7 113 264	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	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	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	14:22
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	5:49
D	Laskentapiste_D (Sorvari)	6:16
E	Laskentapiste_E (Huhtakylä)	11:08
F	Laskentapiste_F (Huhtakylä)	10:31
G	Laskentapiste_G (Viljamaa)	10:28
H	Laskentapiste_H (Karjaneva)	6:26
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	19:15
N	Laskentapiste_N (Mäntylä)	3:26
O	Laskentapiste_O (Nevaranta)	4:06
P	Laskentapiste_P (Niisineva)	50:19
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	31:02
R	Laskentapiste_R (Huhtala)	5:24

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest

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

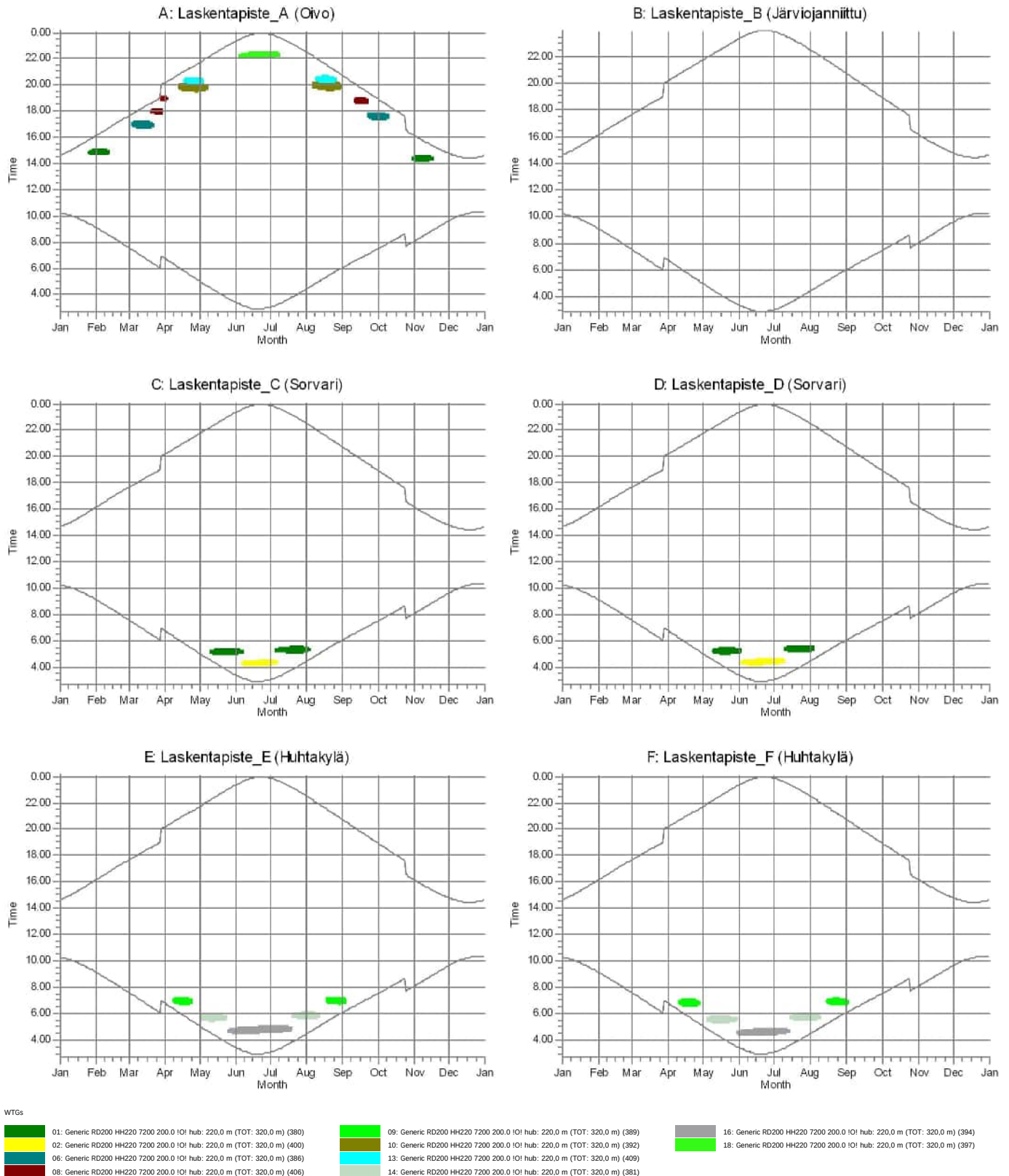
No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (380)	5:57
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (400)	3:05
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (402)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (393)	0:00
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (384)	2:26
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (386)	4:15
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (411)	2:58
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (406)	2:54
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (389)	3:24
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (392)	13:57
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (399)	1:14
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (405)	0:00
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (409)	8:30
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (381)	7:17
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (412)	3:16
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (394)	11:49
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (408)	1:06
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (397)	6:20
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (395)	8:08
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (385)	9:59
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (407)	2:25
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (388)	5:32
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (390)	10:45
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (398)	29:41
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (391)	0:00
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (410)	1:25
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (383)	5:15
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (382)	0:00
29	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (404)	1:39
30	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (387)	5:51
31	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (403)	6:43
32	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (401)	5:25
33	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (396)	2:21
HK1	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (414)	0:00
HK2	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (421)	0:00
HK3	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (415)	0:00
HK4	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (418)	0:00
HK5	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (416)	0:00
HK6	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (419)	0:00
HK7	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (420)	0:00
HK8	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (417)	0:00
HK9	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (422)	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.

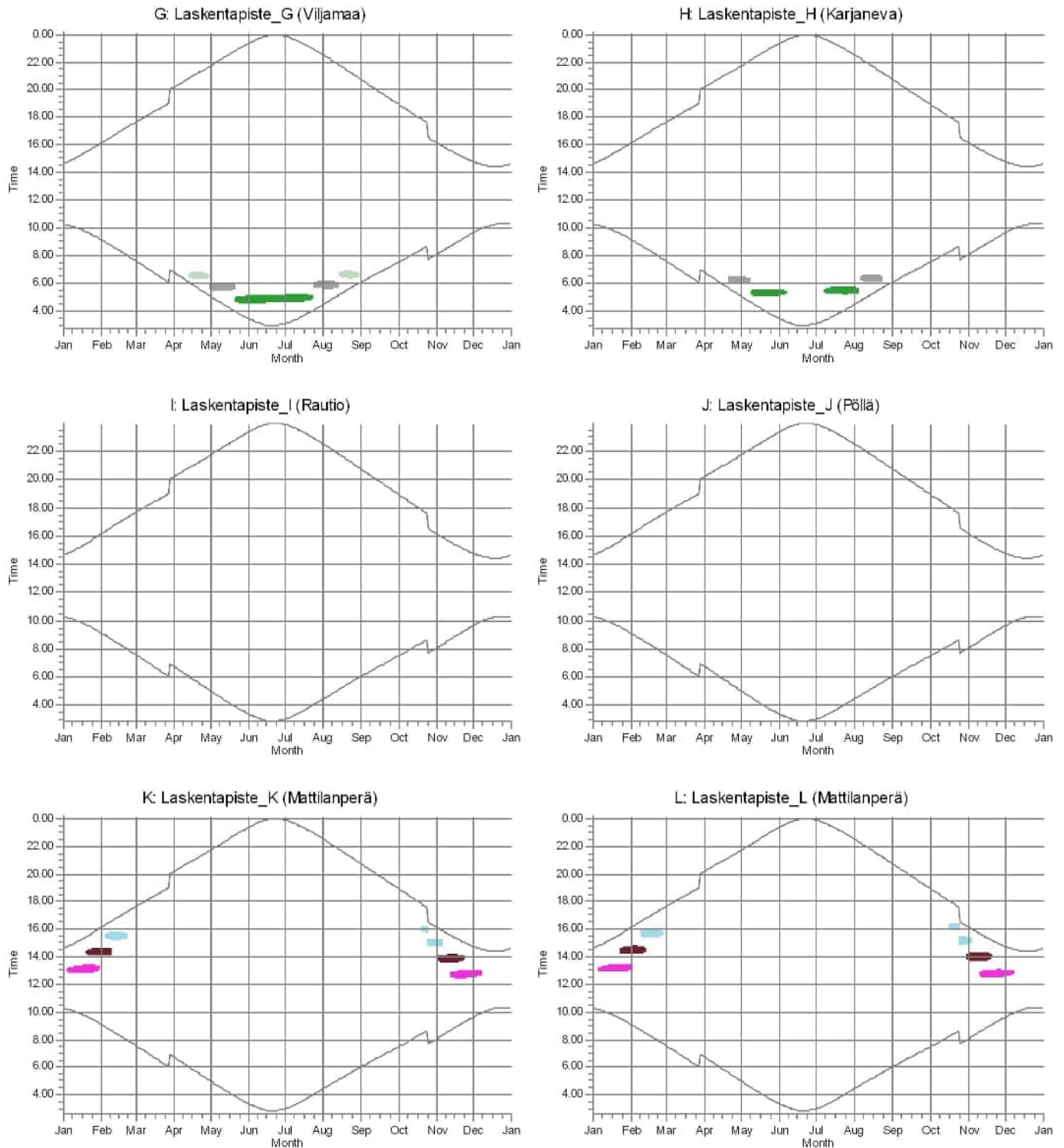
SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest



SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH220_Valke_real case_no forest



WTGs

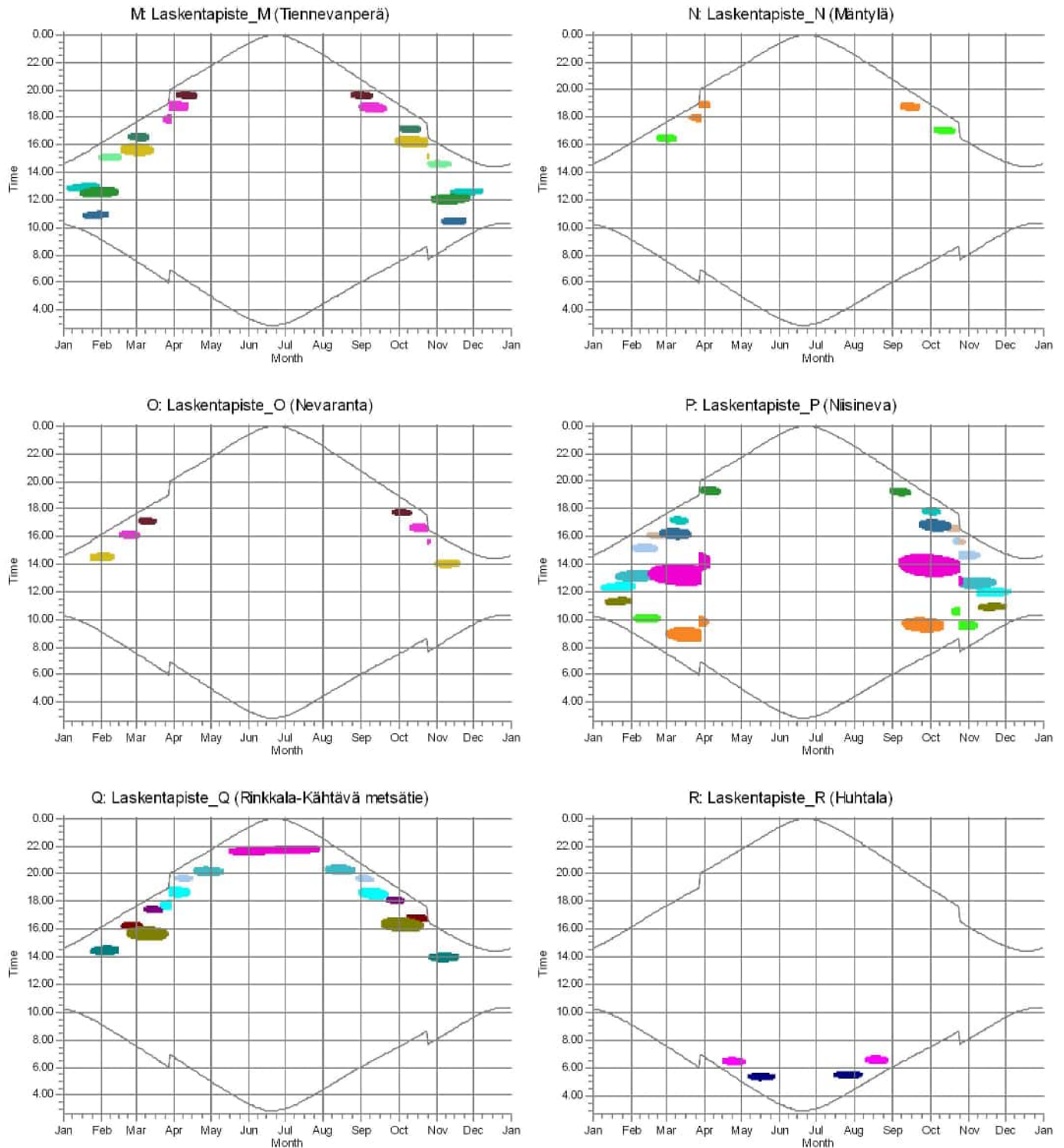
14: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (381)
 16: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (394)

20: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (385)
 31: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (403)

32: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (401)
 33: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (396)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest



WTGs

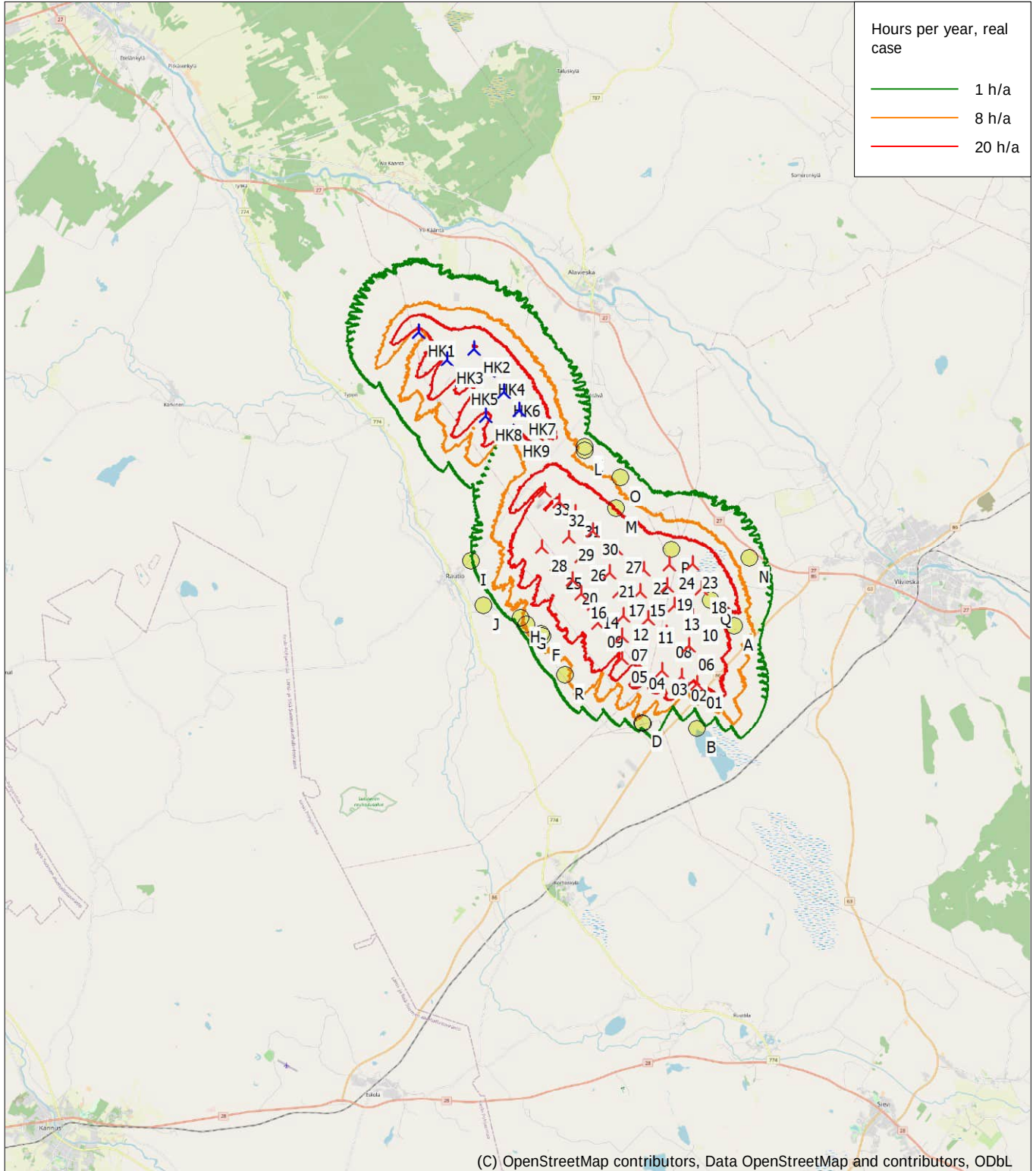
- | | | |
|--|--|--|
| 05: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (384) | 15: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (412) | 24: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (398) |
| 06: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (386) | 17: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (408) | 26: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (410) |
| 07: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (411) | 18: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (397) | 27: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (383) |
| 08: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (406) | 19: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (395) | 29: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (404) |
| 10: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (392) | 21: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (407) | 30: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (387) |
| 11: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (399) | 22: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (388) | 31: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (403) |
| 13: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (409) | 23: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (390) | 32: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (401) |

Project:
Verkasalo

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
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+358104095666
Aarni Nikkola / aarni.nikkola@fcg.fi
Calculated:
19.9.2023 12.36/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_no forest



Map: EMD OpenStreetMap , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 366 940 North: 7 108 640
New WTG Shadow receptor
Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 21. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, Luke forest” (VE1).

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_real case_Luke forest_05102023

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

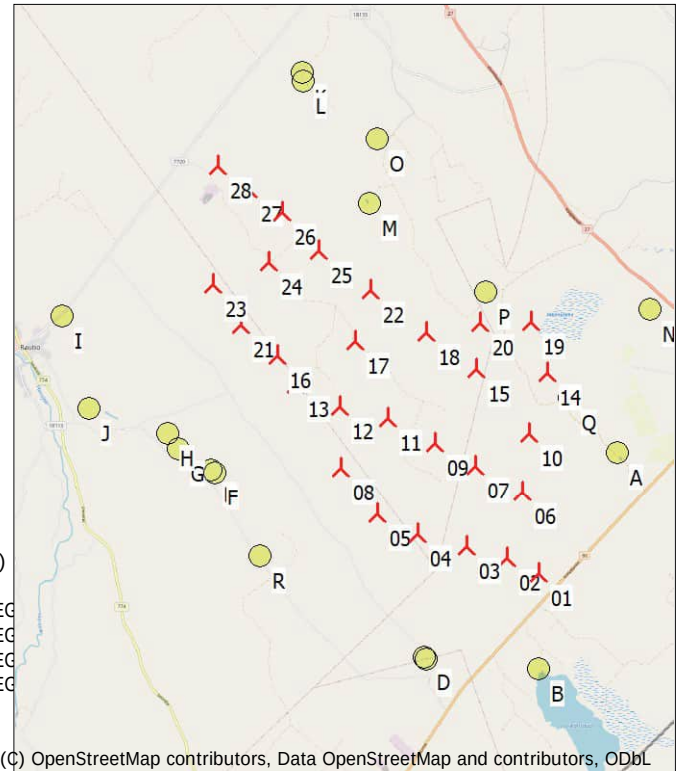
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

Scale 1:125 000

▲ New WTG

● Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 485	7 105 301	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	368 920	7 106 101	71,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	370 503	7 106 453	74,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	369 736	7 106 883	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	368 953	7 107 128	72,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	367 939	7 108 000	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	367 367	7 108 547	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	366 924	7 109 225	67,2	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	367 862	7 109 559	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_real case_Luke forest_05102023

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	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	2:30
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	2:39
E	Laskentapiste_E (Huhtakylä)	5:10
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	8:49
H	Laskentapiste_H (Karjaneva)	6:26
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	9:59
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	21:58
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	25:04
R	Laskentapiste_R (Huhtala)	0:00

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

No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (423)	0:00
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (443)	2:39
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (445)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (436)	0:00
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (427)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (429)	1:59
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (449)	1:36
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (432)	0:00
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (442)	1:09
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (435)	8:06
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (448)	0:00
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (424)	0:00
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (437)	10:26
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (440)	2:30
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (438)	4:23

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_real case_Luke forest_05102023

...continued from previous page

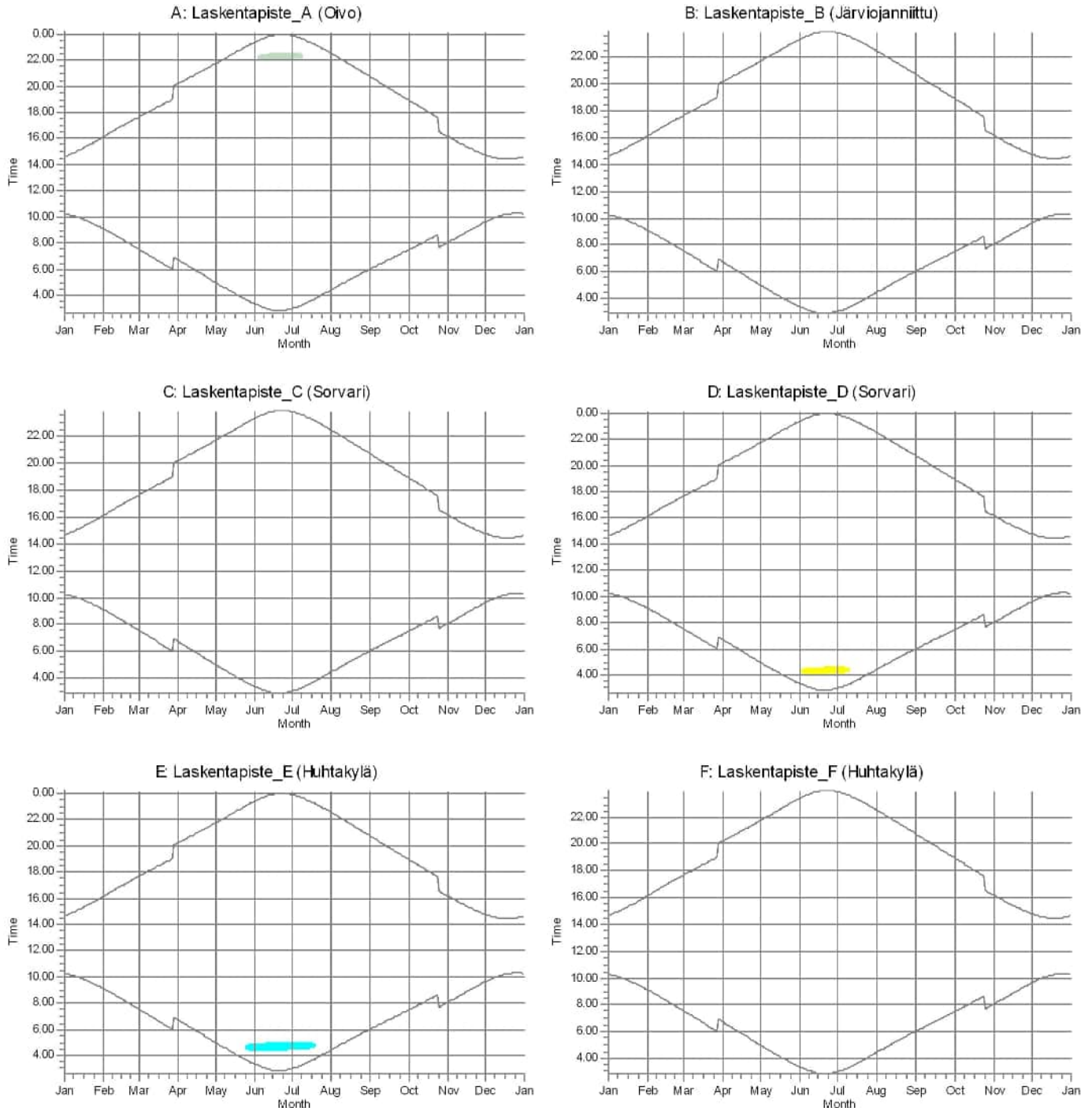
No.	Name	Expected [h/year]
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (428)	10:00
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (450)	0:00
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (431)	0:00
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (433)	0:00
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (441)	29:43
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (434)	0:00
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (426)	0:00
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (425)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (447)	1:39
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (430)	4:31
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (446)	5:12
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (444)	1:57
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (439)	2:21

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: Verkasalo_VE1_RD200x28xHH220_Valke_real case_Luke forest_05102023

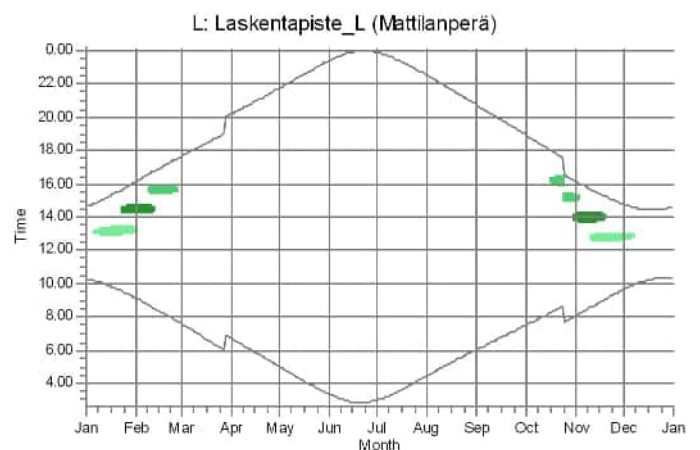
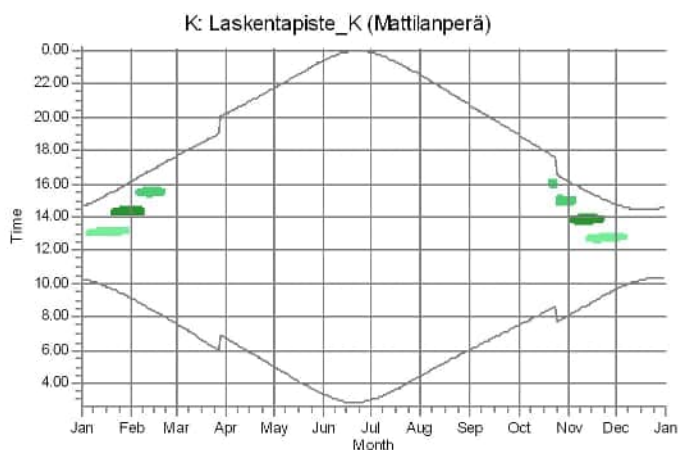
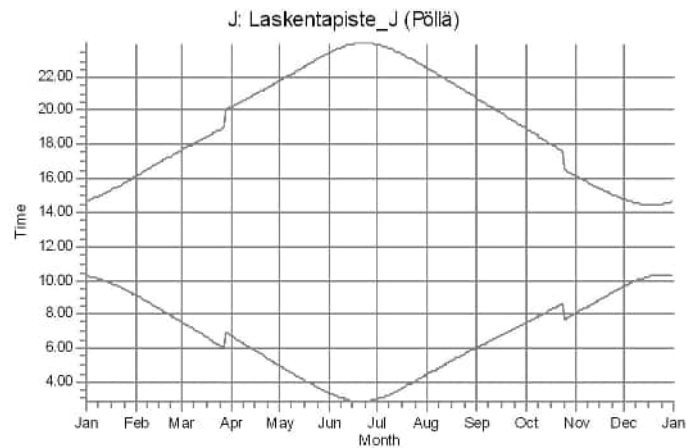
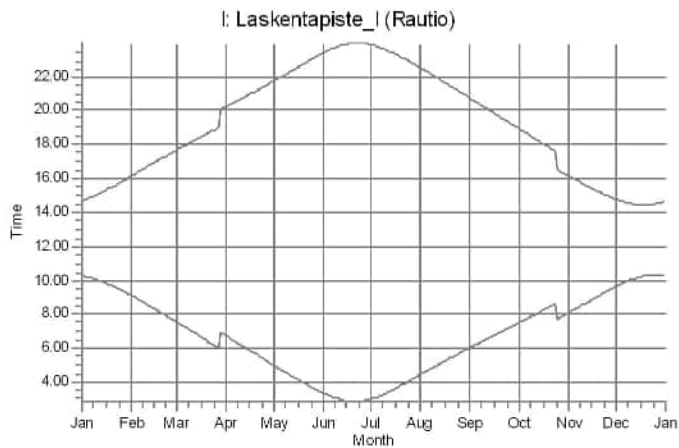
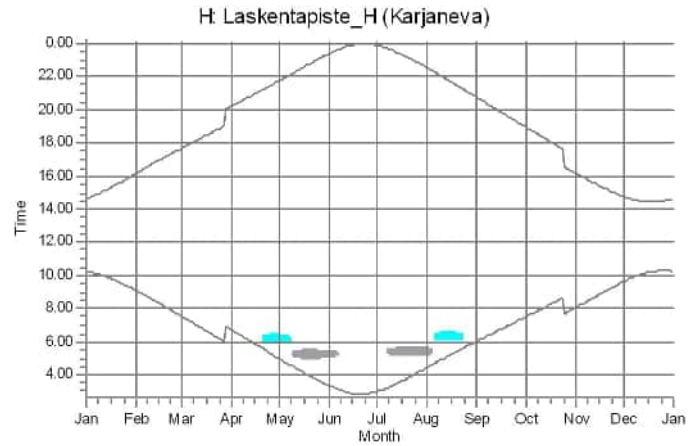
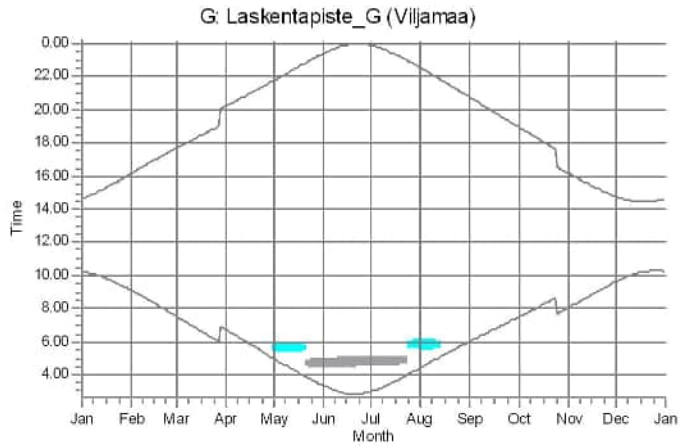


WTGs

02: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (443) 13: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (437) 14: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (440)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_real case_Luke forest_05102023

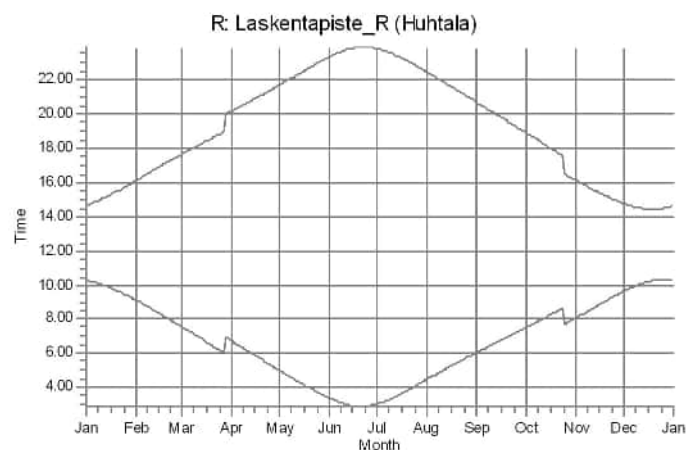
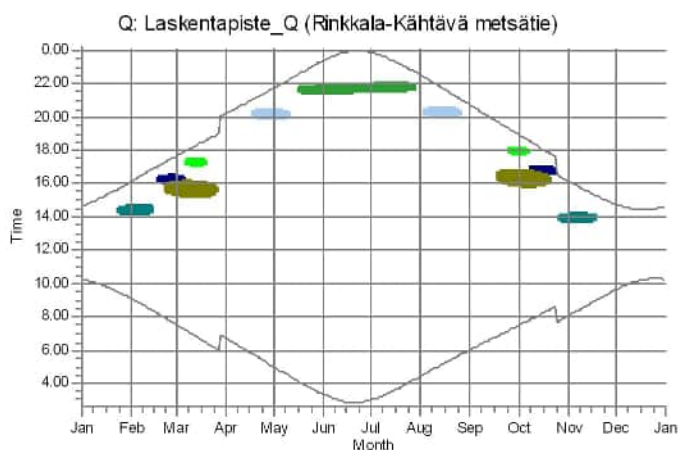
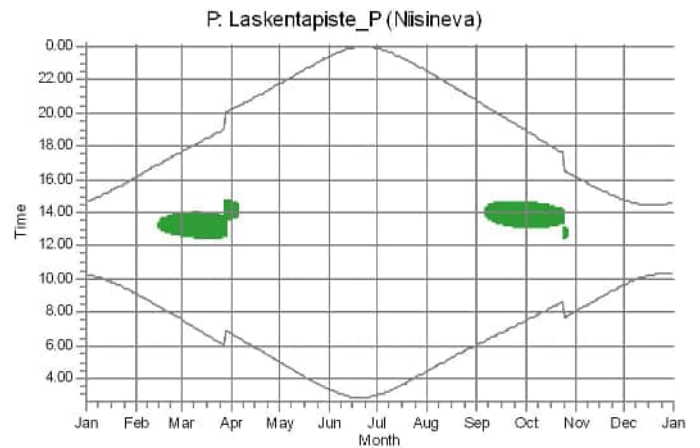
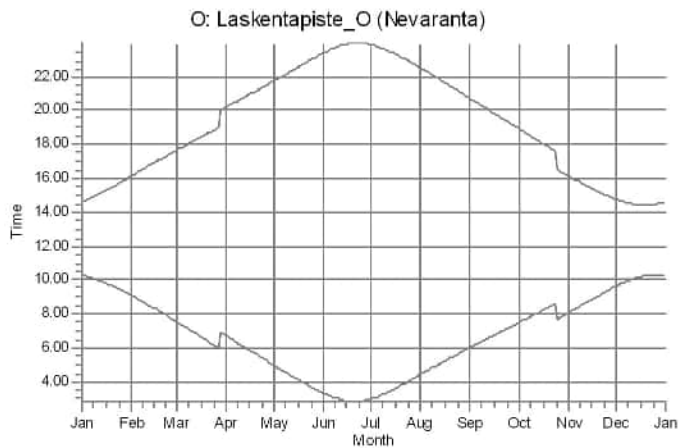
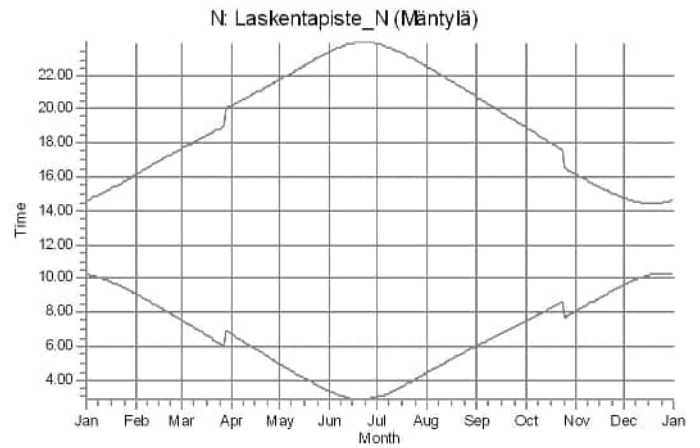
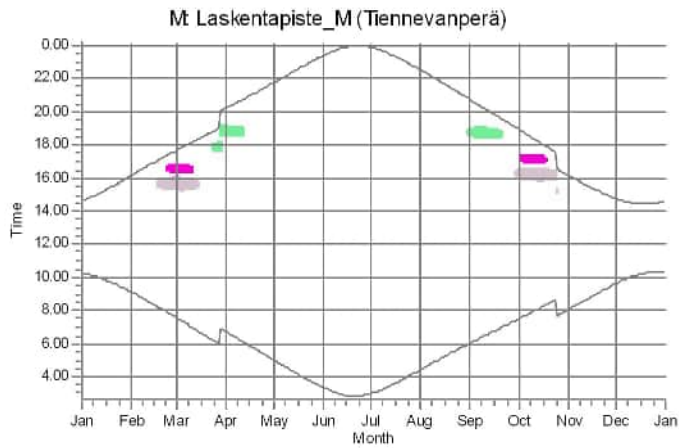


WTGs

- | | | |
|--|--|--|
| 13: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (437) | 26: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (446) | 28: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (439) |
| 16: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (428) | 27: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (444) | |

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_real case_Luke forest_05102023

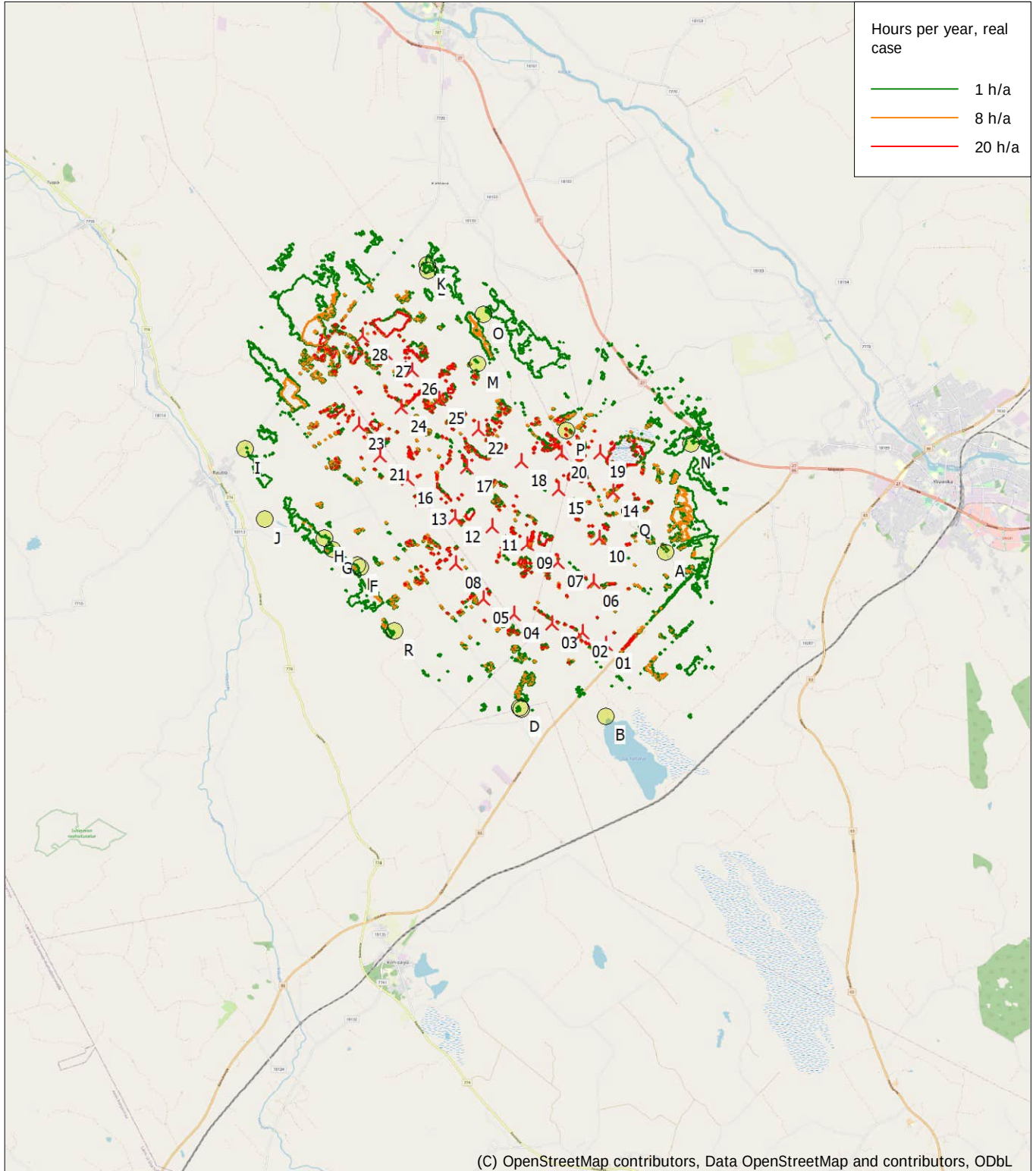


WTGs

06: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (429)	10: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (435)	24: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (447)
07: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (449)	15: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (438)	25: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (430)
09: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (442)	20: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (441)	26: Generic RD200 HH220 7200 200.0 IO! hub: 220.0 m (TOT: 320.0 m) (446)

SHADOW - Map

Calculation: Verkasalo_VE1_RD200x28xHH220_Valke_real case_Luke forest_05102023



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 22. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, Luke forest” (VE1). Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023

Assumptions for shadow calculations

Maximum distance for influence	2 500 m
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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	426	388	391	554	792	1 006	1 143	936	672	564	618	8 086

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

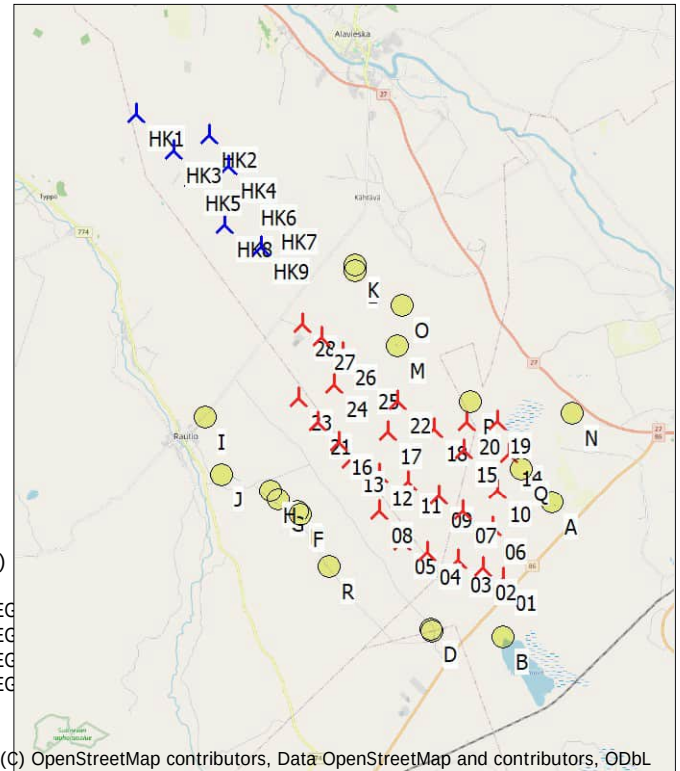
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

Scale 1:200 000

★ New WTG

● Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 485	7 105 301	72,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	371 150	7 106 037	77,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	368 920	7 106 101	71,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	370 503	7 106 453	74,7	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	369 736	7 106 883	72,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	368 953	7 107 128	72,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	368 227	7 107 519	68,6	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	372 422	7 107 527	67,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	371 227	7 107 652	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	367 939	7 108 000	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 253	7 108 202	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	370 442	7 108 273	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	372 176	7 108 397	63,7	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	371 335	7 108 402	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	367 367	7 108 547	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	369 525	7 109 029	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	366 924	7 109 225	67,2	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	367 862	7 109 559	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	368 702	7 109 705	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 126	7 110 369	63,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	367 574	7 110 777	62,8	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	367 096	7 111 177	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
HK1	362 925	7 116 909	50,0	VESTAS V150-4.0 8 200.0	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023

...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]									[RPM]
HK2	364 851	7 116 247	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK3	363 880	7 115 898	53,1	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK4	365 316	7 115 435	55,6	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK5	364 350	7 115 141	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK6	365 790	7 114 681	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK7	366 307	7 114 024	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK8	365 140	7 113 868	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK9	366 091	7 113 264	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	2:30	
B	Laskentapiste_B (Järviojanniittu)	0:00	
C	Laskentapiste_C (Sorvari)	0:00	
D	Laskentapiste_D (Sorvari)	2:39	
E	Laskentapiste_E (Huhtakylä)	5:10	
F	Laskentapiste_F (Huhtakylä)	0:00	
G	Laskentapiste_G (Viljamaa)	8:48	
H	Laskentapiste_H (Karjaneva)	6:26	
I	Laskentapiste_I (Rautio)	0:00	
J	Laskentapiste_J (Pöllä)	0:00	
K	Laskentapiste_K (Mattilanperä)	3:52	
L	Laskentapiste_L (Mattilanperä)	4:17	
M	Laskentapiste_M (Tiennevanperä)	9:58	
N	Laskentapiste_N (Mäntylä)	0:00	
O	Laskentapiste_O (Nevaranta)	0:00	
P	Laskentapiste_P (Niisineva)	21:56	
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	25:01	
R	Laskentapiste_R (Huhtala)	0:00	

SHADOW - Main Result

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023

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

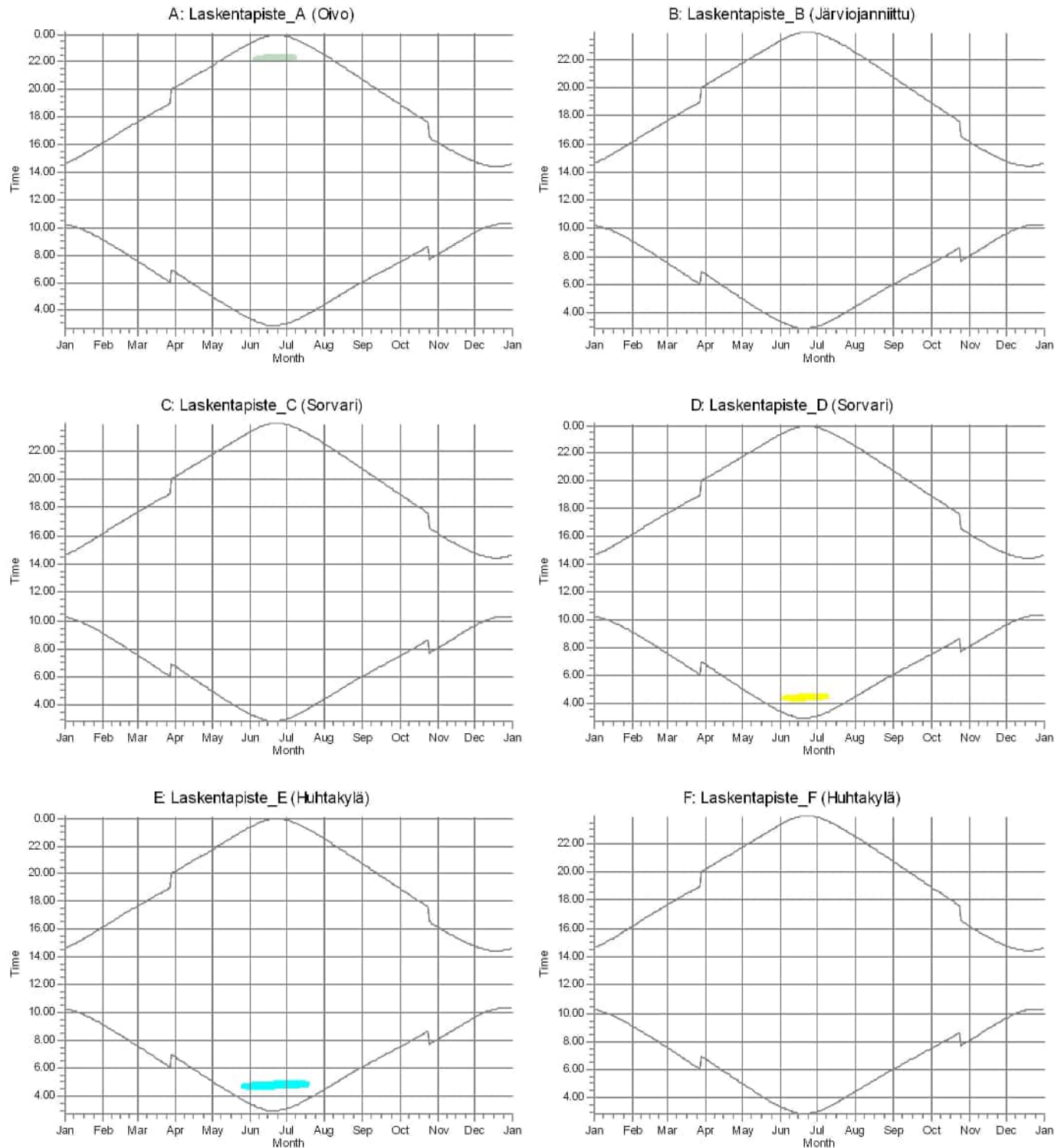
No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (423)	0:00
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (443)	2:39
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (445)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (436)	0:00
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (427)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (429)	1:58
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (449)	1:36
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (432)	0:00
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (442)	1:09
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (435)	8:06
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (448)	0:00
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (424)	0:00
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (437)	10:25
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (440)	2:30
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (438)	4:23
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (428)	9:59
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (450)	0:00
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (431)	0:00
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (433)	0:00
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (441)	29:40
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (434)	0:00
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (426)	0:00
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (425)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (447)	1:39
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (430)	4:31
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (446)	5:12
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (444)	1:57
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (439)	2:21
HK1	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (414)	0:00
HK2	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (421)	0:00
HK3	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (415)	0:00
HK4	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (418)	0:00
HK5	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (416)	0:00
HK6	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (419)	0:00
HK7	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (420)	0:00
HK8	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (417)	0:00
HK9	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (422)	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: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023

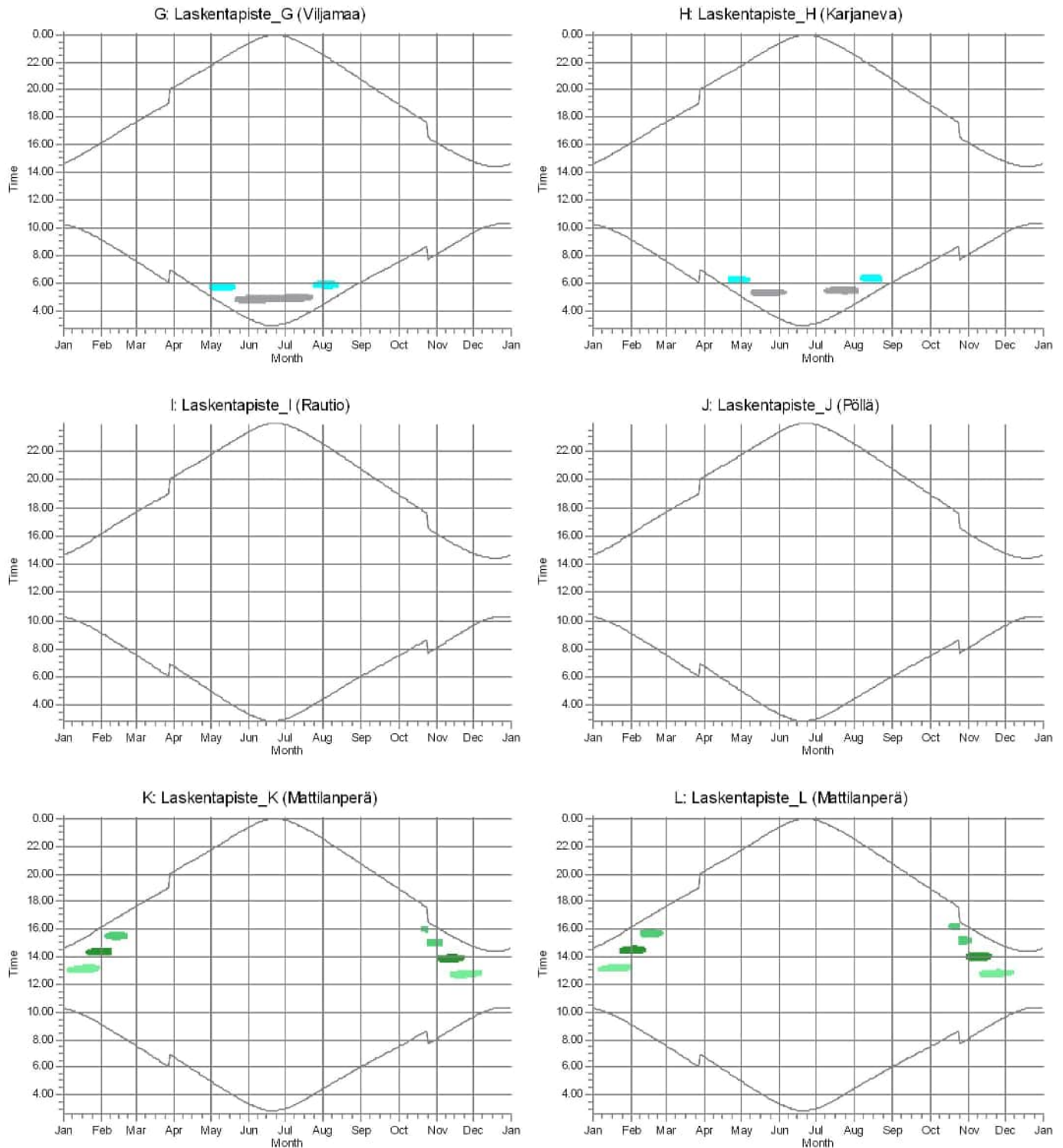


WTGs

02: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (443) 13: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (437) 14: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (440)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH220_Valke_real case_Luke forest_05102023

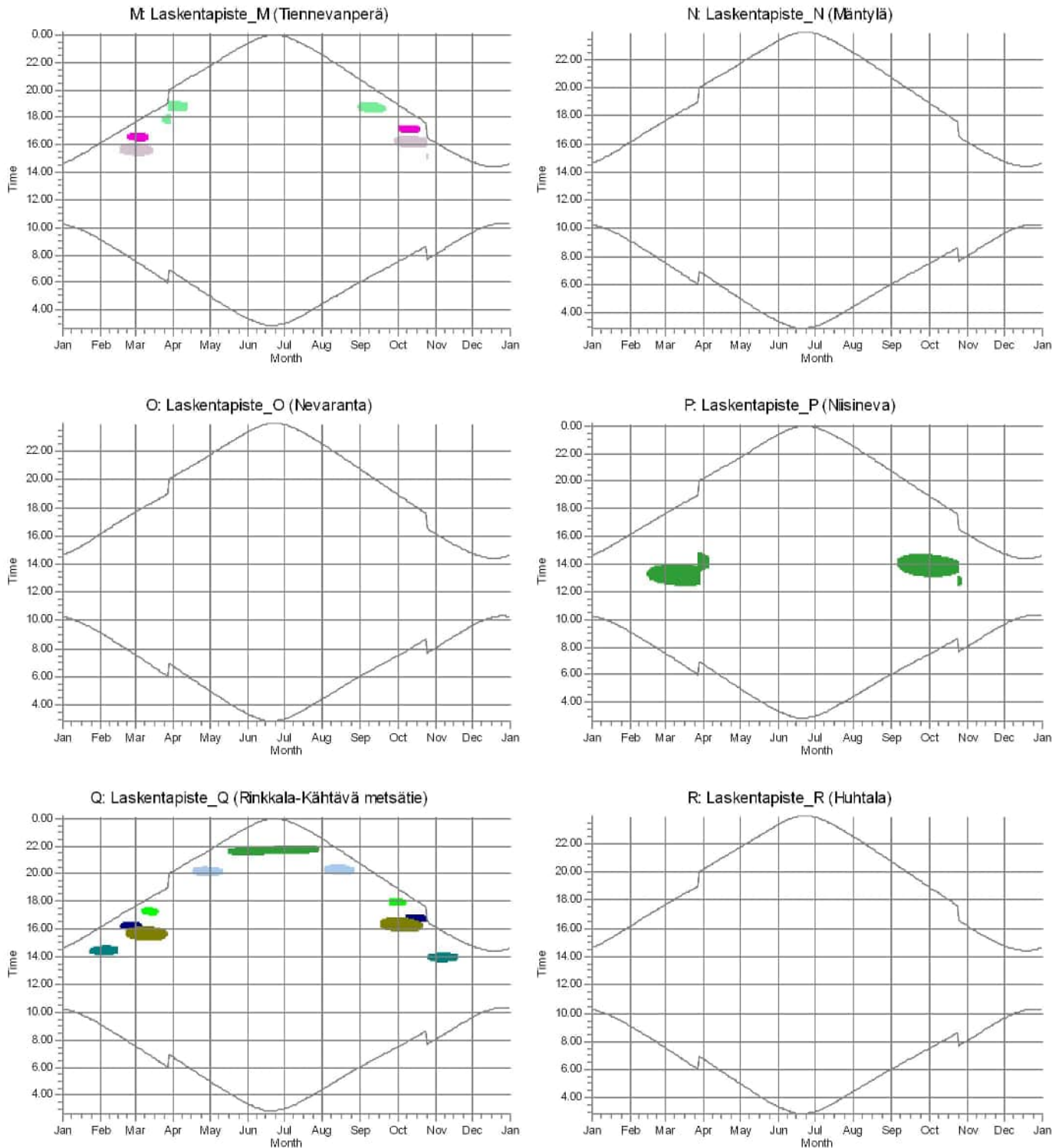


WTGs

- | | | |
|--|--|--|
| 13: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (437) | 26: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (446) | 28: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (439) |
| 16: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (428) | 27: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (444) | |

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_RD200x28xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023



WTGs

06: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (429)
 07: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (449)
 09: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (442)

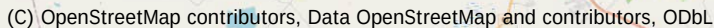
10: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (435)
 15: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (438)
 20: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (441)

24: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (447)
 25: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (430)
 26: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (446)

Verkasalo

FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Aarni Nikkola / aarni.nikkola@fcg.fi
Calculated:
5.10.2023 14.10/3.6.355

Calculation: Verkasalo VE1 RD200x28xHH220+Hangaskurunkangas RD200x9xHH200 Valke real case Luke forest 05102023



0 2,5 5 7,5 10km

 New WTG

Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)

Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 23. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, Luke forest” (VE2).

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_real case_Luke forest_05102023

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

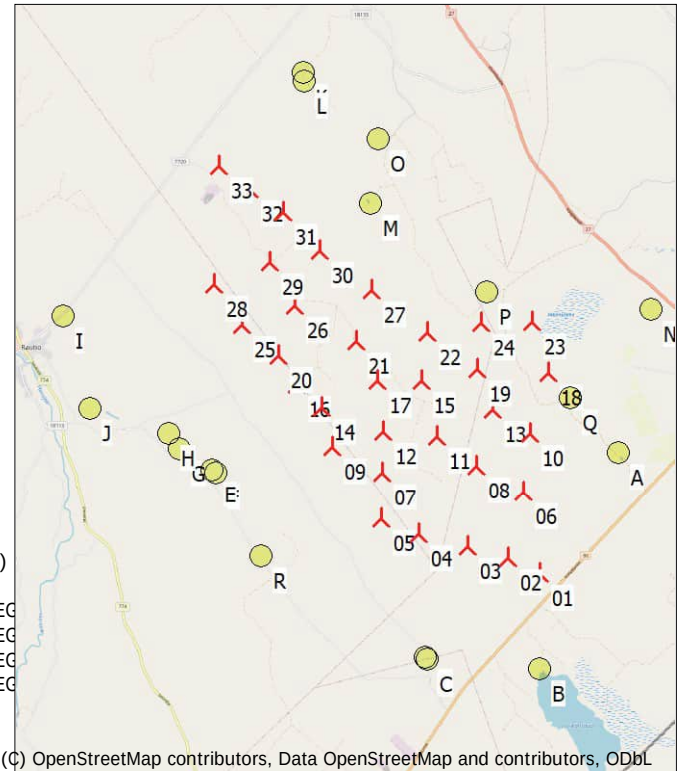
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

Scale 1:125 000

▲ New WTG

● Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 541	7 105 227	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	369 591	7 105 980	71,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	368 764	7 106 453	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	370 521	7 106 556	73,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	369 636	7 106 678	75,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	371 464	7 106 967	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	368 628	7 107 123	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	370 306	7 107 506	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 568	7 107 523	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	367 939	7 108 000	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	367 367	7 108 547	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 250	7 108 818	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	366 924	7 109 225	67,2	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
29	367 862	7 109 559	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_real case_Luke forest_05102023

...continued from previous page

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM
			[m]									[RPM]
30	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Generic		RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
31	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Generic		RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
32	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Generic		RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
33	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Generic		RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
				[m]	[m]	[m]	[m]			
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	2:30
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	2:39
E	Laskentapiste_E (Huhtakylä)	8:46
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	10:28
H	Laskentapiste_H (Karjaneva)	6:26
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	9:59
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	21:58
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	31:04
R	Laskentapiste_R (Huhtala)	0:00

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

No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (380)	0:00
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (400)	2:39
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (402)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (393)	0:00

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_real case_Luke forest_05102023

...continued from previous page

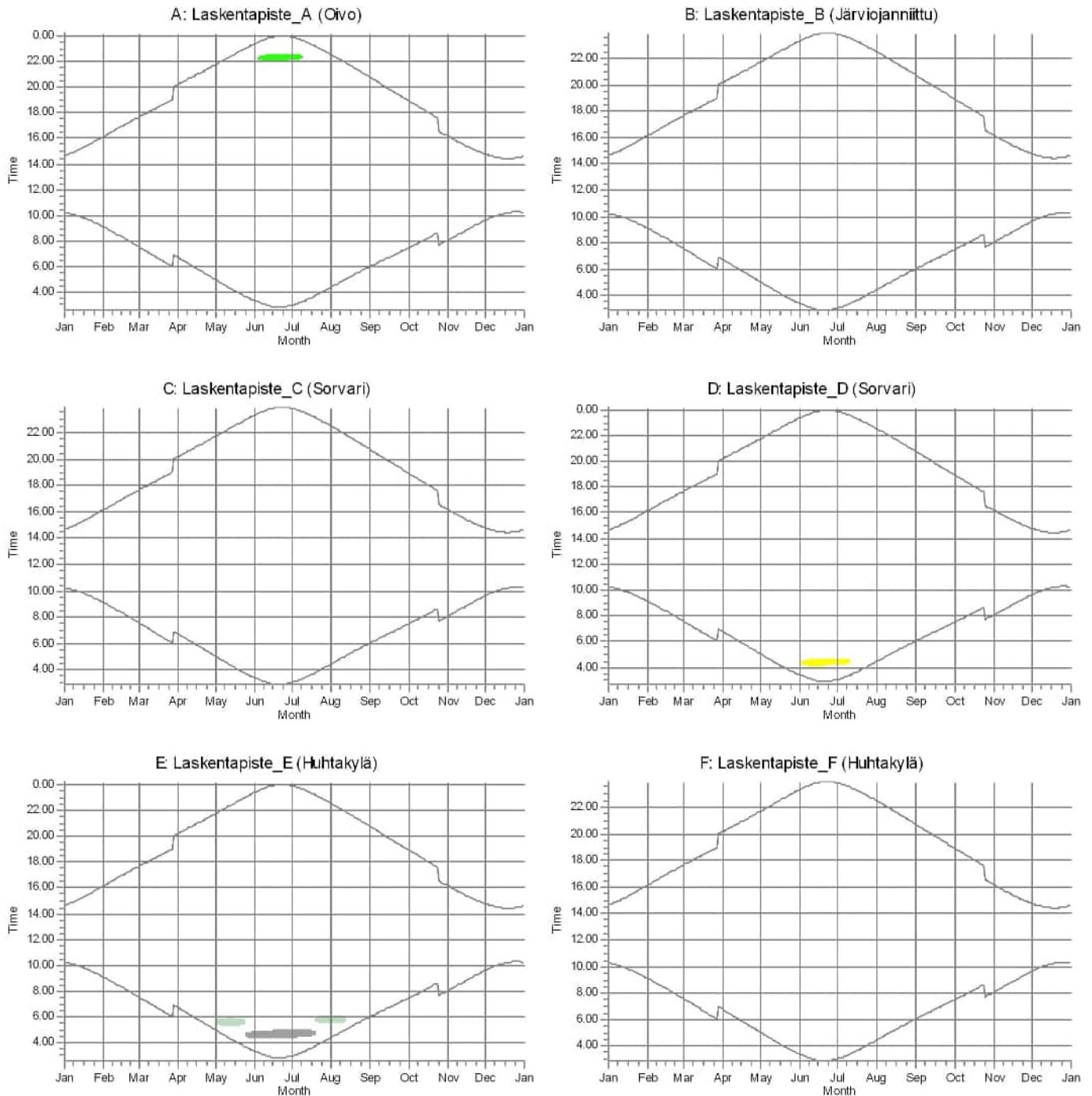
No.	Name	Expected [h/year]
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (384)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (386)	1:59
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (411)	0:00
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (406)	1:36
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (389)	0:00
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (392)	8:06
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (399)	1:14
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (405)	0:00
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (409)	4:33
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (381)	5:15
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (412)	1:20
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (394)	10:26
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (408)	0:00
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (397)	2:30
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (395)	4:23
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (385)	10:00
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (407)	0:00
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (388)	0:00
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (390)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (398)	29:43
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (391)	0:00
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (410)	0:00
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (383)	0:00
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (382)	0:00
29	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (404)	1:39
30	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (387)	4:31
31	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (403)	5:12
32	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (401)	1:57
33	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (396)	2:21

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: Verkasalo_VE2_RD200x33xHH220_Valke_real case_Luke forest_05102023

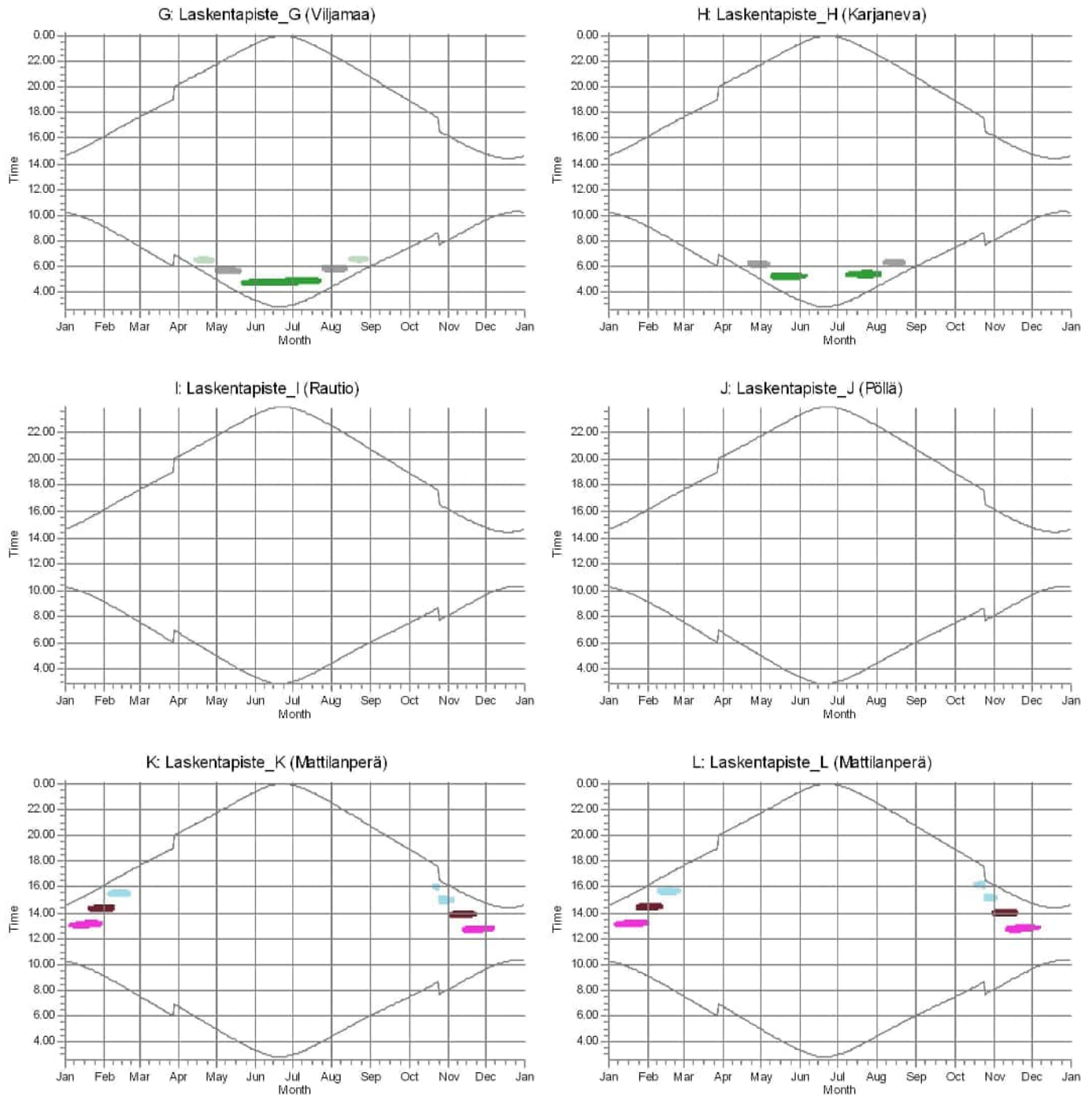


WTGs

02: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (400)	16: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (394)
14: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (381)	18: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (397)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_real case_Luke forest_05102023

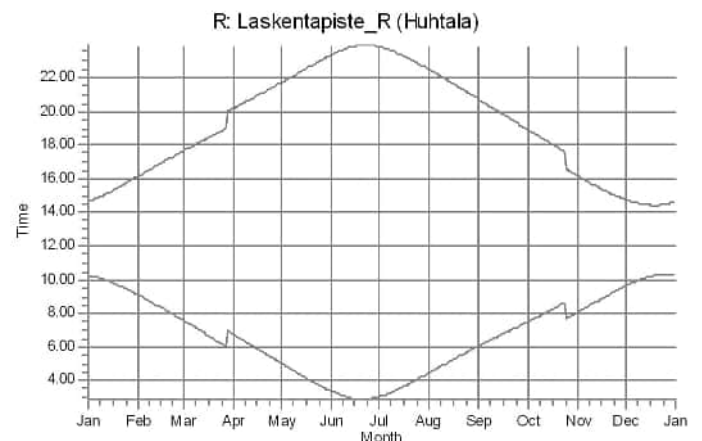
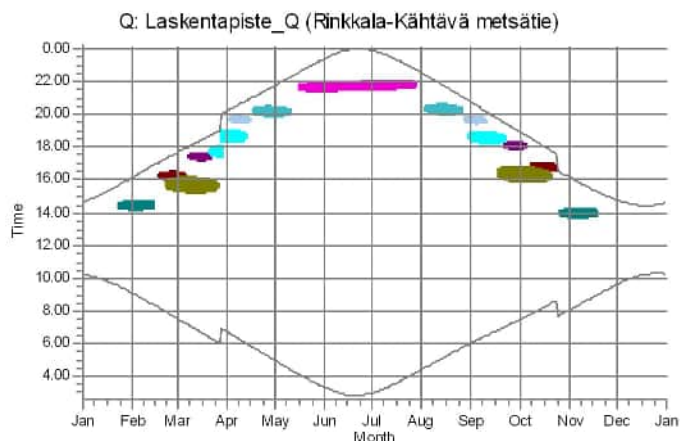
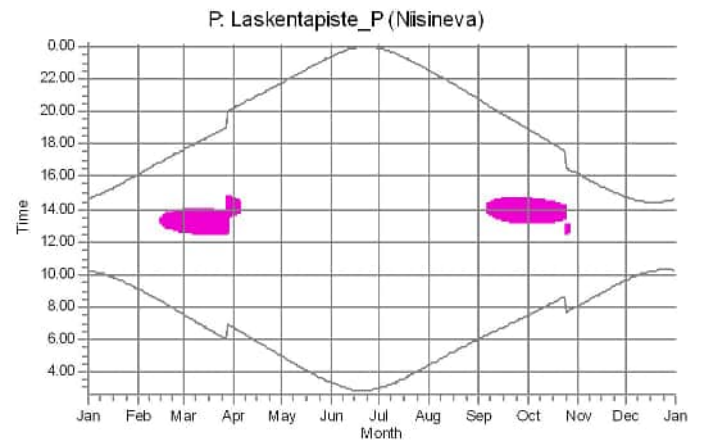
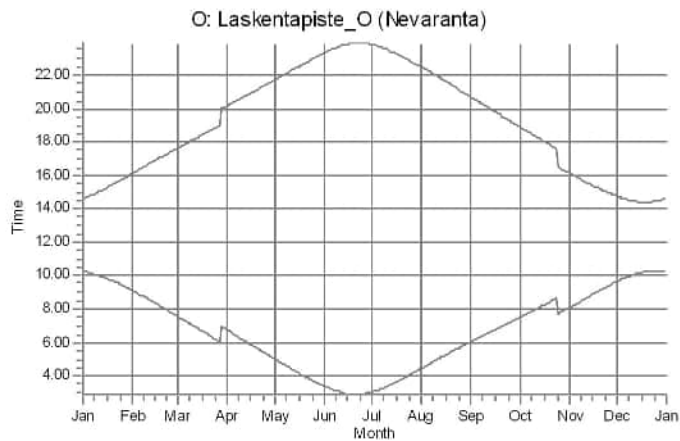
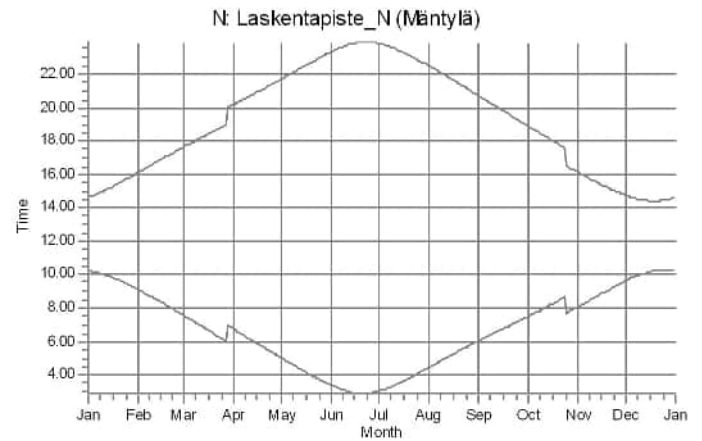
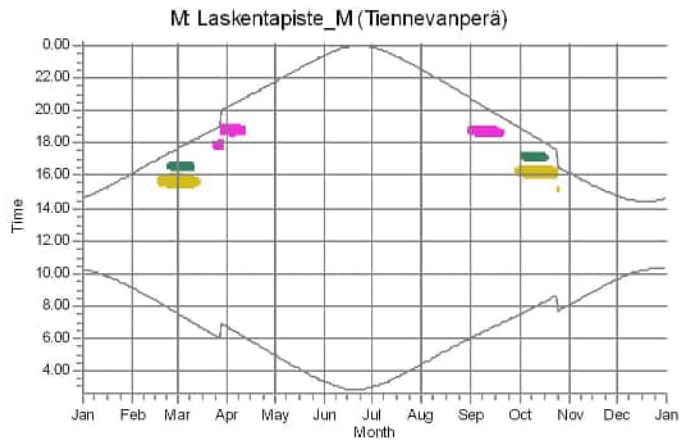


WTGs

14: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (381)	20: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (385)	32: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (401)
16: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (394)	31: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (403)	33: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (396)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_real case_Luke forest_05102023



WTGs

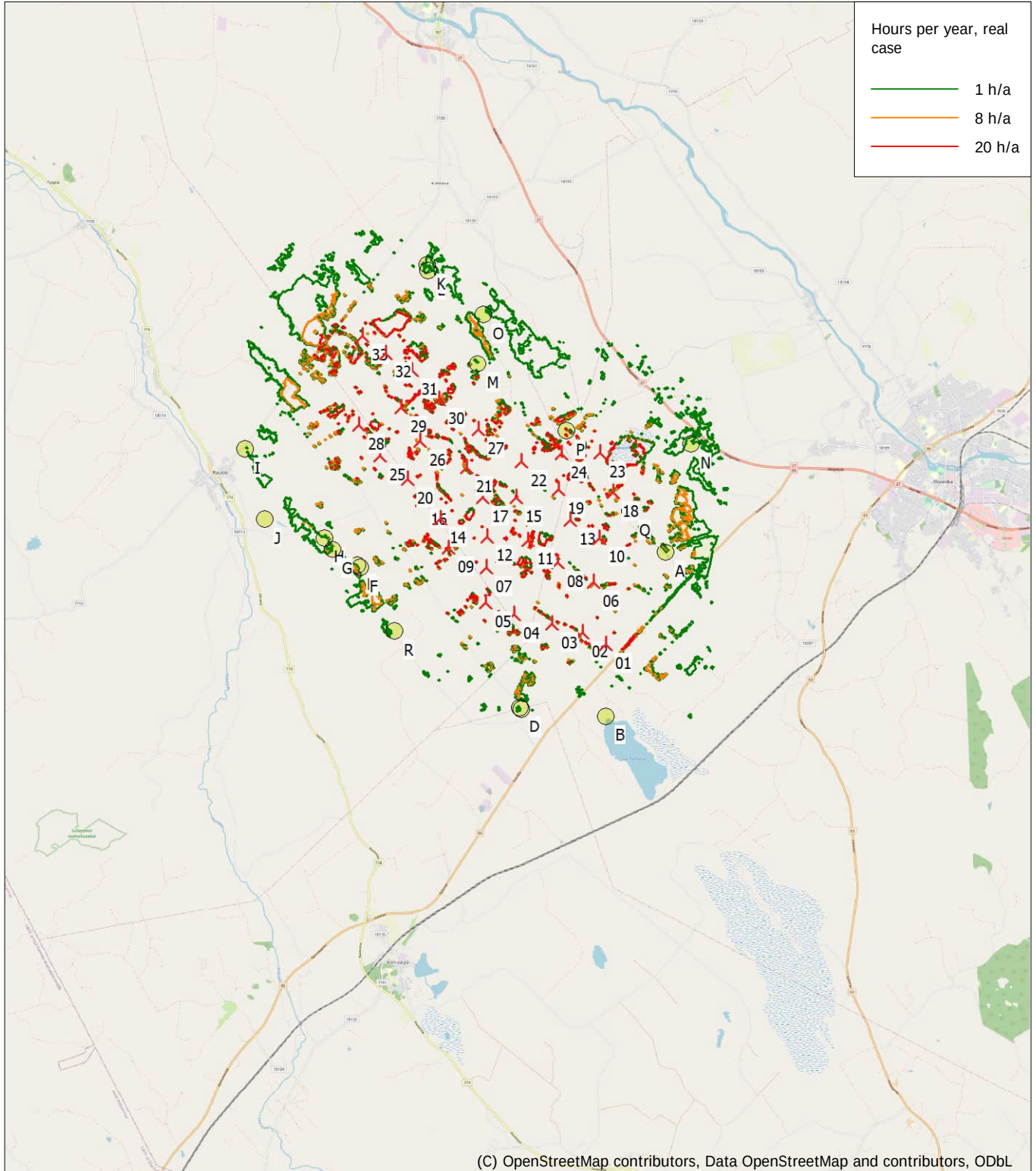
06: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (386)	13: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (409)	29: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (404)
08: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (406)	15: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (412)	30: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (387)
10: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (392)	19: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (395)	31: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (403)
11: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (399)	24: Generic RD200 HH220 7200 200.0 !OI! hub: 220.0 m (TOT: 320.0 m) (398)	

Project:
Verkasalo

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Aarni Nikkola / aarni.nikkola@fcg.fi
Calculated:
5.10.2023 13.32/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE2_RD200x33xHH220_Valke_real case_Luke forest_05102023



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor
Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 24. Verkasalon tuulivoimahanke – varjostusmallinnuksen tulokset ”real case, Luke forest” (VE2). Yhteisvaikutukset Hangaskurunkankaan hankkeen kanssa.

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	426	388	391	554	792	1 006	1 143	936	672	564	618	8 087

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

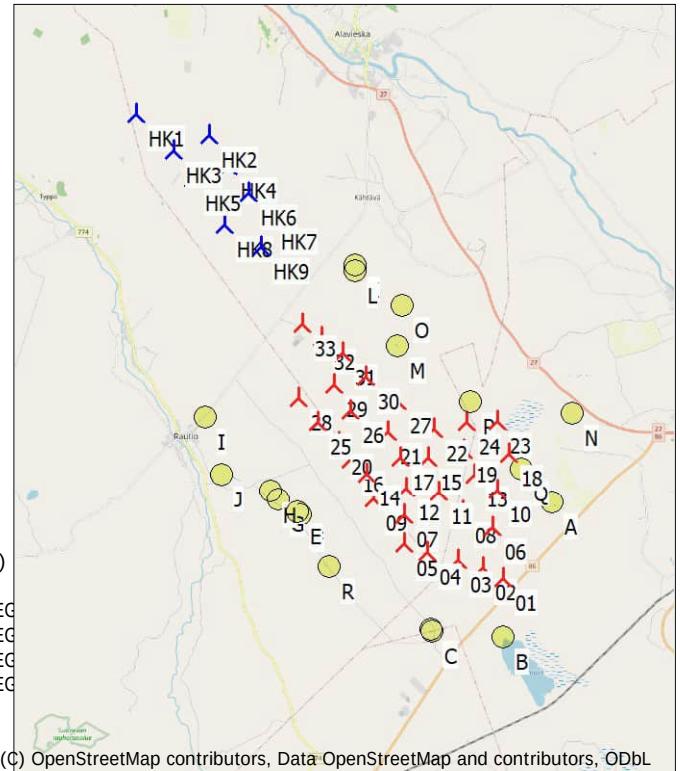
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

Scale 1:200 000

New WTG

Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
05	369 541	7 105 227	72,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	369 591	7 105 980	71,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	371 150	7 106 037	77,1	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	368 764	7 106 453	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	370 521	7 106 556	73,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	369 636	7 106 678	75,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	371 464	7 106 967	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	368 628	7 107 123	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	370 306	7 107 506	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	368 227	7 107 519	68,6	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 568	7 107 523	70,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	372 422	7 107 527	67,9	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	371 227	7 107 652	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	367 939	7 108 000	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	369 253	7 108 202	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	370 442	7 108 273	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	372 176	7 108 397	63,7	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	371 335	7 108 402	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	367 367	7 108 547	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 250	7 108 818	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	369 525	7 109 029	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	366 924	7 109 225	67,2	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
29	367 862	7 109 559	67,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023

...continued from previous page

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM
			[m]									[RPM]
30	368 702	7 109 705	65,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
31	368 126	7 110 369	63,0	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
32	367 574	7 110 777	62,8	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
33	367 096	7 111 177	62,5	Generic RD200 HH220 7200 ...	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
HK1	362 925	7 116 909	50,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK2	364 851	7 116 247	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK3	363 880	7 115 898	53,1	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK4	365 316	7 115 435	55,6	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK5	364 350	7 115 141	55,0	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK6	365 790	7 114 681	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK7	366 307	7 114 024	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK8	365 140	7 113 868	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4
HK9	366 091	7 113 264	57,5	VESTAS V150-4.0 8 200.0 !O...	Yes	VESTAS	V150-4.0-8	8	200,0	200,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
				[m]	[m]	[m]	[m]			[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	2:30
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	2:39
E	Laskentapiste_E (Huhtakylä)	8:45
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	10:28
H	Laskentapiste_H (Karjaneva)	6:26
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	9:58
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	21:56
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	31:02
R	Laskentapiste_R (Huhtala)	0:00

SHADOW - Main Result

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH220_Valke_real case_Luke forest_05102023

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

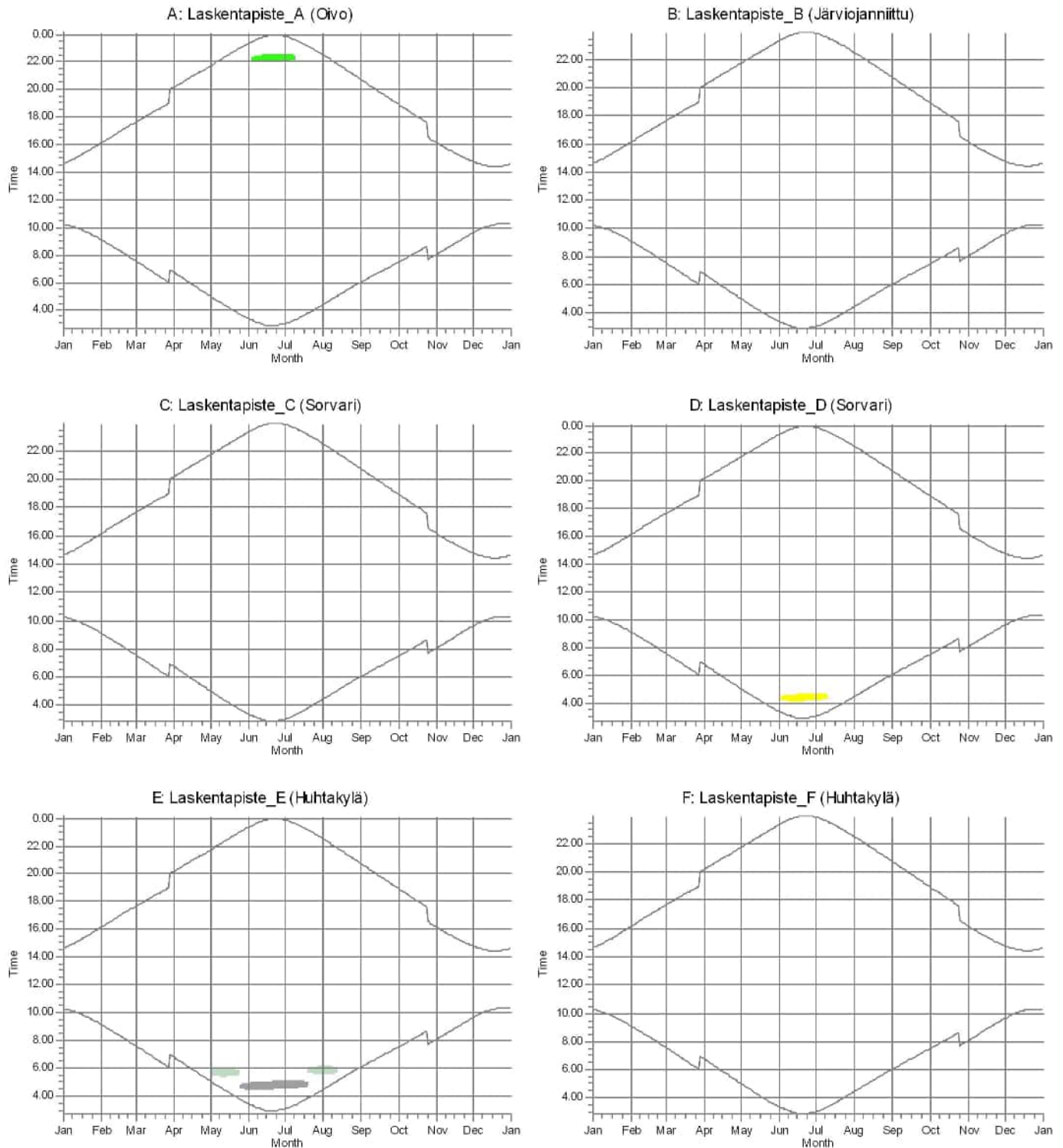
No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (380)	0:00
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (400)	2:39
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (402)	0:00
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (393)	0:00
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (384)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (386)	1:59
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (411)	0:00
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (406)	1:36
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (389)	0:00
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (392)	8:06
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (399)	1:14
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (405)	0:00
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (409)	4:33
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (381)	5:15
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (412)	1:20
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (394)	10:25
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (408)	0:00
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (397)	2:30
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (395)	4:23
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (385)	9:59
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (407)	0:00
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (388)	0:00
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (390)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (398)	29:41
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (391)	0:00
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (410)	0:00
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (383)	0:00
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (382)	0:00
29	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (404)	1:39
30	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (387)	4:31
31	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (403)	5:12
32	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (401)	1:57
33	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (396)	2:21
HK1	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (414)	0:00
HK2	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (421)	0:00
HK3	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (415)	0:00
HK4	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (418)	0:00
HK5	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (416)	0:00
HK6	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (419)	0:00
HK7	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (420)	0:00
HK8	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (417)	0:00
HK9	VESTAS V150-4.0 8 200.0 !O! hub: 200,0 m (TOT: 300,0 m) (422)	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: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH220_Valke_real case_Luke forest_05102023



WTGs

02: Generic RD200 HH220 7200 200.0 I/OI hub: 220.0 m (TOT: 320.0 m) (400)

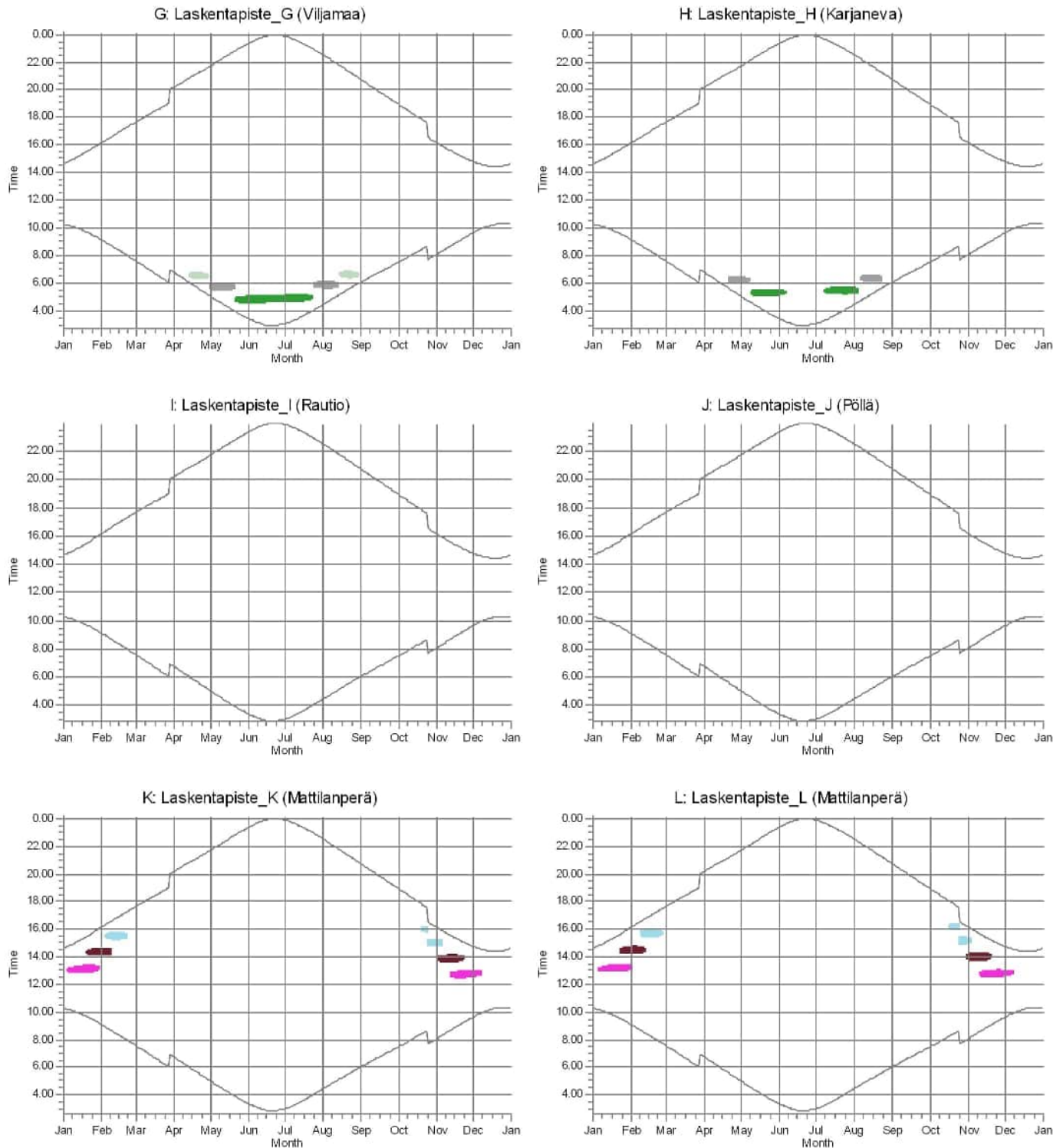
14: Generic RD200 HH220 7200 200.0 I/OI hub: 220.0 m (TOT: 320.0 m) (381)

16: Generic RD200 HH220 7200 200.0 I/OI hub: 220.0 m (TOT: 320.0 m) (394)

18: Generic RD200 HH220 7200 200.0 I/OI hub: 220.0 m (TOT: 320.0 m) (397)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023



WTGs

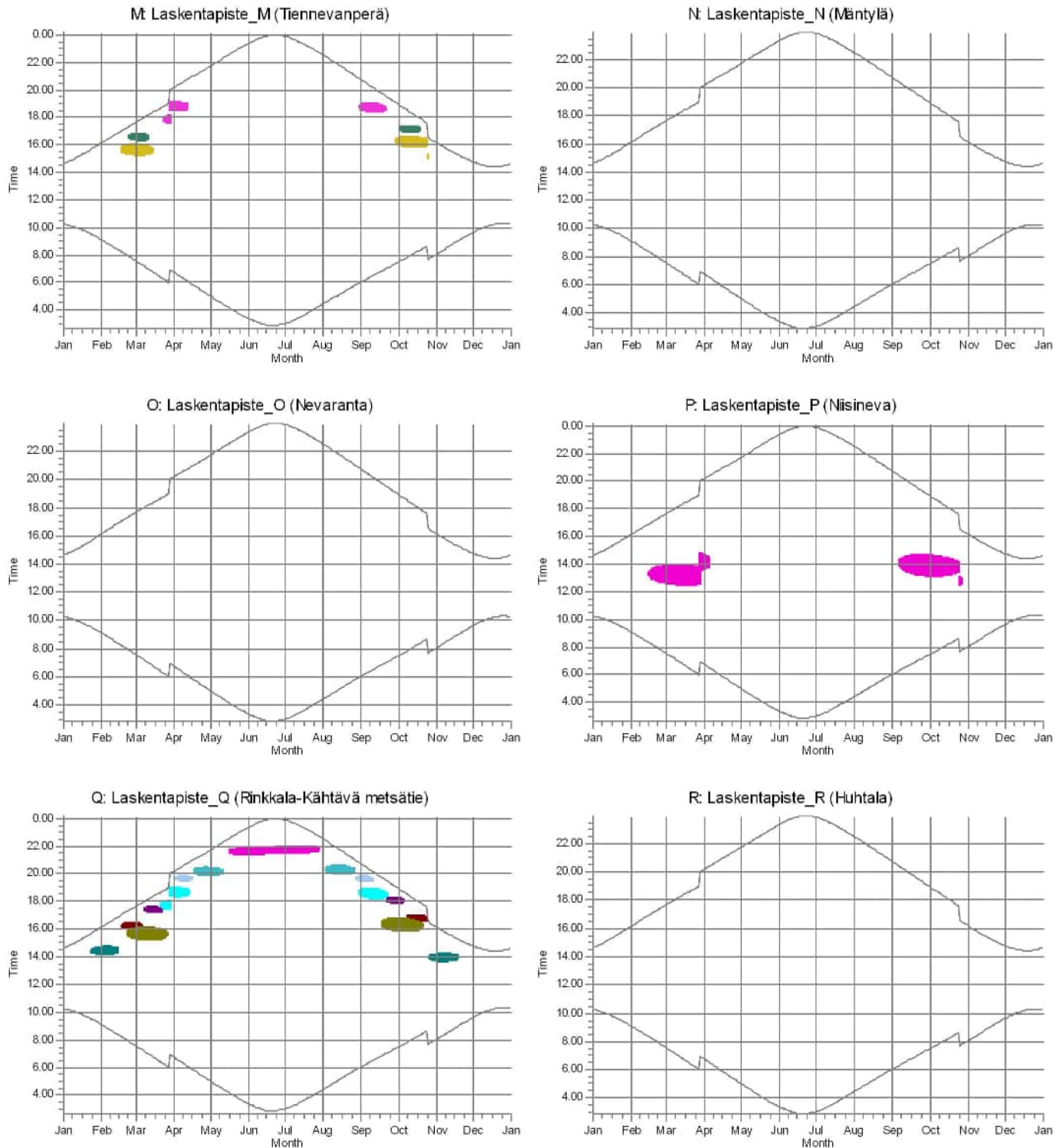
14: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (381)
 16: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (394)

20: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (385)
 31: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (403)

32: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (401)
 33: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (396)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023



WTGs

06: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (386)
 08: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (406)
 10: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (392)
 11: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (399)

13: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (409)
 15: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (412)
 19: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (395)
 24: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (398)

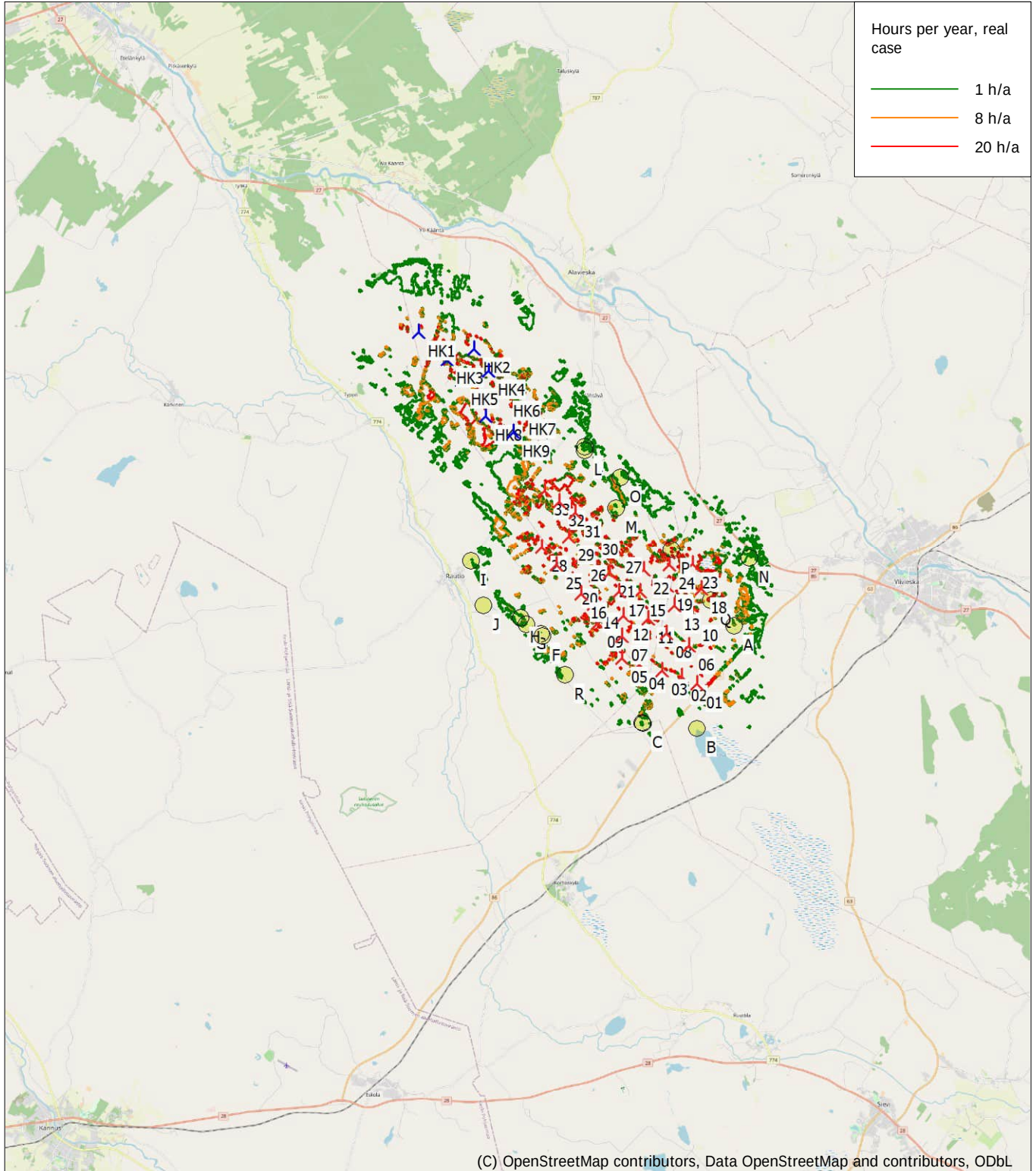
29: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (404)
 30: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (387)
 31: Generic RD200 HH220 7200 200.0 IOI hub: 220.0 m (TOT: 320.0 m) (403)

Project:
Verkasalo

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Aarni Nikkola / aarni.nikkola@fcg.fi
Calculated:
5.10.2023 13.51/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE2_RD200x33xHH220+Hangaskurunkangas_RD200x9xHH200_Valke_real case_Luke forest_05102023



Map: EMD OpenStreetMap , Print scale 1:200 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 366 940 North: 7 108 640
New WTG Shadow receptor
Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 25. Verkasalon tuulivoimahanke – Kuntakohtaiset varjostusmallinnuksen tulokset ”real case, no forest” (VE1).

SHADOW - Main Result

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence	2 500 m
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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)
Obstacles used in calculation
Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

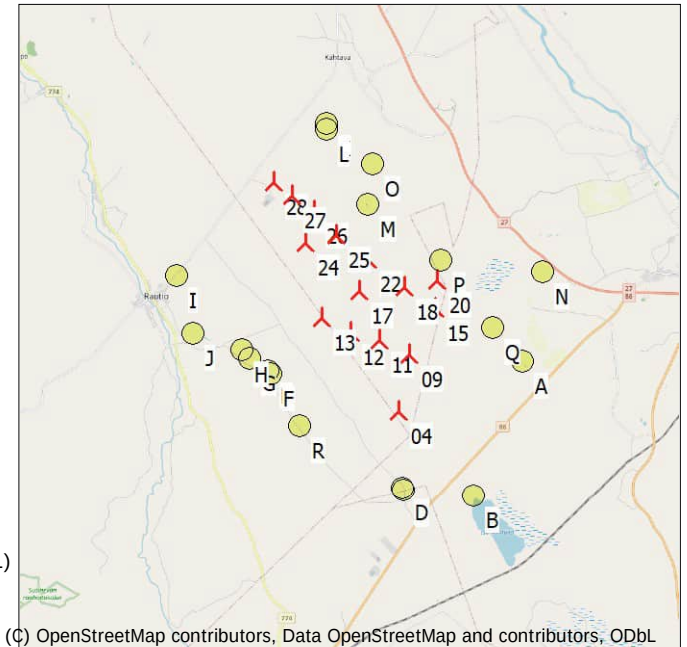
WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	370 503	7 106 453	74,7	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	369 736	7 106 883	72,5	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	368 953	7 107 128	72,0	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	367 862	7 109 559	67,5	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	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	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattiilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattiilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0

To be continued on next page...



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

New WTG

Scale 1:200 000
Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_no forest

...continued from previous page

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]
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	0:00
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	0:00
E	Laskentapiste_E (Huhtakylä)	7:25
F	Laskentapiste_F (Huhtakylä)	6:18
G	Laskentapiste_G (Viljamaa)	3:02
H	Laskentapiste_H (Karjaneva)	2:12
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	17:51
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	4:06
P	Laskentapiste_P (Niisineva)	33:31
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	13:16
R	Laskentapiste_R (Huhtala)	0:00

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

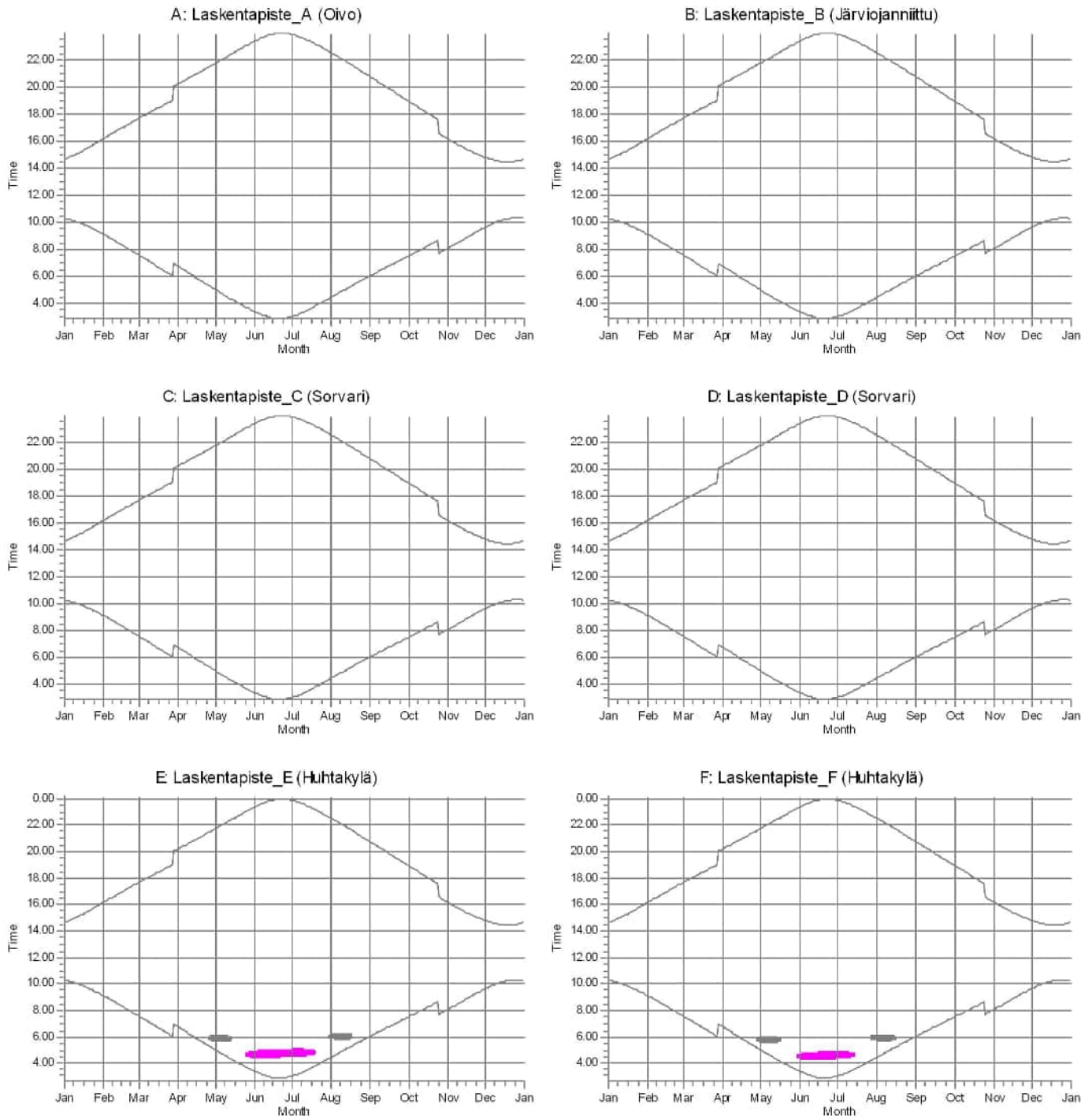
No.	Name	Expected [h/year]
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (542)	0:00
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (547)	1:09
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (551)	0:00
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (538)	3:24
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (543)	11:50
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (544)	8:09
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (552)	2:25
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (541)	5:32
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (546)	29:43
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (539)	5:15
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (550)	1:39
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (540)	5:52
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (549)	6:44
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (548)	5:25
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (545)	2:21

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: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_no forest

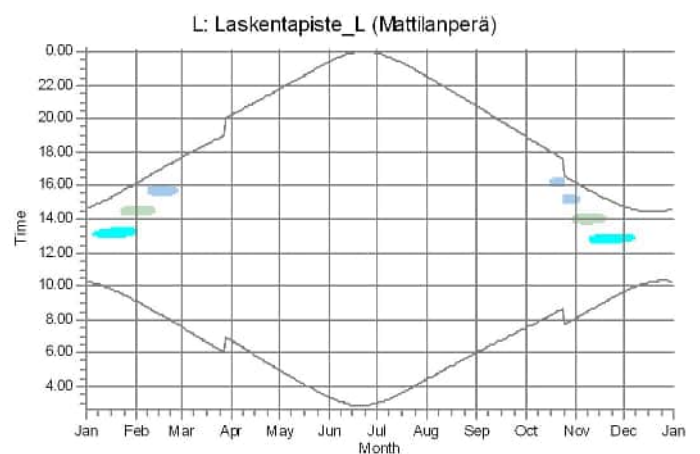
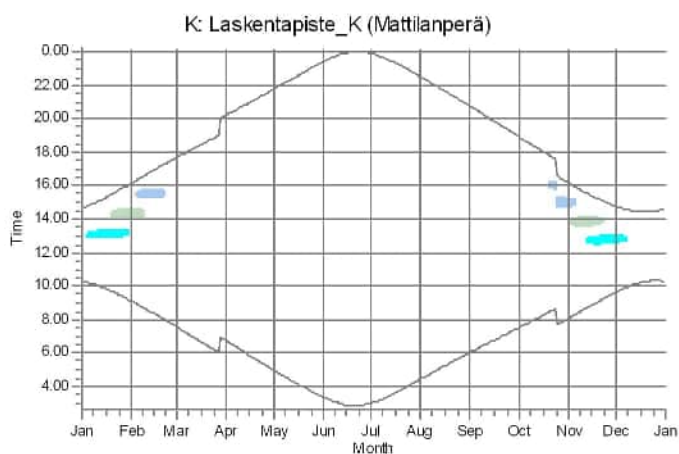
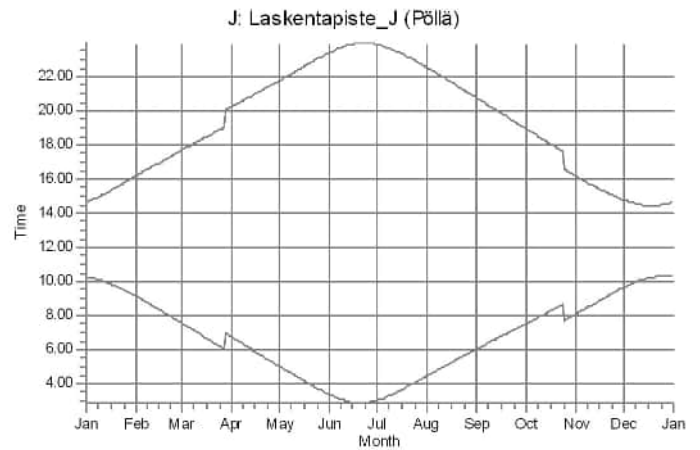
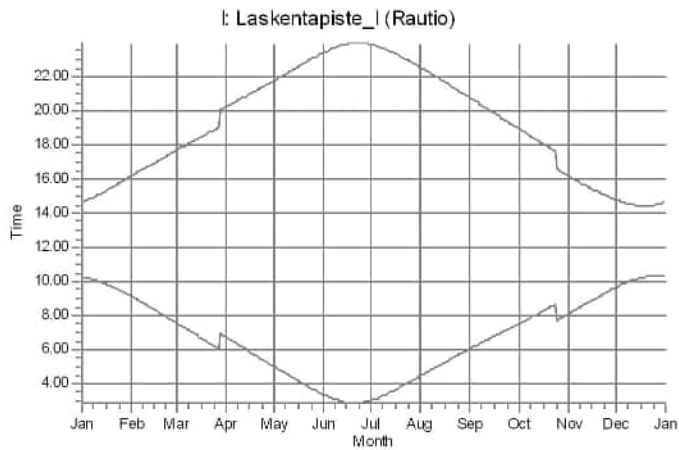
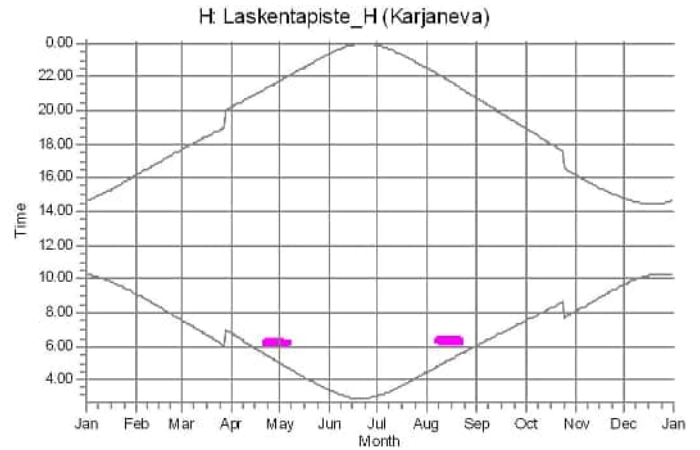
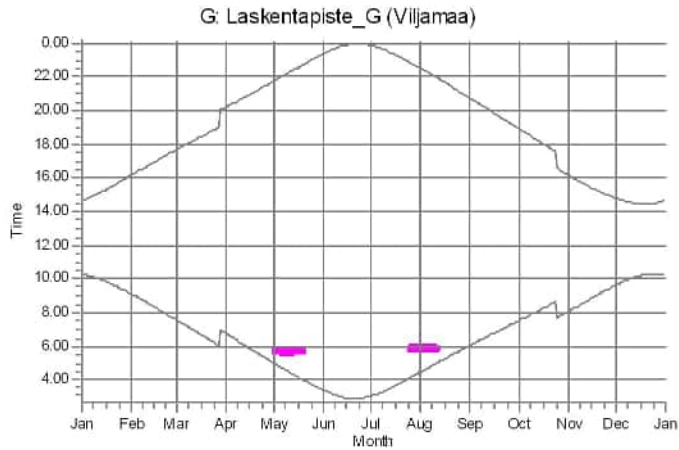


WTGs

- 12: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (538)
- 13: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (543)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_no forest



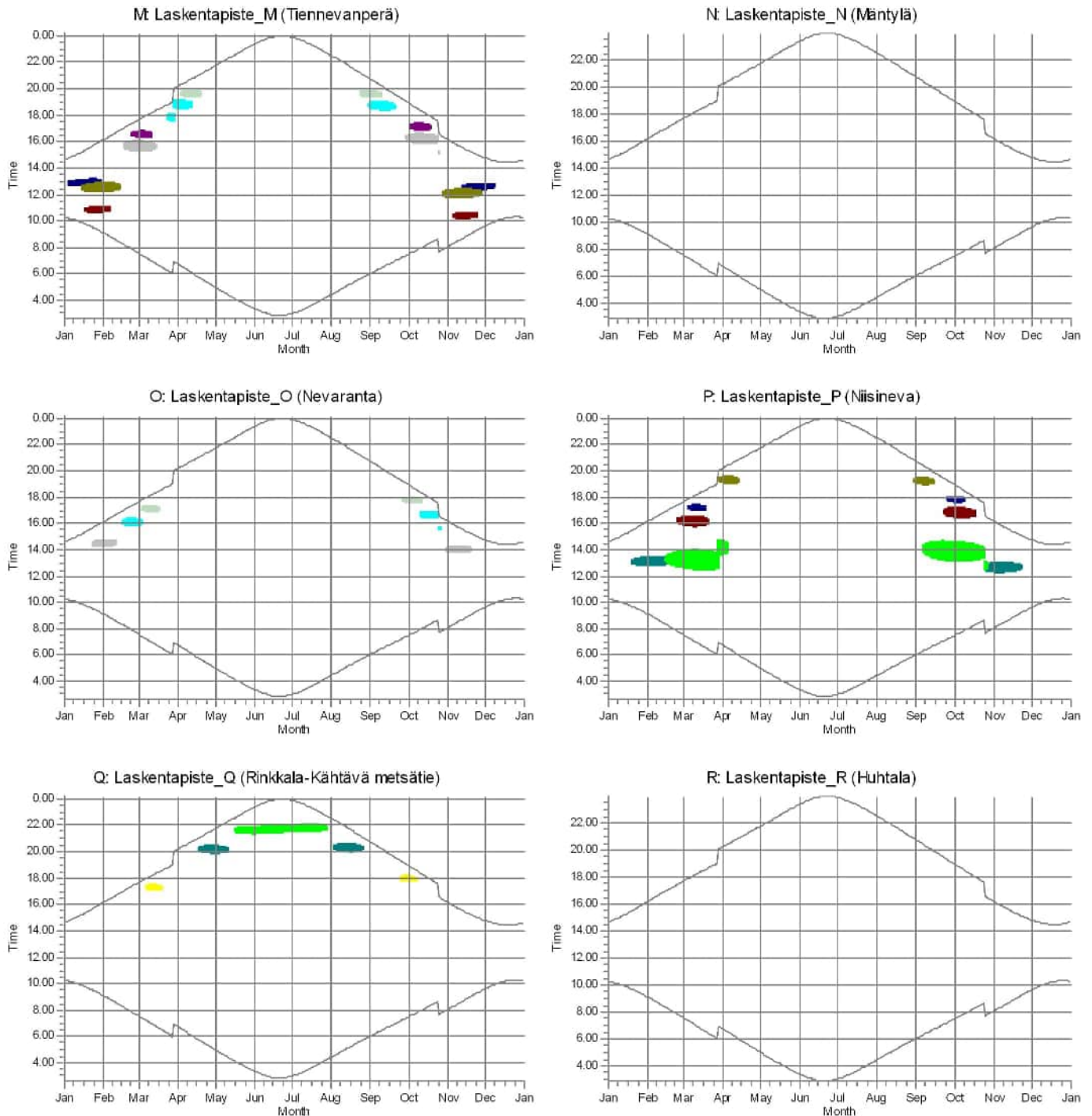
WTGs

- 13: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (543)
 26: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (549)

- 27: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (548)
 28: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (545)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_no forest



WTGs

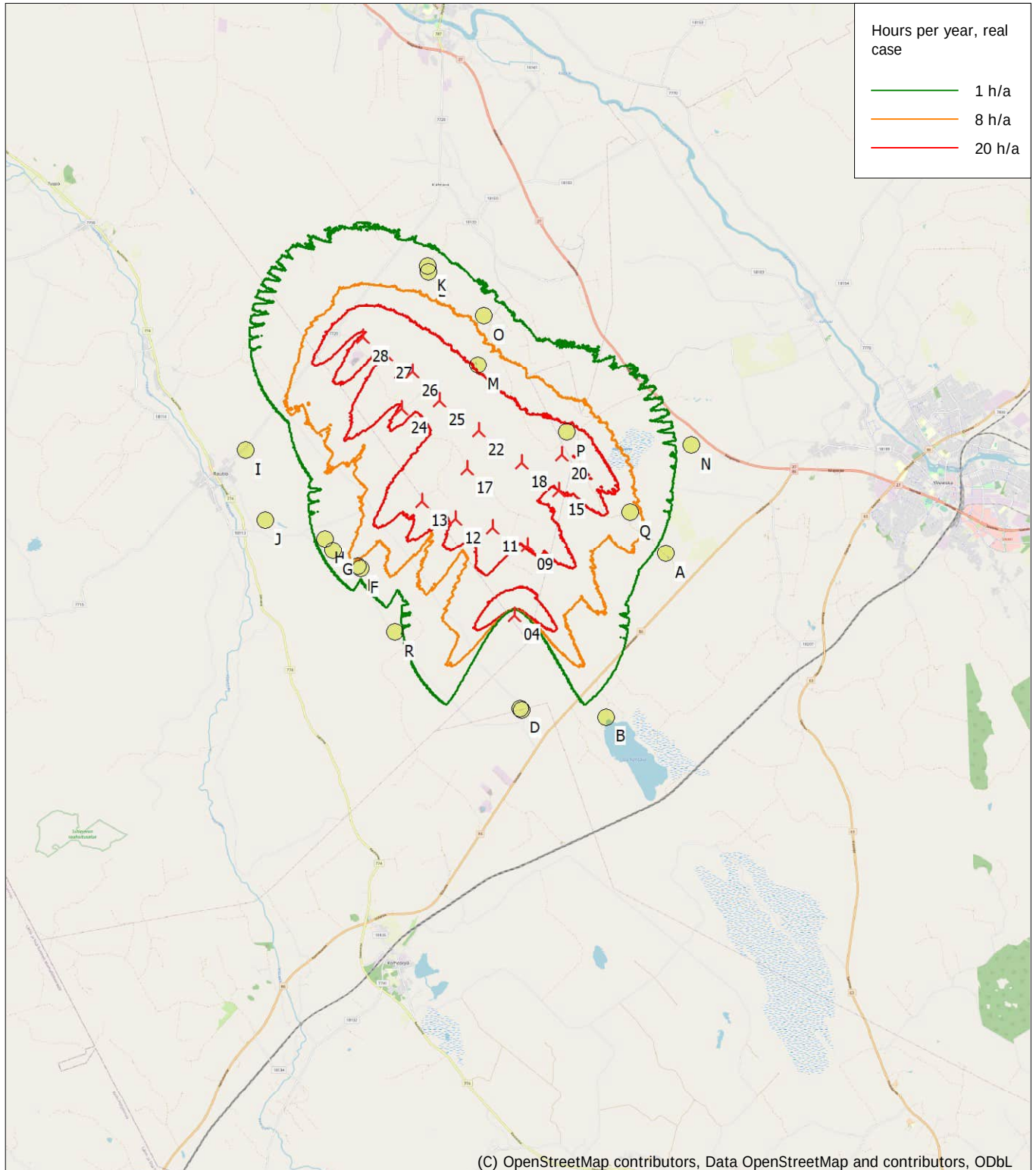
09: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (547)	22: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (539)
15: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (544)	24: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (550)
17: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (552)	25: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (540)
18: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (541)	26: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (549)
20: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (546)	27: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (548)

Project:
Verkasalo

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Calculated:
19.9.2023 13.46/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_no forest



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor
Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

SHADOW - Main Result

Calculation: Verkasalo_VE1_Kalajoki_RD200x5xHH220_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

All coordinates are in

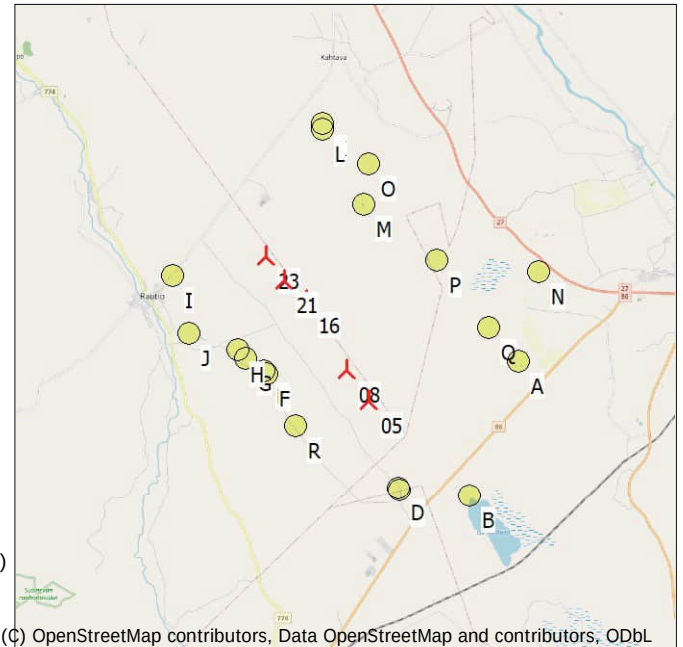
Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
05	369 485	7 105 301	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	368 920	7 106 101	71,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	367 939	7 108 000	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	367 367	7 108 547	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	366 924	7 109 225	67,2	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
							a.g.l.	window		(ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviöjanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0



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

Scale 1:200 000

New WTG

Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE1_Kalajoki_RD200x5xHH220_Valke_real case_no forest

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values
		Shadow hours per year [h/year]
A	Laskentapiste_A (Oivo)	0:00
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	0:00
E	Laskentapiste_E (Huhtakylä)	1:46
F	Laskentapiste_F (Huhtakylä)	1:56
G	Laskentapiste_G (Viljamaa)	5:46
H	Laskentapiste_H (Karjaneva)	4:14
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	0:00
L	Laskentapiste_L (Mattilanperä)	0:00
M	Laskentapiste_M (Tiennevanperä)	0:00
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	0:00
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	0:00
R	Laskentapiste_R (Huhtala)	6:17

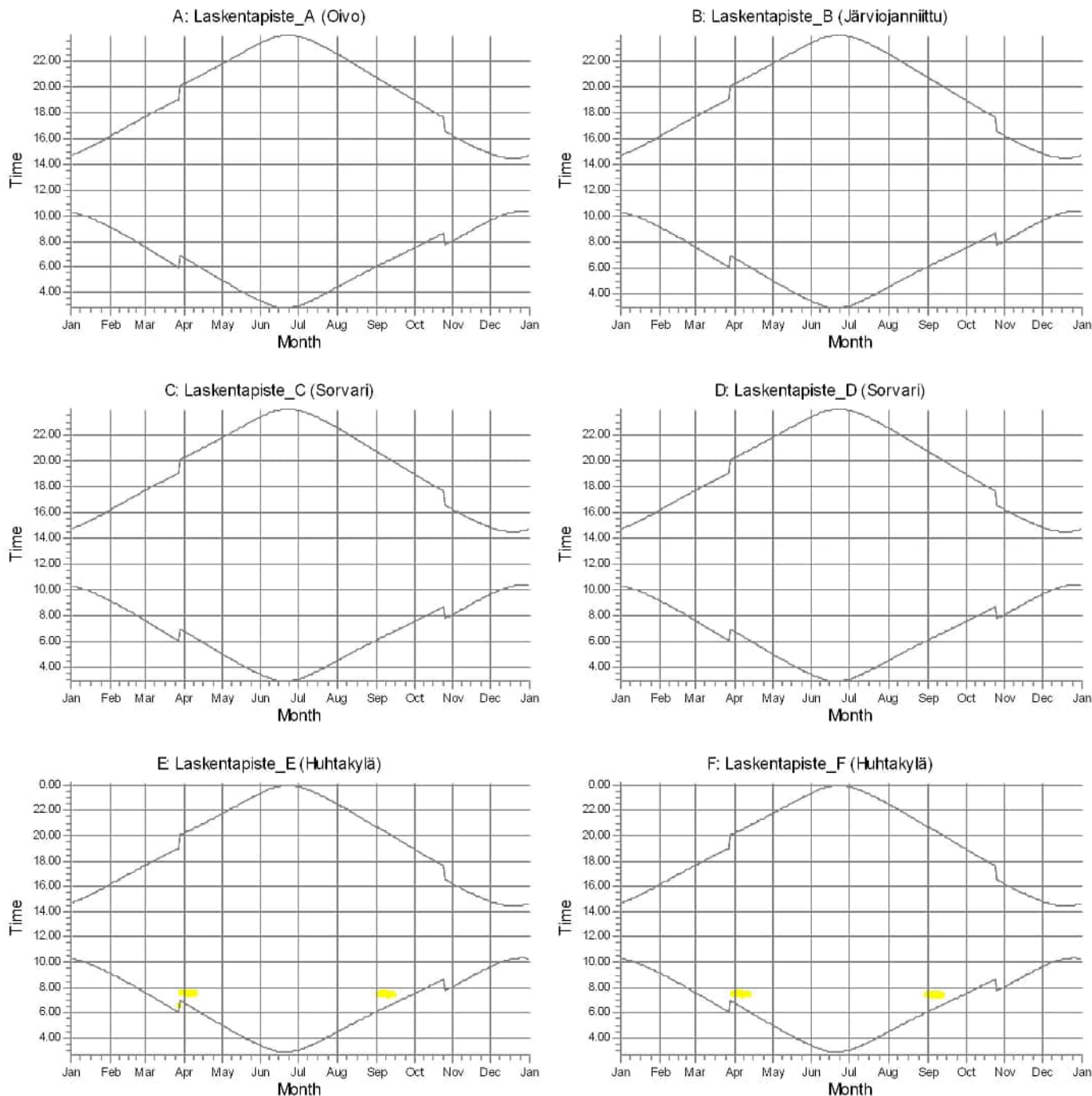
Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (534)	2:39
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (536)	6:06
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (535)	10:00
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (537)	0:00
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (533)	0:00

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

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Kalajoki_RD200x5xHH220_Valke_real case_no forest

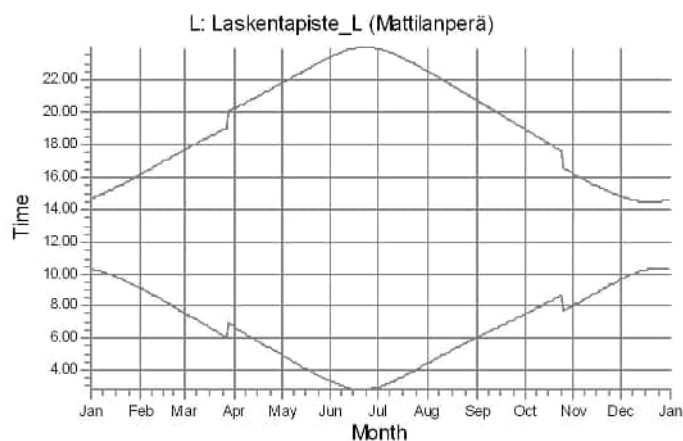
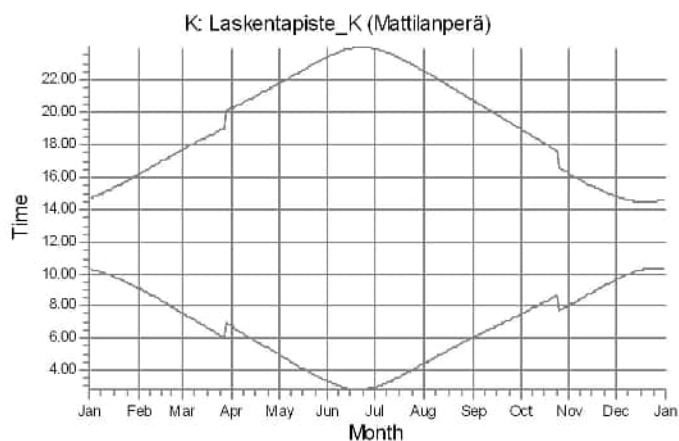
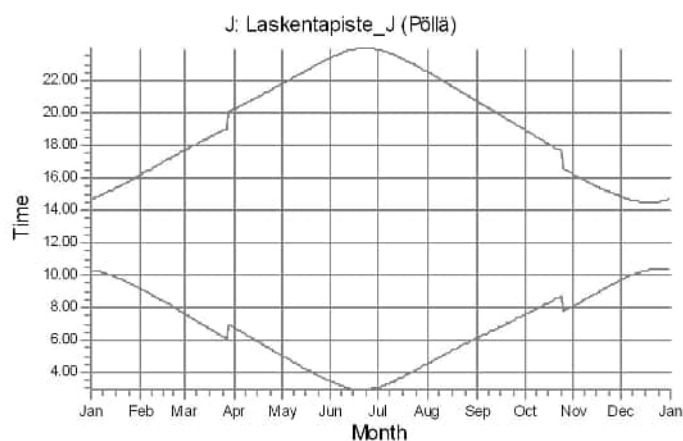
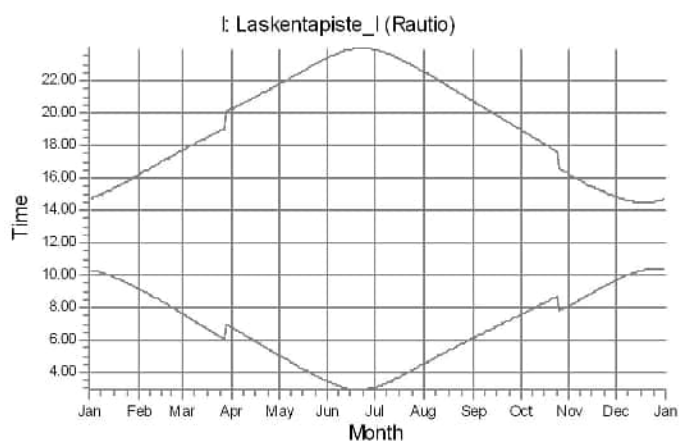
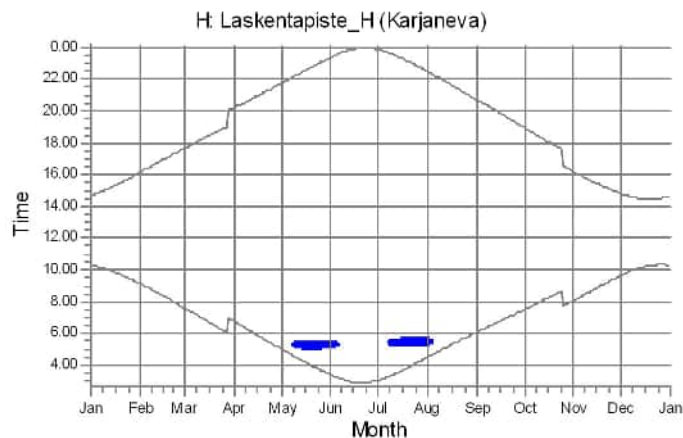
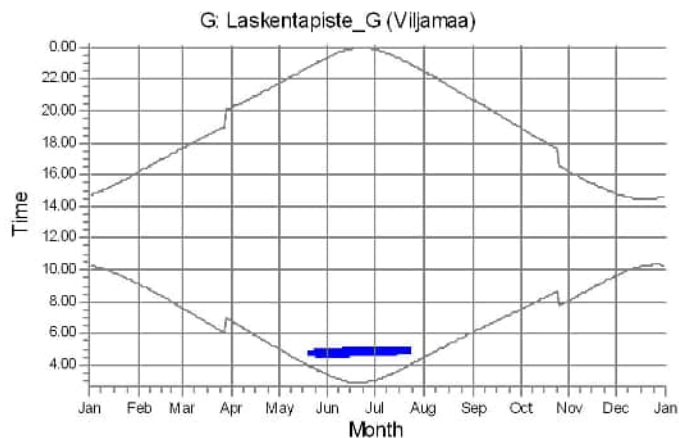


WTGs

08: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (536)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Kalajoki_RD200x5xHH220_Valke_real case_no forest

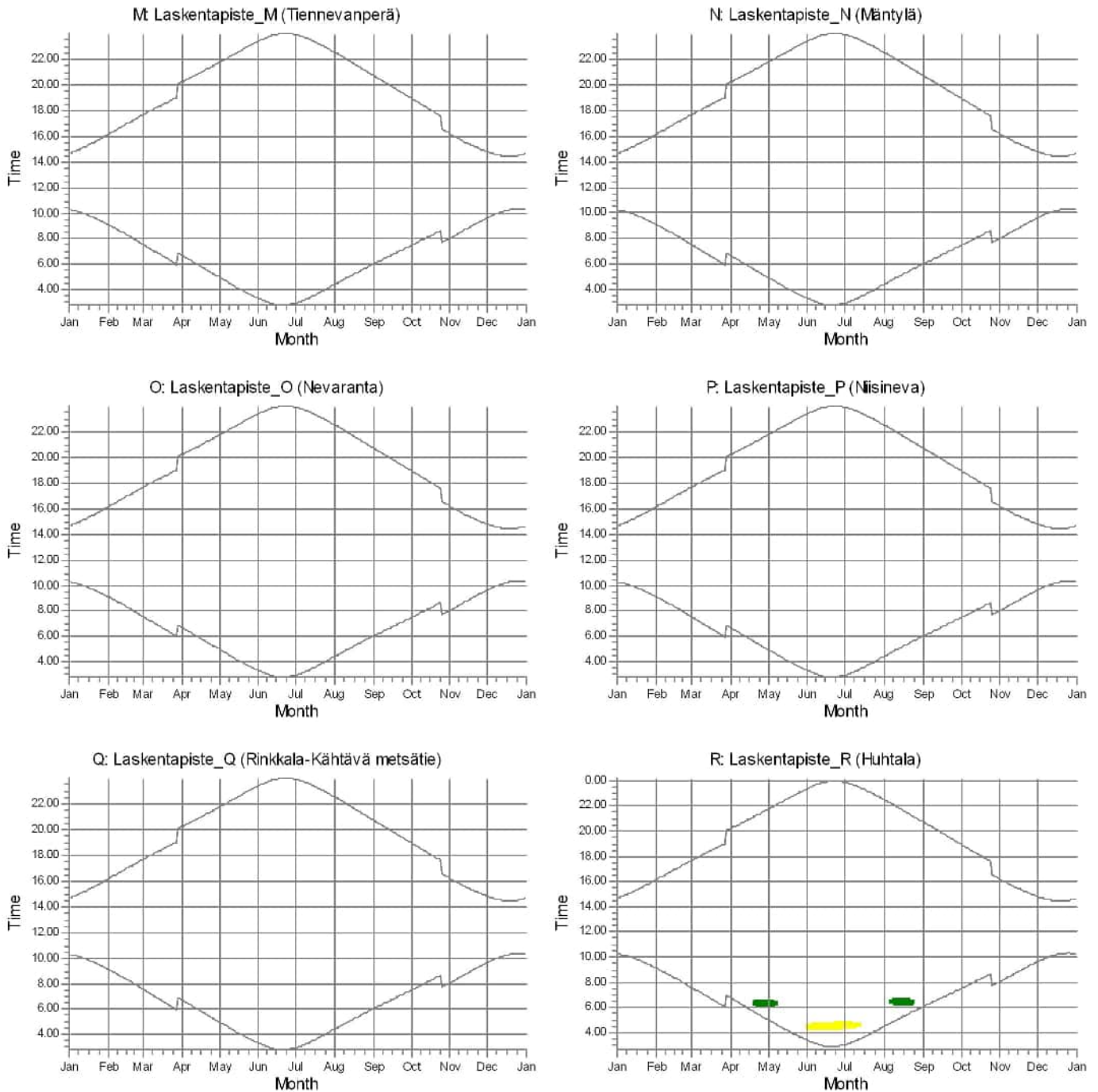


WTGs

16: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (535)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Kalajoki_RD200x5xHH220_Valke_real case_no forest



WTGs

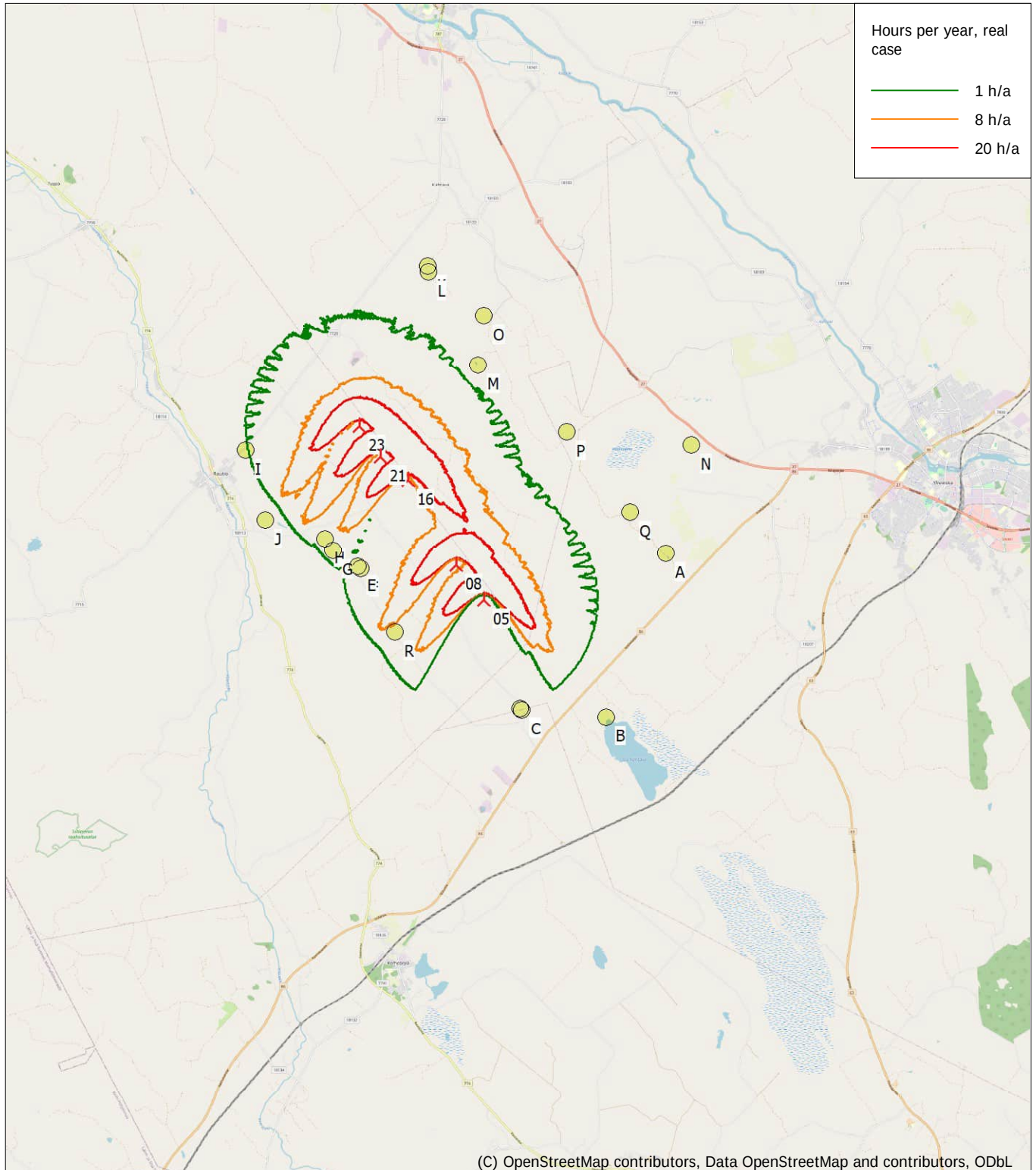


05: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (534)

08: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (536)

SHADOW - Map

Calculation: Verkasalo_VE1_Kalajoki_RD200x5xHH220_Valke_real case_no forest



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
 New WTG Shadow receptor
 Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
 Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

Project:

Verkasalo

Licensed user:

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Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

19.9.2023 16.10/3.6.355

SHADOW - Main Result

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

All coordinates are in

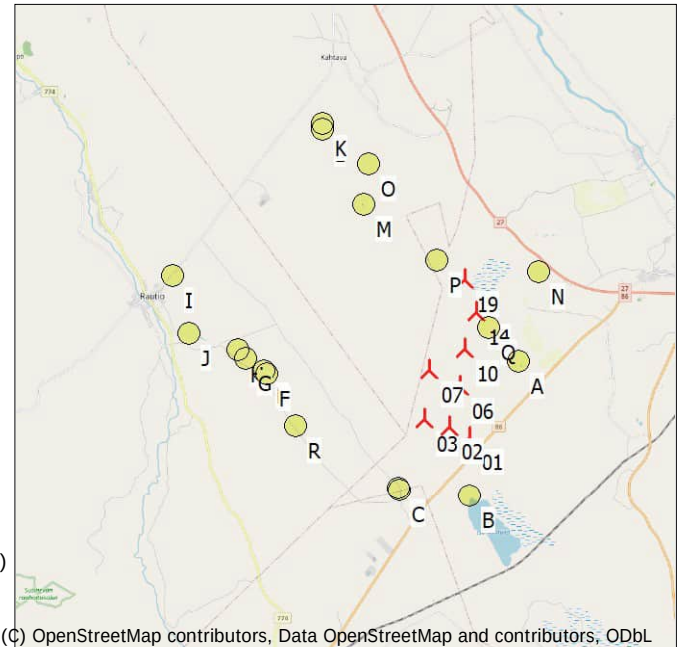
Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	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	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjanneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0



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

Scale 1:200 000

New WTG

Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_no forest

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values
		Shadow hours per year [h/year]
A	Laskentapiste_A (Oivo)	12:03
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	5:50
D	Laskentapiste_D (Sorvari)	6:16
E	Laskentapiste_E (Huhtakylä)	0:00
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	0:00
H	Laskentapiste_H (Karjaneva)	0:00
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	0:00
L	Laskentapiste_L (Mattilanperä)	0:00
M	Laskentapiste_M (Tiennevanperä)	0:00
N	Laskentapiste_N (Mäntylä)	3:26
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	12:13
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	11:44
R	Laskentapiste_R (Huhtala)	0:00

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

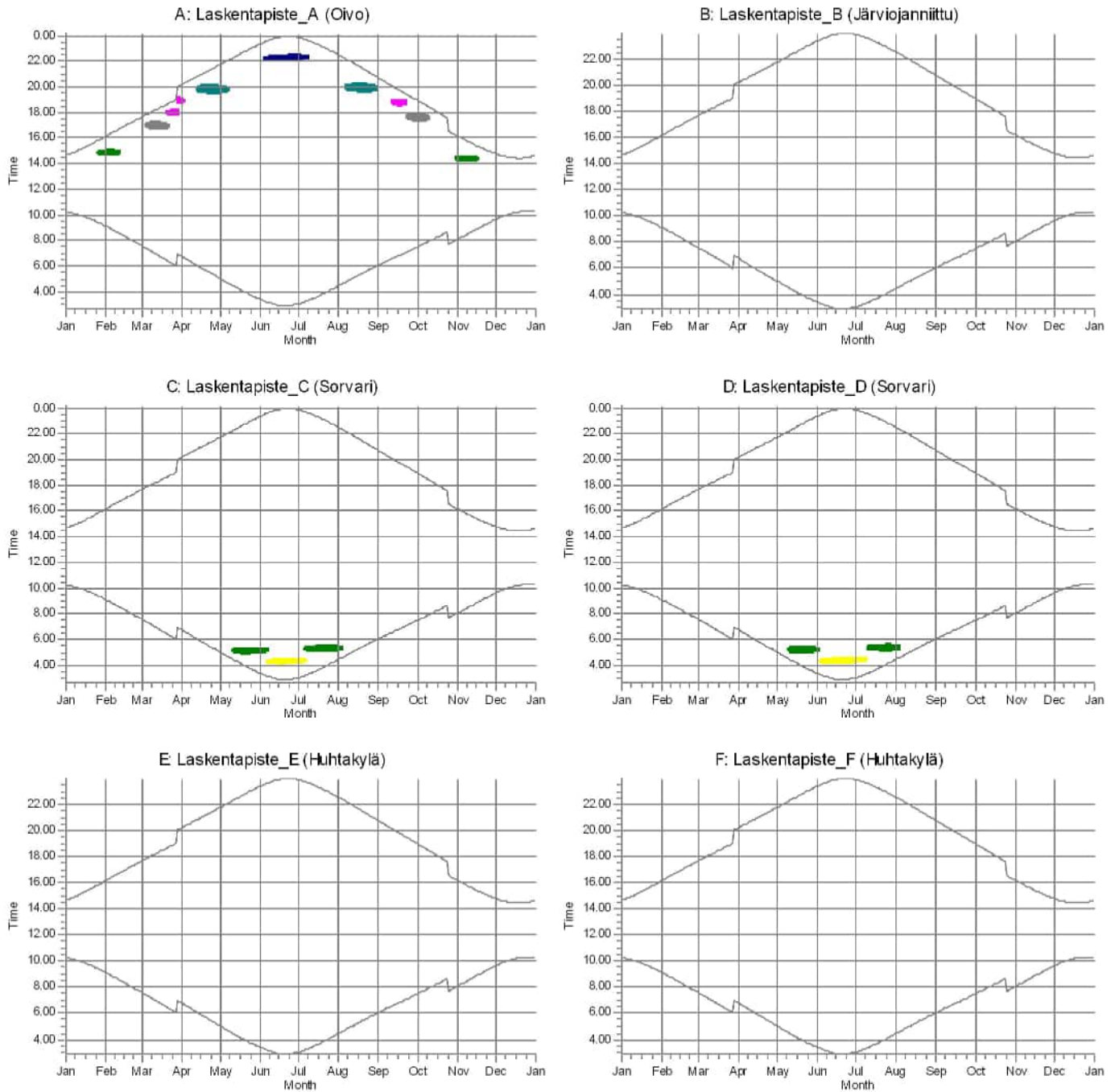
No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (553)	5:57
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (558)	3:05
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (559)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (554)	4:15
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (560)	2:54
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (556)	13:58
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (557)	6:21
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (555)	10:46

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: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_no forest

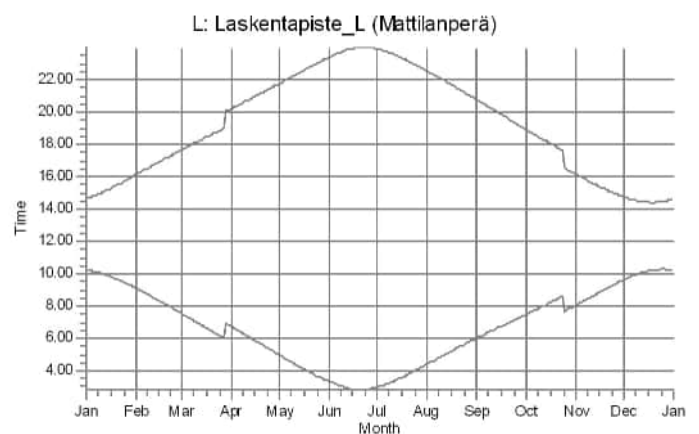
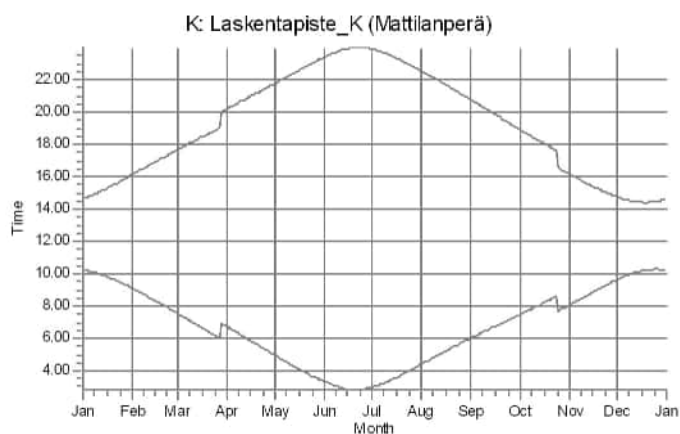
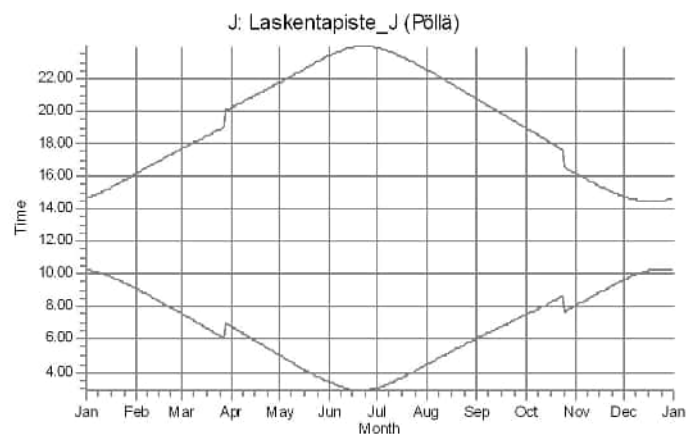
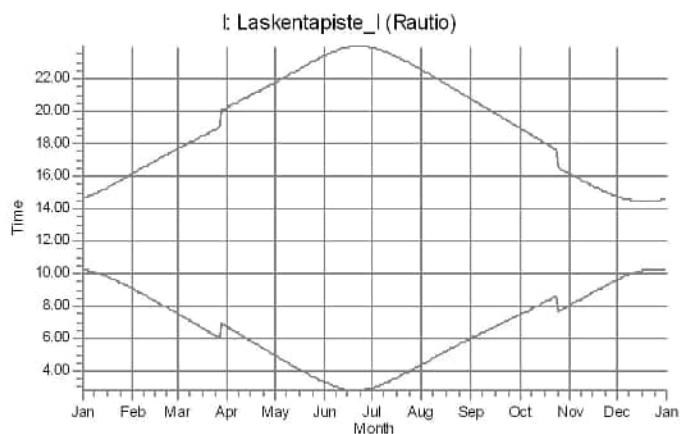
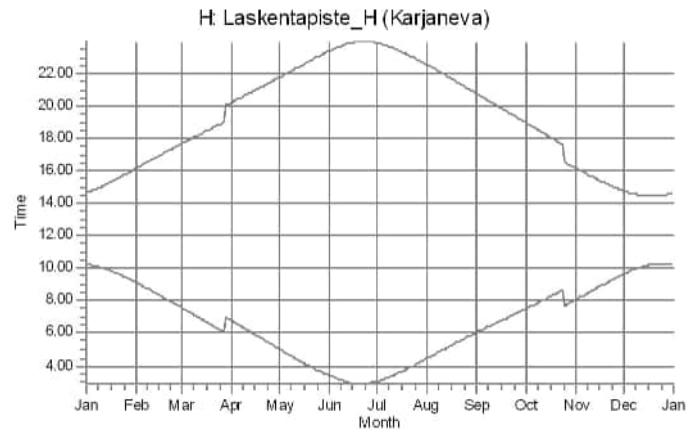
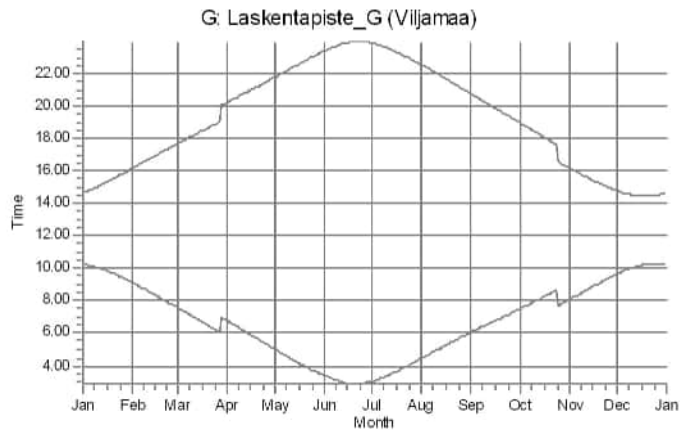


WTGs

01: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (553)
02: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (558)
06: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (554)
07: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (560)
10: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (556)
14: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (557)

SHADOW - Calendar, graphical

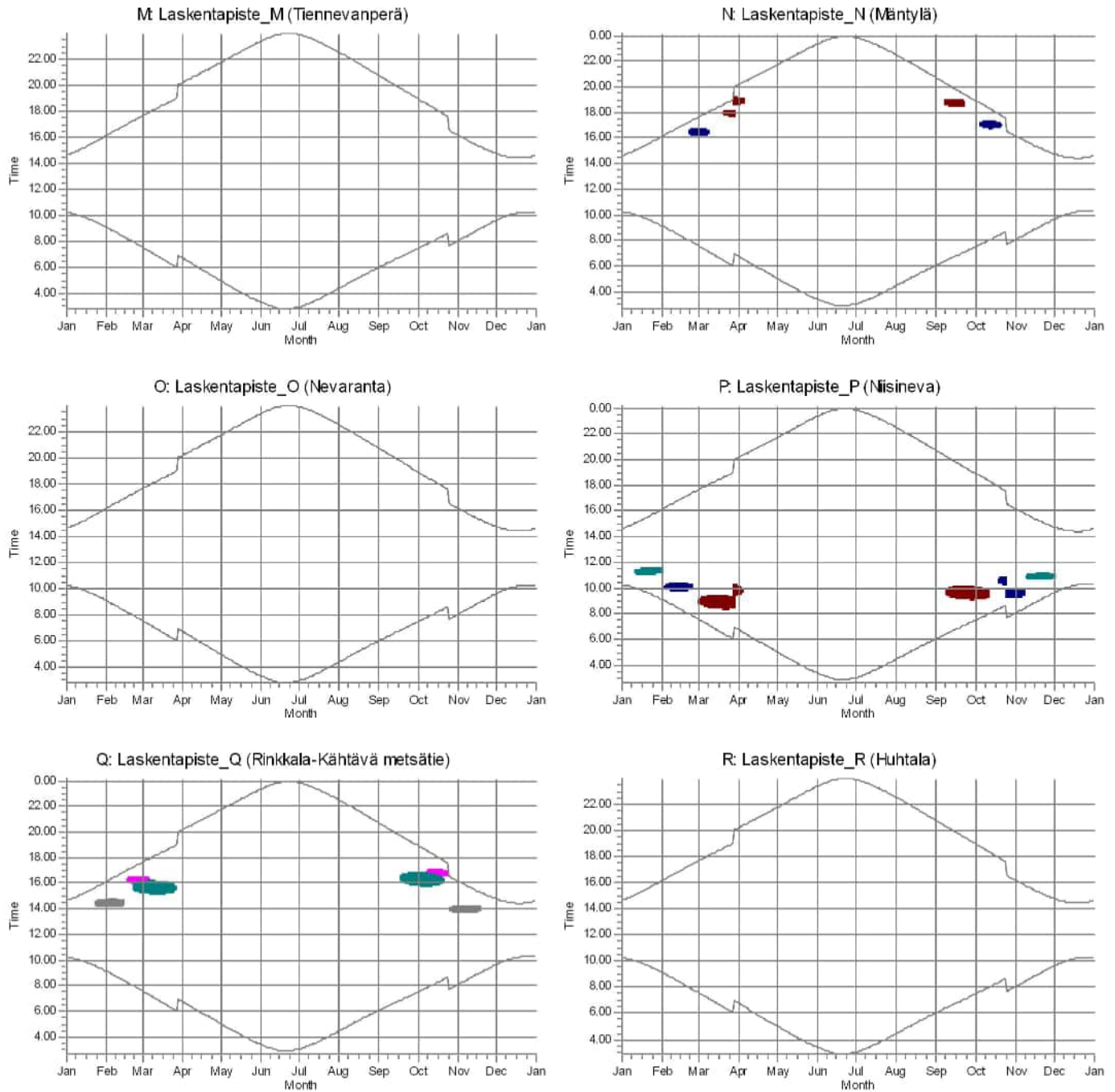
Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_no forest



WTGs

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_no forest



WTGs

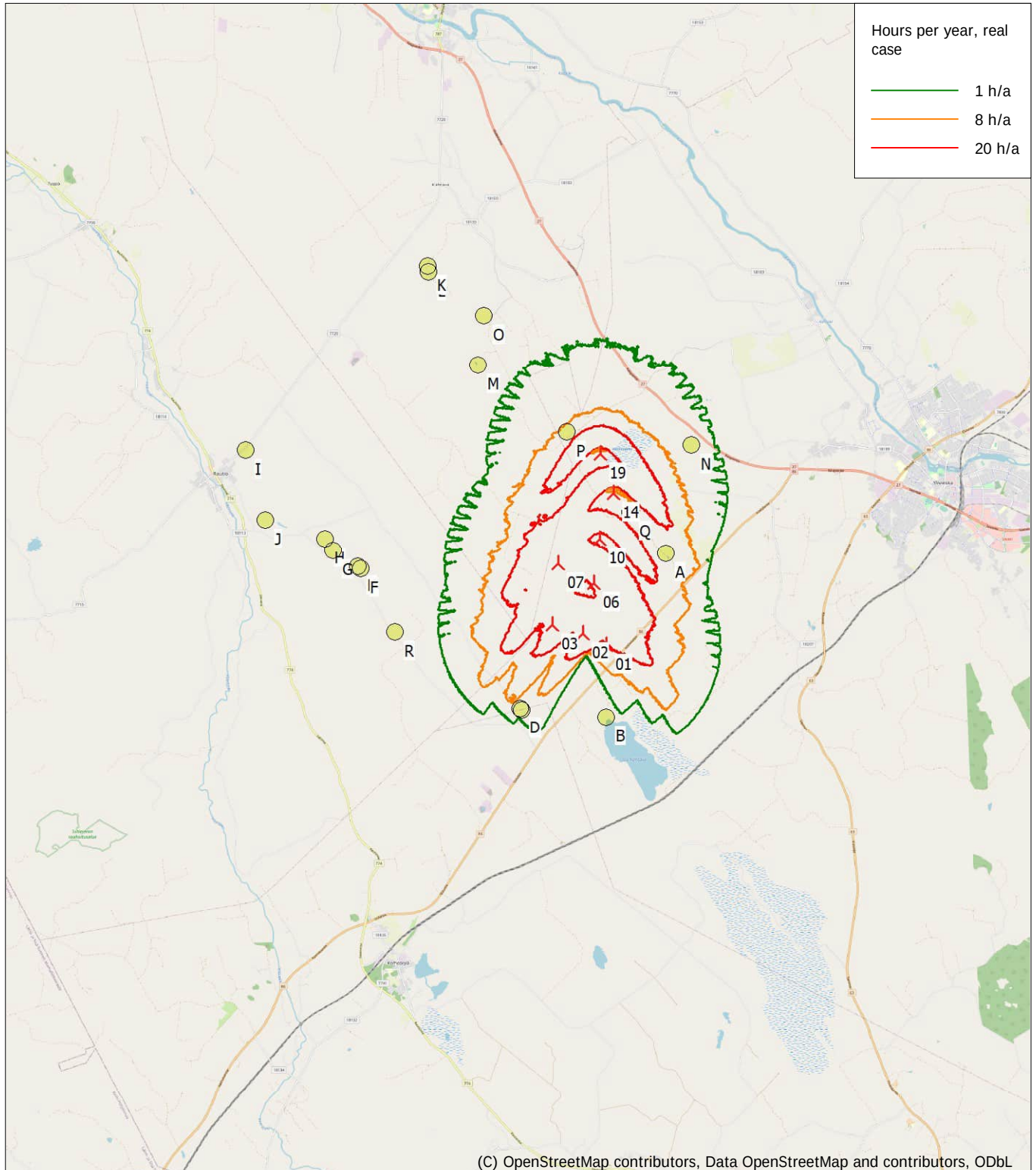
06: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (554)
07: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (560)
10: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (556)
14: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (557)
19: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (555)

Project:
Verkasalo

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
FI-00601 Helsinki
+358104095666
Aarni Nikkola / aarni.nikkola@fcg.fi
Calculated:
19.9.2023 16.10/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_no forest



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor
Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 26. Verkasalon tuulivoimahanke – Kuntakohtaiset varjostusmallinnuksen tulokset ”real case, no forest” (VE2).

SHADOW - Main Result

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence	2 500 m
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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)
Obstacles used in calculation
Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

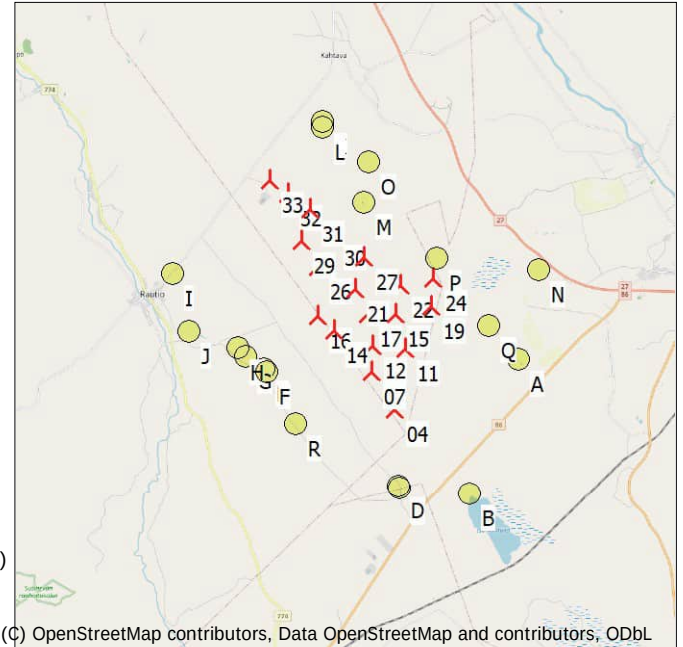
WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	369 591	7 105 980	71,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	370 521	7 106 556	73,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	369 636	7 106 678	75,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	368 628	7 107 123	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	370 306	7 107 506	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 568	7 107 523	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 250	7 108 818	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
29	367 862	7 109 559	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
30	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
31	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
32	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
33	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0

To be continued on next page...



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

New WTG

Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_no forest

...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	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0

Calculation Results

Shadow receptor

Shadow, expected values

No.	Name	Shadow hours per year [h/year]
A	Laskentapiste_A (Oivo)	0:00
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	0:00
E	Laskentapiste_E (Huhtakylä)	8:46
F	Laskentapiste_F (Huhtakylä)	7:56
G	Laskentapiste_G (Viljamaa)	4:42
H	Laskentapiste_H (Karjaneva)	2:12
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	19:16
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	4:06
P	Laskentapiste_P (Niisineva)	36:26
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	14:41
R	Laskentapiste_R (Huhtala)	2:58

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

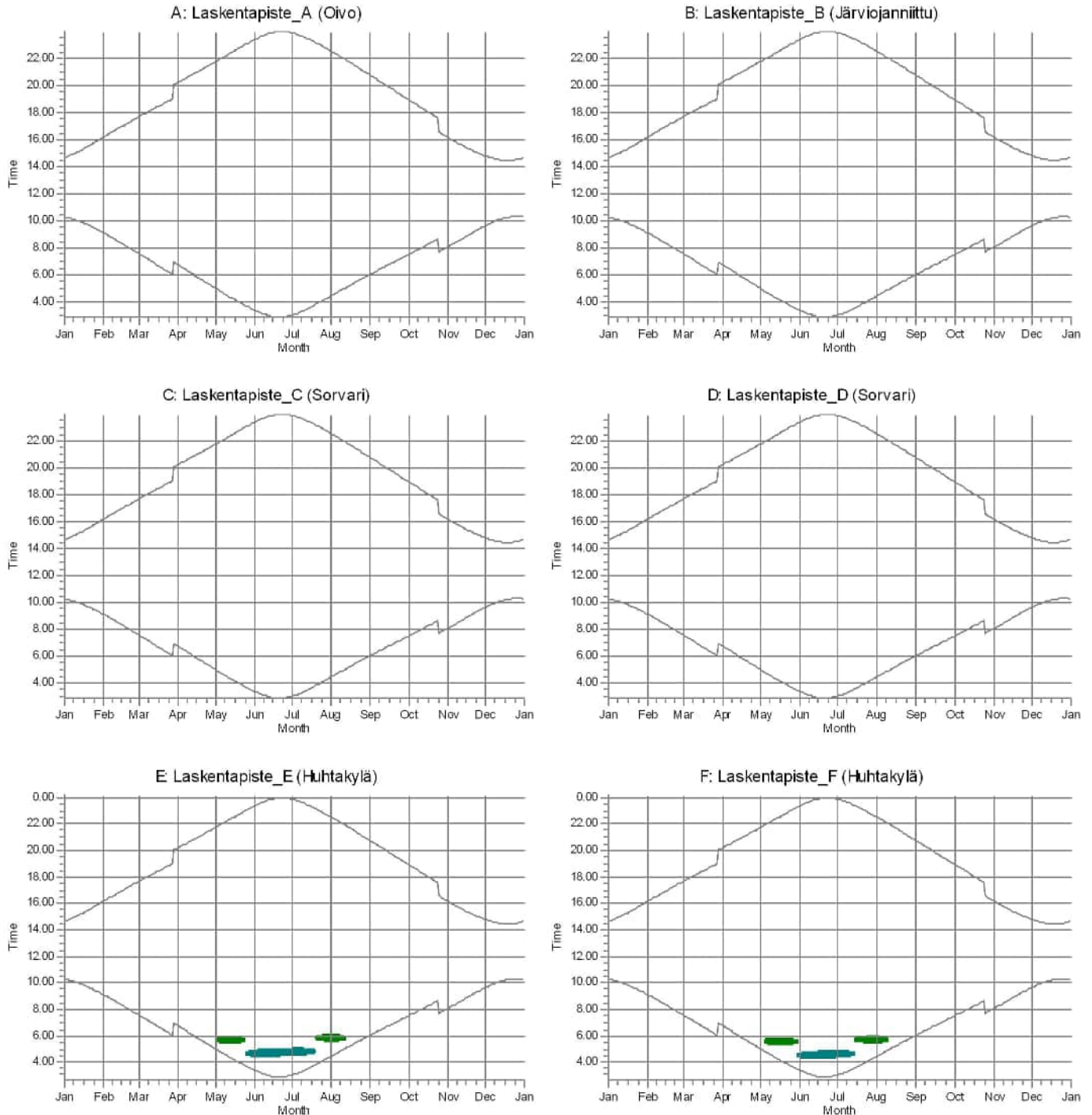
No.	Name	Expected [h/year]
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (565)	0:00
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (578)	2:58
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (570)	1:14
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (574)	0:00
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (561)	7:16
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (579)	3:16
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (566)	11:52
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (576)	1:06
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (567)	8:09
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (575)	2:25
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (564)	5:32
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (569)	29:43
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (577)	1:25
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (562)	5:15
29	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (573)	1:39
30	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (563)	5:52
31	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (572)	6:44
32	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (571)	5:25
33	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (568)	2:21

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: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_no forest



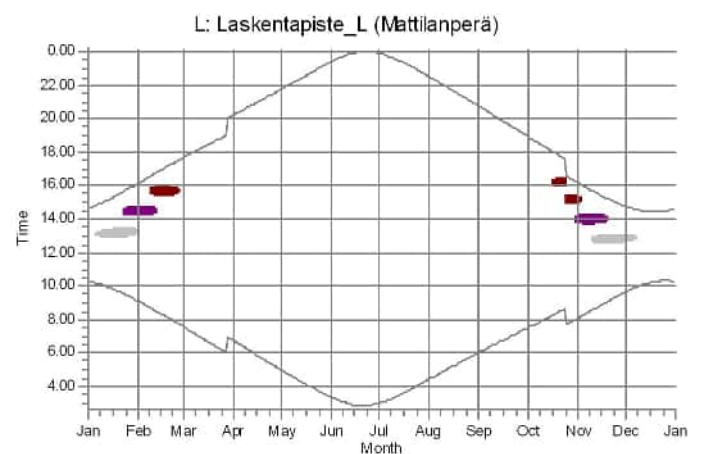
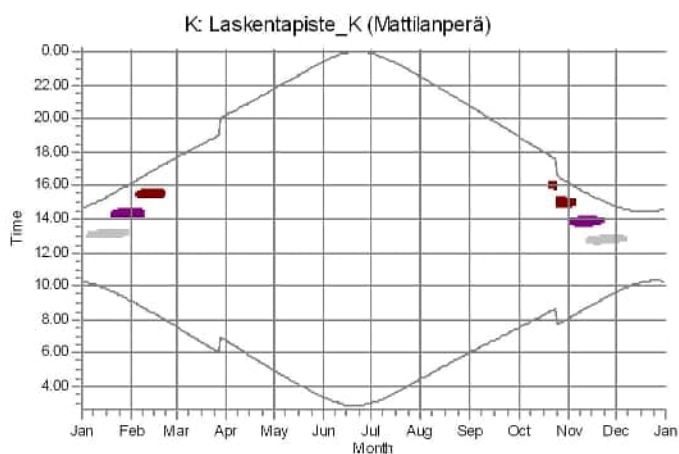
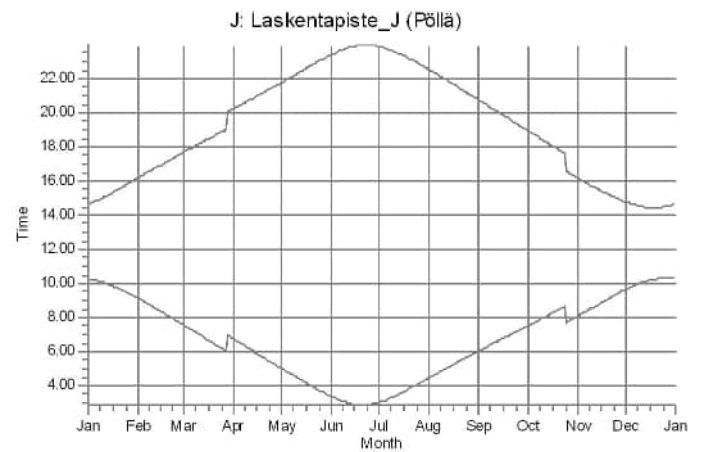
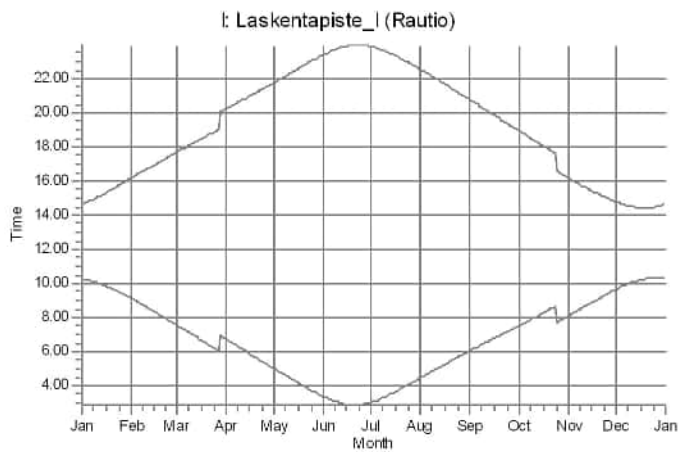
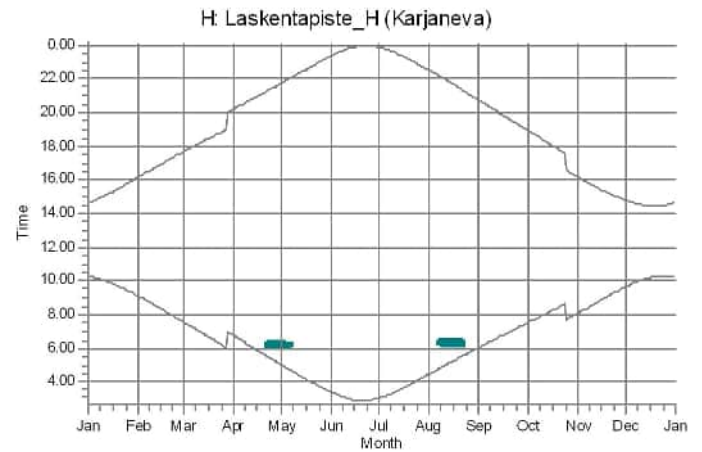
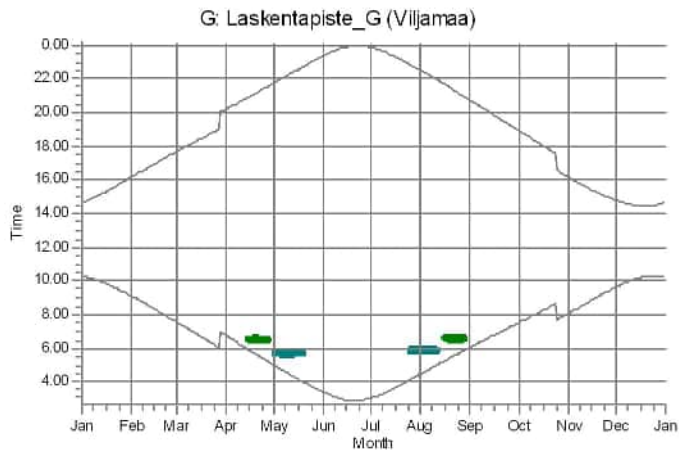
WTGs

14: Generic RD200 HH220 7200 200.0 IOI hub: 220,0 m (TOT: 320,0 m) (561)

16: Generic RD200 HH220 7200 200.0 IOI hub: 220,0 m (TOT: 320,0 m) (566)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_no forest



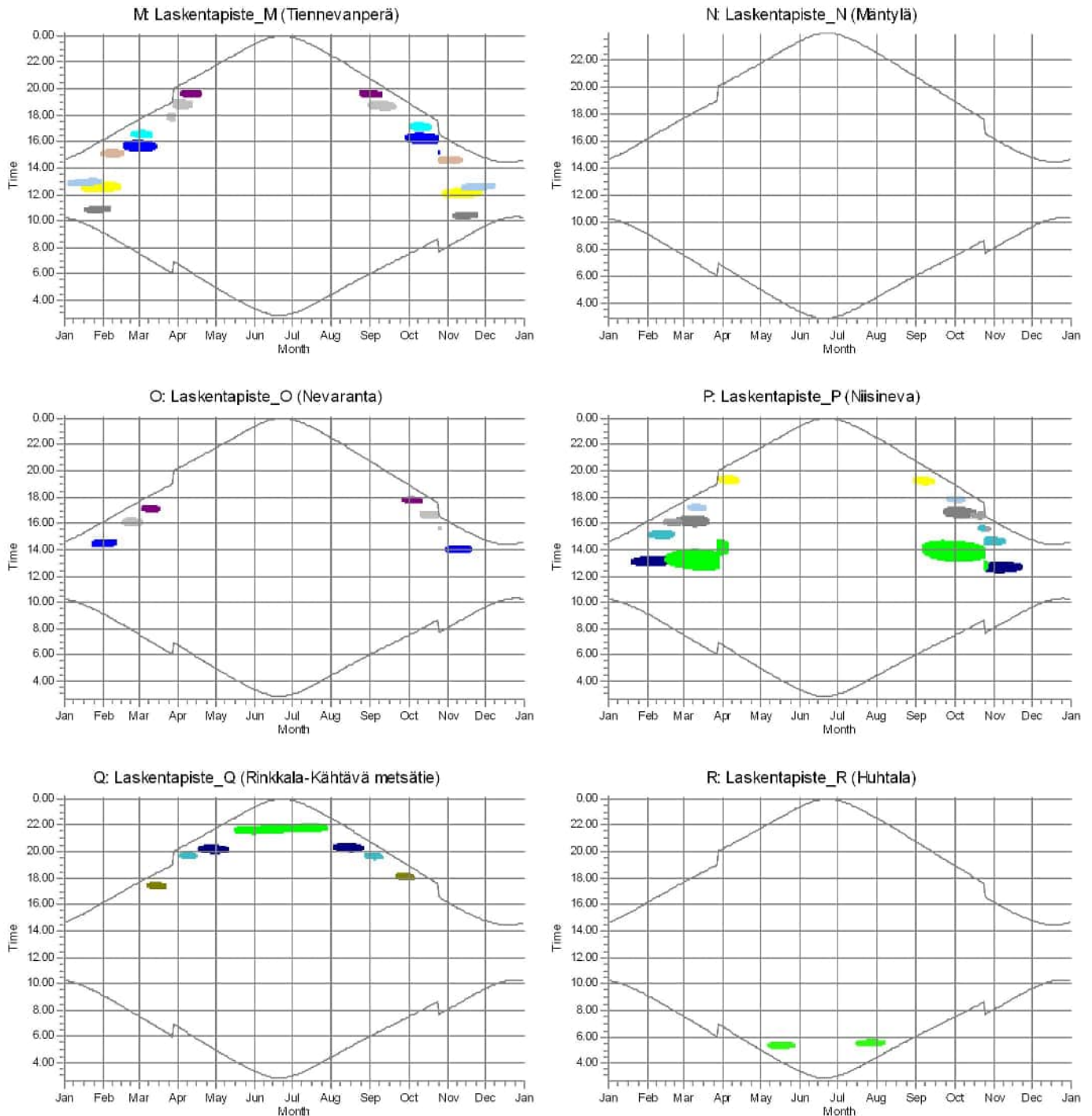
WTGs

14: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (561)
 16: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (566)
 33: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (568)

32: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (571)
 31: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (572)

SHADOW - Calendar, graphical

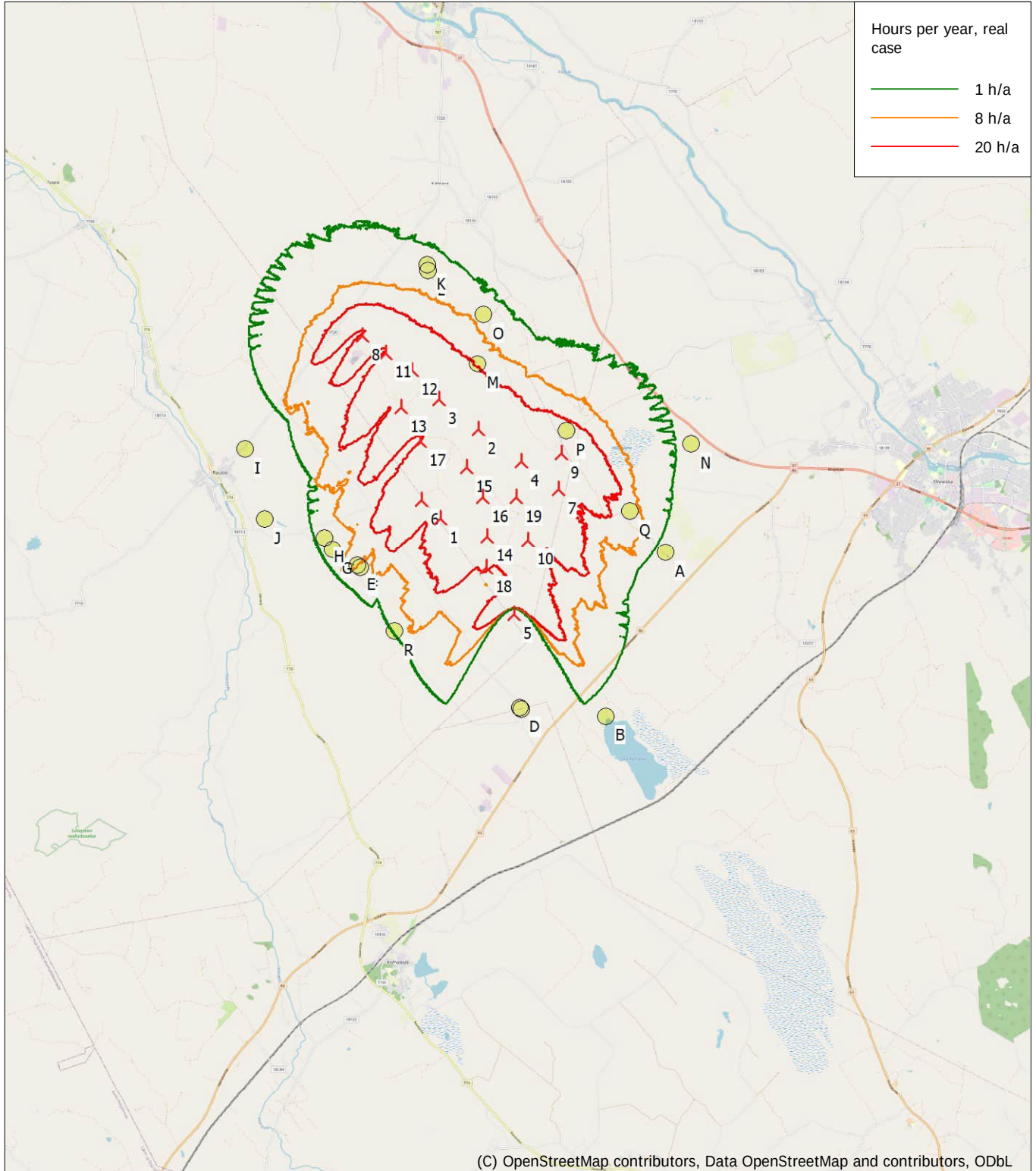
Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_no forest



WTGs

SHADOW - Map

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_no forest



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
 New WTG Shadow receptor
 Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
 Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

Project:

Verkasalo

Licensed user:

FCG Finnish Consulting Group Oy

Osmontie 34, PO Box 950

FI-00601 Helsinki

+358104095666

Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

19.9.2023 16.18/3.6.355

SHADOW - Main Result

Calculation: Verkasalo_VE2_Kalajoki_RD200x5xHH220_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

All coordinates are in

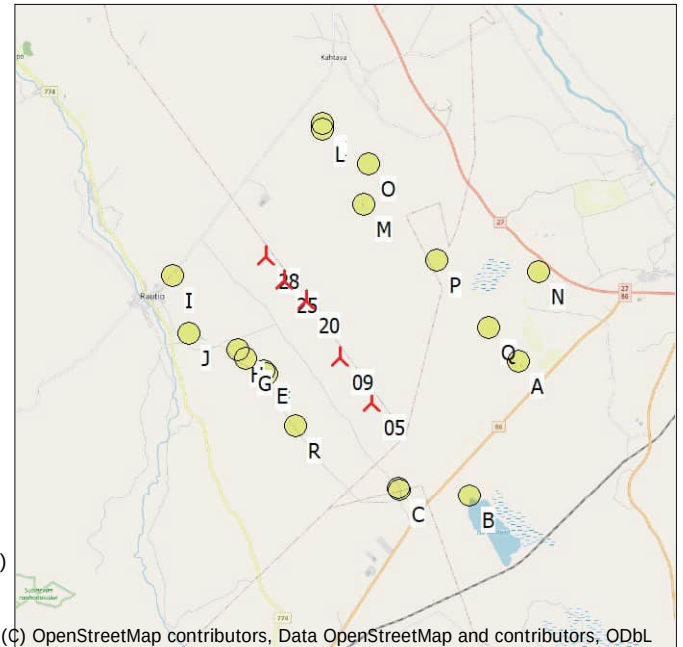
Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
05	369 541	7 105 227	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	368 764	7 106 453	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	367 939	7 108 000	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	367 367	7 108 547	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	366 924	7 109 225	67,2	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
							a.g.l.	window		(ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviöjanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0



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

Scale 1:200 000

New WTG

Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE2_Kalajoki_RD200x5xHH220_Valke_real case_no forest

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values
		Shadow hours per year [h/year]
A	Laskentapiste_A (Oivo)	0:00
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	0:00
E	Laskentapiste_E (Huhtakylä)	2:23
F	Laskentapiste_F (Huhtakylä)	2:35
G	Laskentapiste_G (Viljamaa)	5:46
H	Laskentapiste_H (Karjaneva)	4:14
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	0:00
L	Laskentapiste_L (Mattilanperä)	0:00
M	Laskentapiste_M (Tiennevanperä)	0:00
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	0:00
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	0:00
R	Laskentapiste_R (Huhtala)	2:26

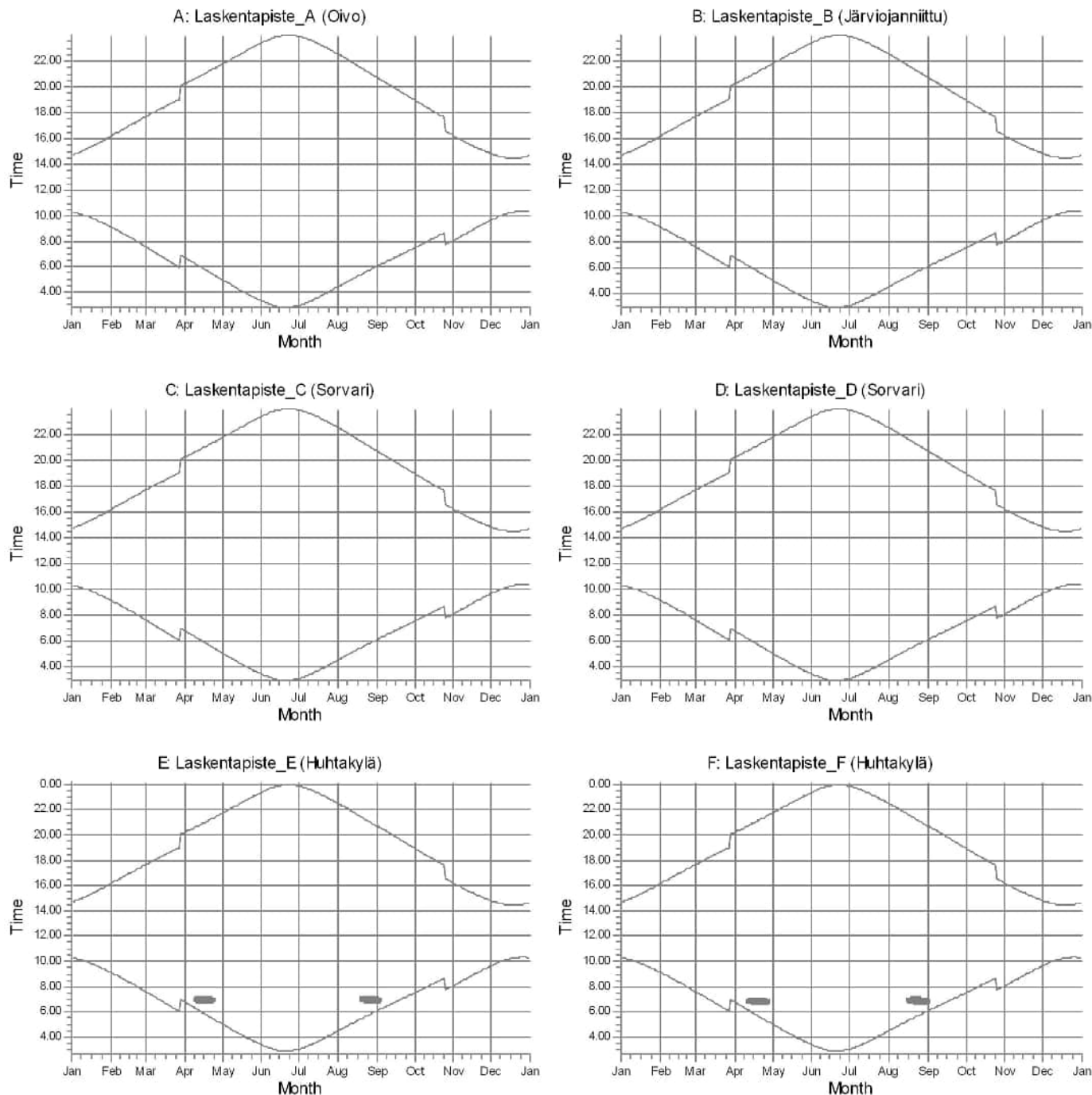
Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Expected [h/year]
05	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (581)	2:26
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (583)	3:25
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (582)	10:00
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (584)	0:00
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (580)	0:00

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

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Kalajoki_RD200x5xHH220_Valke_real case_no forest

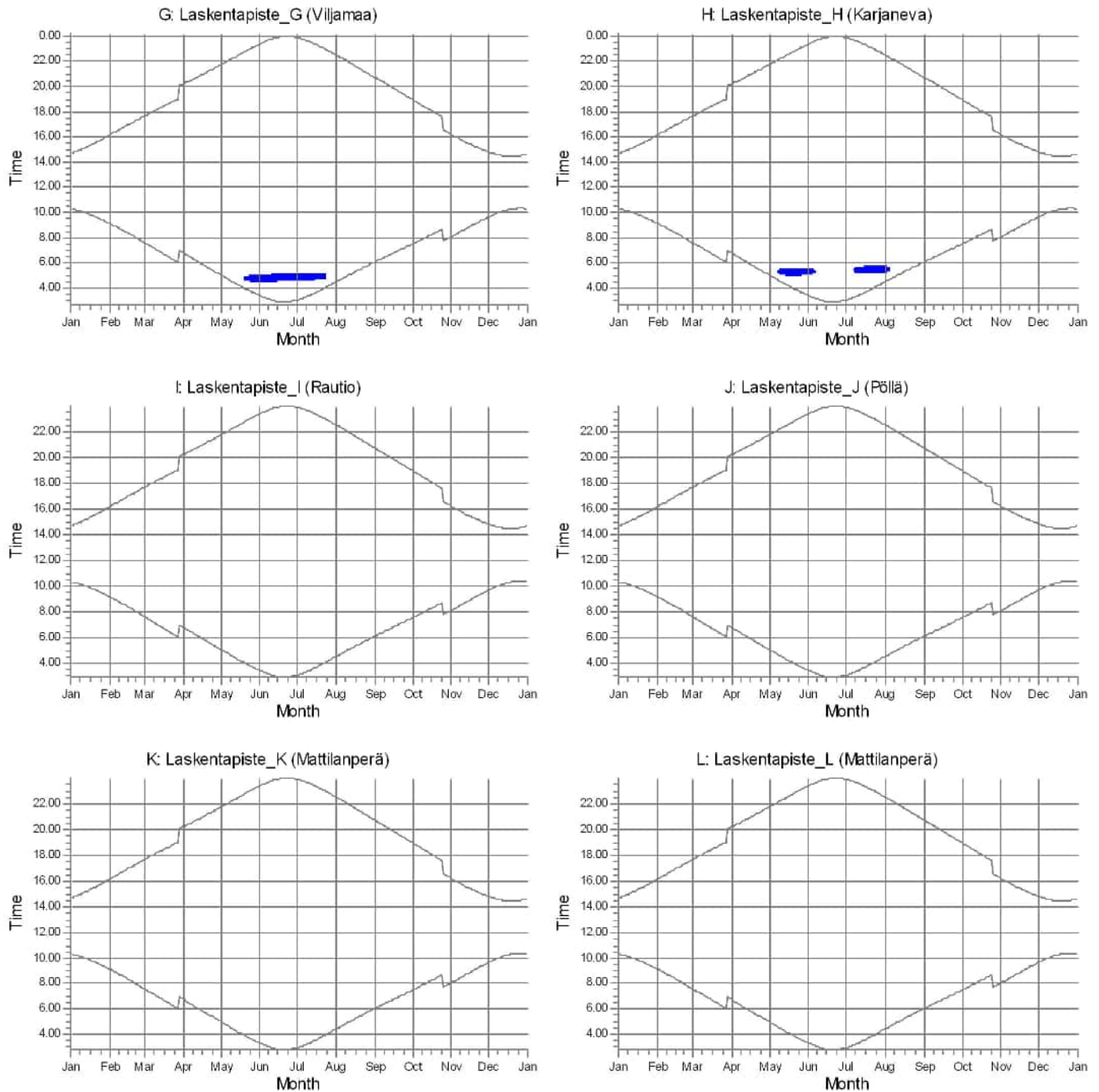


WTGs

09: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (583)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Kalajoki_RD200x5xHH220_Valke_real case_no forest

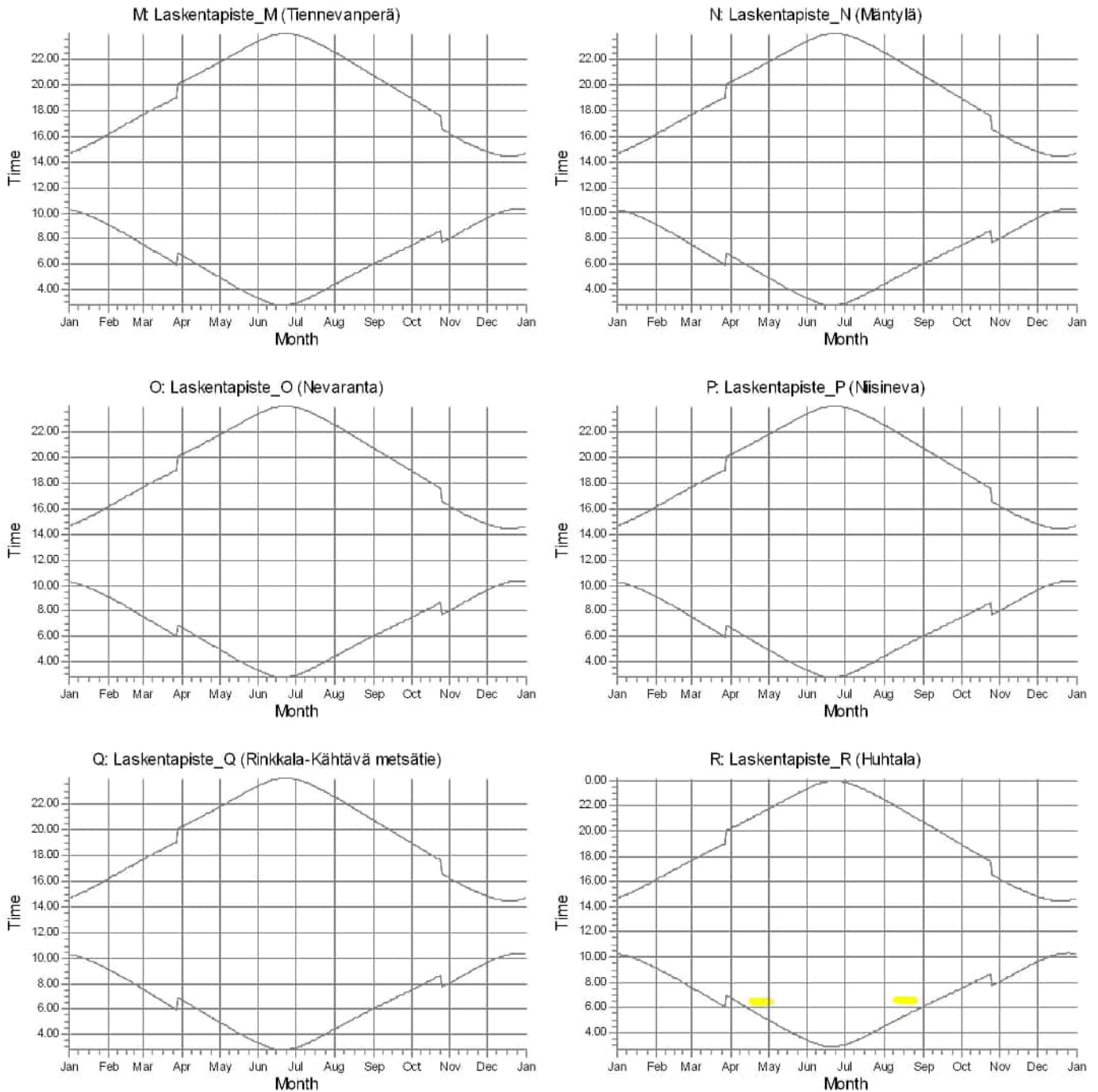


WTGs

20: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (582)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Kalajoki_RD200x5xHH220_Valke_real case_no forest

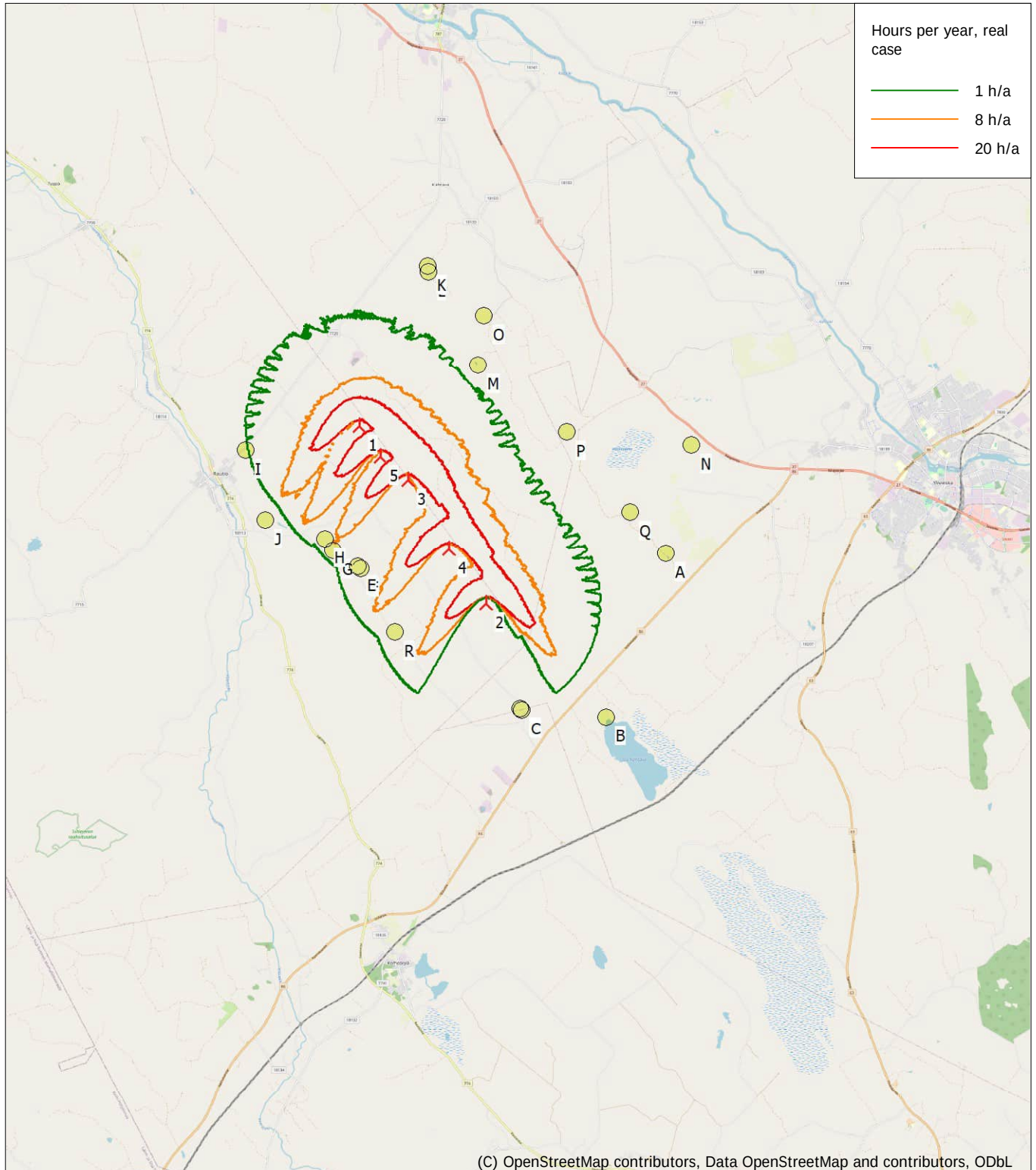


WTGs

05: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (581)

SHADOW - Map

Calculation: Verkasalo_VE2_Kalajoki_RD200x5xHH220_Valke_real case_no forest



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

Project:

Verkasalo

Licensed user:

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Calculated:

20.9.2023 10.12/3.6.355

SHADOW - Main Result

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_no forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)
 Obstacles used in calculation
 Receptor grid resolution: 1,0 m

All coordinates are in

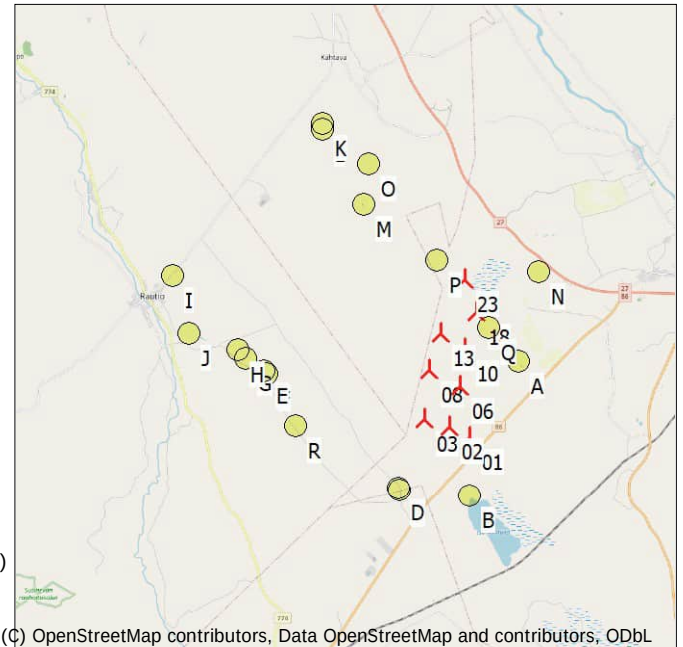
Finish TM ETRS-TM35FIN-ETRS89

WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	371 464	7 106 967	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation	Slope of	Direction mode	Eye height
							a.g.l.	window		(ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järvioljanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mättilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mättilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0



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

Scale 1:200 000

New WTG

Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_no forest

Calculation Results

Shadow receptor

No.	Name	Shadow, expected values
		Shadow hours per year [h/year]
A	Laskentapiste_A (Oivo)	14:23
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	5:50
D	Laskentapiste_D (Sorvari)	6:16
E	Laskentapiste_E (Huhtakylä)	0:00
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	0:00
H	Laskentapiste_H (Karjaneva)	0:00
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	0:00
L	Laskentapiste_L (Mattilanperä)	0:00
M	Laskentapiste_M (Tiennevanperä)	0:00
N	Laskentapiste_N (Mäntylä)	3:26
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	13:56
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	16:20
R	Laskentapiste_R (Huhtala)	0:00

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

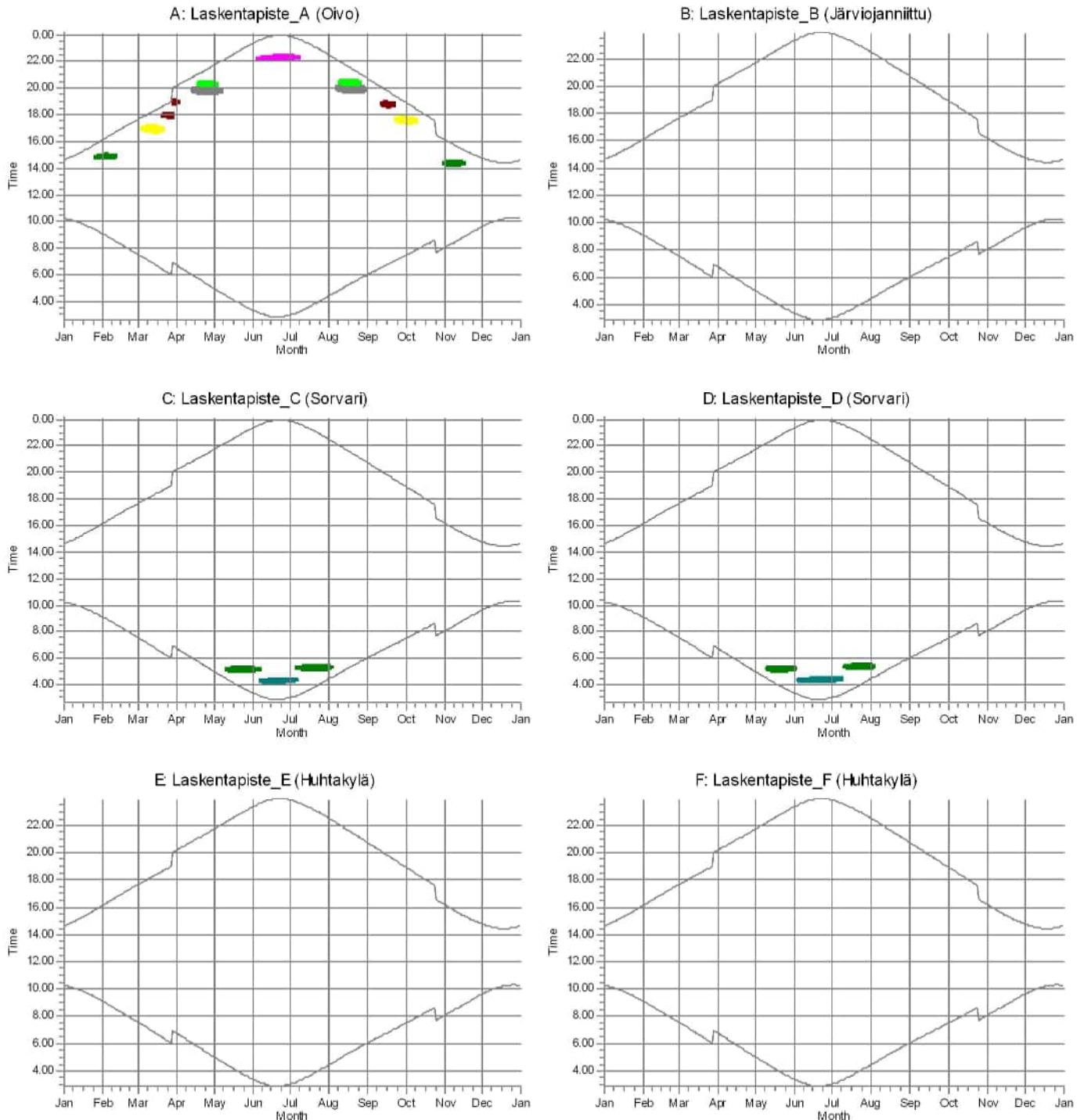
No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (585)	5:57
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (590)	3:05
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (591)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (586)	4:15
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (592)	2:54
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (588)	13:58
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (593)	8:31
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (589)	6:21
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (587)	10:46

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: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_no forest

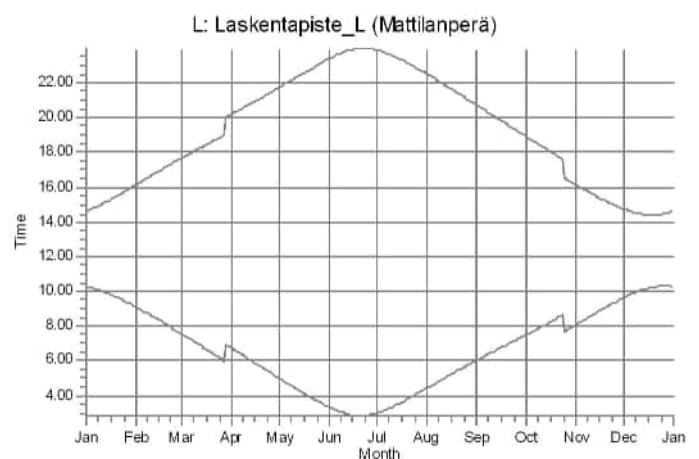
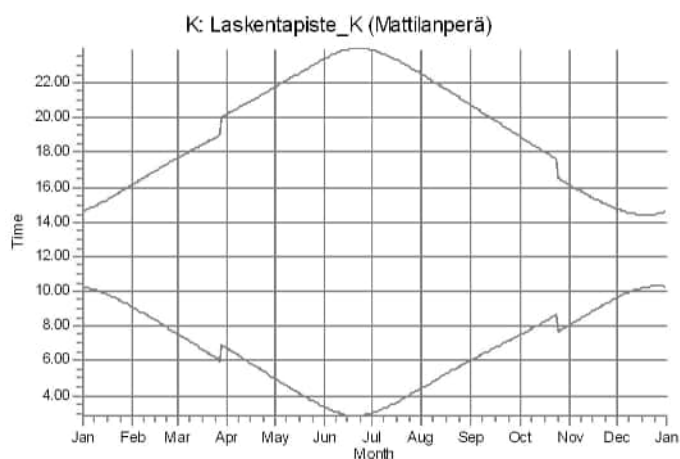
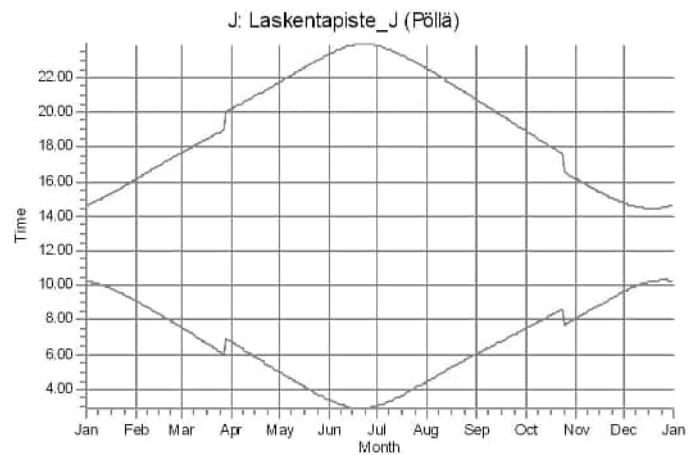
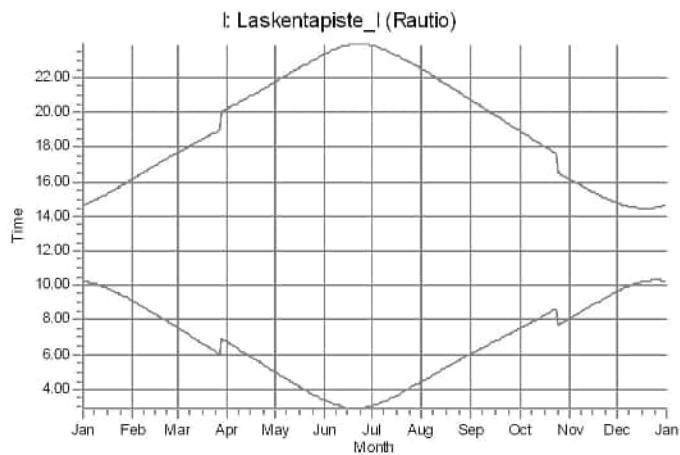
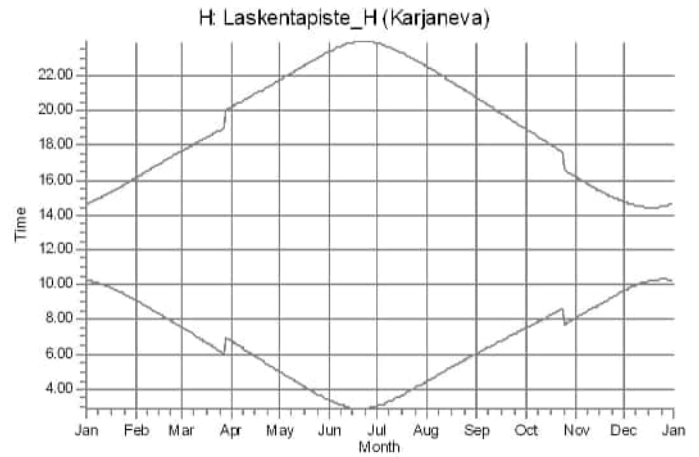
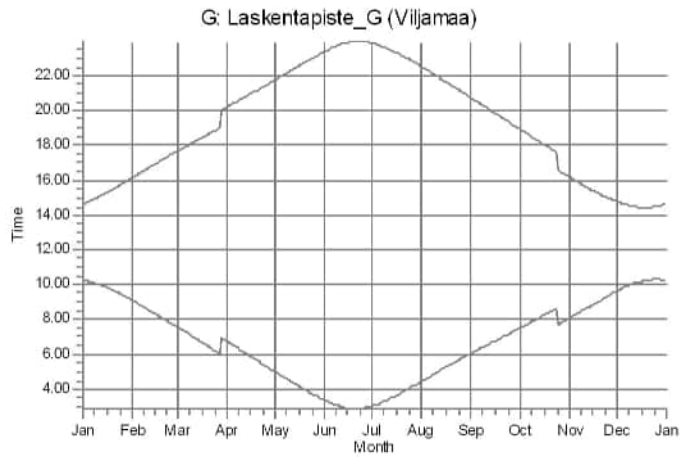


WTGs

01: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (585)	02: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (590)
06: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (586)	08: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (592)
10: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (588)	13: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (593)
18: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (589)	

SHADOW - Calendar, graphical

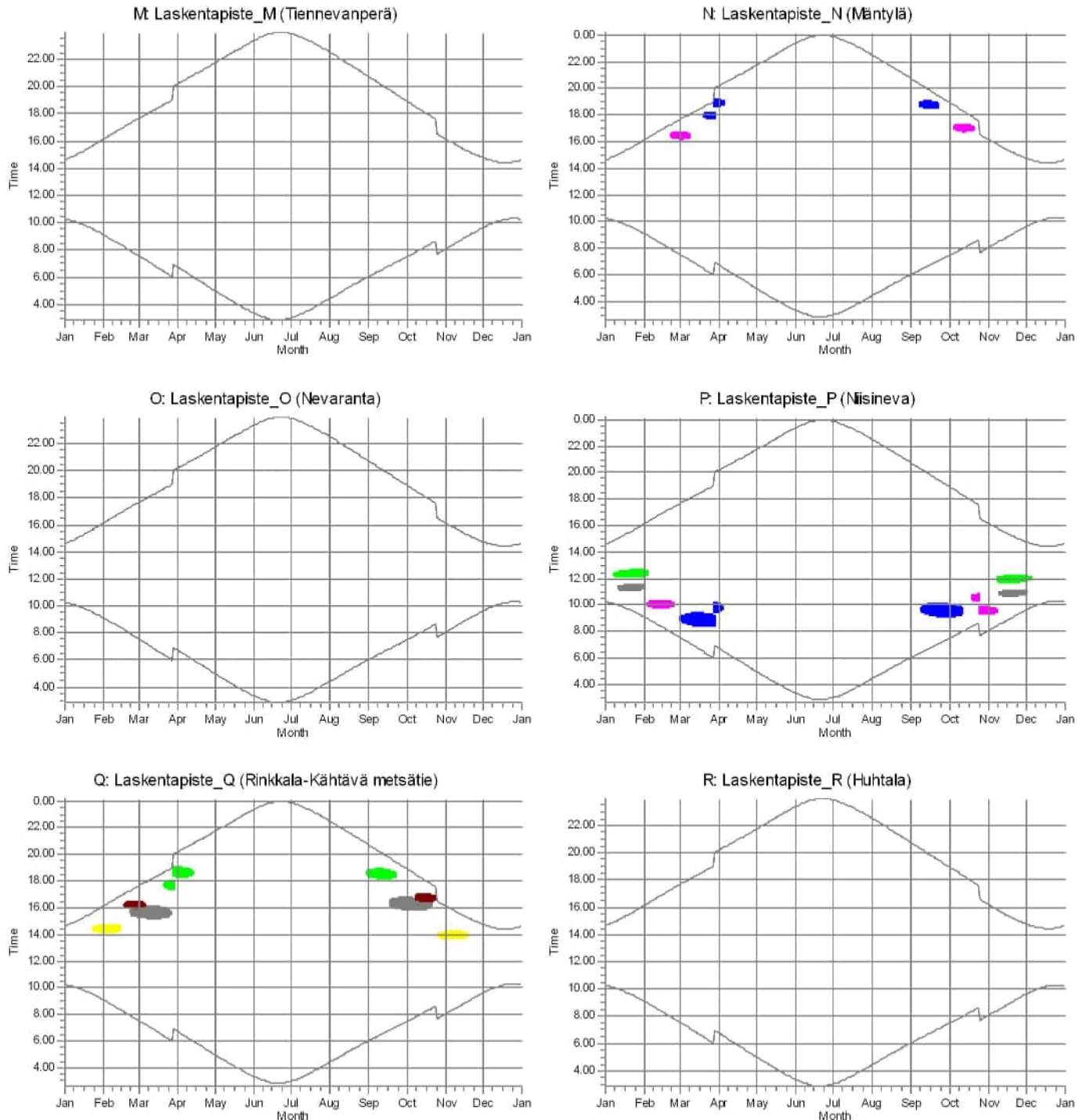
Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_no forest



WTGs

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_no forest



WTGs

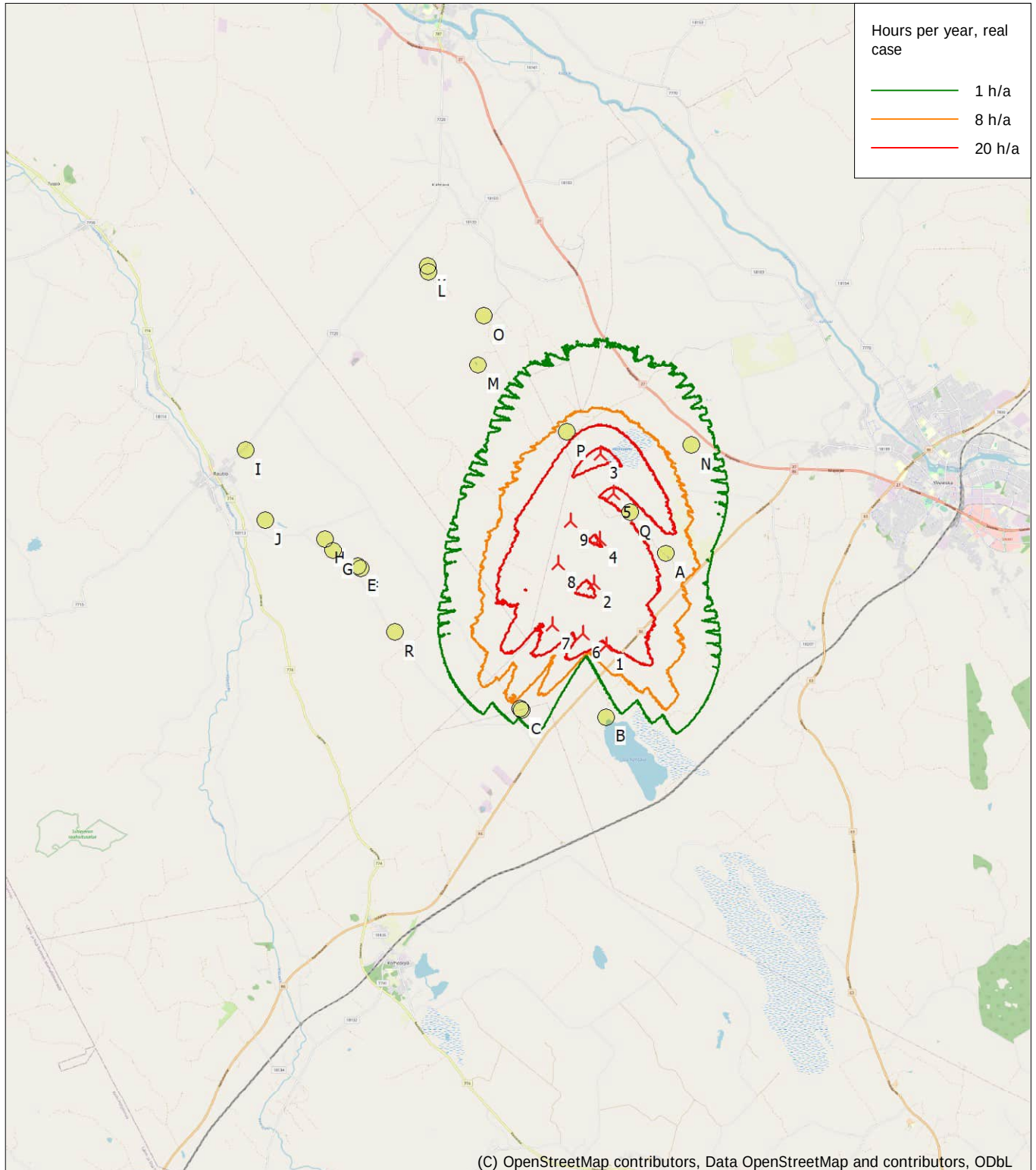
06: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (586)	18: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (589)
23: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (587)	08: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (592)
10: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (588)	13: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (593)

Project:
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Calculated:
20.9.2023 10.12/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_no forest



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 27. Verkasalon tuulivoimahanke – Kuntakohtaiset varjostusmallinnuksen tulokset ”real case, Luke forest” (VE1).

Project:

Verkasalo

Licensed user:

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Calculated:

5.10.2023 14.45/3.6.355

SHADOW - Main Result

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_Luke forest

Assumptions for shadow calculations

Maximum distance for influence 2 500 m
 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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

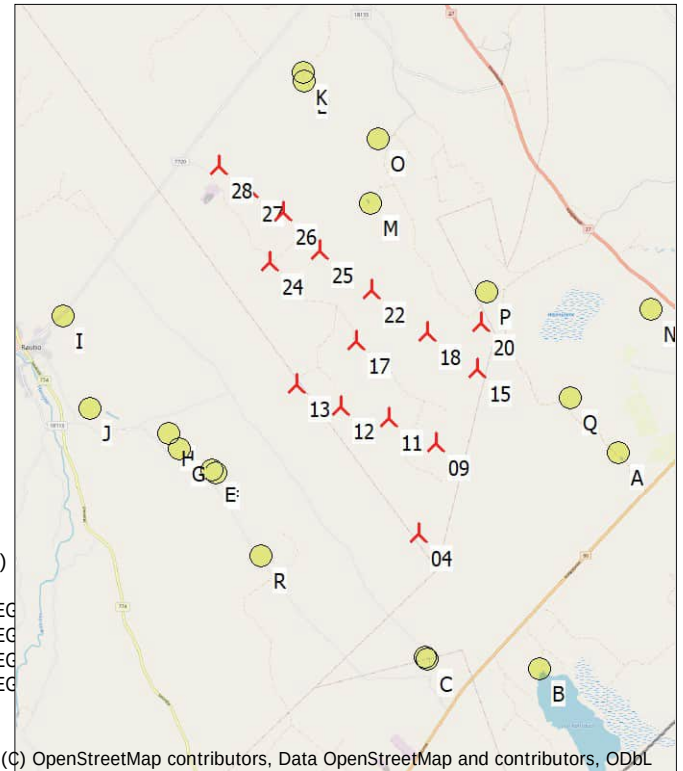
WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
09	370 503	7 106 453	74,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	369 736	7 106 883	72,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	368 953	7 107 128	72,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
20	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	367 862	7 109 559	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
25	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
28	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0

To be continued on next page...



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Scale 1:125 000

New WTG

Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_Luke forest

...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]
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	0:00
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	0:00
E	Laskentapiste_E (Huhtakylä)	5:10
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	3:02
H	Laskentapiste_H (Karjaneva)	2:12
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	9:59
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	21:58
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	13:16
R	Laskentapiste_R (Huhtala)	0:00

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

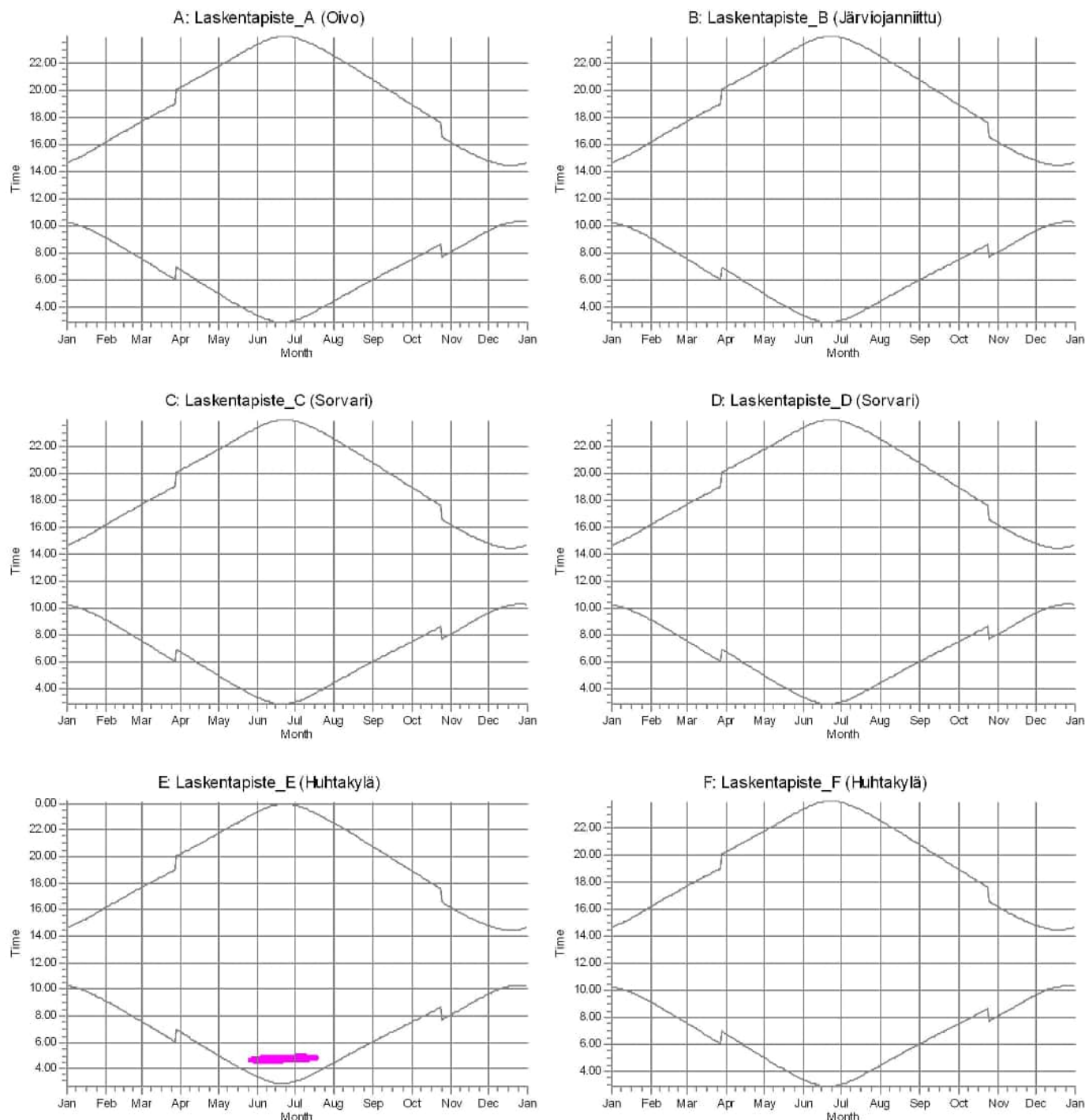
No.	Name	Expected [h/year]
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (542)	0:00
09	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (547)	1:09
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (551)	0:00
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (538)	0:00
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (543)	10:26
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (544)	4:23
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (552)	0:00
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (541)	0:00
20	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (546)	29:43
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (539)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (550)	1:39
25	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (540)	4:31
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (549)	5:12
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (548)	1:57
28	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (545)	2:21

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: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_Luke forest

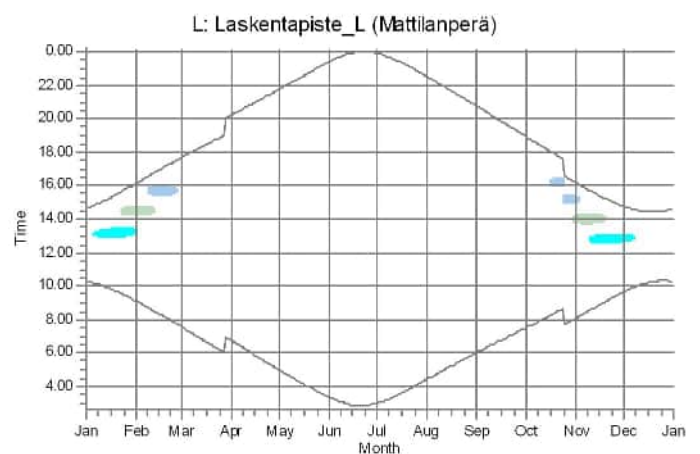
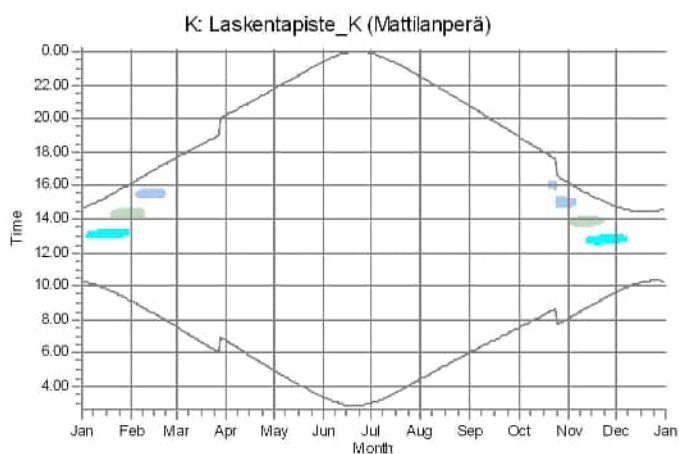
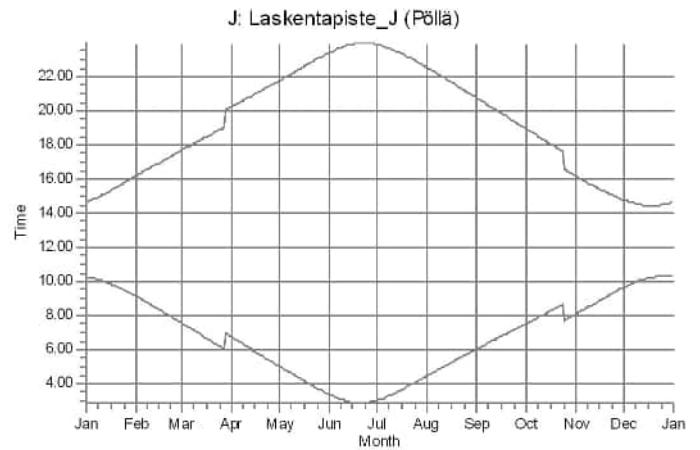
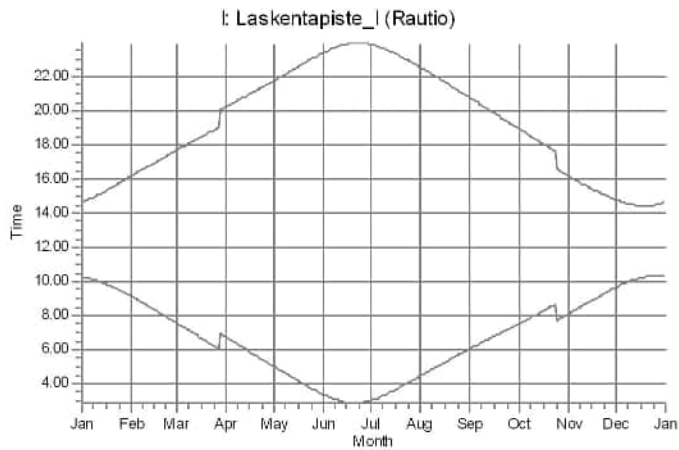
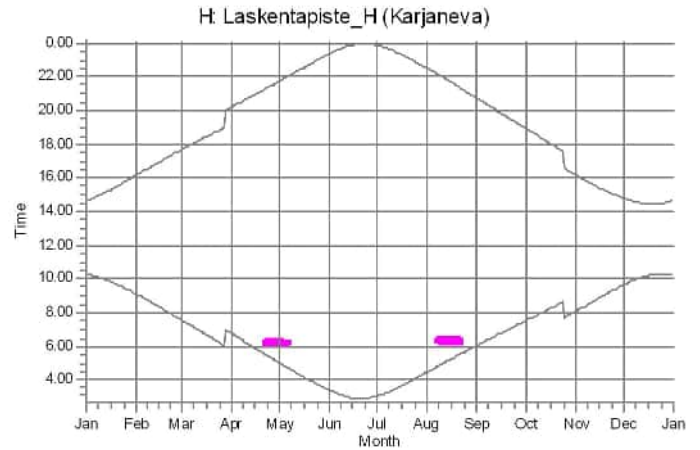
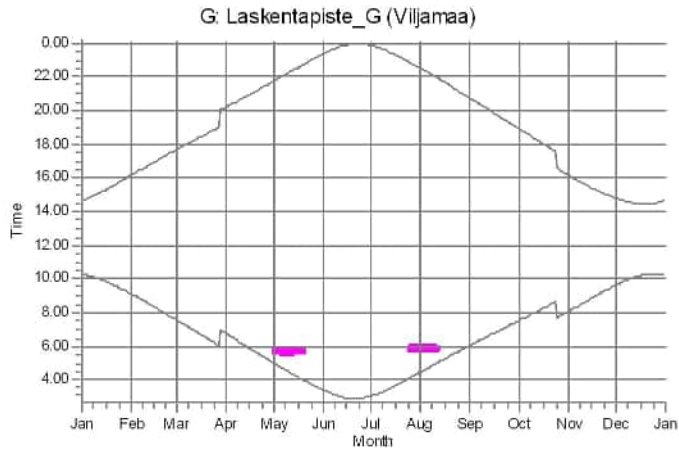


WTGs

13: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (543)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_Luke forest



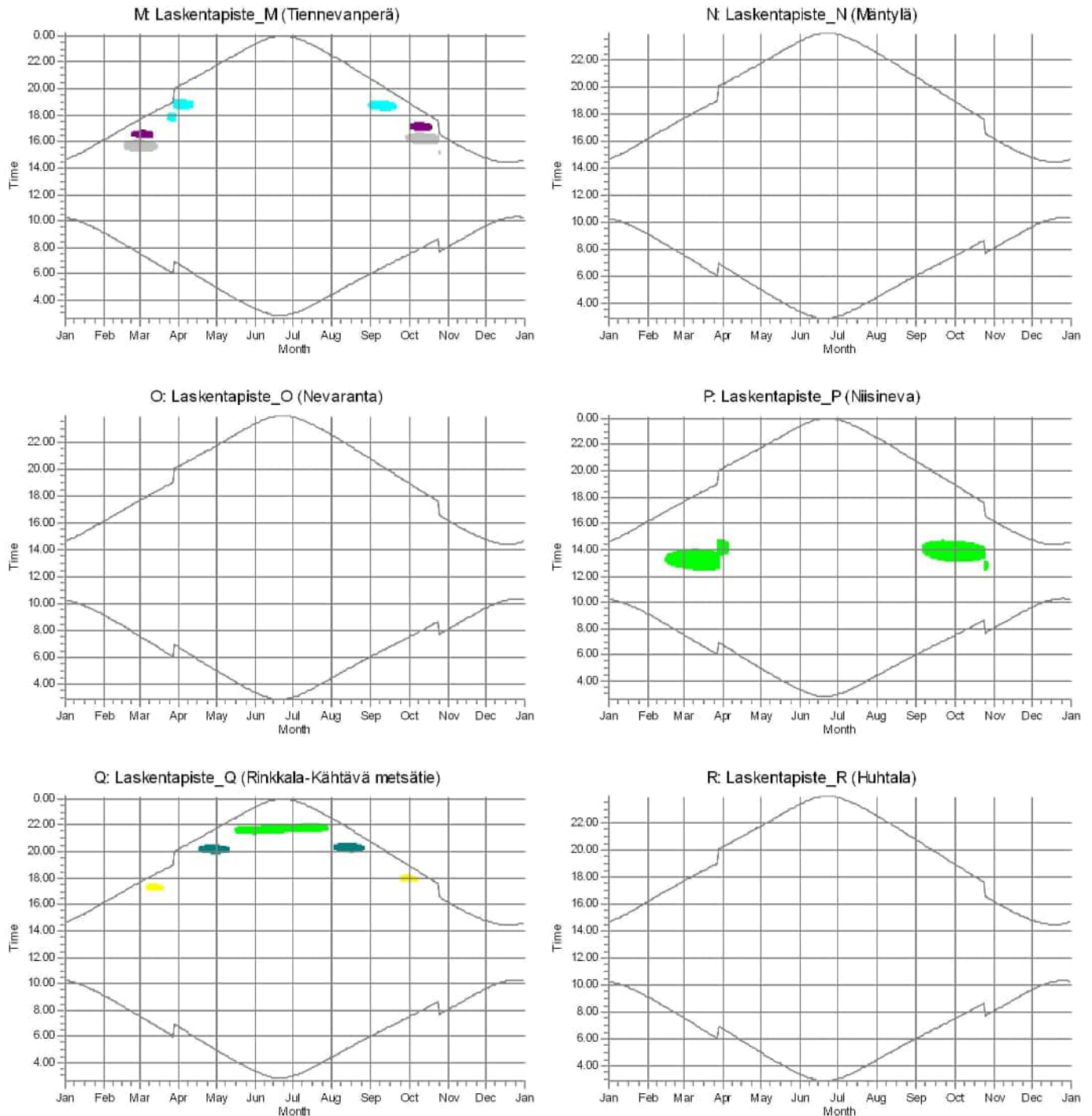
WTGs

- 13: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (543)
 26: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (549)

- 27: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (548)
 28: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (545)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_Luke forest

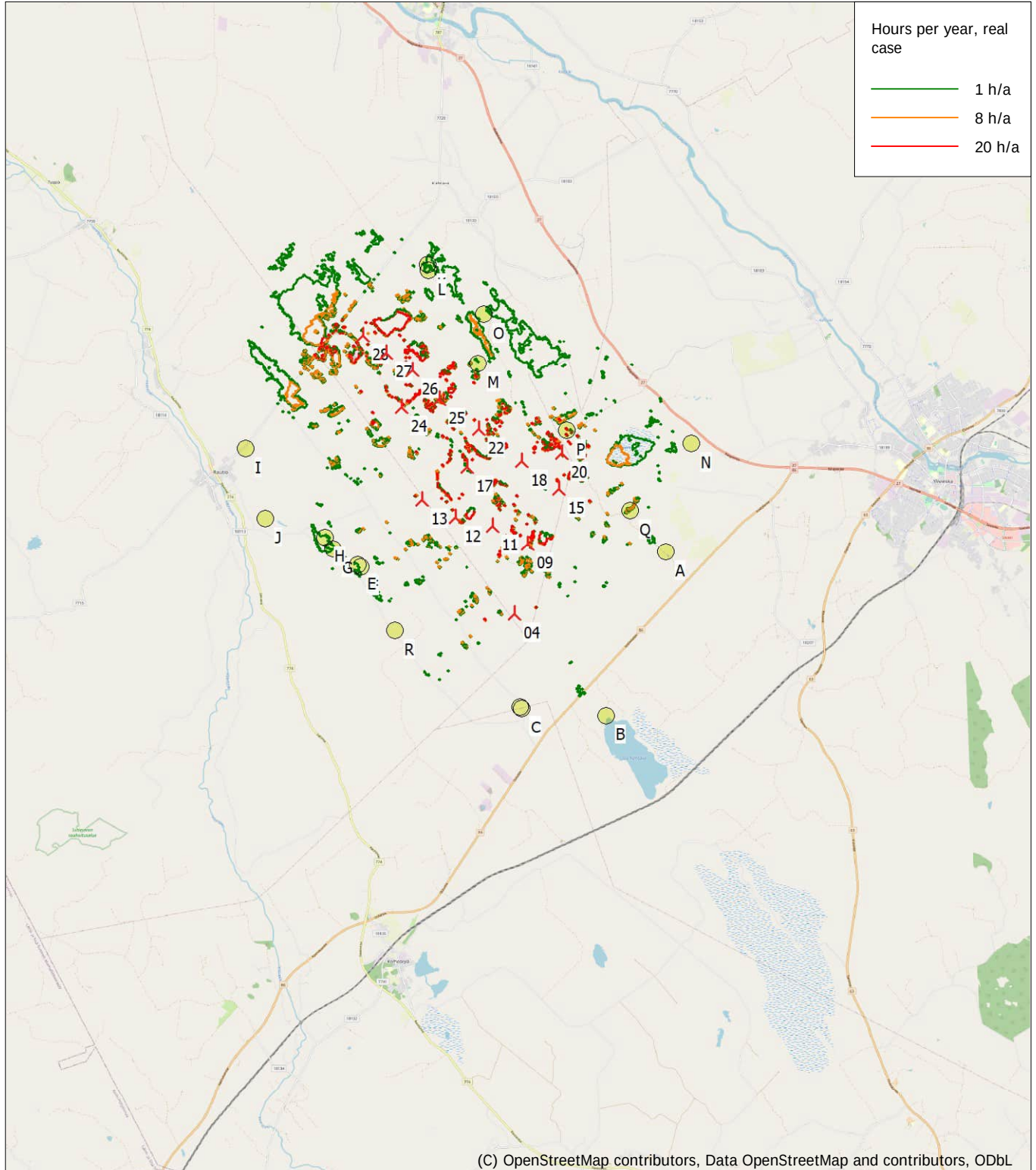


WTGs

09: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (547)	24: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (550)
15: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (544)	25: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (540)
20: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (546)	26: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (549)

SHADOW - Map

Calculation: Verkasalo_VE1_Alavieska_RD200x15xHH220_Valke_real case_Luke forest



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

SHADOW - Main Result

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_Luke forest

Assumptions for shadow calculations

Maximum distance for influence	2 500 m
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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

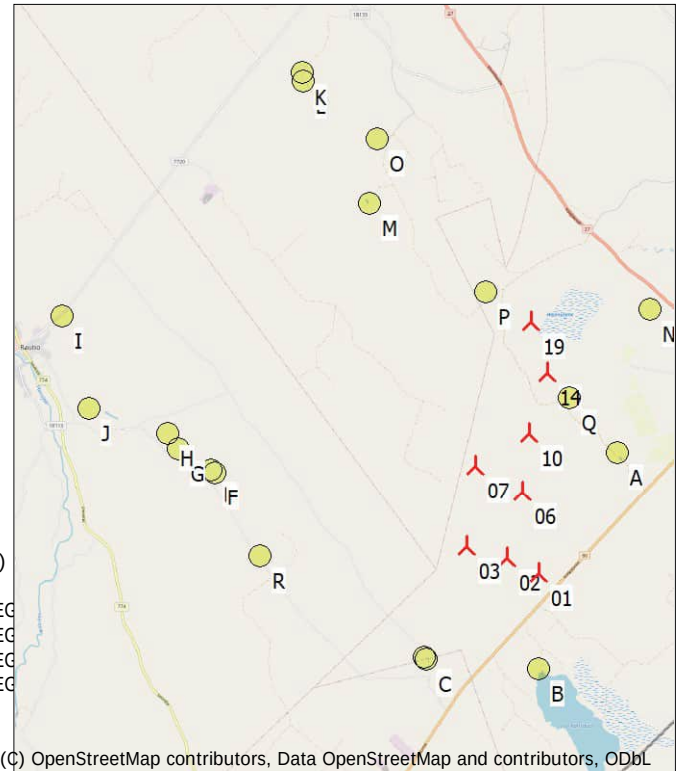
WTGs

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjanneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattiänperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattiänperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0

To be continued on next page...



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Scale 1:125 000

New WTG

Shadow receptor

SHADOW - Main Result

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_Luke forest

...continued from previous page

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]
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	2:30
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	2:39
E	Laskentapiste_E (Huhtakylä)	0:00
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	0:00
H	Laskentapiste_H (Karjaneva)	0:00
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	0:00
L	Laskentapiste_L (Mattilanperä)	0:00
M	Laskentapiste_M (Tiennevanperä)	0:00
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	0:00
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	11:44
R	Laskentapiste_R (Huhtala)	0:00

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

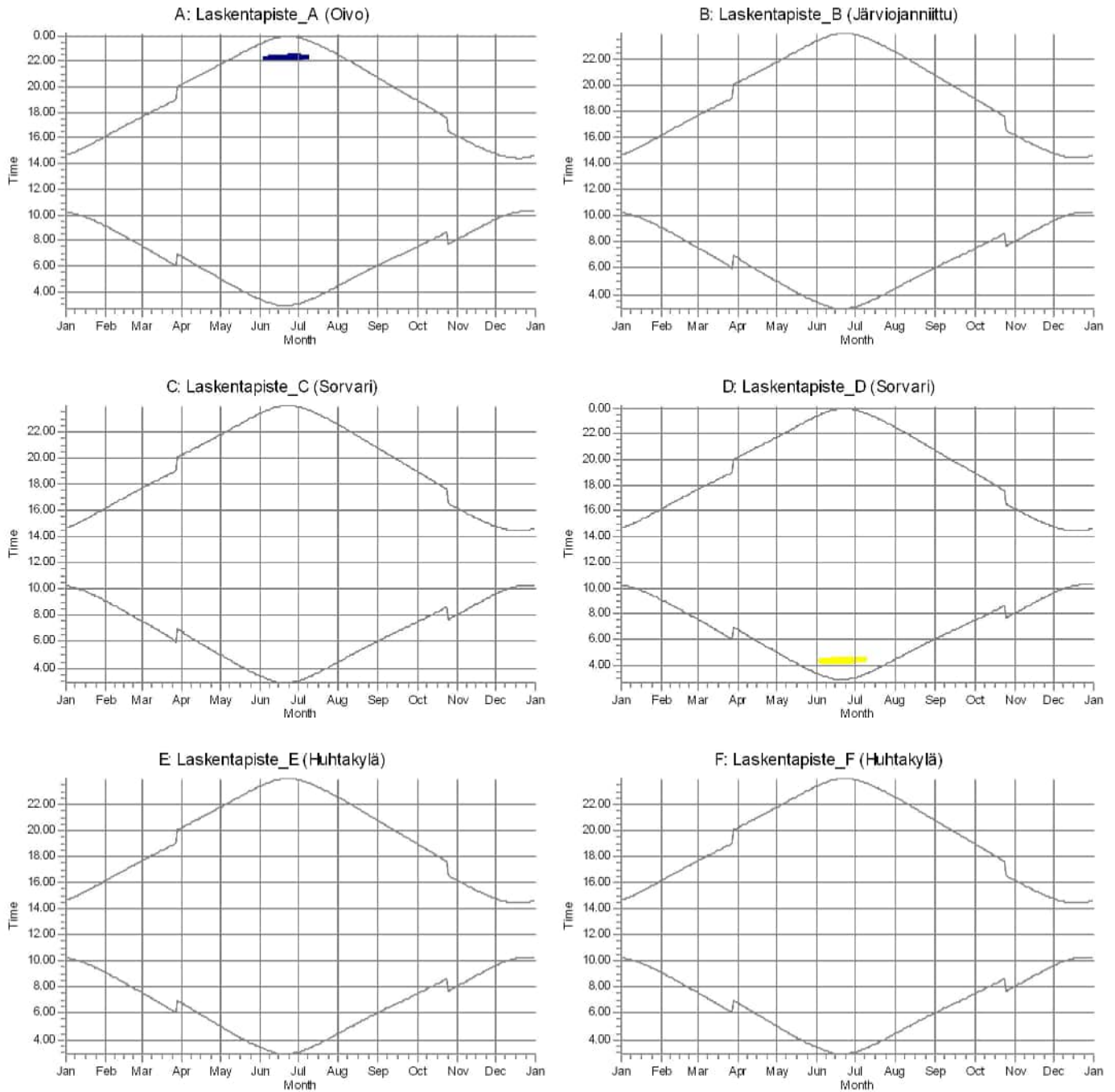
No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (553)	0:00
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (558)	2:39
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (559)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (554)	1:59
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (560)	1:36
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (556)	8:06
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (557)	2:30
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (555)	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: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_Luke forest



WTGs

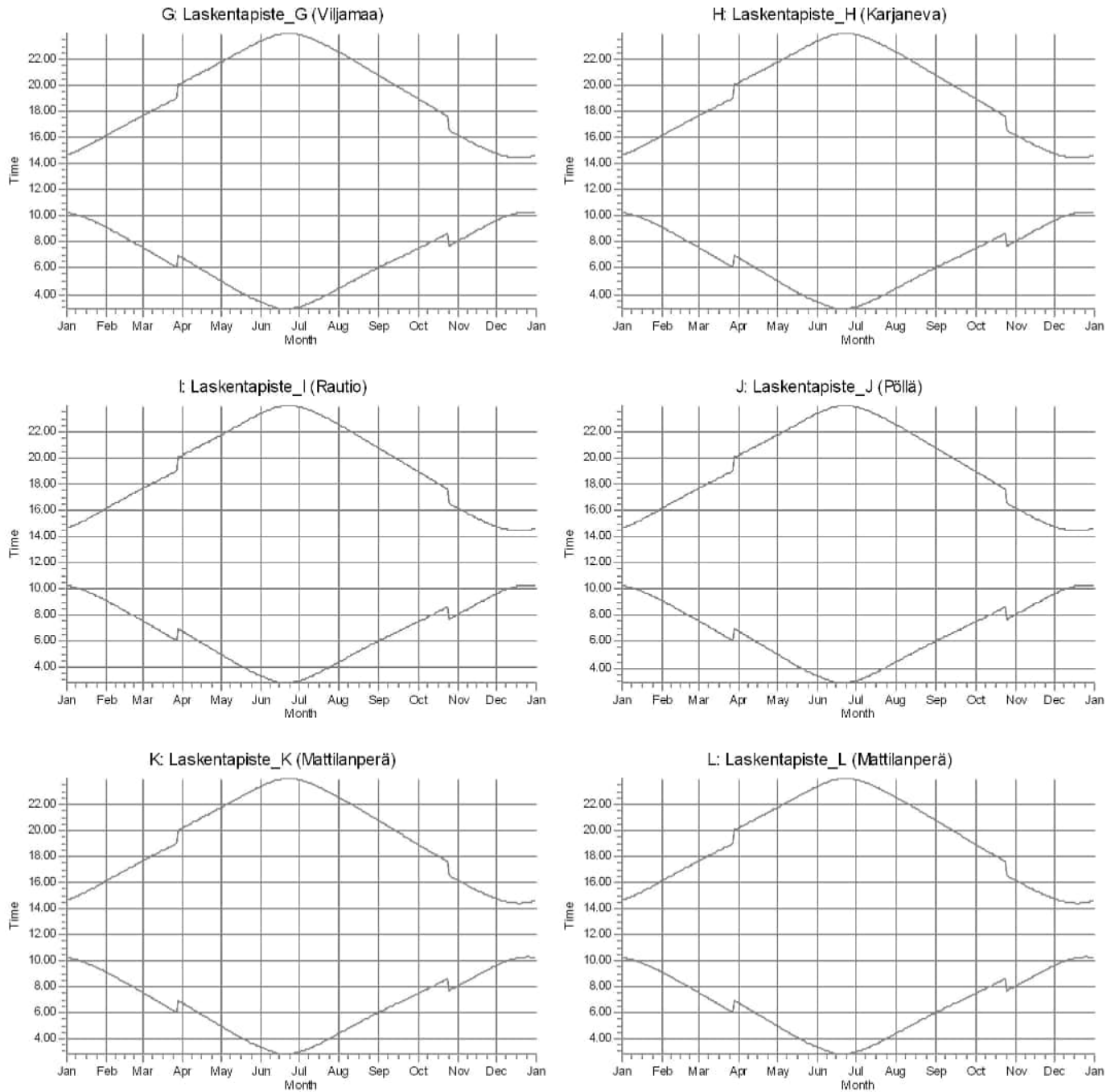


02: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (558)

14: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (557)

SHADOW - Calendar, graphical

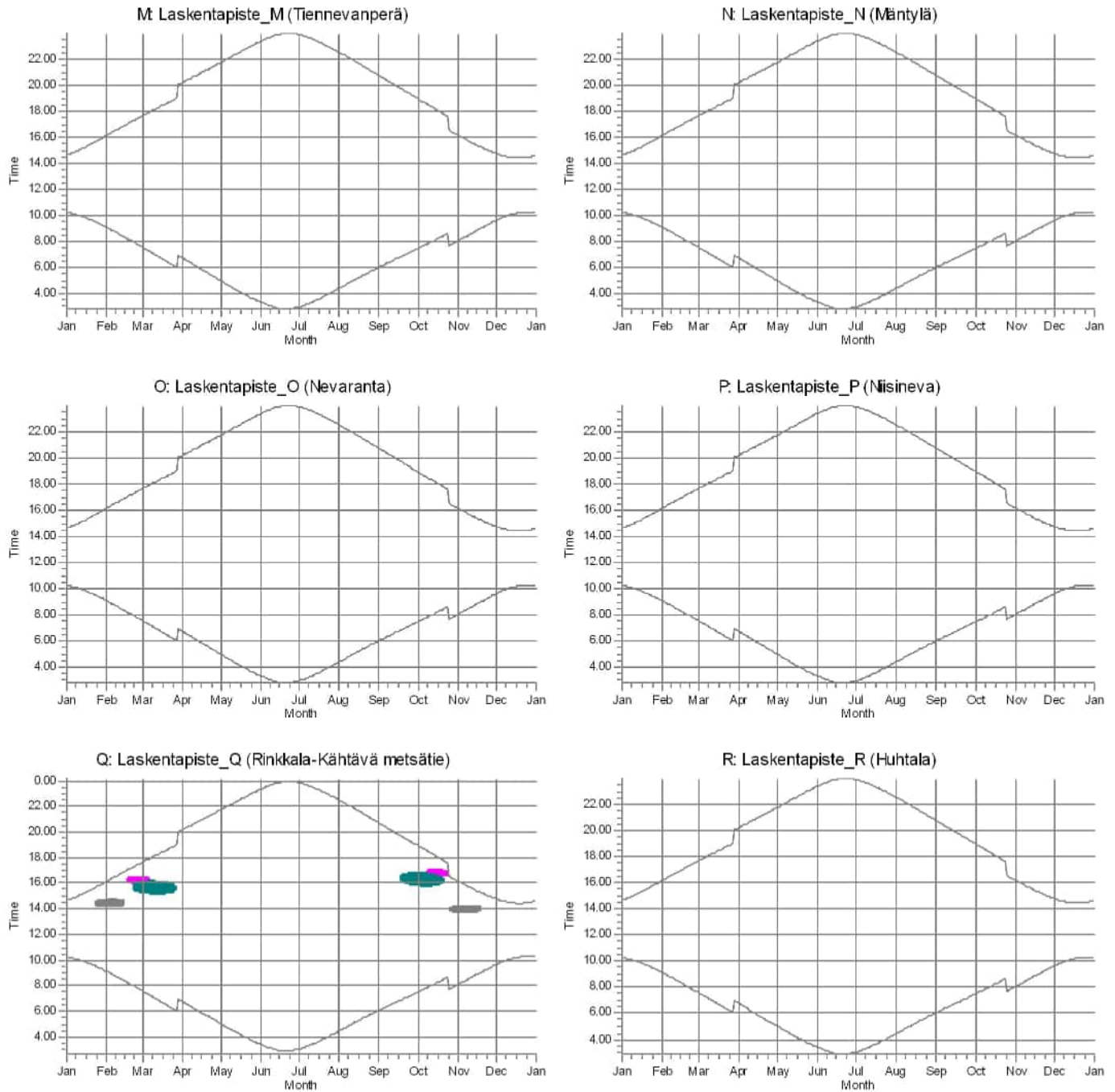
Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_Luke forest



WTGs

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_Luke forest



WTGs

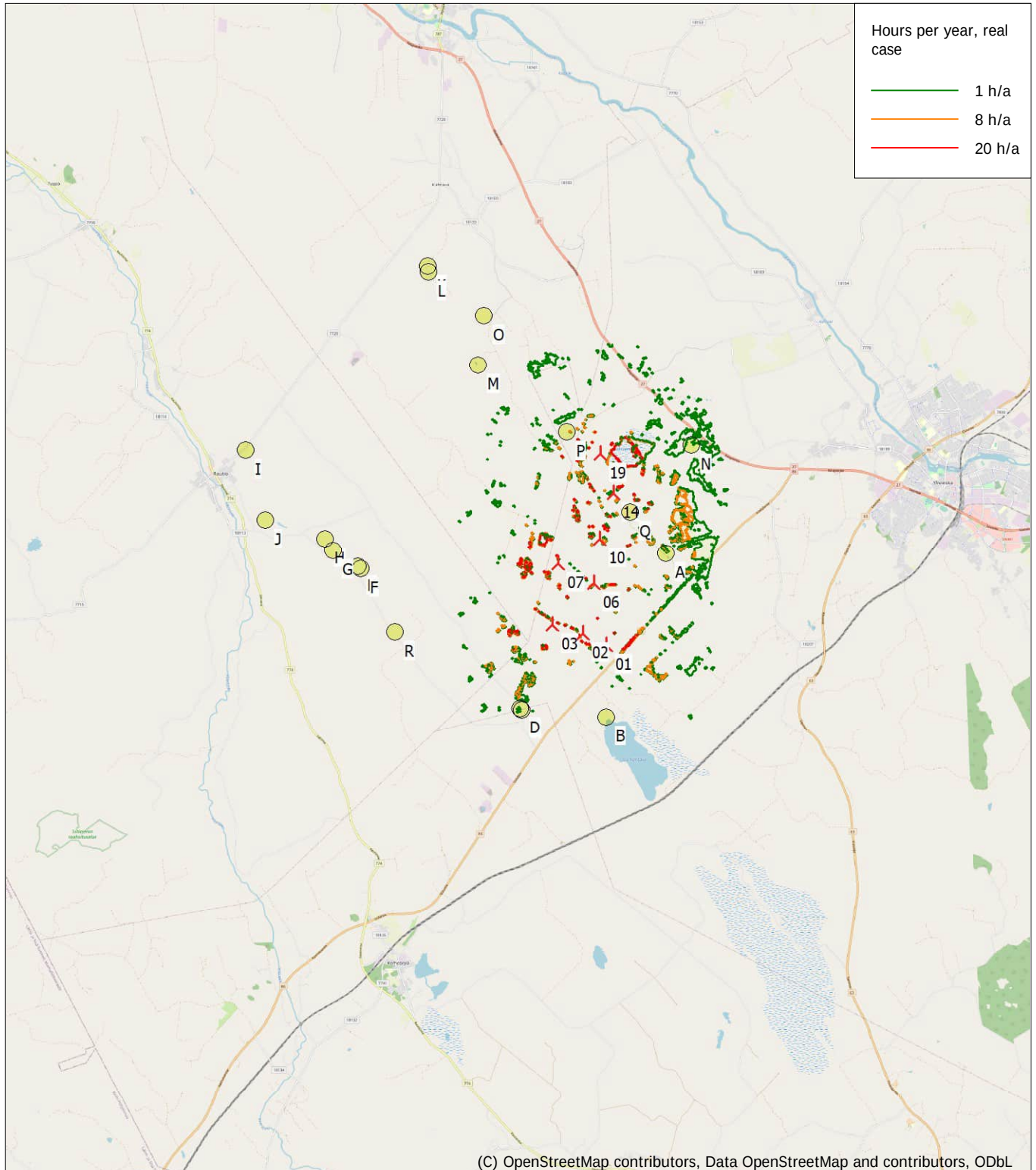
- 06: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (554)
- 07: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (560)
- 10: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (556)

Project:
Verkasalo

Licensed user:
FCG Finnish Consulting Group Oy
Osmontie 34, PO Box 950
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Aarni Nikkola / aarni.nikkola@fcg.fi
Calculated:
5.10.2023 14.54/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE1_Ylivieska_RD200x15xHH220_Valke_real case_Luke forest



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

11.10.2023

Liite 28. Verkasalon tuulivoimahanke – Kuntakohtaiset varjostusmallinnuksen tulokset ”real case, Luke forest” (VE2).

SHADOW - Main Result

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_Luke forest

Assumptions for shadow calculations

Maximum distance for influence	2 500 m
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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

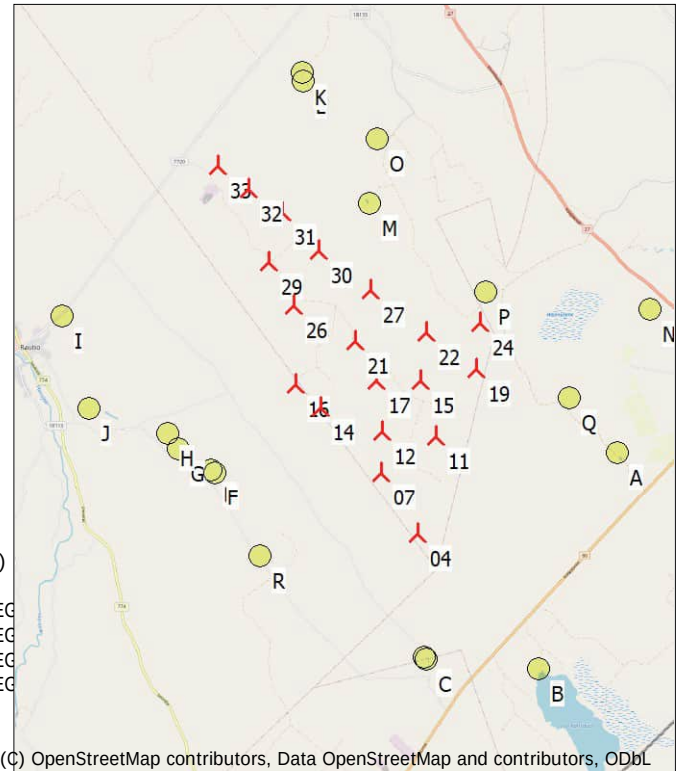
Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

WTGs



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

Scale 1:125 000

New WTG

Shadow receptor

	East	North	Z	Row data/Description	WTG type		Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.					Calculation distance [m]	RPM [RPM]
			[m]									
04	370 157	7 104 947	72,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
07	369 591	7 105 980	71,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
11	370 521	7 106 556	73,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
12	369 636	7 106 678	75,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
14	368 628	7 107 123	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
15	370 306	7 107 506	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
16	368 227	7 107 519	68,6	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
17	369 568	7 107 523	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
19	371 227	7 107 652	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
21	369 253	7 108 202	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
22	370 442	7 108 273	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
24	371 335	7 108 402	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
26	368 250	7 108 818	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
27	369 525	7 109 029	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
29	367 862	7 109 559	67,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
30	368 702	7 109 705	65,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
31	368 126	7 110 369	63,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
32	367 574	7 110 777	62,8	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4
33	367 096	7 111 177	62,5	Generic RD200 HH220 7200 20...Yes	Generic	RD200	HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l.	Slope of window	Direction mode	Eye height (ZVI) a.g.l.
				[m]	[m]	[m]	[m]	[°]		[m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0

To be continued on next page...

SHADOW - Main Result

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_Luke forest

...continued from previous page

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]
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0

Calculation Results

Shadow receptor

Shadow, expected values

No.	Name	Shadow hours per year [h/year]
A	Laskentapiste_A (Oivo)	0:00
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	0:00
E	Laskentapiste_E (Huhtakylä)	8:46
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	4:42
H	Laskentapiste_H (Karjaneva)	2:12
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	3:52
L	Laskentapiste_L (Mattilanperä)	4:17
M	Laskentapiste_M (Tiennevanperä)	9:59
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	21:58
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	14:41
R	Laskentapiste_R (Huhtala)	0:00

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

No.	Name	Expected [h/year]
04	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (565)	0:00
07	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (578)	0:00
11	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (570)	1:14
12	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (574)	0:00
14	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (561)	5:15
15	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (579)	1:20
16	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (566)	10:26
17	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (576)	0:00
19	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (567)	4:23
21	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (575)	0:00
22	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (564)	0:00
24	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (569)	29:43
26	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (577)	0:00
27	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (562)	0:00
29	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (573)	1:39
30	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (563)	4:31
31	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (572)	5:12
32	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (571)	1:57
33	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (568)	2:21

Project:

Verkasalo

Licensed user:

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Aarni Nikkola / aarni.nikkola@fcg.fi

Calculated:

5.10.2023 15.13/3.6.355

SHADOW - Main Result

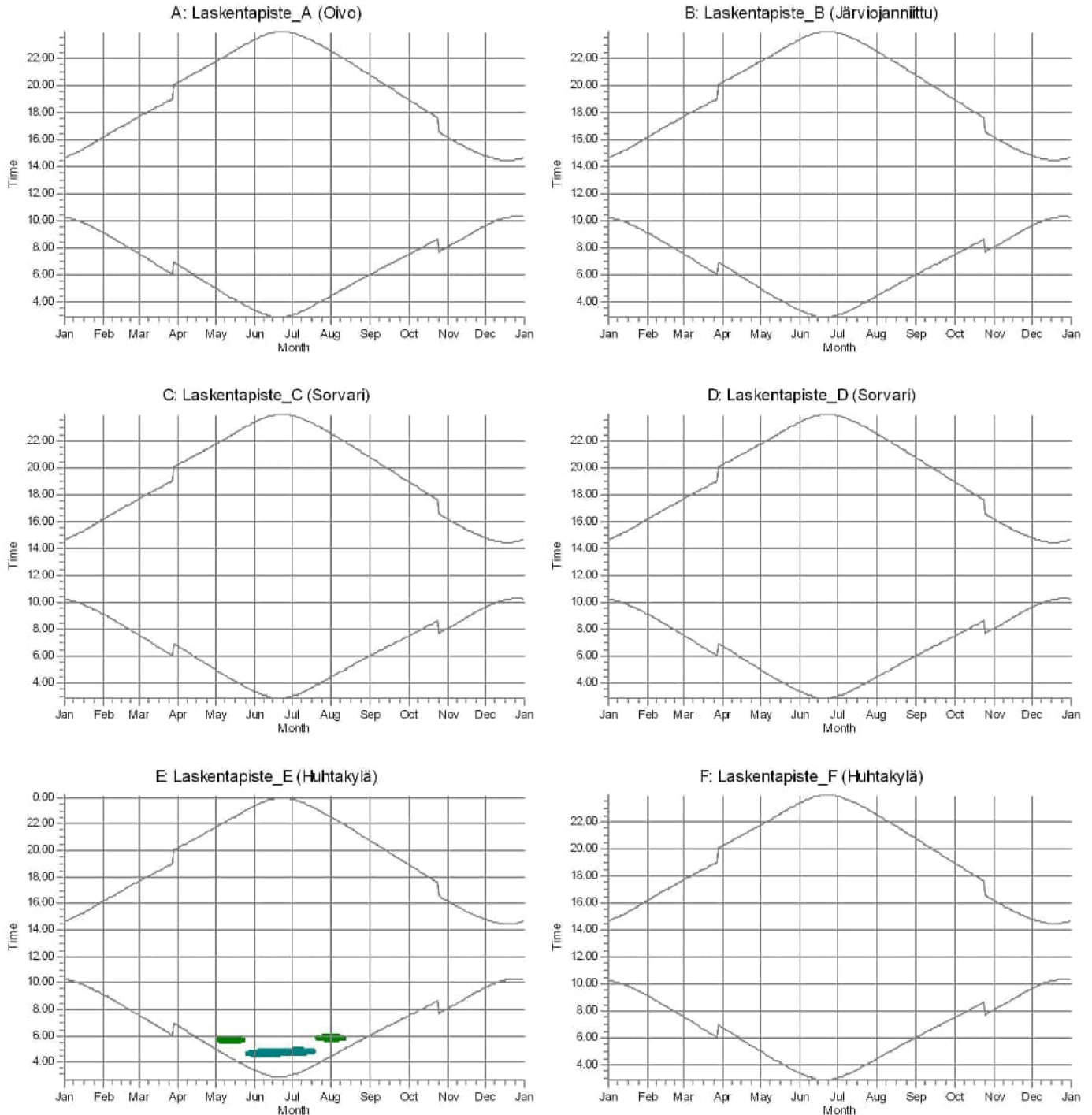
Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_Luke forest

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: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_Luke forest



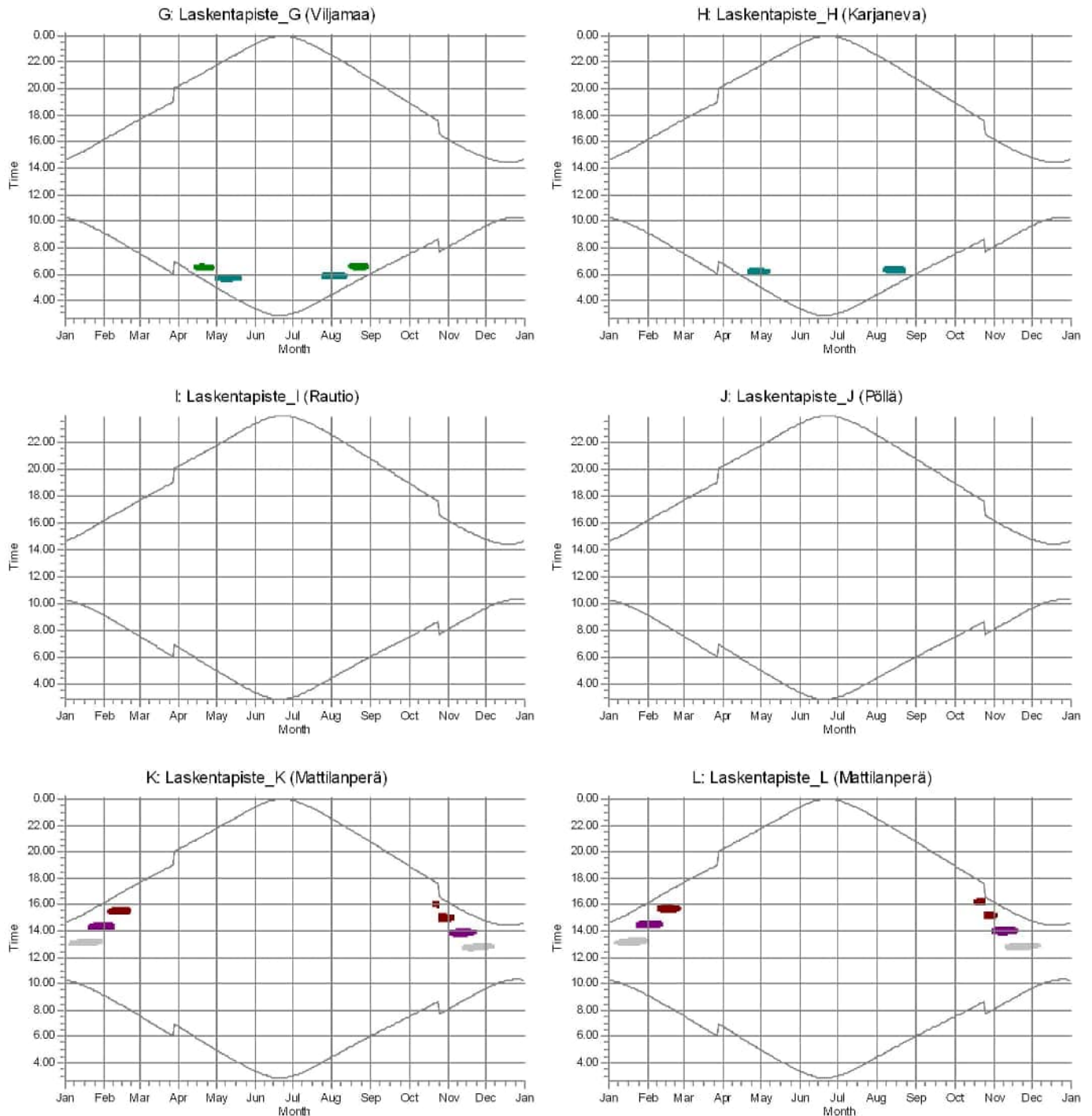
WTGs

14: Generic RD200 HH220 7200 200.0 IOI hub: 220,0 m (TOT: 320,0 m) (561)

16: Generic RD200 HH220 7200 200.0 IOI hub: 220,0 m (TOT: 320,0 m) (566)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_Luke forest



WTGs

14: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (561)

16: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (566)

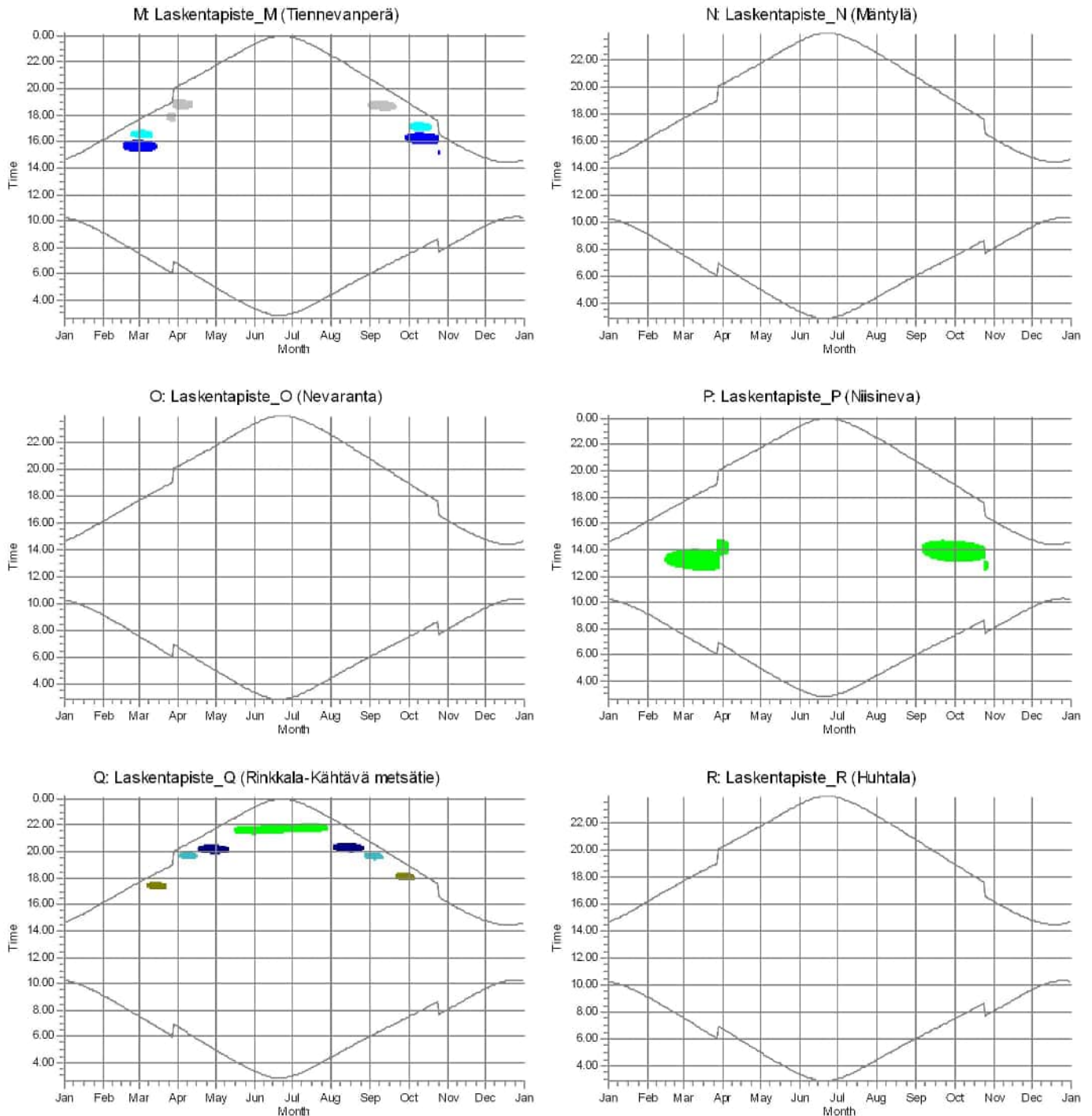
33: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (568)

32: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (571)

31: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (572)

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_Luke forest



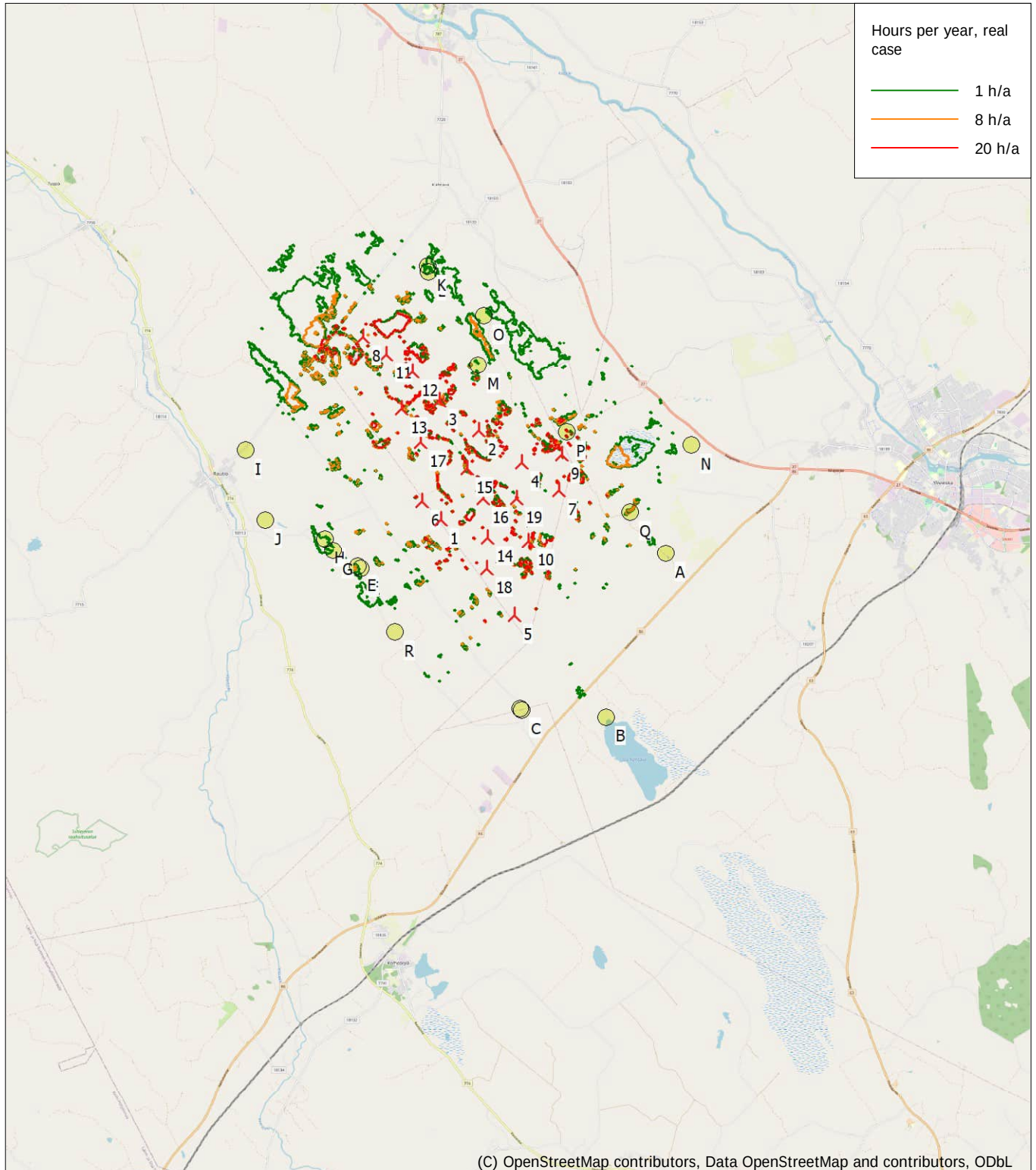
WTGs

30: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (563)
 19: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (567)
 24: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (569)
 11: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (570)

31: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (572)
 29: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (573)
 15: Generic RD200 HH220 7200 200.0 IO! hub: 220,0 m (TOT: 320,0 m) (579)

SHADOW - Map

Calculation: Verkasalo_VE2_Alavieska_RD200xxHH220_Valke_real case_Luke forest



0 2,5 5 7,5 10km

Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
 New WTG  Shadow receptor

Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
 Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m

SHADOW - Main Result

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_Luke forest

Assumptions for shadow calculations

Maximum distance for influence	2 500 m
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:

MERRA-2_N64,00_E024,375 (4)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
597	427	389	391	555	793	1 007	1 145	937	673	565	619	8 097

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_Verkasalo_1.wpo (1)

Area object(s) used in calculation:

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Area object (Heights a.g.l. for e.g. Forest (ORA tool) or ZVI obstructions): REG

Obstacles used in calculation

Receptor grid resolution: 1,0 m

All coordinates are in

Finish TM ETRS-TM35FIN-ETRS89

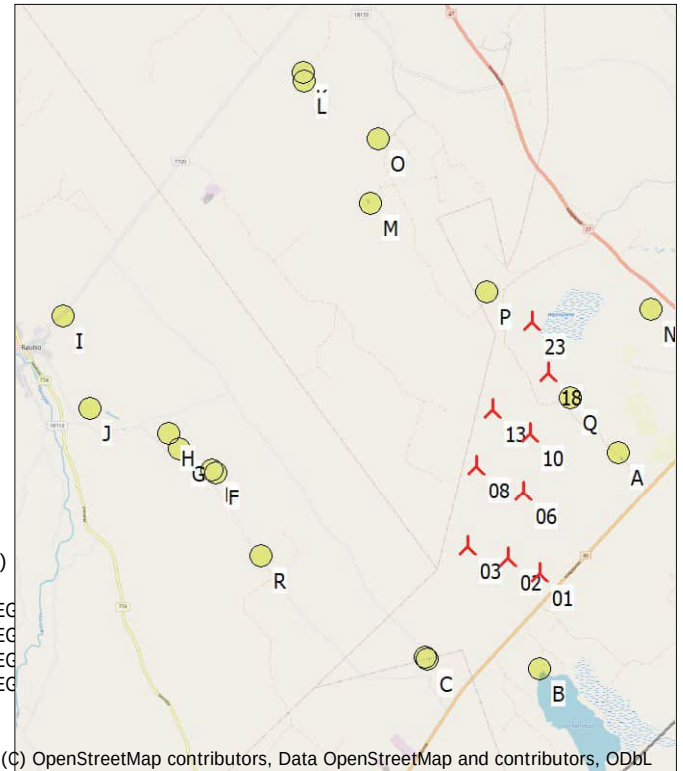
WTGs

	East	North	Z	Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Shadow data	
					Valid	Manufact.				Calculation distance [m]	RPM [RPM]
			[m]								
01	372 136	7 104 203	80,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
02	371 622	7 104 479	80,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
03	370 957	7 104 711	79,4	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
06	371 914	7 105 569	73,3	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
08	371 150	7 106 037	77,1	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
10	372 083	7 106 541	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
13	371 464	7 106 967	70,0	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
18	372 422	7 107 527	67,9	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4
23	372 176	7 108 397	63,7	Generic RD200 HH220 7200 20...Yes	Generic	RD200 HH220-7 200	7 200	200,0	220,0	2 500	10,4

Shadow receptor-Input

No.	Name	East	North	Z	Width	Height	Elevation a.g.l. [m]	Slope of window [°]	Direction mode	Eye height (ZVI) a.g.l. [m]
A	Laskentapiste_A (Oivo)	373 516	7 106 167	70,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
B	Laskentapiste_B (Järviojanniittu)	372 065	7 102 626	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
C	Laskentapiste_C (Sorvari)	370 211	7 102 863	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
D	Laskentapiste_D (Sorvari)	370 180	7 102 899	82,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
E	Laskentapiste_E (Huhtakylä)	366 759	7 106 162	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
F	Laskentapiste_F (Huhtakylä)	366 819	7 106 110	67,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
G	Laskentapiste_G (Viljamaa)	366 243	7 106 530	65,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
H	Laskentapiste_H (Karjaneva)	366 073	7 106 785	64,5	5,0	5,0	1,0	90,0	"Green house mode"	6,0
I	Laskentapiste_I (Rautio)	364 417	7 108 809	61,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0
J	Laskentapiste_J (Pöllä)	364 785	7 107 263	61,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
K	Laskentapiste_K (Mattilanperä)	368 566	7 112 661	59,4	5,0	5,0	1,0	90,0	"Green house mode"	6,0
L	Laskentapiste_L (Mattilanperä)	368 569	7 112 523	60,1	5,0	5,0	1,0	90,0	"Green house mode"	6,0
M	Laskentapiste_M (Tiennevanperä)	369 574	7 110 463	60,0	5,0	5,0	1,0	90,0	"Green house mode"	6,0
N	Laskentapiste_N (Mäntylä)	374 166	7 108 516	60,2	5,0	5,0	1,0	90,0	"Green house mode"	6,0

To be continued on next page...



SHADOW - Main Result

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_Luke forest

...continued from previous page

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]
O	Laskentapiste_O (Nevaranta)	369 753	7 111 523	57,6	5,0	5,0	1,0	90,0	"Green house mode"	6,0
P	Laskentapiste_P (Niisineva)	371 457	7 108 909	60,7	5,0	5,0	1,0	90,0	"Green house mode"	6,0
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	372 769	7 107 100	70,9	5,0	5,0	1,0	90,0	"Green house mode"	6,0
R	Laskentapiste_R (Huhtala)	367 519	7 104 685	70,6	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	Laskentapiste_A (Oivo)	2:30
B	Laskentapiste_B (Järviojanniittu)	0:00
C	Laskentapiste_C (Sorvari)	0:00
D	Laskentapiste_D (Sorvari)	2:39
E	Laskentapiste_E (Huhtakylä)	0:00
F	Laskentapiste_F (Huhtakylä)	0:00
G	Laskentapiste_G (Viljamaa)	0:00
H	Laskentapiste_H (Karjaneva)	0:00
I	Laskentapiste_I (Rautio)	0:00
J	Laskentapiste_J (Pöllä)	0:00
K	Laskentapiste_K (Mattilanperä)	0:00
L	Laskentapiste_L (Mattilanperä)	0:00
M	Laskentapiste_M (Tiennevanperä)	0:00
N	Laskentapiste_N (Mäntylä)	0:00
O	Laskentapiste_O (Nevaranta)	0:00
P	Laskentapiste_P (Niisineva)	0:00
Q	Laskentapiste_Q (Rinkkala-Kähtävä metsätie)	16:20
R	Laskentapiste_R (Huhtala)	0:00

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

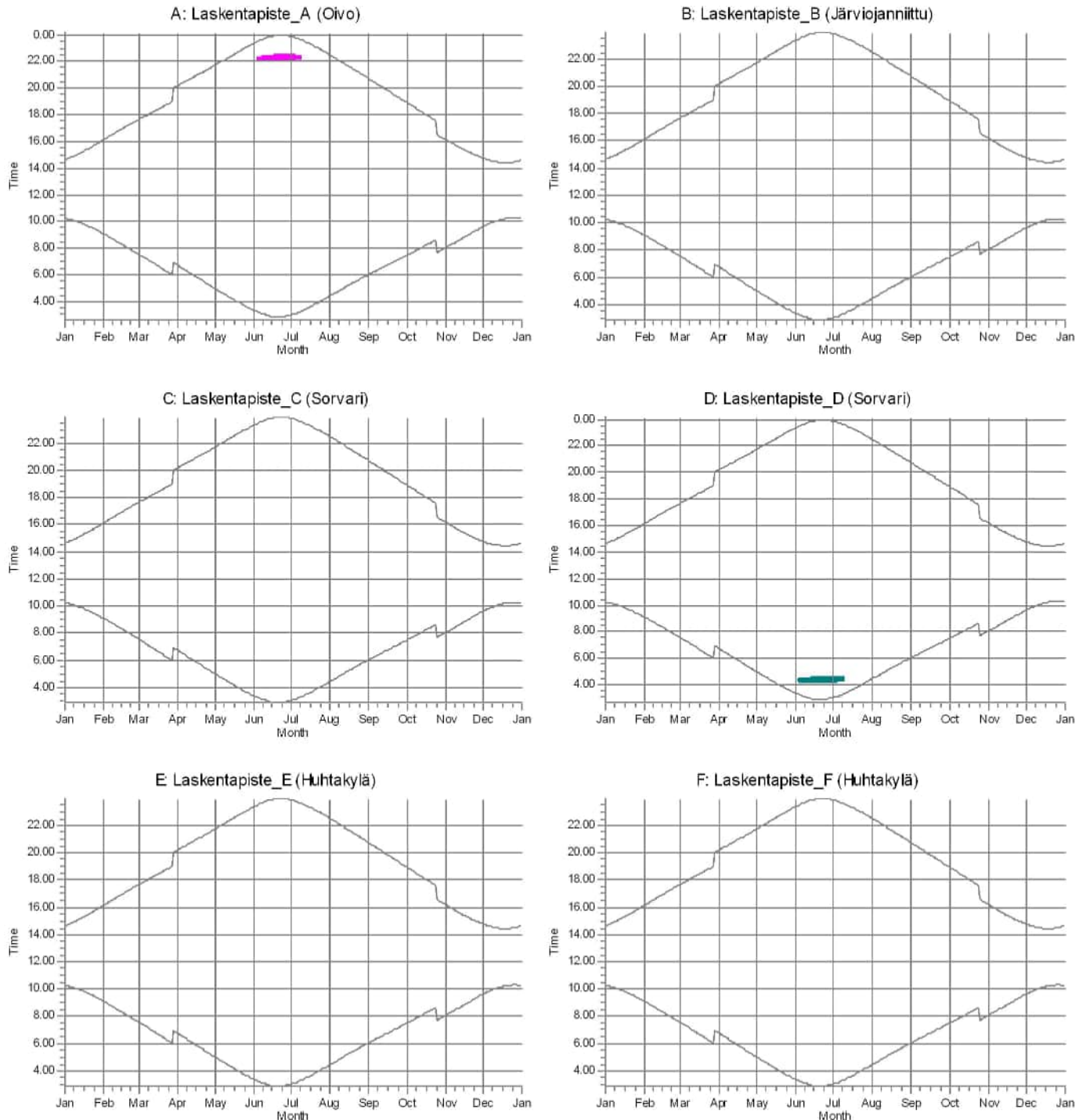
No.	Name	Expected [h/year]
01	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (585)	0:00
02	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (590)	2:39
03	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (591)	0:00
06	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (586)	1:59
08	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (592)	1:36
10	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (588)	8:06
13	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (593)	4:33
18	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (589)	2:30
23	Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (587)	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: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_Luke forest



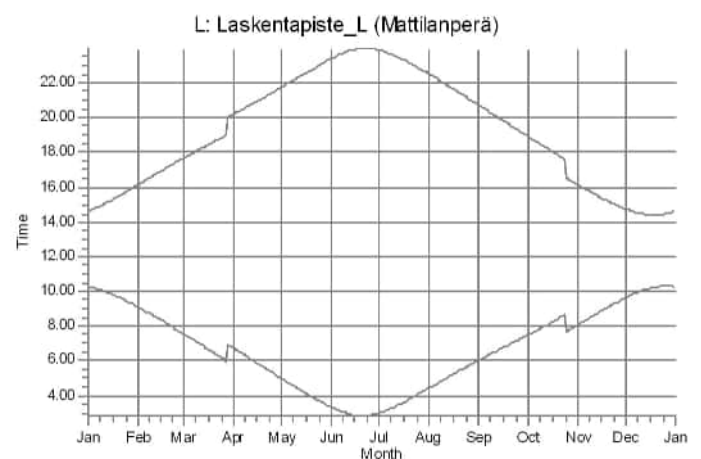
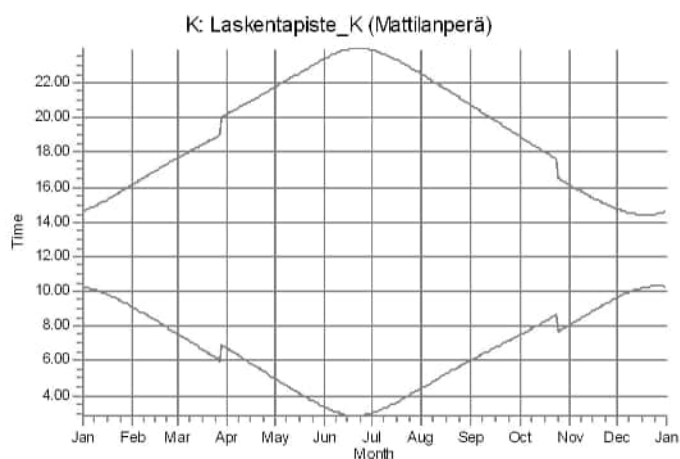
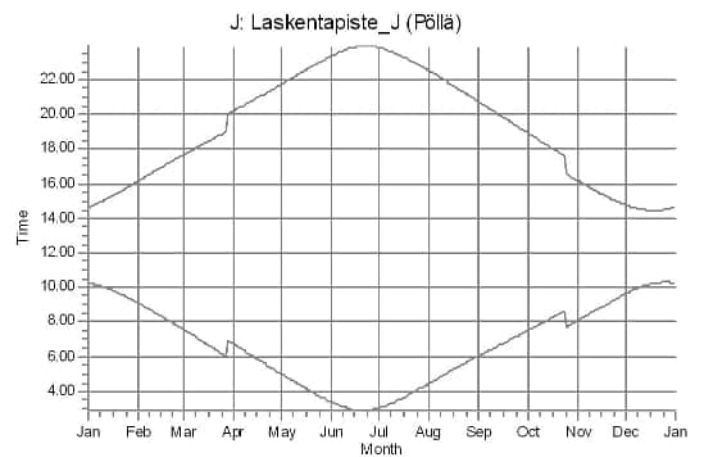
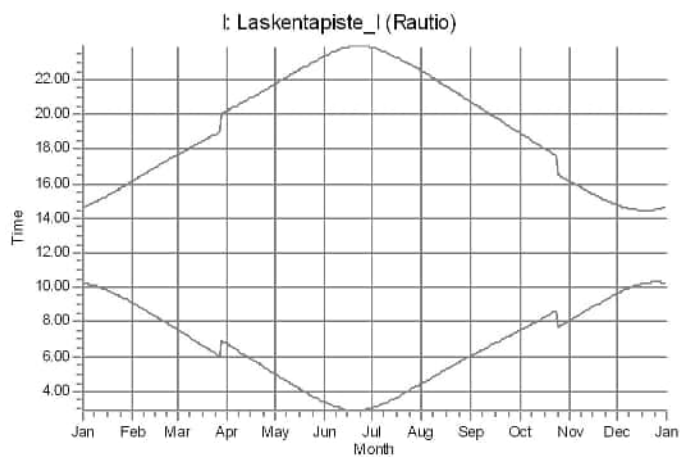
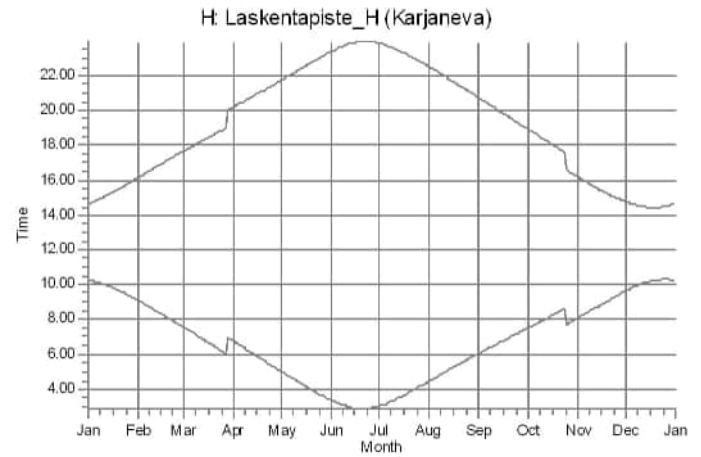
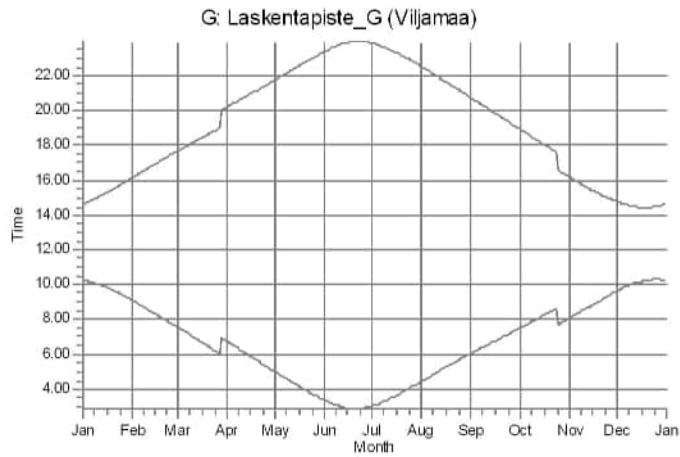
WTGs

18: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (589)

02: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (590)

SHADOW - Calendar, graphical

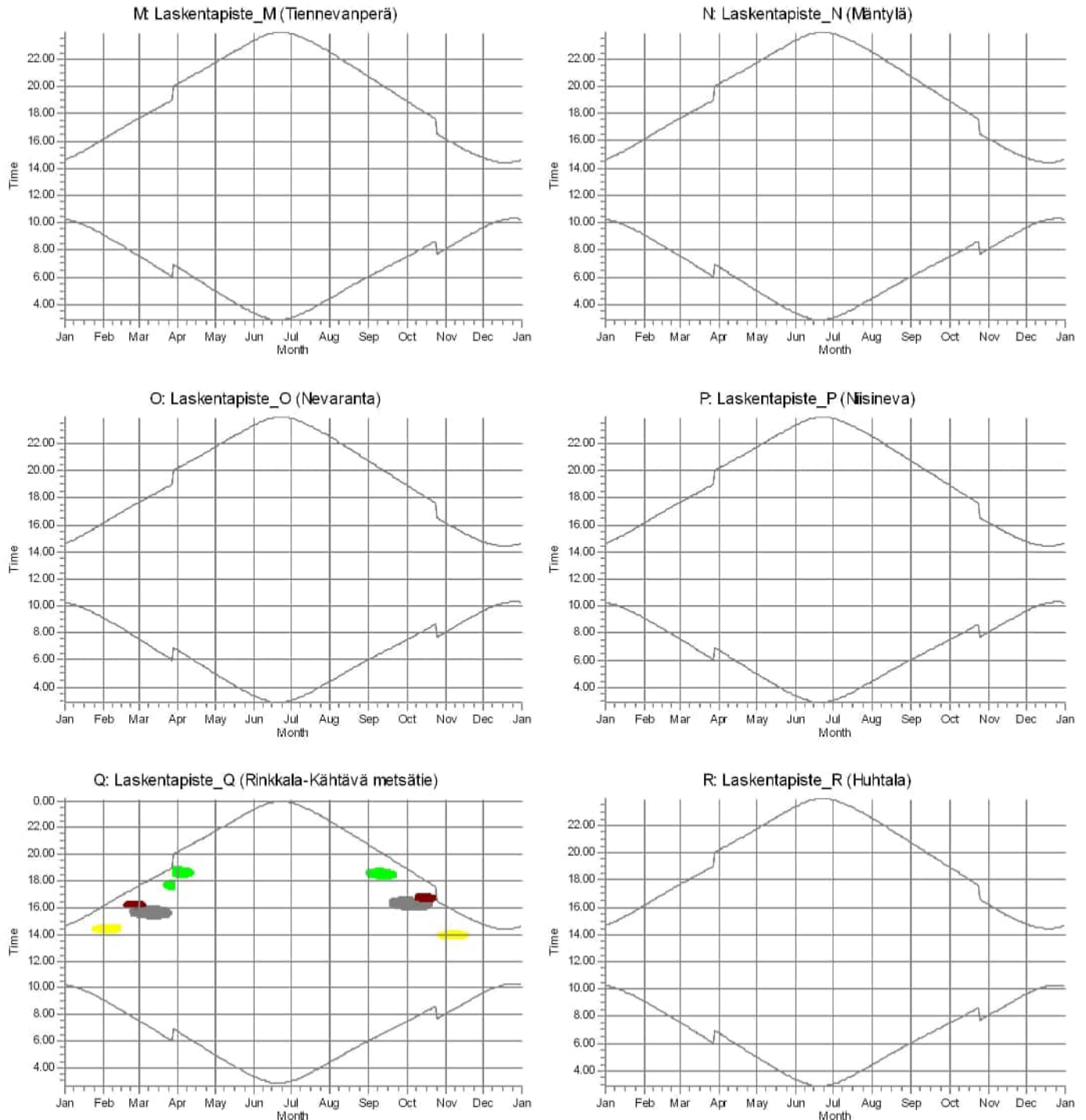
Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_Luke forest



WTGs

SHADOW - Calendar, graphical

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_Luke forest



WTGs

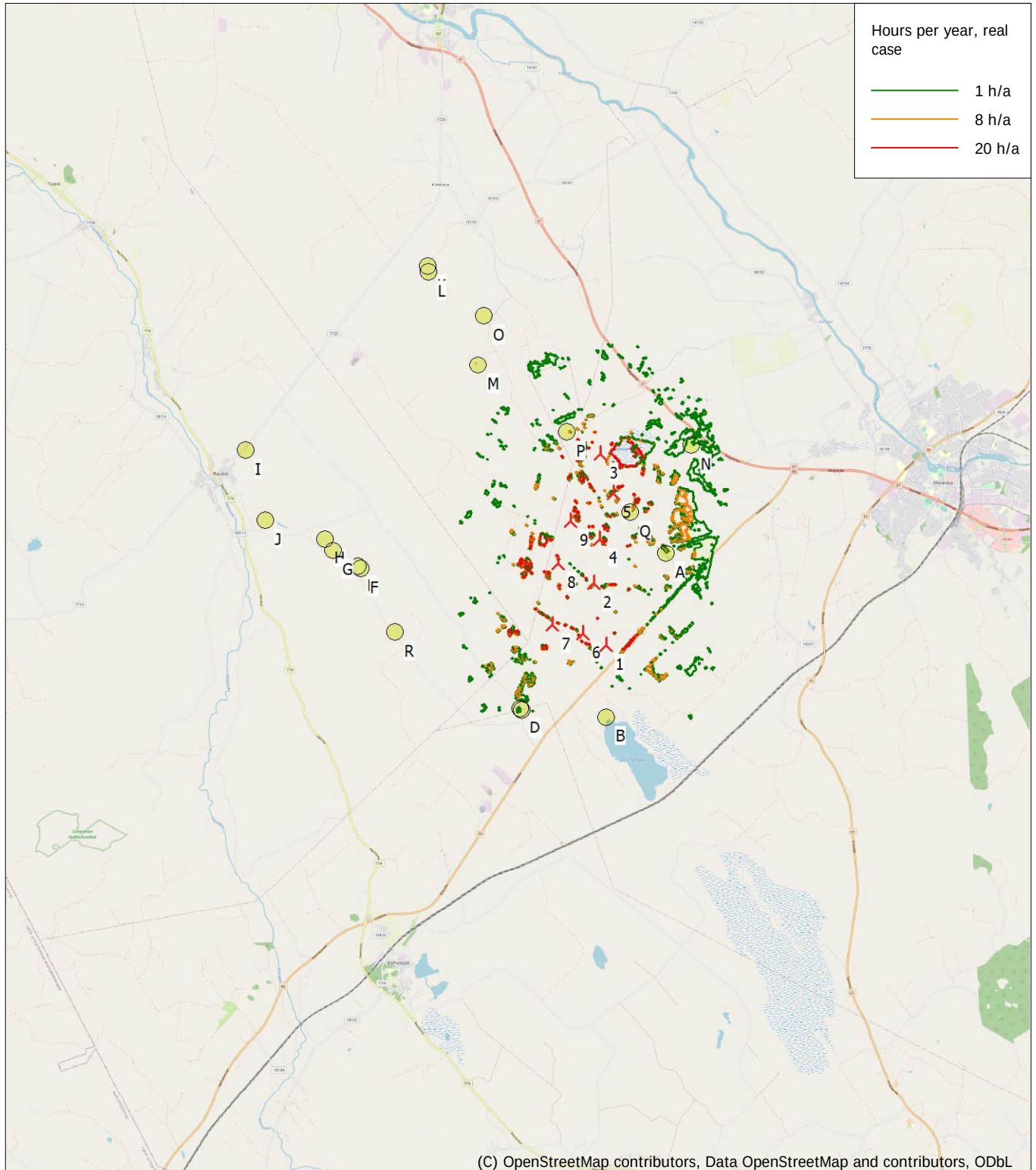
06: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (586)	08: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (592)
10: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (588)	13: Generic RD200 HH220 7200 200.0 !O! hub: 220,0 m (TOT: 320,0 m) (593)

Project:
Verkasalo

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5.10.2023 15.22/3.6.355

SHADOW - Map

Calculation: Verkasalo_VE2_Ylivieska_RD200x9xHH220_Valke_real case_Luke forest



Map: EMD OpenStreetMap , Print scale 1:125 000, Map center Finish TM ETRS-TM35FIN-ETRS89 East: 370 780 North: 7 106 020
New WTG Shadow receptor
Flicker map level: Height Contours: CONTOURLINE_Verkasalo_1.wpo (1)
Time step: 3 minutes, Day step: 7 days, Map resolution: 20 m, Visibility resolution: 10 m, Eye height: 1,5 m