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Päätös siirto-oikeuksien käyttöönotosta ja suojausmahdollisuuksien varmistamisesta Suomen ja Viron tarjousalueiden rajalla

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Ratkaisu

Energiavirasto katsoo, että Viron tarjousalueella ei ole riittäviä suojausmahdollisuuksia ja pyytää Fingridiä myöntämään Suomen ja Viron tarjousalueiden rajalle pitkän aikavälin siirto-oikeustuotteita.

Päätös on voimassa toistaiseksi.

Päätöstä on noudatettava muutoksenhausta huolimatta.

Selostus asiasta

Komission asetus (EU) 2016/1719 pitkän aikavälin kapasiteetin jakamista koskevista suuntaviivoista (jäljempänä FCA suuntaviivat) astui voimaan 17.10.2016. Asetuksen tavoitteena on edistää tehokasta alueiden välistä pitkän aikavälin kauppaa, joka tarjoaa markkinaosapuolille alueiden välisiä pitkän aikavälin suojausmahdollisuuksia.

FCA suuntaviivojen 30 Artiklan mukaisesti Energiaviraston on tehtävä päätös pitkän aikavälin siirto-oikeuksien käyttöönottoa koskien Suomen tarjousalueen rajoilla. Päätökset on koordinoitava tarjousaluerajalla toimivaltaisten sääntelyviranomaisten kesken ja niiden on perustuttava arviointiin, joka on tehtävä vähintään 4 vuoden välein. Energiavirasto teki edellisen kerran arvion suojausmahdollisuuksista Suomen ja Viron tarjousalueiden välisellä rajalla ja antoi 6.4.2017 Viron sääntelyviranomaisen kanssa koordinoidun päätöksen (2266/400/2016), jonka mukaan siirto-oikeuksia ei myönnetä Suomen ja Viron tarjousalueen rajalla.

Siirto-oikeuksien käyttöönottoa koskevien päätösten on perustuttava erilliseen arviointiin suojausmahdollisuuksien riittävyydestä sekä markkinaosapuolten kuulemiseen heidän tarpeistaan alueiden välisille suojausmahdollisuuksille. Energiavirasto teetti vuonna 2016 yhdessä Ruotsin, Tanskan ja Norjan sääntelyviranomaisten kanssa selvityksen FCA suuntaviivojen 30 Artiklan mukaisessa arvioinnissa käytettävästä menetelmästä (*Methods for evaluation of the Nordic forward market for electricity*). Arviointinsa tueksi Energiavirasto sekä muut Baltic kapasiteetin laskenta-alueen sääntelyviranomaiset teettivät Thema Consulting Groupilla yhteisen numeerisen selvityksen (*Analysis of Electricity Forward Market Hedging Opportunities in Finnish, Estonian, Latvian and Lithuanian Bidding Zones´ Borders, 18.2.2021*).

Energiavirasto on koordinoinut tämän päätöksen tekemistä Viron sääntelyviranomaisen (Konkurentsiamet) kanssa. Päätöksen liitteistä löytyy toimivaltaisten viranomaisten koordinoidut näkemykset erittelevä dokumentti (*Agreement between the Estonian Competition Authority and the Energy Authority of Finland Regarding the Hedging opportunities on the Finnish – Estonian Bidding Zone Border Pursuant to the Commission Regulation (EU) no 2016/1719*)

Päätöksiä tehdessään toimivaltaisten sääntelyviranomaisten on kuultava muita kapasiteetinlaskenta-alueen sääntelyviranomaisia sekä huomioitava heidän näkemyksensä. Suomen ja Viron tarjousalueraja kuuluu ns. Baltic-kapasiteetinlaskenta-alueeseen. Suomen ja Viron sääntelyviranomaiset ovat kuulleet muita alueella toimivia sääntelyviranomaisia. Energiavirasto on kuullut markkinaosapuolia heidän tarpeistaan alueiden välisille suojausmahdollisuuksille. Energiavirasto on kuullut kantaverkonhaltija Fingrid Oyj:tä tarjousalueiden välisistä suojausmahdollisuuksista sekä pitkän aikavälin siirto-oikeuksien käyttöönotosta.

Sääntelyviranomaisten kuuleminen

Päätöksiä tehdessään toimivaltaisten sääntelyviranomaisten on kuultava muita kapasiteetinlaskenta-alueen sääntelyviranomaisia sekä huomioitava heidän näkemyksensä.

Ruotsin, Latvian, Liettuan ja Puolan sääntelyviranomaiset eivät lausuneet Suomen ja Viron tarjousaluerajan osalta.

Kantaverkonhaltijan kuuleminen

Energiavirasto varasi 9.3.2021 – 23.3.2021 välisenä aikana Fingridille mahdollisuuden esittää näkemyksensä FCA-suuntaviivojen mukaisista tarjousalueiden välisistä suojausmahdollisuuksista sekä mahdollisesta pitkän aikavälin siirto-oikeuksien käyttöönotosta Suomen tarjousalueen rajoilla. Lausuntopyynnön liitteenä toimitettiin Energiaviraston sekä Viron, Latvian ja Liettuan regulaattoreiden teettämä numeerinen selvitys tarjolla olevista suojausmahdollisuuksista sekä Energiavirastoon toimitetut lausunnot markkinaosapuolten esittämistä tarpeista suojausmahdollisuuksien parantamiseksi. Fingrid toimitti lausuntonsa 23.3.2021.

Lausunnossaan Fingrid toteaa, että Energiaviraston numeerisessa selvityksessä tarkastellaan lukuisia indikaattoreita, jotka yhdistettynä markkinatoimijoiden näkemyksiin antavat kattavan kuvan suojausmahdollisuuksien toteutumisesta.

Fingrid esittää, että suojausmahdollisuuksien riittävyydessä ei näytä tapahtuneen sellaisia oleellisia muutoksia, jotka antaisivat aihetta muuttaa Energiaviraston

6.4.2017 antamaa aiempaa päätöstä, jonka mukaisesti siirto-oikeuksia ei myönnetä Suomen ja Ruotsin tarjousalueiden rajoilla eikä Suomen ja Viron tarjousalueen rajalla.

Fingrid toteaa haluavansa kiinnittää huomiota vuoden 2020 monin tavoin poikkeuksellisiin olosuhteisiin, joiden vaikutukset heijastuvat Energiaviraston numeerisen selvityksen tuloksiin. Fingrid katsoo, että lämpimän talven, koronapandemian ja ennätyssuuren pohjoismaisen vesivoiman tarjonta yhdistettynä siirtorajoituksiin sai systeemihinnan ja aluehinnan eron kasvamaan tavallista suuremmaksi, mikä näkyi pitkän aikavälin trendistä poikkeavana kehityksenä.

Fingrid toteaa, että jos Energiavirasto kuitenkin katsoo, että suojausmahdollisuudet eivät ole riittävät, Fingrid pitää parempana vaihtoehtona siirto-oikeustuotteiden myöntämistä Suomen tarjousalueiden rajoilla kuin muiden alueiden välisten pitkän aikavälin suojaustuotteiden antamista saataville sähkön tukkumarkkinoiden toiminnan tukemiseksi. Fingridin mukaan tehokkuuden näkökulmasta olisi tärkeää myös, että Suomen tarjousalueen rajoilla mahdolliset ratkaisut ovat yhtenevät.

Markkinaosapuolten kuuleminen

Energiavirasto järjesti julkisen kuulemisen 28.1.–18.2.2021 välisenä aikana markkinaosapuolille heidän tarpeistaan alueiden välisille suojausmahdollisuuksille. Energiavirastoon toimitettiin yhteensä 11 lausuntoa markkinaosapuolten suojaustarpeita koskien. Energiavirasto järjesti mainitun lisäksi julkisen kuulemisen arviointityön tueksi teetetyn selvityksen tuloksista 9.3.-23.3.2021 välisenä aikana. Energiavirastoon toimitettiin yhteensä 6 lausuntoa konsulttiselvityksen tuloksia koskien.

Suojausmahdollisuuksia koskevissa lausunnoissa esitettiin erilaisia näkemyksiä markkinoilta saatavien tuotteiden riittävyydestä ja tarpeisiin vastaamisesta. Osa vastaajista esitti saatavilla olevien tuotteiden riittävän sellaiseen ja vastaavan heidän suojaustarpeitaan. Osa vastaajista esitti, että kantaverkonhaltijoiden tulisi ostaa ja myydä nykyisiä rajat ylittäviä suojaustuotteita. Osa vastaajista totesi muuttuneen markkinatilanteen johtaneen siihen, että suojausmahdollisuudet ovat heikentyneet siten, että saatavilla olevat tuotteet eivät mahdollista riittävää suojaamista ja että kantaverkonhaltijan tulisi tarjota siirto-oikeuksia.

Markkinaosapuolten kuulemisen perusteella nykyisellään suojaaminen perustuu johdannaistuotteisiin, joiden kohde-etuutena ovat markkina-alueen siirtorajoituksetonta hintaa kuvaava ns. systeemihinta sekä aluehinnan erotus tähän. Energiavirastolle esitetyissä lausunnoissa kyseenalaistettiinkin siirto-oikeuksien soveltuvuus Pohjoismaiseen markkinamalliin. Kahden tarjousalueen välisen siirto-oikeuden esitettiin heikentävän systeemihinnan merkitystä ja vahvistavan aluehinnan merkitystä. Tällaisten tuotteiden esitettiin soveltuvan paremmin tilanteeseen, jossa suojaus joudutaan toteuttamaan tarjousaluekohtaisilla tuotteilla ja mahdollisesti yksittäiseen likvidiin tarjousalueeseen tukeutumalla.

Energiavirastolle annetuissa lausunnoissa esitettiin toisaalta myös, että EPAD-tuote ei myöskään täysin ole suuntaviivojen mukainen alueiden väliseen kaupankäyntiin liittyvä tuote. EPAD-tuotteen ongelmaksi nostettiin myös kilpailun puute ja markkinavoima johtuen tuotetta myyvien tahojen pienestä lukumäärästä suhteessa tuotetta ostaviin sekä epäilykset hinnoittelusta, kun tuotteille on olemassa vain yksi markkinapaikka. Osa vastaajista esitti, että ei ole tarvetta eikä kiinnostusta suojata yksittäisten tarjousalueiden välisiä hintaeroja siirto-oikeuksilla.

Energiaviraston toimivalta

Komission asetus (EU) 2016/1719 pitkän aikavälin kapasiteetin jakamista koskevista suuntaviivoista 2 artiklan mukaan tässä asetuksessa sovelletaan asetuksen (EY) N:o 714/2009 2 artiklassa, komission asetuksen (EU) N:o 543/2013 (1) 2 artiklassa ja Euroopan parlamentin ja neuvoston direktiivin 2009/72/EY (2) 2 artiklassa säädettyjä määritelmiä. Euroopan parlamentin ja neuvoston direktiivin 2009/72/EY 35 artiklan mukaan kunkin jäsenvaltion on nimettävä yksi kansallinen sääntelyviranomainen kansallisella tasolla.

Lain Energiavirastosta (870/2013) 1 §:n 2 momentin mukaan Energiavirasto hoitaa kansalliselle sääntelyviranomaiselle kuuluvat tehtävät, joista säädetään:

3) sähkön sisämarkkinoita koskevista yhteisistä säännöistä ja direktiivin 2003/54/EY kumoamisesta annetun Euroopan parlamentin ja neuvoston direktiivin 2009/72/EY, jäljempänä sähkömarkkinadirektiivi, nojalla annetuissa, suuntaviivoja koskevissa komission asetuksissa tai päätöksissä.

Asiaan liittyvä lainsäädäntö

Komission asetus (EU) 2016/1719 pitkän aikavälin kapasiteetin jakamista koskevista suuntaviivoista

FCA-suuntaviivojen 30 artiklan mukaan:

1. Siirtoverkonhaltijoiden on tarjousalueen rajalla myönnettävä pitkän aikavälin siirto-oikeuksia, jolleivat kyseisen tarjousalueen rajan toimivaltaiset sääntelyviranomaiset ole tehneet koordinoituja päätöksiä olla myöntämättä pitkän aikavälin siirto-oikeuksia tarjousalueen rajalla. Päätöksiään tehdessään tarjousalueen rajan toimivaltaisten sääntelyviranomaisten on kuultava kyseisen kapasiteetin laskenta-alueen sääntelyviranomaisia ja otettava niiden lausunnot asianmukaisesti huomioon.

2. Jos tarjousalueen rajalla ei ole pitkän aikavälin siirto-oikeuksia tämän asetuksen voimaantullessa, kyseisen tarjousalueen rajan toimivaltaisten sääntelyviranomaisten on tehtävä koordinoituja päätöksiä pitkän aikavälin siirto-oikeuksien käyttöönotosta viimeistään kuuden kuukauden kuluttua tämän asetuksen voimaantulosta.

3. Edellä olevan 1 ja 2 kohdan mukaisten päätösten on perustuttava arviointiin, jossa tutkitaan, onko sähkön termiinimarkkinoilla tarjolla riittävästi suojausmahdollisuuksia asianomaisilla tarjousalueilla. Tarjousalueen rajan toimivaltaisten sääntelyviranomaisten on suoritettava arviointi koordinoidusti, ja siihen on sisällytettävä ainakin

a) markkinaosapuolten kuuleminen heidän tarpeistaan alueiden välisille suojausmahdollisuuksille asianomaisilla tarjousalueen rajoilla;

b) arviointi.

4. Edellä 3 kohdan b alakohdassa tarkoitetussa arvioinnissa on tarkasteltava sähkön tukkumarkkinoiden toimintaa, ja sen on perustuttava avoimiin perusteisiin, joihin kuuluu vähintään

a) analyysi siitä, suojaako termiinimarkkinoilla tarjottava tuote tai tuotteiden yhdistelmä vuorokausimarkkinoiden hintojen epävakaudelta asianomaisella tarjousalueella. Tällainen tuote tai tuotteiden yhdistelmä on katsottava asianmukaiseksi suojaukseksi kyseisen tarjousalueen vuorokausimarkkinoiden hinnan muutosriskiltä, jos kyseisen tarjousalueen vuorokausimarkkinoiden hinta korreloi riittävästi tuotteen tai tuotteiden yhdistelmän kohde-etuuden hinnan kanssa;

b) analyysi siitä, ovatko termiinimarkkinoilla tarjotut tuotteet tai tuotteiden yhdistelmät tehokkaita. Tätä varten on arvioitava vähintään seuraavat indikaattorit:

i) kaupankäyntihorisontti;

ii) osto- ja myyntihinnan välinen ero;

iii) kaupatut määrät suhteessa fyysiseen kulutukseen;

iv) avointen sopimusten määrä (open interest) suhteessa fyysiseen kulutukseen;

5. Jos 3 kohdassa tarkoitettu arviointi osoittaa, että yhdellä tai useammalla tarjousalueella ei ole riittäviä suojausmahdollisuuksia, toimivaltaisten sääntelyviranomaisten on pyydettävä asianomaisia siirtoverkonhaltijoita

a) myöntämään pitkän aikavälin siirto-oikeuksia tai

b) varmistamaan, että saataville annetaan muita alueiden välisiä pitkän aikavälin suojausinstrumentteja sähkön tukkumarkkinoiden toiminnan tukemiseksi.

6. Jos toimivaltaiset sääntelyviranomaiset päättävät esittää 5 kohdan b alakohdassa tarkoitetun pyynnön, asianomaisten siirtoverkonhaltijoiden on laadittava tarvittavat järjestelyt ja toimitettava ne toimivaltaisten sääntelyviranomaisten hyväksyttäviksi viimeistään kuusi kuukautta niiden esittämän pyynnön jälkeen. Nämä tarvittavat järjestelyt on toteutettava viimeistään kuuden kuukauden kuluttua toimivaltaisten sääntelyviranomaisten antaman hyväksynnän jälkeen. Toimivaltaiset sääntelyviranomaiset voivat pidentää toteuttamisen määräaikaa asianomaisten siirtoverkonhaltijoiden pyynnöstä enintään 6 kuukaudella.

7.Jos sääntelyviranomaiset päättävät, että kyseessä olevat siirtoverkonhaltijat eivät saa myöntää pitkän aikavälin siirto-oikeuksia tai että niiden on annettava saataville muita alueiden välisiä pitkän aikavälin suojausinstrumentteja, tarjousalueen rajojen siirtoverkonhaltijoihin ei sovelleta 16, 28, 29, 31–57, 59 ja 61 artiklaa.

8.Tarjousalueen rajan toimivaltaisten sääntelyviranomaisten on tarjousalueen rajan siirtoverkonhaltijoiden yhteisestä pyynnöstä tai omasta aloitteestaan tehtävä vähintään 4 vuoden välein yhteistyössä viraston kanssa arviointi 3–5 kohdan mukaisesti.

Perustelut

Yleistä suojausmahdollisuuksien arvioinnista

FCA-suuntaviivojen tavoitteena on a) edistää tehokasta alueiden välistä pitkän aikavälin kauppaa, joka tarjoaa markkinaosapuolille alueiden välisiä pitkän aikavälinsuojausmahdollisuuksia; b) optimoida alueiden välisen pitkän aikavälin kapasiteetin laskenta ja jakaminen; c) tarjota syrjimätön pääsy alueiden väliseen pitkän aikavälin kapasiteettiin; d) varmistaa siirtoverkonhaltijoiden, viraston, sääntelyviranomaisten ja markkinaosapuolten oikeudenmukainen ja syrjimätön kohtelu; e) ottaa huomioon tarve taata oikeudenmukainen ja säännönmukaisesti toimiva pitkän aikavälin kapasiteetin jakaminen sekä säännönmukainen hinnanmuodostus; f) varmistaa pitkän aikavälin kapasiteetin jakamista koskevien tietojen avoimuus ja luotettavuus ja parantaa niitä; g) edistää Euroopan sähkönsiirtoverkon ja sähköalan tehokasta toimintaa ja kehittämistä pitkällä aikavälillä;

FCA-suuntaviivat edellyttävät kantaverkonhaltijoiden tarjoavan siirto-oikeuksia elleivät markkinoilta saatavat suojaustuotteet mahdollista riittäviä suojausmahdollisuuksia. Suojausmahdollisuuksien arvioinnin on perustuttava markkinaosapuolten näkemyksiin heidän tarpeistaan sekä erilliseen arviointiin saatavilla olevista tuotteista ja näiden tehokkuudesta.

Energiavirasto katsoo FCA-suuntaviivojen tavoitteena olevan alueiden välisten pitkän aikavälin suojausmahdollisuuksien edistämisen tarkoittavan, että suojausmarkkinoiden tarjoamia suojausmahdollisuuksia ja sähkön tukkumarkkinoiden toimintaa on tarkasteltava suuntaviivojen 30 artiklan mukaisessa tarjousaluekohtaisessa tarkastelussa kokonaisuutena. Täten suojausmahdollisuuksien ei voida katsoa tarkoittavan vain suppeasti suoraan tarjousalueiden välisiä hintaeroja suojaavia tuotteita. Energiavirasto katsoo, että tarjousaluekohtaisessa tarkastelussa lähtökohtaisesti systeemihinnan ja aluehinnan erotukselta suojaava EPAD-tuote on relevantti, mutta tarkastelussa voidaan huomioida myös muut yleisesti sähkön hintasuojaamiseen soveltuvat tuotteet ja tuotteiden yhdistelmät.

Suojausmahdollisuuksien numeerinen arviointi

FCA-suuntaviivojen 30 artiklan mukaisesti toimivaltaisen sääntelyviranomaisen on suoritettava avoimiin perusteisiin perustuva sähkön tukkumarkkinoiden toimintaa tarkasteleva arviointi. Arvioinnin tulee perustua avoimiin perusteisiin ja siihen kuuluu vähintään analyysi siitä, suojaako termiinimarkkinoilla tarjottava tuote tai tuotteiden yhdistelmä vuorokausimarkkinoiden hintojen epävakaudelta, sekä analyysi tuotteen tai tuotteiden tehokkuudesta vähintään seuraavia indikaattoreita käyttäen; kaupankäyntihorisontti, osto- ja myyntihinnan välinen ero (bid-ask spread), kaupatut määrät suhteessa fyysiseen kulutukseen, avointen sopimusten määrä (open interest) suhteessa fyysiseen kulutukseen.

Energiavirasto teetti vuonna 2016 yhdessä muiden Pohjoismaisten sääntelyviranomaisten kanssa selvityksen arvioinnissa käytettävästä menetelmästä (*Methods for evaluation of the Nordic forward market for electricity*). Selvitys arvioi menetelmiä FCA-suuntaviivojen edellyttämien indikaattorien arviointiin sekä esittää korrelaatioanalyysin käyttöä tuotteen tai tuotteiden yhdistelmän suojauksen arviointia varten.

Selvityksessä todetaan, että yksittäisille indikaattoreille ei ole tunnistettuja numeerisia raja-arvoja, joiden perusteella tuotteen nähtäisiin olevan yksiselitteisesti tehokas tai tehoton. Markkinaosapuolten suojaustarpeet ja toisaalta myös suojaamiselle asetetut odotukset vaihtelevat. Yksittäisiä indikaattoreita tulisikin tarkastella yhdessä ja osana kokonaisuutta. Pohjoismaiden sekä Viron, Latvian ja Liettuan sääntelyviranomaiset sopivat käyttävänsä vuonna 2021 tehtävää suojausmahdollisuuksia koskevaa arviointia varten yhteistä menetelmää (*Methodology for assessment of the Nordic forward market*), joka pohjautuu vahvasti vuonna 2016 teetettyyn selvitykseen.

Energiavirasto teetti arviointinsa tueksi Viron, Latvian sekä Liettuan sääntelyviranomaisten kanssa numeerisen selvityksen (*Analysis of Electricity Forward Market Hedging Opportunities in Finnish, Estonian, Latvian and Lithuanian Bidding Zones´ Borders*). Energiaviraston arviointi sekä selvitys noudattavat yhdessä sovittua menetelmää ja perustuvat NASDAQ-pörssitalon toimittamaan markkinadataan vuodesta 2012 lähtien siltä osin, kun dataa oli saatavilla. Seuraavat kappaleet käsittelevät yksitellen FCA-suuntaviivojen edellyttämiä indikaattoreita perustuen mainittuihin selvityksiin. Energiaviraston käsityksen mukaan NASDAQ:lta saatu markkinadata ei täysimääräisesti kata koko johdannaismarkkinaa, mutta tämän voidaan katsoa antavan kuvan markkinoiden tilanneesta, sillä markkinapaikalla tapahtuvan kaupankäynnin voidaan olettaa toimivan referenssinä markkinapaikan ulkopuoliselle ja kahdenväliselle kaupankäynnille.

Volyymit kuvaavat käydyn kaupan määrää ja ovat suoraviivainen tapa tarkastella markkinoiden kokoa tai likviditeettiä tietyllä aikavälillä. Kaikkien alueiden johdannaistuotteiden (EPAD-tuotteiden) yhteenlasketun määrän voidaan havaita laskeneen hieman vuoden 2017 jälkeen, asettuen noin 2 TWh – 4,5 TWh tasolle. Kaupankäynti suojausmarkkinoilla painottuu pidemmän maturiteetin tuotteisiin ja lyhemmän maturiteetin tuotteilla volyymit ovat vähäisiä. Viikko EPAD:n volyymit ovat koko tarkasteluajanjakson ajan hyvin vähäistä. Energiaviraston näkemyksen mukaan markkinaosapuolet suojaavat pääsääntöisesti pidemmillä tuotteilla ja lyhemmillä tuotteilla tarvittaessa täsmennetään hankittua suojausta, mikä myös havaitaan tuotteiden volyymeja tarkasteltaessa. Tarkasteltaessa johdannaistuotteilla käydyn kaupan määrää päivittäistasolla, havaitaan, että kaupankäynti Helsingin suojaustuotteella on pysynyt vuositasolla tarkasteltuna melko tasaisena noin 0,1 – 0,3 TWh tasolla. Tallinnan EPAD -tuotteen volyymit ovat olleet koko tarkastelujakson ajan merkittävästi alhaisemmat, jääden vuoden 2014 jälkeen pysyvästi alle 0,005 TWh:n.

Kaupankäynnin volyymien avulla arvioidaan myös FCA-suuntaviivoissa edellytetty indikaattori kaupatuista määristä suhteessa fyysiseen kulutukseen. Arviossa siis verrataan johdannaistuotteiden volyymiä fyysiseen sähkön kokonaiskulutukseen. Kaikkien vuosittaisten EPAD-tuotteiden suhde tarkasteluaikana vuosittaiseen kaikkien tarjousalueiden kokonaiskulutukseen on laskenut hieman viimeisen neljän vuoden aikana, ollen lopussa noin 2-3 -kertainen verrattuna fyysiseen kulutukseen. Energiavirasto tulkitsee tämän johtuvan osin käydyn kaupan määrän laskusta samalla ajanjaksolla. Kun tarkastellaan vain Helsingin EPAD-suojaustuotteen kaupankäynnin määrän suhdetta saman alueen fyysiseen kulutukseen, havaitaan että suhde on pysynyt hyvin tasaisena neljän viimeisen vuoden ajan, vaihdellen välillä 0,5 – 1,5. Viron EPAD -suojaustuotteelle vastaava suhdeluku on ollut vuodesta

2014 lähtien todella alhainen, vaihdellen välillä 0 – 0,2 ja ollen valtaosan ajasta lähellä nollaa, johtuen EPAD -tuotteen vähäisistä kaupankäyntimääristä.

Kaupankäyntihorisontti on FCA-suuntaviivojen edellyttämä suoraviivainen indikaattori, joka kuvaa johdannaistuotteiden tarjontaa. Se tarkoittaa tarjottujen ja selvitettyjen eri maturiteettisten johdannaistuotteiden määriä, eli käytännössä uniikkien tuotteiden listausta ottamatta kantaa siihen, kuinka paljon kyseisillä tuotteilla käydään kauppaa. Tarkasteluajankohtana tarjottavia uniikkeja johdannaistuotteita oli yhteensä 9272 kpl, joista EPAD-johdannaisia oli 3115 kpl. Energiavirasto ei tässä erittele tarkemmin tarjottuja johdannaisia, mutta nämä löytyvät tämän päätöksen liitteenä olevasta numeerisesta selvityksestä.

Avoimien sopimusten määrä viittaa tietyllä hetkellä olevien avoimien johdannaissopimusten määrään. Avointen sopimusten määrä fyysiseen kulutukseen verrattuna on FCA-suuntaviivojen edellyttämä indikaattori. Yhteenlaskettu avointen sopimusten määrä laski vuoden 2019 alussa noin 200 TWh:n tasolle. Helsingin EPAD -johdannaisten avointen sopimusten määrä on pysynyt melko tasaisena koko tarkasteluajanjakson ajan. Yhteenlaskettu avointen sopimusten määrä verrattuna fyysiseen kulutukseen on pysynyt melko tasaisena vuositason, kvartaalitason sekä kuukausitason tuotteilla, ollen kaikilla tuotteilla tasolla 0,2 – 0,4. Pohjoismaisilla suojaustuotteilla suojataan siis noin 20 – 40 % fyysisen kulutuksen määrästä. Helsingin kuukausitason EPAD – tuotteille sama suhdeluku on pysynyt tasaisena koko tarkastelujakson, ollen välillä 0,2 – 0,35. Tallinnan kuukausitason EPAD -tuotteille sama suhdeluku on ollut erittäin pieni koko jakson ajan yksittäisiä piikkejä lukuun ottamatta, ollen vuoden 2015 jälkeen jatkuvasti alle 0,05.

Riskipreemiolla tarkoitetaan tässä tapauksessa EPAD-johdannaisen viimeistä ns. closing-hintaa verrattuna kyseisellä ajanjaksolla toteutuneeseen spot-hintaan. Riskipreemion tasoa seuraamalla voidaan arvioida johdannaistuotteiden mahdollista systemaattista yli- tai alihinnoittelua sekä markkinaosapuolten halukkuutta maksaa suojauksista. Kuukausitason sekä kvartaalitason tarkastelu osoitti, että Suomen tarjousalueen EPAD -johdannaisilla oli tilastollisesti merkittävä positiivinen riskipreemio 5 %:n merkitsevyystasolla. Systeemihintaan sidotuille johdannaisille vastaavaa tilastollisesti merkittävää riskipreemiota ei havaittu tarkasteltuna ajanjaksona.

Osto- ja myyntihinnan välinen ero on FCA-suuntaviivoissa edellytetty indikaattori, joka lasketaan suoraviivaisesti osto- ja myyntitarjousten erotuksena. Näiden lukujen erolla voidaan arvioida markkinoiden likviditeettiä. Mitä pienempi tuotteen osto- ja myyntitarjousten erotus on, sitä tehokkaammin tuotteella voidaan käydä kauppaa. Tarkastelun kohteena olivat keskimääräinen pienin sekä suurin osto- ja myyntihinnan ero vuosi-, kuukausi-, viikko- ja päivätasolla. Tallinnan EPAD -suojaustuotteiden osto- ja myyntihinnan ero oli melko korkea kaikkien eri aikavälien suojaustuotteilla. Helsingin EPAD -suojaustuotteilla vastaava ero oli pienempi, mutta ero lähti merkittävään kasvuun 2020 alkupuolella, päätyen noin 8 €/MWh tasolle tarkastelujakson lopussa. Kaikkien Pohjoismaisten vuositason suojaustuotteiden keskimääräinen osto- ja myyntitarjousten erotus pysyi tasaisena noin vuoden 2016 loppuun asti, minkä jälkeen tapahtuneen hetkittäisen korkean eron jälkeen ero on ollut laskusuuntainen aina tarkastellun ajanjakson loppuun asti.

Amihudin likviditeetin puutteen suhdeluvulla pyritään arvioimaan hintojen muutosherkkyyttä verrattuna suuriin kaupankäyntimääriin, minkä kautta voitaisiin arvioida likviditeettiä. Suhdeluku lasketaan jakamalla avaamis- ja sulkemishintojen erotus kyseisen päivän kaupankäyntiin käytetyllä rahasummalla. Energiavirasto toteaa, että menetelmän käyttöä energiamarkkinoiden arviointiin on tutkittu rajoitetusti ja suojausmahdollisuuksia tulee tulkita kokonaisuutena peilaten tätä suhdelukua myös muihin tarkasteltuihin muuttujiin. Tarkasteluajanjakson alkuvaiheessa systeemihinnan suojaustuotteilla suhdeluku pysyi tasaisena ollen jatkuvasti alle 0,1 tasolla. Vuodesta 2017 lähtien suhdeluku lähti kasvuun kuukausi-, kvartaali- ja vuositason tuotteilla. Sekä Helsingin että Tallinnan EPAD -suojaustuotteilla suhdeluku lähti kasvuun vuoden 2017 jälkeen, minkä jälkeen tasaantui samalle tai hieman pienemmälle tasolle 2019 loppuun mennessä. Energiavirasto katsoo, että tämän suhdeluvun painoarvon tulisi olla kokonaisarvioinnissa vähäinen, koska empiiristä tutkimusta sen käytöstä sähkömarkkinoiden osalta ei ole riittävästi saatavilla.

FCA-suuntaviivat edellyttävät edellä esitettyjen tuotteiden kaupankäymisen tehokkuutta kuvaavien indikaattorien tarkastelun lisäksi analyysiä siitä, suojaako termiinimarkkinoilla tarjottavat tuote tai tuotteiden yhdistelmä hintojen epävakaudelta asianomaisella tarjousalueella. Tuotteen tai tuotteiden yhdistelmän riittävyyttä arvioidaan tuotteen tai tuotteiden yhdistelmän ja niiden kohde-etuuden hinnan korrelaation avulla. Energiaviraston numeerinen korrelaatioanalyysi tarkasteli korrelaatiota kahdella tavalla. EPAD-johdannaisen korrelaatiota tarkasteltiin toteutuneeseen systeemihinnan ja aluehinnan eroon sekä EPAD- ja systeemihintatuotteen yhdistelmän korrelaatiota toteutuneeseen aluehintaan. Johdannaisten osalta tarkastelussa käytettiin viimeisen kaupankäyntipäivän ns. closing-hintaa, jonka oletetaan vastaavan parhainta käytettävissä olevaa tietoa. Suomen ja Viron spot -hintojen kuukausikeskiarvojen korrelaatio viimeisen viiden vuoden ajanjaksolla on ollut melko korkea, ollen 0.94. Vastaava korrelaatio aluehinnan ja systeemihinnan erotukselle Suomen ja Viron tarjousalueiden välillä on 0,95. Energiavirasto toteaa, että viiden vuoden ajalle laskettu yhden lukuarvon sellaisenaan korkea korrelaatio kuukausikeskiarvoihin perustuen ei käytännössä anna täyttä kuvaa korrelaatiosta tai sen riittävyydestä, koska pitkän aikavälin keskiarvojen käyttäminen ei tuo esille lyhyemmän aikavälin heikompia korrelaatioita. Kun tarkastellaan Suomen ja Viron spot-hintojen viikkokeskiarvoja, voidaan havaita, että korrelaatio on vaihdellut vuodesta 2016 lähtien välillä 0,8 – 1 ja että vuoteen 2019 jatkunut korrelaation vahvistuva kehitys muuttui heikentyväksi.

Energiavirasto toteaa kokonaisarviointina ja suojausmahdollisuuksien numeeriseen selvitykseen perustuen, että suojausmahdollisuuksien aiempi hyvä kehitys on viimeisen neljän vuoden tarkastelujakson aikana pysähtynyt tai vaihtunut heikentyväksi kehityssuunnaksi. Energiavirasto arvioi, että Tallinnan EPAD -suojaustuotteiden osto- ja myyntitarjousten ajoittain erittäin korkea ero viittaa tehottomuuteen alueen suojausmahdollisuuksissa. Energiavirasto toteaa, että Helsingin EPAD -suojaustuotteiden osto- ja myyntihinnan eron kasvu viittaa suojausmahdollisuuksien heikkenemiseen erityisesti tarkastellun ajanjakson lopussa. Energiavirasto arvioi, että Suomen tarjousalueen EPAD -johdannaisissa havaittu tilastollisesti merkittävä riskipreemio johtuu osin siitä, että suojauksia tarvitsevien sähkön ostajien määrä on suurempi kuin sähkön myyjien ja viittaa erityisesti sähkön ostajien kannalta heikentyneisiin suojausmahdollisuuksiin.

Markkinaosapuolten näkemykset suojausmahdollisuuksista

Energiavirastolle markkinaosapuolten kuulemisessa toimitettujen vastausten perusteella markkinoiden nykyisin tarjoamista suojausmahdollisuuksista on toimijoiden keskuudessa erilaisia näkemyksiä. Osa vastaajista esittää nykyisillään saatavilla olevien tuotteiden riittävän sellaisenaan ja vastaavan heidän suojaustarpeitaan. Samalla kuitenkin valtaosassa vastauksista korostui tarve parantaa suojausmahdollisuuksia. Energiavirasto katsoo, että FCA-suuntaviivojen tarkoituksena on varmistaa, että kaikilla markkinaosapuolilla on yhtäläiset mahdollisuudet hankkia tarvitsemansa suojaukset.

Osassa lausunnoista tuotiin esille se, että sähkömarkkinoilla tapahtuvat muutokset kuten siirtoihin perustuvan kapasiteetin laskentamenetelmän käyttöönotto tai siirtokapasiteetin varaukset aFRR -kapasiteettimarkkinalle tulisi huomioida päätöstä tehtäessä, sillä ne voivat heikentää fyysisen markkinan ymmärrettävyyttä ja ennustettavuutta ja siten johtaa suojauksien tarpeen kasvuun. Energiavirasto katsoo, että muuttuvassa markkinatilanteessa tulevien suojausmahdollisuuksien arviointiin liittyy aina epävarmuutta. Energiavirasto toteaa, että FCA suuntaviivojen mukaisesti Energiaviraston tulee tutkia suojausmahdollisuuksien riittävyyttä enintään neljän vuoden välein tehtävässä arvioinnissa. Energiavirasto toteaa, että vaikka arvioinnissa huomioidaan odotettavissa olevia muutoksia markkinoilla, arviointi perustuu ensisijaisesti vallitsevaan markkinatilanteeseen sekä käytettävissä olevaan markkinadataan. Energiavirasto huomauttaa, että sääntelyviranomainen voi tehdä arvioinnin tarvittaessa jo ennen neljän vuoden takarajaa siirtoverkonhaltijoiden yhteisestä pyynnöstä tai omasta aloitteestaan.

Osa vastaajista katsoi, että suojausmahdollisuuksia tulisi parantaa tarjousalueiden väliseen hintaeroon perustuvilla uusilla EPAD -tuotteilla, kun taas osa vastaajista esitti ratkaisuksi EPAD -tuotteiden likviditeetin parannusta. Vastauksissa esitettiin myös suojausmahdollisuuksien parantamista myöntämällä siirto-oikeustuotteita. Toisaalta osa vastaajista katsoi, että mahdolliset siirto-oikeustuotteet saattaisivat heikentää EPAD -suojaustuotteiden likviditeettiä entisestään. Energiavirasto katsoo, että nykyiset suojaustuotteet ja menettelyt sekä siirto-oikeudet eivät lähtökohtaisesti ole toisiaan pois sulkevia. Täten Energiavirasto pitää mahdollisena, että mikäli suojausmarkkinoilta saatavien tuotteiden ei katsota mahdollistavan FCA-suuntaviivojen edellyttämiä suojausmahdollisuuksia, voidaan näitä täydentää tarjoamalla siirto-oikeuksia. FCA-suuntavivojen mukaisesti on myös mahdollista varmistaa muiden tuotteiden saatavuus, mikäli tämä katsottaisiin tarpeelliseksi. Energiavirasto katsookin, että FCA-suuntaviivat antavat toimivaltaisille sääntelyviranomaisille laajan harkintavallan suojausmahdollisuuksien parantamiseksi.

Energiavirasto toteaa, että markkinatoimijoiden vastauksissa korostuu tarve parantaa suojausmahdollisuuksia ja että vastausten perusteella erityisesti Virossa toimivien markkinaosapuolten ei ole mahdollista hankkia riittäviä suojauksia.

Kantaverkonhaltijan näkemys suojausmahdollisuuksista

Energiavirastolle antamassaan lausunnossa Fingrid esittää, että Energiaviraston teettämän numeerisen selvityksen perusteella suojausmahdollisuuksien riittävyydessä ei ole tapahtunut sellaista muutosta, joka antaisi aihetta pyytää Fingridiä myöntämään tarjousalueen rajalle siirto-oikeustuotteita tai varmistamaan että saataville annetaan muita pitkän aikavälin suojaustuotteita sähkön tukkumarkkinoiden toiminnan tukemiseksi. Fingrid toteaa haluavansa kiinnittää huomiota vuoden 2020 poikkeuksellisiin olosuhteisiin ja lähivuosien kehitysnäkymiin ja esittää että arvioinnin tulee keskittyä pitkän aikavälin trendiin. Energiavirasto toteaa, että numeerisen selvityksen perusteella suojausmahdollisuudet Suomen ja Viron tarjousalueiden rajalla ovat huonontuneet 2017 tehtyyn selvitykseen verrattuna. Energiavirasto huomauttaa, että johtopäätöksiä suojausmahdollisuuksien riittävyydestä ei voi tehdä pelkän numeerisen selvityksen perusteella. FCA suuntaviivojen mukaisesti analyysin tulee kattaa myös markkinaosapuolten kuulemisesta saadut näkemykset heidän tarpeistaan alueiden välisille suojausmahdollisuuksille.

Fingrid esittää vastauksessaan pitävänsä parempana vaihtoehtona siirto-oikeustuotteiden myöntämistä Suomen tarjousalueiden rajoilla kuin muiden alueiden välisten pitkän aikavälin suojaustuotteiden antamista saataville sähkön tukkumarkkinoiden toiminnan tukemiseksi, mikäli Energiavirasto katsoo, että suojausmahdollisuudet eivät ole riittävät. Fingridin mukaan tehokkuuden näkökulmasta olisi tärkeää myös, että Suomen tarjousalueen rajoilla mahdolliset ratkaisut ovat yhtenevät. Fingrid toteaa lausunnossaan, ettei siirtoverkonhaltijaa voitaisi velvoittaa myymään nykyisiä aluehintaerotuotteita tai toimimaan niiden markkinatakaajana, sillä kyseiset tuotteet suojaavat aluehinnan ja laskennallisen referenssihinnan väliseltä hintaerolta, eivätkä ne siten ole FCA suojaviivojen 30 artiklan 5 kohdan b alakohdan mukaisia alueiden välisiä pitkän aikavälin suojausinstrumentteja. Energiavirasto katsoo, että FCA -suuntaviivat mahdollistavat myös muiden pitkän aikavälin suojausinstrumenttien antamisen sähkön tukkumarkkinoiden tukemiseksi ja että aluehintaeroon perustuva tuote yhdistettynä systeemihintaan perustuvaan tuotteeseen muodostavat yhdessä hankittuna suuntaviivojen mukaisen suojausinstrumentin.

Johtopäätökset

Energiavirasto katsoo, että Suomen ja Viron tarjousalueiden välisen rajan suojausmahdollisuuksien arvioinnissa olennaisin tarkastelukohde on Viron tarjousalueen suojaustuotteiden riittävyys, koska sähkön siirtosuunta on valtaosan ajasta Suomesta Viroon. Arvioinnin perusteella Tallinnan EPAD -suojaustuotteen avointen sopimusten määrä, avointen sopimusten suhde fyysiseen kulutukseen sekä kaupankäyntimäärät ovat olleet alhaisia tarkastelujakson ajan. Samojen suojaustuotteiden osto- ja myyntihintojen eron havaittiin kasvaneen tarkastelujakson viimeisen vuoden aikana kuukausi- ja kvartaalitason tuotteilla. Energiavirasto toteaa arviointiin perustuen, että Virossa toimivat markkinaosapuolet käyttävät suojauksiin ennemmin Helsingin EPAD-johdannaisia kuin Tallinnan EPAD-johdannaisia johtuen Tallinnan EPAD-johdannaisten alhaisesta likviditeetistä. Helsingin ja Viron tarjousalueiden hintojen riittävän korkea korrelaatio on aiemmin mahdollistanut eri tarjousalueen suojaustuotteen hyödyntämisen suojauksissa. Numeerisen selvityksen perusteella voidaan kuitenkin todeta Helsingin ja Viron tarjousalueiden hintojen korrelaation positiivisen kehityssuunnan vaihtuneen heikentyneeksi korrelaatioksi vuoden 2019 jälkeen, heikentäen erityisesti Virossa toimivien markkinaosapuolien suojausmahdollisuuksia. Energiavirasto katsoo Suomen ja Viron tarjousalueiden hintojen korrelaation pienenemiseen sekä muihin yllä eriteltyihin seikkoihin perustuen, että aluehinnan ja systeemihinnan erotukselta suojaava EPAD -tuote ei enää mahdollista suojaamista riittävällä tasolla Viron markkinaosapuolille.

Energiavirasto katsoo kokonaisarviointina sekä numeeriseen arviointiin että markkinaosapuolten näkemyksiin perustuen, että Viron tarjousalueella ei voida todeta olevan riittäviä FCA -suuntaviivojen tarkoittamia suojausmahdollisuuksia. FCA -suuntaviivojen mukaisesti sääntelyviranomaiset voivat pyytää siirtoverkonhaltijoita joko myöntämään siirto-oikeuksia tai varmistamaan että saataville annetaan muita alueiden välisiä pitkän aikavälin suojausinstrumentteja sähkömarkkinoiden toiminnan tukemiseksi. Energiavirasto katsoo, että siirto-oikeustuotteiden käyttöönotto mahdollistaa Viron markkinaosapuolille suojauksen Helsingin EPAD -johdannaista käyttäen ja siten parantaa Virossa toimivien markkinaosapuolten suojausmahdollisuuksia. Energiavirasto katsoo, että siirto-oikeustuotteet ovat tehokkain tapa parantaa suojausmahdollisuuksia varmistaen samalla FCA suuntaviivojen tavoitteiden toteutumisen.

Energiavirasto katsoo, että Viron tarjousalueella ei ole riittäviä suojausmahdollisuuksia ja pyytää Fingridiä myöntämään Suomen ja Viron rajalle pitkän aikavälin siirto-oikeustuotteita.

Sovelletut säännökset

Komission asetus (EU) 2016/1719 30 artikla

Laki sähkö- ja maakaasumarkkinoiden valvonnasta (590/2013) 36 §

Muutoksenhaku

Muutoksenhakua koskeva ohjeistus liitteenä.

Liitteet Valitusosoitus Markkinaoikeuteen

Agreement between the Estonian Competition Authority and the Energy Authority of Finland Regarding the Hedging opportunities on the Finnish – Estonian Bidding Zone Border Pursuant to the Commission Regulation (EU) no 2016/1719

NordREG Methodology for assessment of the Nordic forward market, 11.9.2020

Analysis of Electricity Forward Market Hedging Opportunities in Finnish, Estonian, Latvian and Lithuanian Bidding Zones´ Borders, 18.2.2021

Jakelu Fingrid Oyj

VALITUSOSOITUS

Valitusoikeus hallintopäätöksestä

Energiaviraston antamaan hallintopäätökseen saa hakea muutosta valittamalla siten kuin laissa oikeudenkäynnistä hallintoasioissa (808/2019) säädetään. Valituskelpoisella hallintopäätöksellä tarkoitetaan päätöstä, jolla asia on ratkaistu tai jätetty tutkimatta.

Hallintopäätökseen saa hakea muutosta valittamalla se, johon päätös on kohdistettu tai jonka oikeuteen, velvollisuuteen tai etuun päätös välittömästi vaikuttaa ja se, jonka valitusoikeudesta laissa erikseen säädetään.

Valitusviranomainen

Valitusviranomainen Energiaviraston päätökseen on markkinaoikeus.

Valituksen tekeminen ja valitusaika

Valituksen saa tehdä sillä perusteella, että päätös on lainvastainen.

Valitus on tehtävä kirjallisesti 30 päivän kuluessa päätöksen tiedoksisaannista.

Valituksen tekemisestä säädetään lisäksi sähköisestä asioinnista viranomaistoiminnassa annetussa laissa (13/2003). Määräaikojen laskemisesta säädetään säädettyjen määräaikain laskemisesta annetussa laissa (150/1930).

Valituksen sisältö

Valituksessa on ilmoitettava:

- päätös, johon haetaan muutosta (*valituksen kohteena oleva päätös*);
- miltä kohdin päätökseen haetaan muutosta ja mitä muutoksia siihen vaaditaan tehtäväksi (*vaatimukset*);
- vaatimusten perustelut; sekä
- mihin valitusoikeus perustuu, jos valituksen kohteena oleva päätös ei kohdistu valittajaan.

Valituksessa on lisäksi ilmoitettava valittajan nimi ja yhteystiedot. Jos puhevaltaa käyttää valittajan laillinen edustaja tai asiamies, myös tämän yhteystiedot on ilmoitettava. Yhteystietojen muutoksesta on valituksen vireillä ollessa ilmoitettava viipymättä tuomioistuimelle.

Valituksessa on ilmoitettava myös se postiosoite ja mahdollinen muu osoite, johon oikeudenkäyntiin liittyvät asiakirjat voidaan lähettää (*prosessiosoite*). Mikäli valittaja on ilmoittanut enemmän kuin yhden prosessiosoitteen, voi tuomioistuin valita, mihin ilmoitetuista osoitteista se toimittaa oikeudenkäyntiin liittyvät asiakirjat.

Oikaisuvaatimuksen tekijä saa valittaessaan oikaisuvaatimuspäätöksestä esittää vaatimuksilleen uusia perusteluja. Hän saa esittää uuden vaatimuksen vain, jos se perustuu olosuhteiden muutokseen tai oikaisuvaatimuksen tekemisen määräajan päättymisen jälkeen valittajan tietoon tulleeseen seikkaan.

Valituksen liitteet

Valitukseen on liitettävä:

- valituksen kohteena oleva päätös valitusosoituksineen;
- selvitys siitä, milloin valittaja on saanut päätöksen tiedoksi, tai muu selvitys valitusajan alkamisen ajankohdasta; sekä
- asiakirjat, joihin valittaja vetoaa vaatimuksensa tueksi, jollei niitä ole jo aikaisemmin toimitettu viranomaiselle.

Valituskirjelmän toimittaminen valitusviranomaiselle

Valituskirjelmä on toimitettava valitusajan kuluessa markkinaoikeuteen, jonka osoite on:

Markkinaoikeus
Radanrakentajantie 5
00520 HELSINKI

faksi: 029 56 43314
sähköposti: markkinaoikeus@oikeus.fi

Valituskirjelmä voidaan toimittaa valitusviranomaiselle myös postitse.

Valituksen voi tehdä myös hallinto- ja erityistuomioistuinten asiointipalvelussa osoitteessa https://asiointi2.oikeus.fi/hallintotuomioistuimet

Kun valituskirjelmä toimitetaan hallinto- ja erityistuomioistuinten asiointipalvelun kautta, liitteet voi toimittaa skannattuna asiointipalvelussa tai kirjeitse. Kirjeitse toimitettaessa mainitse asiasta asiointipalvelun Viesti-kentässä.

Oikeudenkäyntimaksu

Valittajalta peritään markkinaoikeudessa oikeudenkäyntimaksu 2050 euroa. Tuomioistuinmaksulaissa (1455/2015) on erikseen säädetty tapauksista, joissa maksua ei peritä.

REPUBLIC OF ESTONIA
COMPETITION AUTHORITY

energiavirasto

Agreement between the Estonian Competition Authority and the Energy Authority of Finland Regarding the Hedging opportunities on the Finnish – Estonian Bidding Zone Border Pursuant to the Commission Regulation (EU) no 2016/1719

Pursuant to Commission Regulation (EU) no 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation (FCA Guideline) the following National Regulatory Authorities (NRAs):

NRA	Country	Contact details
Estonian Competition Authority (ECA), (Konkurentsiamet)	Estonia	Address: 39 Tatari Street, 10134 Tallinn Phone: +372 667 2400 Fax: +372 667 2401 E-mail: info@konkurentsiamet.ee
Energy Authority (Energiavirasto)	Finland	Address: Lintulahdenkuja 2 A, 00530 Helsinki, Finland Phone: + 358 29 5050 000 Fax: + 358 9 6221 911 E-mail: kirjaamo@energiavirasto.fi

agree as a coordinated decision on cross-zonal risk hedging opportunities of the Finnish – Estonian (FI-EE) bidding zone border as follows.

The Article 30(1) of the FCA Guideline obliges the Transmission System Operators (TSOs) on a bidding zone border to issue long-term transmission rights unless the competent regulatory authorities of the bidding zone border have adopted coordinated decisions not to issue long-term transmission rights on the bidding zone border.

On April 6, 2017 Estonian and Finnish NRAs agreed that there are sufficient hedging opportunities for FI-EE bidding zone border in the concerned bidding zones.

In accordance with Article 30(8) of the FCA Guideline at least every 4 years, the competent regulatory authorities of the bidding zone border shall perform, in cooperation with the Agency for the Cooperation of Energy Regulators (ACER), an assessment of hedging opportunities pursuant to paragraphs 3 to 5 of Article 30 of the FCA Guideline.

Acting in accordance with Article 30(3) of the FCA Guideline, the NRAs have conducted an assessment on whether the electricity forward market provides sufficient hedging opportunities in the concerned bidding zones on each side of the bidding zone border. The specifics of the assessment have been agreed in coordination with the NRAs in question, including but not limited to the consultation and an evaluation as defined in Article 30(3) of the FCA Guideline. Pursuant to Article 30(1) of the FCA Guideline, the relevant authorities of the capacity calculation region have been consulted.

Based on the numerical analysis "Analysis of Electricity Forward Market Hedging Opportunities in Finnish, Estonian, Latvian and Lithuanian Bidding Zones Borders" performed by THEMA and public consultations for the market participants, Finnish and Estonian NRAs agree that the market does not provide sufficient hedging opportunities in the concerned FI and EE bidding zones.

Pursuant to Articles 30(1), 30(2), 30(3) and 30(5) of the FCA Guideline, the Finnish and Estonian NRAs agree to request the respective TSOs to issue long-term transmission rights on the FI-EE - bidding zone border.

Signed digitally

Märt Ots
Director General
Estonian Competition Authority

Simo Nurmi
Director General
Energy Authority of Finland

SIGNATURES ALLEKIRJOITUKSET UNDERSKRIFTER SIGNATURER UNDERSKRIFTER

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authority to sign	asemavaltuutus	ställningsfullmakt	autoritet til å signere	myndighed til at underskrive
representative	nimenkirjoitusoikeus	firmateckningsrätt	representant	repræsentant
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Methodology for assessment of the Nordic forward market

11 August 2020

Introduction

The Nordic energy regulators in NordREG have a close cooperation on the development of a coordinated methodology for an assessment of the functioning of the Nordic electricity forward market. The assessment will be carried out following requirements in Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation (FCA GL).

NordREG finds it crucial that the assessment covers the most important indicators that are relevant for market participants in the Nordic electricity market. NordREG also finds it important to use indicators that are well-founded in economic theory and applicable considering the specific characteristics of electricity markets. Hence, NordREG engaged consultants in 2016 and organised workshops about the implementation of the FCA GL in order to gain more insights related to the methodology for evaluating the Nordic financial electricity market. In November 2016 EC Group delivered the report "*Methods for evaluation of the Nordic forward market for electricity*" which gave valuable input to the regulators on how to carry out the assessment following the FCA GL.

This document presents the Nordic energy regulators coordinated methodology for assessment of the Nordic forward market. The document is an update of the similar document published in 2016.

Background

The aim of the FCA GL is to establish common rules for Forward Capacity Allocation and provide market participants with sufficient hedging opportunities related to the area price risk. The FCA GL makes clear that the reference tools to allow for cross-border hedging are Long-Term Transmission Rights (LTTRs) auctioned by the TSOs. However, an exemption is possible, if cross-border financial hedging tools on both side of an interconnector exist and have shown their efficiency. In such a case, issuing of LTTRs is not mandatory, as long as the competent regulatory authorities of the bidding zone border have adopted coordinated decisions not to issue LTTRs. The guideline also provides for alternative products to be offered instead of LTTRs in order to support the functioning of the electricity market.

According to the FCA GL, the regulators` decisions on whether to introduce LTTRs or not, shall be based on an assessment "*which shall identify whether the electricity forward market provides sufficient hedging opportunities in the concerned bidding zones*". The assessment shall include at least "a) *a consultation with market participants about their needs for cross-zonal risk hedging opportunities on the concerned bidding zone borders*" and "b) *an evaluation*".

The aim of the evaluation is to "*investigate the functioning of wholesale electricity markets*". The FCA GL lists minimum criteria/indicators to include in the evaluation. The FCA GL does not exclude the possibility to add other indicators/criteria for the evaluation of the functioning of the market.

Basic features of the Nordic electricity forward market

The Nordic countries constitute 12 interconnected bidding areas in the European day-ahead market coupling. Available transmission capacity is given to the market through implicit auctioning. Power exchanges[1]offer futures contracts for hedging the day-ahead system price in the Nordic market area. The system price is an index price of the Nordic market. It is the resulting power price of all bids and offers in the Nordic bidding zones if there was no congestion between the bidding zones.

Since the system price is an index of all Nordic bidding zones, it attracts liquidity from all Nordic market participants. This is a benefit in an electricity market with many, small bidding zones, as the system price may work as a more liquid hub for trading than any individual bidding zone would be able to.

Electricity Price Area Differentials (EPADs) are used for hedging the price difference between the specific bidding zone price and the system price. However, these contracts are traded to a much lesser extent than the system price contracts. In areas, where the area prices are highly correlated with the system price, there could be a relatively low demand for EPAD contracts also due to the transaction costs involved with buying EPADs.

The structure of an EPAD contract is different from an LTTR in several ways. One feature of the EPAD vs LTTRs is that the EPAD will hedge the remaining price risk that arises from a specific bidding zone price diverging from the system price, it will not transfer the risk exposure from one area price to another area price. This is an important feature and a benefit for market participants in a system with many bidding zones. Other important differences are that TSOs do not have any role in the EPAD trade and EPAD contracts cannot be subject to curtailment.

The assessment of the Nordic forward market should recognize the link between the system price contracts and the EPAD contracts. An EPAD without a system price contract would not give a fully firm hedge towards the area price risk. Just like an LTTR also needs to be complemented by a hedge for the local destination area price in order to give a fully firm hedge.

Further, the assessment should take account of the whole market, not only the forward market. The level of risk aversion among retailers can to a certain extent be explained by the contract types offered and demanded in the retail market. For example, in markets where there is a large share of retail contracts settled on the basis of the area spot price, or other forms of variable contracts related to the spot price, the area price risk for retailers is largely reduced and the need for hedging reduced accordingly. Hence, we can expect that the demand for hedging is higher in areas with a large share of fixed price contracts than in areas with a large share of variable price contracts in the retail market. However, it also depends on the production side in the area, and the demand for hedging amongst producers.

A trend that has developed since 2016 is the growing prevalence of power purchasing agreements (PPAs)[2]. These contracts - that are typically physical - allow sellers and buyers to agree fixed prices also for extensive durations. Since the contracts are bilateral and bespoke, and not standardised, it is up to the parties to the contracts to define the content.

PPAs exist in two forms: A developer of a wind / solar park (typically) selling to either 1) an end customer or 2) a utility company that merges the contract into its portfolio. The developer can gain access to a fixed price that extends further in time than the Nordic forward market or LTTRs can. The end customer gets certainty for origin of power production and can use this in marketing green solutions etc. However, PPAs do not contribute to the price formation, since prices are not necessarily published.

[1] Nasdaq Commodities and EEX are the main exchanges offering Nordic power futures.
[2] ICIS European Daily Electricity Markets 22 January 2020, p. 1, p.3-4.

In a Nordic context, Denmark is the only country to have issued LTTRs. This means that market participants seeking to relocate their price risk in Denmark to a more liquid hedging market in Germany can use these for that purpose – to the extent that there is capacity available for purchase and contracts that fit their portfolio.

Basic features of hedging strategies in the Nordic forward market

Theory and experience show that a complete elimination of risk is not necessarily optimal. The primary objective for market participants is normally to maximize profits at acceptable levels of risk. This leads to an objective for risk management to reduce risk to acceptable levels at acceptable costs, not necessarily to eliminate all risk. For the electricity market, the implication is that the more volatile the day-ahead prices are, the more expensive it would be for someone to guarantee a fixed price instead of the volatile day-ahead price. There are also transaction costs involved with risk hedging. Transactions costs should not be regarded as a market failure but rather a natural outcome of a forward market.

In a competitive market it is important that the hedging opportunities are *sufficient*, but it is not a goal in itself to eliminate *all* risk from the market participants. Hence, the regulators should carefully assess whether the market participants are able to reduce risk to acceptable levels at acceptable costs, before potential/possible measures to improve the situation are proposed. The Nordic energy regulators cannot see that the objective of the FCA GL is to remove all risk from the market participants related to the volatility of area prices, as this would not be a cost-effective measure in a competitive market.

A hedge portfolio of a market participant in the Nordic area naturally consists of different combinations of products. For example, system price contracts in combination with several EPADs and possibly also structured bilateral products. It can also include e.g. German or Dutch contracts. The regulators should try to identify potentially relevant proxies. One way to identify the relevant proxies can be to ask market participants which contracts they consider relevant in their hedge portfolios, and to analyse the most commonly used proxies.

Proposal for measures to use when assessing the Nordic forward market

Open interest*: Refers to all open positions with a clearing house at a given point in time. It corresponds to the total number of energy derivative contracts that have not yet been closed out by an offsetting trade. Open interest is a more dynamic measure of liquidity compared to e.g. traded volumes, because it reflects the decrease or increase of money brought into the futures market.*[3]

Electricity contracts used for hedging are normally kept until delivery. Often one can observe a drop in the open interest of a contract just ahead of delivery. This can be explained by the cascading effect, as yearly contracts are cascaded into quarterly contracts before year end, etc.

Data from the Nordic forward market between 2013 and 2015 shows that the yearly system price contracts have a much higher share of the open interest than e.g. quarterly contracts, even though they are traded in approximately similar volumes. This indicates that the yearly contracts are more used for hedging, while quarterly contracts tend to be used more by speculative traders. Further, the data also shows that the trade in EPADs is dominated by yearly contracts that are turned into open interest in quarterly contracts before the end of the year (the cascading effect).[4]

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[3] *Bjørndalen, J. et al (2016)* Methods for evaluation of the Nordic forward market for electricity

[4] Ibid.

Open interest in relation to physical consumption**:** This is a criterion in the FCA GL which regulators are obliged to assess in the analysis. Open interest shall be evaluated in relation to physical consumption.

Open interest may also be analysed in relation to physical production to provide further insight into the supply side of the market.

Trading horizon: *The trading horizon shows for different listed contracts which maturities that can be traded and cleared and is thus an indicator of hedging possibilities.*

By focusing on individual trading horizons over a period of time and across bidding zones when measuring traded volumes and open interest, greater insights into market behaviour and levels of market activity can be gained. This is not a specific method, just something to be aware of when collecting information about traded volumes and open interest.

This is a criterion in the FCA GL which regulators are obliged to assess in the analysis. It may be relevant to compare the trading horizon for the financial products with the trading horizon in LTTR contracts.

Traded volumes: *A number of MWh sold and bought for a given derivative during a specified period, provide information on liquidity and demand for a particular hedging instrument*[5].

Trading volume is mostly linked to market breadth. Contracts in high demand are traded more and can be easily sold or bought, whereas contracts with low traded volumes can be difficult to sell or buy.

To allow for greater detail in the analyses, trading volumes for each product should be structured along trading horizons and bidding zones over a number of time periods, such as years and months. Additional granularity may be gained by disentangling traded volumes by marketplace, such as OTC and exchange. Traded volumes of EPADs may be relevant to compare with traded volumes of system price contracts and of LTTRs.

Traded volumes in specific contracts may also be visualized over their trading horizons to track market activity. A low market activity could indicate less liquidity, regardless of the overall traded volume. This could also be visualized by presenting the number of days without any trade in each contract.

Bid-ask spreads: *The best quoted bid-ask spread is the difference between the highest bidding (buying) price and the lowest asking (selling) price at any given time or during any given time period*[6].

The bid-ask spread is a direct measure of liquidity/transaction cost. Generally, the smaller the bid-ask spread, the more liquid is the market. Conversely, large spreads can cause high search and delay costs. While market makers generally commit themselves to ensure bid-ask spreads are within agreed limits, the actual market spread may vary both within each day and over time. Also, there may be a large discrepancy between the quotes of market makers and the market participant`s willingness to pay or accept, especially when the market is particularly thin.

Most of the trading of EPADs in the Nordic market is done OTC (over the counter), or “Off Orderbook”, through brokers. Most of these deals are done through voice brokering, and thus complete data on bid/ask spreads cannot be obtained in a reliable manner. The analysis should

[5] *Bjørndalen, J. et al (2016)* Methods for evaluation of the Nordic forward market for electricity
[6] Ibid.

use the bid-ask spreads reported by the exchange with caution, as these do not represent all of the market. To have a more complete picture of the real bid-ask spreads in the market, brokers and market participants should be interviewed. For this analysis, the differences between the bidding zones should be outlined.

This is a criterion in the FCA GL in which regulators are obliged to assess in the analysis.

Traded volumes in relation to physical consumption/Churn rate: *A ratio between the total traded volumes of a power derivative and the total electricity consumption in a given period.*

Churn rate can be understood as a number showing how many times a megawatt hour is traded before it is delivered in real time. One challenge with using the churn rate in Nordic bidding zones is that the actual traded volume for a specific bidding zone consists of both EPADs and system price contracts. It is not possible to split the system price contract volume on bidding zones, as several market participants have physical positions to hedge in numerous bidding zones and do not have to specify for which zone a particular trade is made. Also, if only the EPAD volume is covered in the churn rate, this would give a misleading picture of the whole market.

Hence, if churn rate is used on the Nordic market, the number for the system prices contracts for the Nordic region should be seen in relation to the physical consumption in all the Nordic countries, as this is difficult to divide on bidding zones. Possibly, the churn rate per EPAD contract could be analysed and compared with the consumption in the relevant bidding zone, but this would not give the whole picture of the relevant market. Such a churn rate could however be compared to a similarly calculated churn rate for LTTRs. Also, the evolution/trend in the long run could be of interest although shorter term variations might lack reasonable explanations.

This is a criterion in the FCA GL which regulators are obliged to assess in the analysis.

Traded volumes may also be analysed in relation to physical production to provide further insight into the supply side of the market.

Ex-post risk premiums*: The ex-post differential between the futures prices and the realized delivery date spot prices*[7].

Forward risk premiums are relatively easy to calculate with readily available data and is commonly used in the forward and futures pricing literature.

Contracts in the financial forward market are listed for trading for a given period of time. In the Nordic market the majority of the trading activity in a contract takes place during the final period before delivery. This is also described in academic literature and is often called "Time-to-maturity" (Benth et al (2006), Diko et al (2008))[8]. The prices that are actually traded towards the end of the trade period (close to delivery) are often at a different level than the prices in the beginning of the trade period. Further, the bid-ask spreads often tend to be tighter closer towards the delivery time compared to in the beginning of the trading period. Hence, in the calculation of ex- post risk premiums the regulators should preferably use last recorded trading prices for individual contracts because it represents the best estimate of the expected price just before

[7] Redl, C., Haas, R., Huber,C. & Böhm, B. (2009): *Price formation in electricity forward markets and the relevance of systematic forecast errors*. Energy Economics, 31.

[8] Benth, F. E.;Cartea, Á.;& Kiesel, R. (2008). Pricing forward contracts in power markets by the certainty equivalence principle: Explaining the sign of the market risk premium. *Journal of Banking & Finance, 32*, 2006-2021. https://core.ac.uk/download/files/153/6244108.pdf

Diko, P.; Lawford, S.; Limpens, V. (2006): "Risk premia in Electricity Forward Prices" *Studies in Nonlinear Dynamics and Econometrics Volume* 10, *Issue 3* http://quantlabs.net/academy/download/free_quant_instituitional_books_/[Diko]%20Risk%20Premia%20in%20Electricity%20Forward%20Prices.pdf delivery starts.

The regulators should also consider testing the statistical significance of the quantified risk premium, for example by a t-test.

Recommendation on how to calculate risk premiums in the Nordic market:

- The analysis should preferably consist of actual transaction prices, for example last traded price or the average of traded prices the 10 last trading days or similar. Alternatively, the closing prices of the last traded day (or the average of the 10 last trading days or similar) can be used. However, it is important to be aware that the closing prices are sometimes set by the exchange, and it occurs that no trades actually found place for that specific closing price. Hence, the closing price should be used with caution.

- The average risk premium can hide large variations, the regulators should consider including at least the standard deviations. Further, the analysis should preferably say something about statistical significance, for example by performing a t-test.

- In order to illustrate dynamic development, the ex-post risk premia could be shown over a certain time span. This would shed light on variations over time.

- Ex-post risk premiums for System price contracts and EPADs may also be compared to ex-post risk premiums of LTTRs.

Correlation: *a measure of linear association between two variables.*

The FCA GL art 30.3 states that forward "*products or combination of products shall be considered as an appropriate hedge against the risk of change of the day-ahead price of the concerned bidding zone where there is a sufficient correlation between the day-ahead price of the concerned bidding zone and the underlying price against which the product is settled*".

In the Nordic market, a combination of a system price and an EPAD contract would, by definition, give a 100 percent correlation with settlement price of a specific bidding zone. The correlation between the area prices and the system price shows the degree of which the area prices move in the same direction as the system price, and to what degree the system price contract can be used as a proxy for hedging purposes.

For hedging purposes, what matters is the correlation between the average delivery price of the hedging horizon and the average price of the underlying for the hedging contracts over the same period.[9]

Amihud Illiquidity ratio (Optional): *An average of ratios between daily absolute return of a power derivative and its daily traded volume in Euro, over a certain time period*[10].

The illiquidity ratio aims to show the price impact of each traded euro and is a commonly used measure of liquidity. In an illiquid market a large buyer will drive up the market price while a large seller will lower it. The premium the buyer and seller have to pay is called the price-impact cost, and this is what this ratio tries to capture.

The illiquidity ratio can be calculated for each power derivate over its trading period using daily data on returns and traded volumes. The development of the ratio for different types of

[9] *Bjørndalen, J. et al (2016)* Methods for evaluation of the Nordic forward market for electricity

[10] *Amihud, Y. (2002)* Illiquidity and stock returns: cross-section and time-series effects. *Journal of financial markets, 5*(1), 31-56.

derivatives (e g monthly EPAD-contracts) can then be shown graphically over time, to look at the evolution of liquidity. One weakness of this measure is that the daily return could be zero even after a day with high trading volume and large price variations. Such a day would not contribute to increase the illiquidity ratio. However, the ratio should be assessed as one liquidity measure among others, having this weakness in mind and also taking into account that trends over time might give more information than discrete values at random intervals. This is included as an optional measure for each regulator to use if they see fit.

Additional qualitative assessments

When assessing the existing opportunities for market participants to hedge, it is important to also have a qualitative assessment of their needs and possibilities. This is motivated since the full depth of the market might not be accessible to analyse quantitively due to data being unavailable. For example, it is not possible for the Nordic regulators to access trade data on bilateral trade in contracts such as PPAs.

However, it is of interest to the regulators to understand the combined effect of the Nordic forward market, LTTRs and bilateral contracts on hedging opportunities. This could therefore be assessed via consulting market participants or regulators conducting potential further interviews.

Public

Analysis of Electricity Forward Market Hedging Opportunities in Finnish, Estonian, Latvian and Lithuanian Bidding Zones´ Borders

Commissioned by The Finnish Energy Authority

2/18/2021

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Brief summary

In this report, we examine possible measures of the sufficiency of hedging opportunities in the Finnish, Estonian, Latvian and Lithuanian bidding zones, as well as the bordering bidding zones in Sweden (SE1, SE3, SE4) and Norway (NO4).

This work follows the calculation of the measures specified in the NordREG Methodology, including open interest, the trading horizon, traded volumes, bid-ask spreads, churn rates, ex-post risk premia, correlation coefficients, and the Amihud Illiquidity ratio.

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THEMA Consulting Group is a Norwegian consulting firm focused on Nordic and European energy issues, and specializing in market analysis, market design and business strategy.

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CONTENT

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1 SUMMARY

In this report, we examine possible measures of the sufficiency of hedging opportunities in the Finnish, Estonian, Latvian and Lithuanian bidding zones, as well as the bordering bidding zones in Sweden (SE1, SE3, SE4) and Norway (NO4).

This work follows the calculation of the measures specified in the NordREG Methodology, including open interest, the trading horizon, traded volumes, bid-ask spreads, churn rates, ex-post risk premia, correlation coefficients, and the Amihud Illiquidity ratio.

We find that open interest in system price contracts was stable from around 2013 to 2018 but experienced a notable decline from the start of 2019. This implies a decline in the size of exposures being hedged using such contracts and may suggest declining liquidity. Total open interest in EPAD contracts has been stable throughout the studied period. There is even a slight increase in the use of EPADs in 2020. Looking at the relevant EPAD contracts, open interest in both TAL (Tallin) and RIG (Riga) EPADs is much lower than that of the other EPADS examined, at around 0.1 TWh each. The exposures hedged using these products are therefore likely to be much smaller than for other EPADs and the liquidity of the products relatively poor in comparison. The Helsinki (HEL) EPAD has had a stable and relatively high level of open interest throughout the studied period at around 30-40 TWh. This is broadly comparable to the open interest for Stockholm EPADs, and significantly higher than open interest for Luleå, Malmö and Trondheim EPADs (with open interests in the 1-9 TWh range). This Helsinki contract is therefore likely to be significantly more liquid.

The figures for open interest in relation to physical consumption mirror the results for open interest. For system price contracts, open interest in relation to physical consumption has remained stable throughout the studied period at around 0.2-0.4. Similarly, for the HEL EPAD, this measure has remained stable throughout the studied period at around 0.3. Levels for RIG and TAL EPADs have remained low, reflecting the low absolute levels of open interest in these contracts. The values in the TAL and RIG EPADs vary between 0 and 0.05 and indicate low liquidity for these specific products. The HEL EPAD appears to be considerably more liquid in comparison.

Total traded volumes in system price contracts increased between 2014 and 2017 but have fallen back in recent years, indicating worsening liquidity. Daily traded volumes in EPADs have been varied around 0.5 TWh. For the specific EPADs, daily traded volumes have been stable throughout the period, albeit at very low levels in some areas, notably TAL and RIG. These two EPADs have daily traded volumes below 0.005 TWh (cf. numbers above 0.1 TWh for HEL and STO EPADs). For the TAL and RIG EPADs, we also see extended periods without any trading activity, which almost certainly reflects low liquidity on the exchange. Daily traded volumes for the HEL EPAD are higher, at around 0.1-0.3 TWh, suggesting relatively high liquidity.

The churn rate for system price contracts has declined in the last six years, reaching a level of around 2 in 2019. This reflects declining volumes of trade. For both the TAL and RIG EPAD, the churn rate has been below 0.2 for the last five years. For HEL, the churn rate has varied at around 0.5 to 1.5 throughout most of the studied period. These figures highlight that traded volumes for the TAL and RIG EPAD are comparatively low even when accounting for differences in the level of consumption between different bidding zones.

None of the system price contracts have ex-post risk premia that are statistically significantly different from zero at a five percent level of significance. We, therefore, conclude that there is no systematic difference in these derivatives' prices compared to underlying spot prices. The same is true for the TAL EPAD. Both the RIG and HEL EPADS have premia that are statistically different from zero for the monthly contracts. The same is also true of the quarterly RIG EPAD contract. Consumers appear to pay a premium to buy forward in these areas using these contracts. This suggests that demand for EPADs outweighs supply in these areas, that buyers are more averse to holding power price risk than sellers, or some combination of the two.

There seems to be no clear trend in the development of bid-ask spreads for system price products, although yearly products do appear to have had lower average spreads after 2018. The system price contracts show relatively tight bid-ask spreads for the longer contracts (year, month and quarter), at around 0.5 EUR/MWh,

but higher spreads for the near-term contracts, on the order of 1–2 EUR/MWh. This likely reflects the relative illiquidity of near-term contracts.

We see that for all durations, the RIG and TAL EPADs have relatively high bid-ask spreads. These are around 5 EUR/MWh for the RIG EPAD and vary in the range 1–13 EUR/MWh for the TAL EPAD. The size of these spreads suggests both poor liquidity and high transaction costs for market participants. The HEL EPAD has lower spreads (below 1 EUR/MWh), comparable to some of the other EPADs studied.

Over the last five years, the correlation analysis shows that there has been a high degree of correlation between spot prices in Finland and the Baltic states, with correlation coefficients in excess of 0.8. There is also a high degree of correlation among prices within the Baltic States. The correlation between the Nordic system price and that in Finland is relatively high (greater than 0.8), while zonal prices in the Baltic States are markedly less correlated with the system price.

Looking at the trends over time, it is clear that the latter half of 2020 saw a significant decoupling in terms of the system price with area prices in Finland and the Baltic states. This is reflected in a sharply declining correlation between weekly average spot prices in this period. This change may have motivated some of the increase in open interest for EPADs noted earlier. Correlation between Finland and the Baltic states also appears to have worsened somewhat since mid-2019, potentially reducing the attractiveness of proxy hedging in the Baltic states using Helsinki EPADs. In contrast, correlation among the Baltic states as a group appears to have improved, with very close correlation in prices among the Baltic states in 2020 and correlation coefficients for weekly average among these countries prices of close to 1.

Table 1 Summing up the key findings

	System price	HEL EPAD	RIG EPAD	TAL EPAD
Open interest	Stable 2013 to 2018, decline from early 2019 may suggest declining liquidity	Stable at 30-40 TWh, suggests relatively good liquidity	Broadly stable at low level (≈0.1 TWh), suggests poor liquidity. Uptick in 2020	Stable at low level (≈0.1 TWh), suggests poor liquidity
Open interest/ physical consumption	Stable at 0.2-0.4	Stable at 0.3 suggesting relatively good liquidity	Stable at 0-0.05, suggesting low liquidity	Stable at 0-0.05, suggesting low liquidity
Traded volume	Increased between 2014 and 2017 but have fallen back in recent years, indicating worsening liquidity	Stable at around 0.1-0.3 TWh, suggesting relatively good liquidity	Stable at low level (<0.005 TWh), suggesting poor liquidity	Stable at low level (<0.005 TWh), suggesting poor liquidity
Churn rate	Decreasing to 2 in 2019, suggesting worsening liquidity	Varying between 0.5 and 1.5 in the studied period	Stable at a low level of below 0.2, suggesting poor liquidity	Stable at a low level of below 0.2, suggesting poor liquidity
Risk premiums	Not significant at a 5% level, indicating no systematic difference in these derivatives' prices compared to the underlying spot price	Statistically different from zero for the monthly contracts. Consumers appear to pay a premium to buy forward.	Statistically different from zero for the quarterly contracts. Consumers appear to pay a premium to buy forward.	Not significant at a 5% level, indicating no systematic difference in these derivatives' prices compared to the underlying spot price

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	System price	HEL EPAD	RIG EPAD	TAL EPAD
Amihud illiquidity ratio	The Amihud measure should be used with caution when assessing liquidity because of the lack of empirical evidence on its use from commodity/electricity markets. The calculated ratios provide results that are counter-intuitive and conflict with some of the other indicators in this report.			
Bid/Ask spreads	No clear trend. Around 0.5 EUR/MWh	Relatively low (below 1 EUR/MWh)	Relatively high (around 5 EUR/MWh) indicating both poor liquidity and high transaction costs for market participants	Relatively high (1–13 EUR/MWh) indicating both poor liquidity and high transaction costs for market participants
Correlation		Generally well correlated with system price and prices in the Baltic states, albeit with marked weakening of correlation in 2020.	Less correlated with system price, but generally well correlated with other Baltic countries and Finland. Recently, correlation with Finland has weakened and correlation with other Baltic states has strengthened.	Less correlated with system price, but generally well correlated with other Baltic countries and Finland. Recently, correlation with Finland has weakened and correlation with other Baltic states has strengthened.

2 HEDGING OPPORTUNITIES IN THE FINNISH, ESTONIAN, LATVIAN AND LITHUANIAN BIDDING ZONES

In this section, we set out background information on the tools used to hedge power price risk. We also provide some general discussion of typical approaches to hedging price risk and how these differ among market actors based on their hedging needs.

2.1 Hedging tools

Power price risk can be managed in a variety of ways and, in this section, we outline the main tools used by market actors for this purpose. For completeness, it should be noted that firms can also manage these risk exposures through the maintenance of greater capital reserves and vertical integration, namely the joint-ownership of both generation and consumption or supply businesses. In the latter case, the firm alters its structure to help ensure that price risk exposure is offset internally within its business. These approaches to risk management, though commonly observed, are not discussed further below, since they do not constitute what are typically thought of as hedging strategies.

2.1.1 Power futures

Futures contracts are standardised financial contracts for power that effectively allow market participants to lock in a price for power delivered in future periods. Financial futures contracts do not entail any physical power supply. Rather, during the delivery period specified by the contract, cash is exchanged between the market participant and the exchange such that these payments make up for any difference between the future contract's price before delivery and the power price during the delivery period. Changes in the value of the futures contract between the time of a trade and delivery will also be settled between the exchange and the market party, with the timing of this settlement varying between different contract types.

In some markets, forwards offer participants a similar ability to fix prices ahead of delivery, but result in the physical delivery of power, rather than cash settlement.

In most Continental European power markets, power futures are referenced against the spot price of a specific bidding zone. In the Nordic market, such contracts a reference against the Nordic system price, rather than the price of a specific bidding zone. The system price is calculated as the clearing price that would be obtain if clearing the entire Nordic region as a single bidding zone, ignoring transmission constraints between Nordic bidding zones.

Futures contracts can cover delivery periods of different lengths and may also be profiled within that period, for example covering only certain peak settlement periods.

2.1.2 Electricity Price Area Differential (EPADs)

Since Nordic futures are referenced against the Nordic system price, they cannot be used directly to hedge the power price of a specific bidding zone. EPADs are similar financial contracts that reference the spread between a specific Nordic bidding zone and the system price. They are available as baseload contracts (i.e. with no profiling). Combining an EPAD for a specific bidding zone with a system-price future contract effectively produces a futures contract referenced to the specific area price. Combing the purchase of an EPAD for one zone with the offsetting sale of an EPAD in another zone produces a financial contract (a so-called EPAD Combo) that hedges the price between the two zones.

Exchange-traded EPADs do not exist for all Nordic bidding zones and do not currently cover Lithuania, although over-the-counter (OTC) contracts may be available bilaterally.

2.1.3 Transmission rights

Transmission rights are contracts typically issued by transmission owners that provide the holder with a right or obligation to flow power in a specific direction between connected bidding zones. Such rights are typically issued as Financial Transmission Rights (FTRs) and are financial in the sense that the right is cash-settled based on the price spread between the relevant zones. An FTR option provides the holder with the price spread only where this spread is positive. An FTR obligation will result in a payment between the holder and issuer of the obligation that reflects the direction of the relevant price spread. For example, if the obligation involves flowing power from a low- to a high-price zone, the obligation will be profitable and result in a payment to the holder of the obligation. If, however, the obligation is from a high- to a low-price area, the obligation holder is liable to pay the spread to the issuer.

Such contracts can be used to hedge the price spread between connected zones directly. They can also allow market participants to hedge using futures (or other hedging instruments) referenced against power prices in the other bidding zone. In the latter case, the transmission rights allow the firm to manage the risk that the reference price differs from the power price to which they are exposed (so-called basis risk).

2.1.4 Power Purchase Agreements (PPAs)

Power Purchase Agreements are bilateral agreements for the sale of power. They typically cover periods of 5-15 years and are often, though not necessarily, physical contracts, resulting in the provision of power rather than cash settlement. As bespoke contracts, the specific terms can vary from contract to contract. Often the contract will specify the profile and volume of power to be delivered, the delivery location and the agreed price. The contract may also include covenants designed to ensure the creditworthiness of the parties involved and may require that the counterparties have guarantees provided by banks or parent companies.

PPAs may be sold by specific generation projects or by utilities. In the latter case, the power is generally supplied by a portfolio of sites. Where power is sold by a variable generator, such as an onshore wind site, the volume of power sold under the PPA will often be 'shaped' or 'sleeved' by a third party that takes responsibility for correcting any mismatch between the generation project's output and the volume of power that must be supplied under the PPA.

PPAs allow the parties involved to agree on the future price of power in advance and therefore reduce their exposure to changes in the spot price of power for the delivery period specified in the PPA.

2.1.5 Coal, gas and (carbon) emissions futures

A variety of other commodity futures exist and are used by some market actors in their power price hedging activity. These futures are similar to power futures, except that they reference the price of another traded commodity, such as coal, gas or emissions allowances. In bidding zones where the power price is strongly linked to the marginal costs of gas-fired generation, for example, there may be a strong correlation between power prices and gas prices. In this case, power prices could be hedged through the use of gas futures, with these futures acting as a proxy to hedge the actor's fundamental power price risk exposure. Such hedges are so-called 'proxy hedges' and typically entail some degree of risk (so-called basis risk) due to a potential mismatch in changes between the actual price to which the actor is exposed (the power price) and the price referenced by the hedging instrument (the gas price). This risk may be justified, for example, because of the greater liquidity or lower costs associated with the use of proxy hedging instruments.

2.2 Approaches to hedging

Hedging needs and strategies vary among market actors. However, there are some commonalities in the nature of organisations' risk exposure and hedging options that produce some common approaches to hedging. We set these out briefly here. These generalisations reflect common approaches and are not necessarily true in all cases.

2.2.1 Suppliers, generators and consumers

The hedging needs and objectives of any market actor are often largely defined by its role as a supplier, generator or consumer. As such, hedging strategies are often similar among different participants within the same group.

Suppliers' risk exposure generally arises from entering into supply contracts with fixed, or partly fixed, prices. The supplier is therefore exposed to power price risk due to the need to purchase power to meet these supply obligations. Generally speaking, power price volatility is relatively large in comparison to the margin charged on the supply contract. A pure supplier will generally, therefore, seek to secure this margin by buying power sufficient to cover its supply obligations under any agreement shortly after the supply agreement is entered into. It may practice a so-called back-to-back hedging strategy, in which fixed-price supply commitments are fully or close-to-fully hedged as soon as they are made and any changes in expected volumes are quickly reflected in the volume of power hedged. Where there are significant changes in the market shares between suppliers, or rapid changes in the volumes of contracts with fixed prices, liquid hedging instruments are especially important to hedgers pursuing such a strategy. Conversely, a lack of liquid instruments may weaken competition for fixed-price supply contracts.

Generators are typically looking to hedge over relatively long timeframes, reflecting the relative certainty that their physical assets will still be available and owned by them several years into the future. Although power prices are a very significant determinant of generator revenues, the importance of revenue stability to owners and management varies. Hedging activity will often be influenced significantly by the firm's expectations of future power price developments relative to the market.

Although consumers' direct exposure to the power price may be lower than that of generators, business consumers and especially energy-intensive consumers often operate a margins business in which the power price can mean the difference between making a net profit and a net loss. Where power cost volatility is high relative to the margin, hedging may therefore be important, even where power costs are only one of a number of cost drivers. Like generators, hedging behaviour will also be influenced by expectations of future prices. However, hedging decisions by manufactures will also be significantly influenced by considerations related to their end market. In particular, the desired hedging horizon will reflect the business' certainty over future orders and activity. The desire to hedge will also often be informed by an assessment of the firm's likely future competitiveness if power costs are hedged. For example, while it might seem attractive to purchase power futures when prices are low, this wouldn't necessarily be a good idea if you expect competitors' power costs to sink much lower in the relevant period.

2.2.2 Hedger size

Actors' approach to hedging is also determined to some extent by the organisation's administrative capacity. Consumers and smaller actors will typically have fewer staff members responsible for power price hedging. For these actors, the administrative burdens of direct exchange membership may be prohibitive and therefore a bank or broker will be used to help support hedging activity. Large consumers may have sufficient resources to run periodic PPA processes themselves but may still not wish to commit to the ongoing administrative costs of direct exchange membership. In contrast, large generators are already relatively well-informed on market developments and may be able to conduct fundamental power market analysis independently. As such, they and are more likely to trade directly on the exchange or to seek to trade bilaterally using their wider network of potentially interested counterparties.

Banks, brokers and trading firms sometimes act as intermediaries, offering retail power price hedging services to smaller actors, often alongside related services such as lines of credit or balancing management.

3 NORDREG METRICS

In the following sections, we conduct a quantitative assessment of the sufficiency of hedging opportunities for Finnish, Estonian, Latvian and Lithuanian Bidding Zones as well as the bordering bidding zones SE1, SE3, SE4 and NO4.

This work follows the calculation of the measures specified in the NordReg Methodology, including the open interest, trading horizon, traded volumes, bid-ask spreads, churn rates, ex-post risk premia, correlation, and the Amihud Illiquidity ratio.

We have received data on both system price and EPAD products from Nasdaq. Measures have been calculated on a Nordic basis and for the different bidding zones.

3.1 Data summary

The calculation of the measures in the following section was done using data provided by Nasdaq. Three different data sets were made available. The first covered data on *open interest* for the time period from 04.03.2012 to 31.08.2020, including the daily open interest of individual contracts, expressed as the number of contracts and the volume and the value of the contracts. The second data set used was *end-of-day* trading data for the time period 02.01.2012 to 30.06.2020, including the daily trading data of individual contracts, including the volumes traded, closing/opening price, best bid/ask and high/low price. The third data set included trading data for the same time period as the *end-of*-day data, and included deal source, deal price, number of contracts traded, the size of the contracts and the volumes traded. All data sets covered both EPAD and Nordic system price contracts.

To give an overview of the sample size, and the number of the unique contracts in the data, Table 2 shows the count of individual contracts in the *end-of-day* trading data.

Table 2: Number of unique contracts included in the qualitative analysis

		Day	Month	Quarter	Week	Year	Total
Base							
	DS Futures		22	15		11	48
	Futures	2			79		81
	Options			227		249	476
Base Day							
	Futures	522					522
EPAD							
	DS Futures		180	82		45	307
Peak							
	DS Futures		18	8		2	28
	Futures				78		78
Power Base							
	DS Futures		90	38		14	142
	Futures		63	29	381	15	488
	Options		2	109		119	230
Power Day							
	Futures	2593					2593
Power EPAD							
	DS Futures		936	335		80	1351
	Futures		680	254	1890	96	2920
Power Peak							
	DS Futures		29	12		3	44
	Futures				124		124
Total		3111	1994	1053	2543	571	9272

4 DESCRIPTIVE MEASURES

4.1 Open interest

Open interest refers to the total size of open positions with a clearing house at a given point in time. When a market participant wishes to hedge a physical exposure to the power price using financial derivatives, they will create an open position for the relevant contract and keep this position until delivery. When a speculator trades such contracts, he or she will typically open a position by buying or selling the relevant contract and then close this position at a later point using an offsetting trade. For example, they will try to buy the contract when priced low and then sell it at a higher price. As such, information on the size, distribution and dynamics of open interest can be used to infer the volume of physical exposures that are being hedged and the composition of products used to construct these hedges. Trends in the level of open interest reflect changes in the amount of money brought into the futures market and the scale of futures being used for hedging as opposed to speculation.

For individual contracts, there will typically be a steady increase in open interest from the beginning of the trading period until the last trading day before delivery. This occurs as hedges are built up over time. Just ahead of contract delivery there is a sudden drop in open interest for the relevant contract caused by cascading, the process by which open positions in a specific contract are transformed into open positions in shorter contracts covering the same delivery period. For example, open positions in a yearly contract are transformed into open positions in four quarterly contracts shortly before the start of the relevant delivery year. The resulting drop in open interest in the yearly contract is therefore perfectly offset by the increase in open interest for quarterly contracts.

4.1.1 Open interest system price contracts

The figure shows that the bulk of open interest in Nordic system price contracts is established in yearly contracts. It also shows that total open interest was stable from around 2013 to 2018, but there is a notable decline from the start of 2019. This decline suggests that the volume of physical exposures being hedged using Nordic system price futures has fallen.

Figure 1 presents the open interest (TWh) in Nordic system price contracts for the period 2012 to 2021. Separate lines are shown for weekly, monthly, quarterly, and yearly contracts. The figure shows that the bulk of open interest in Nordic system price contracts is established in yearly contracts. It also shows that total open interest was stable from around 2013 to 2018, but there is a notable decline from the start of 2019. This decline suggests that the volume of physical exposures being hedged using Nordic system price futures has fallen.

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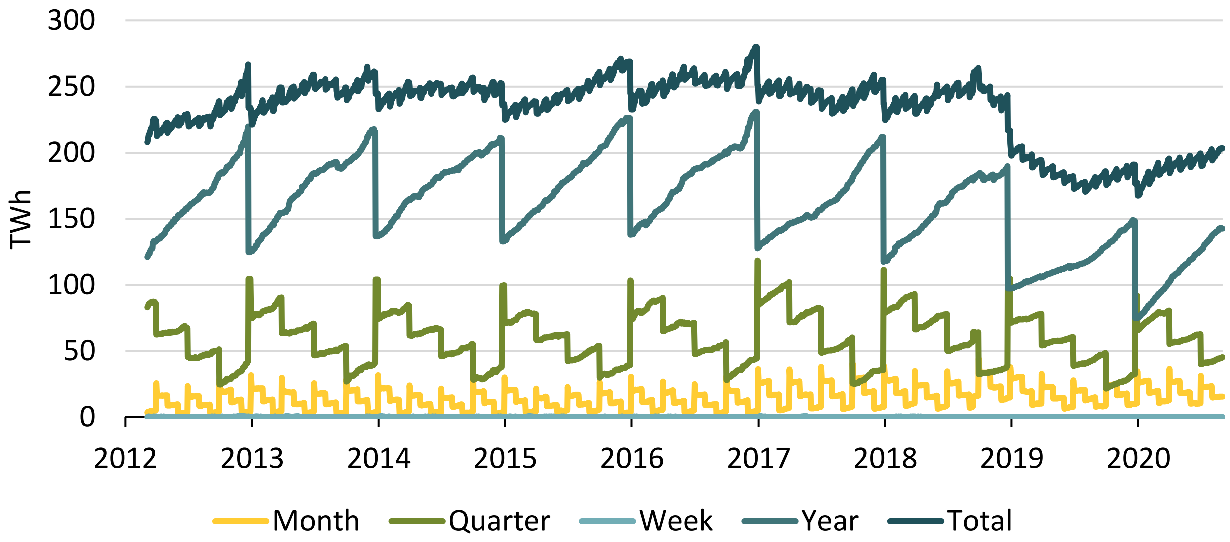
Figure 1: Open interest (TWh), Nordic system price contracts



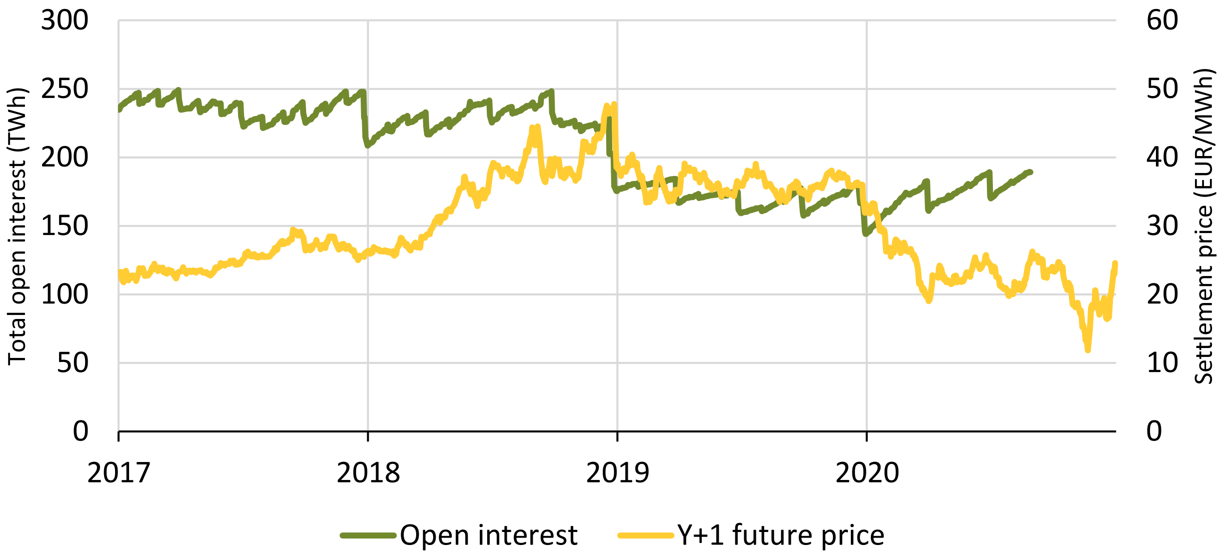
Data source: Nasdaq

This decline may be due to generators adjusting the share of their total exposures that they choose to hedge based on their view of market fundamentals and the perceived downside risk. Specifically, they may reduce the volume of exposures hedged where they have little reason to fear lower prices.[1] To examine whether price levels might have played a role in the decline in total open interest observed, Figure 2 shows total open interest against the settlement price of the front-year (Y+1) futures contract. In interpreting this chart, it is important to bear in mind that the direction of causality may also run the other way, with a lack of hedging demand depressing the price of futures contracts.

At the end of 2018, prices for the 2020 contract were indeed much lower than those of the 2019 contract, as shown by the significant drop in front-year prices at the start of 2019, i.e. when the front-year changes from 2019 to 2020. However, the price of the 2020 contract, at just under 40 EUR/MWh was not low compared to prices in earlier years. As such, it appears that low-price expectations alone are probably not responsible for the reduction in open interest from 2019.

[1] Note that consumers would naturally have an opposing position – they might be inclined to hedge more if prices are not expected to go any lower. Therefore, for open interest to be affected there must be some difference between the responses of generators and consumers. For example, generators may have hedging strategies that react more quickly or to a larger degree in response to price expectations, or they may be more likely to adjust their overall hedging position by changing their position in system-price futures rather than through other instruments.

Figure 2: Daily total open interest (TWh) against front year daily settlement price (EUR/MWh)

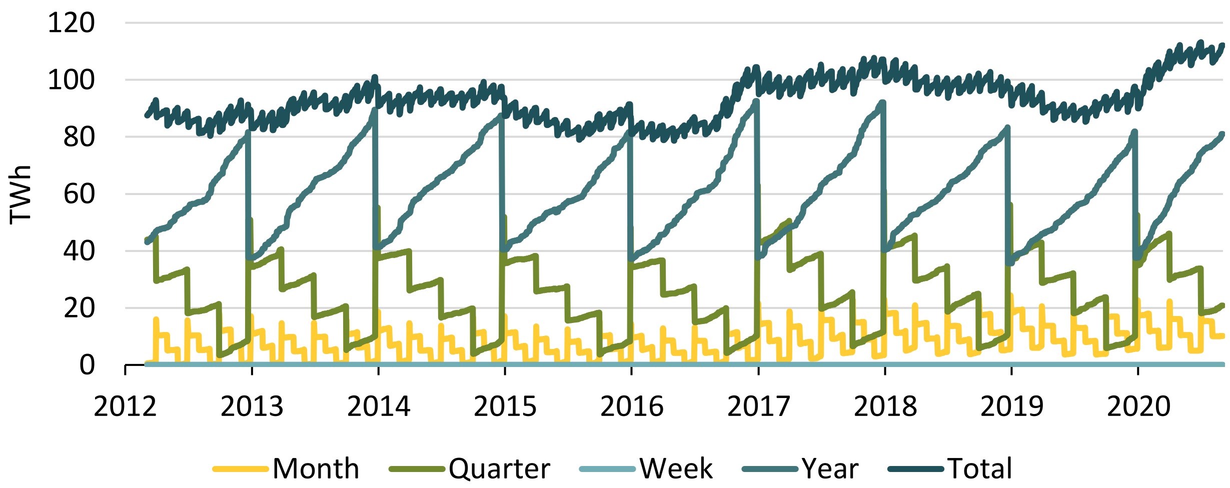


Data source: Nasdaq (for open interest) and Nasdaq (via Montel, for settlement price)

4.1.2 Open interest EPADS contracts

Figure 3 shows the daily total open interest (TWh) in EPAD contracts, for all bidding zones. Total open interest in EPAD contracts has been stable throughout the studied period. There is even a slight increase in the use of EPADs in 2020. This may reflect higher perceived area price risk – 2020 was marked by a record high hydrological balance in Norway and limited transmission capacity between Norway and Sweden due to outages.

Figure 3: Total open interest (TWh) EPADs, all bidding zones

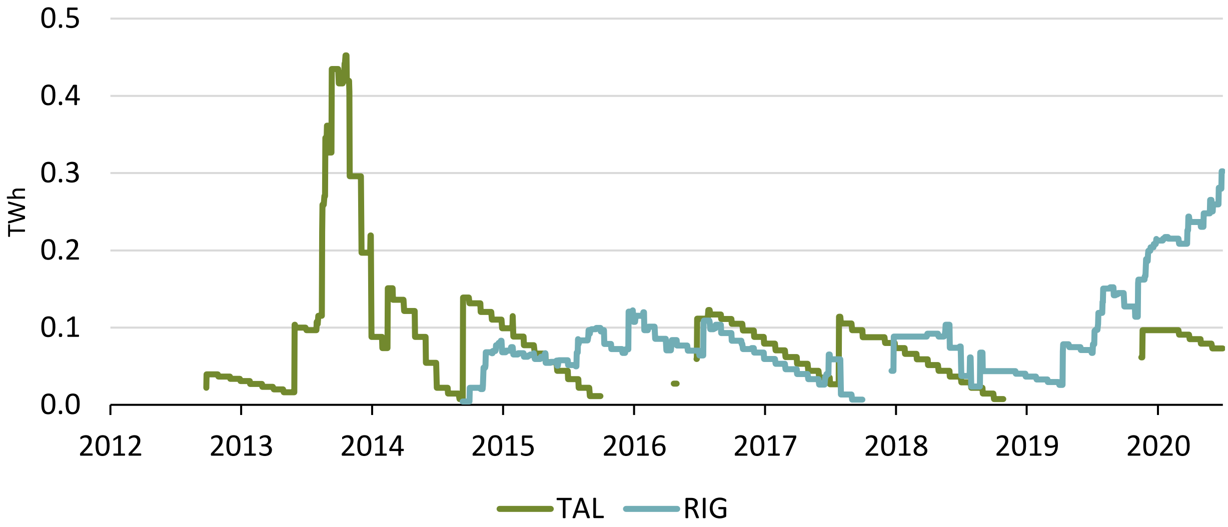


Data source: Nasdaq

Figure 4, Figure 5 and Figure 6 show the daily total open interest (TWh) in EPAD contracts for the relevant bidding zones. For both TAL (Tallin) and RIG (Riga) EPADs, open interest has been at around 0.1 TWh in recent years. There seems to have been an increase in open interest in the RIG EPAD over the last couple of years.

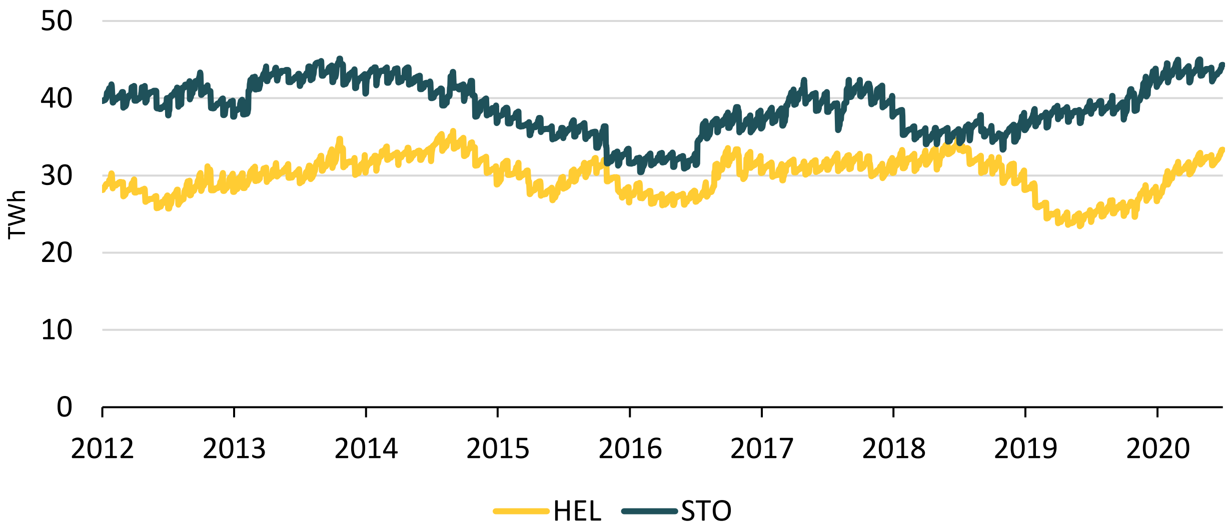
Total open interest is however low for both the TAL and RIG EPADs suggesting that they are not extensively used for hedging. Both Helsinki (HEL) and Stockholm (STO) EPADs have had a stable level of open interest through the studied period at around 30-40 TWh. Relative to other EPADs, open interest in the HEL and STO EPADs is high. They appear to be used to hedge far larger volumes and this is likely to contribute to a more liquid market. Open interest in the Malmö (MAL) EPAD has increased from about 2017 and has seen a doubling of open interest from levels of around 4 TWh to around 8 TWh by 2020. The Lulea (LUL) EPAD, has had relatively stable open interest throughout the period at around 2-4 TWh. For the Tromsø (TRO) EPAD, a short spike of open interest around 2017 was followed by a rapid decline, reaching levels of around 1 TWh in 2020.

Figure 4: Total open interest (TWh) TAL and RIG EPADs



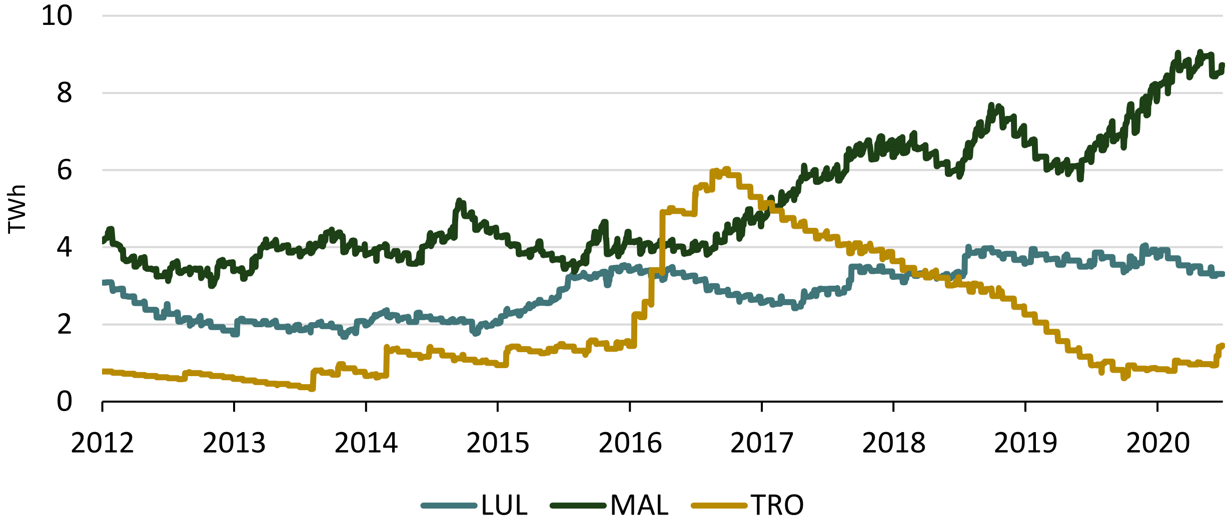
Data source: Nasdaq

Figure 5: Total open interest (TWh) HEL and STO EPADs



Data source: Nasdaq

Figure 6: Total open interest (TWh) LUL, MAL and TRO EPADs



Data source: Nasdaq

4.1.3 Summing up open interest

Open interest in system price contracts was stable from around 2013 to 2018 but experienced a notable decline from the start of 2019. This implies a decline in the size of exposures being hedged using such contracts and may suggest declining liquidity. Total open interest in EPAD contracts has been stable throughout the studied period. There is even a slight increase in the use of EPADs in 2020. Looking at the relevant EPAD contracts, we see that for both TAL (Tallin) and RIG (Riga) EPADs open interest is low and liquidity is likely to be poor. The Helsinki (HEL) EPAD has had a stable and relatively high level of open interest through the studied period at around 30-40 TWh. This contract is therefore likely to be significantly more liquid.

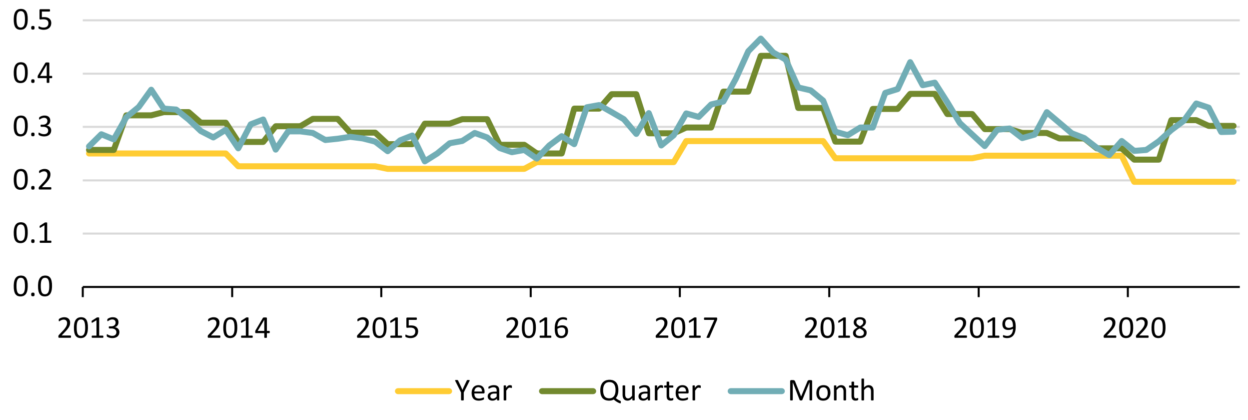
4.2 Open interest in relation to physical consumption

By dividing open interest by physical consumption, we can get an indication of the share of physical consumption that is hedged in the futures market.

4.2.1 Open interest in relation to physical consumption in system price contracts

Figure 7 shows, for monthly, quarterly and yearly contracts, the open interest recorded for the contract shortly prior to delivery divided by total physical consumption in the relevant delivery period. The results show that this measure has remained stable throughout the studied period at around 0.2-0.4. Again, this suggests that Nordic system price futures hedge something like 20-40% of physical consumption in the Nordics.

Figure 7: Open interest in relation to physical consumption, Nordic system contracts



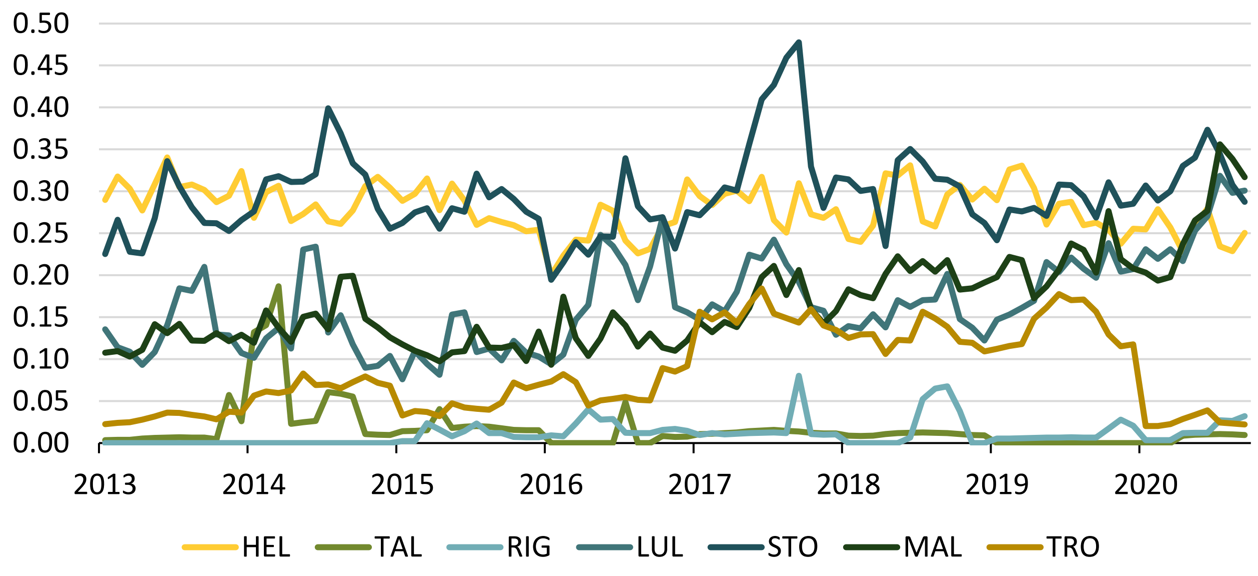
Data source: Nasdaq (for open interest) and Nord Pool (for physical consumption)

4.2.2 Open interest in relation to physical consumption in EPAD contracts

In Figure 8, we replicate the approach used in Figure 7 to show open interest in relation to physical consumption but for the EPADs of the relevant bidding zones. For EPADs, this is done only for monthly contracts.

The results show that for the HEL and STO EPAD, this measure has remained stable throughout the studied time period at around 0.3. This would imply that EPADs in these bidding zones hedge around 30% of the physical consumption in their bidding zone. However, it is important to note that some contracts, like the HEL contract for example, may be used to hedge exposure in other correlated bidding zones such that not all of the open interest in the contract is directly related to consumption in the associated zone. For the MAL and LUL EPAD, there has been an increase in this measure for the last couple of years, reaching levels of around 0.3 in 2020. The TRO EPAD had a sharp increase in this measure around 2017, before a similarly sharp decrease in early 2020. Levels for RIG and TAL EPADs have remained low throughout the studied time period, reflecting the low absolute levels of open interest in these contracts.

Figure 8: Open interest in relation to physical consumption, monthly EPADs



Data source: Nasdaq (for open interest) and Nord Pool (for physical consumption)

4.2.3 Summing up open interest in relation to physical consumption

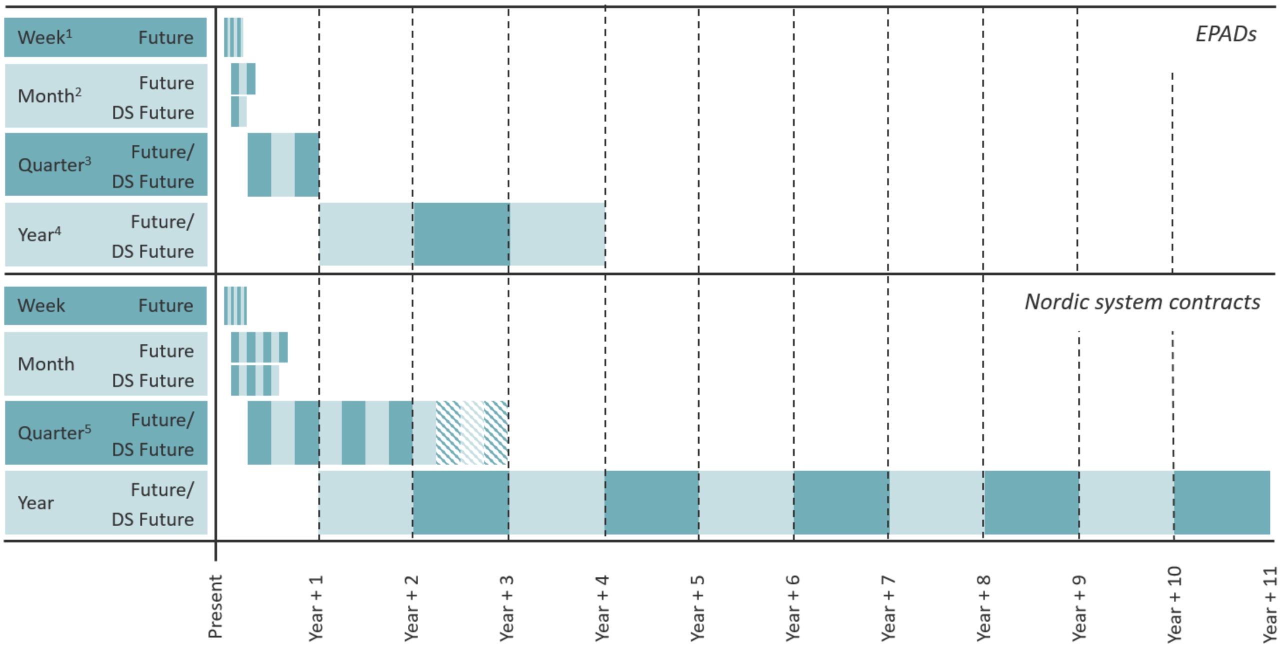
The results show that open interest in relation to physical consumption for system price contracts has remained stable throughout the studied period at around 0.2-0.4. Similarly, for the HEL EPAD, this measure has remained stable throughout the studied period at around 0.3. Levels for RIG and TAL EPADs have remained low throughout the studied period, reflecting the low absolute levels of open interest in these contracts. There is no clear cut-off point for determining a sufficient level for these metrics and attention needs to be paid to the presence of alternative opportunities to hedge. The values in the TAL and RIG EPADs vary between 0 and 0.05 and indicate low liquidity for these specific products. The HEL EPAD appears to be considerably more liquid in comparison.

4.3 Trading horizon

The trading horizon is a descriptive measure showing the different listed series that can be traded and cleared on the exchange. It describes the technical hedging opportunities that exist via exchange-based derivatives and is not a measure of efficiency or liquidity per se.

Figure 9 shows the trading horizon for different contract types that can be traded on Nasdaq, including EPADs and Nordic system contracts.

Figure 9: Trading horizon for different contract types, EPADs and Nordic system contracts



Source: Nasdaq (2020) Trading Appendix 2. Contract Specifications.

Note: [1]Weekly EPADs exist only for Swedish and Finnish bidding zones.
[2]Monthly Futures have three listed series for Norwegian, Danish, Estonian and Latvian areas and four listed series for Swedish and Finnish areas; Monthly DS Futures have two listed series for Norwegian, Danish, Estonian and Latvian areas and four series listed for Swedish and Finnish areas.
[3]Both quarterly contract types have three series listed for Norwegian, Danish, Estonian and Latvian areas and four series listed for Swedish and Finnish areas.
[4]Both yearly contract types have three series listed for Norwegian, Danish and Estonian areas, two series listed for Latvian areas and four series listed for Swedish and Finnish areas.
[5]The number of concurrently listed quarterly futures varies from eight to eleven, shown here by the striped area. The reason for this variation is that the quarterly contracts are added for one year (four quarters) at a time. There are always series listed for the next two years (eight quarters) and, in the first quarter of the year, a new full third year is added to the listed series, making eleven series (two years and three quarters) in total.

We see that EPAD contracts have a significantly shorter time horizon than system price contracts. This might create challenges for players wanting to hedge long term area price exposure.

4.4 Traded volumes

Traded volumes are a descriptive measure used to indicate the liquidity of the market. Traded volumes show the number of MWh bought and sold during a specific period. Larger volumes will tend to indicate more active trade and suggest a larger number of transactions and a larger number of active market participants.

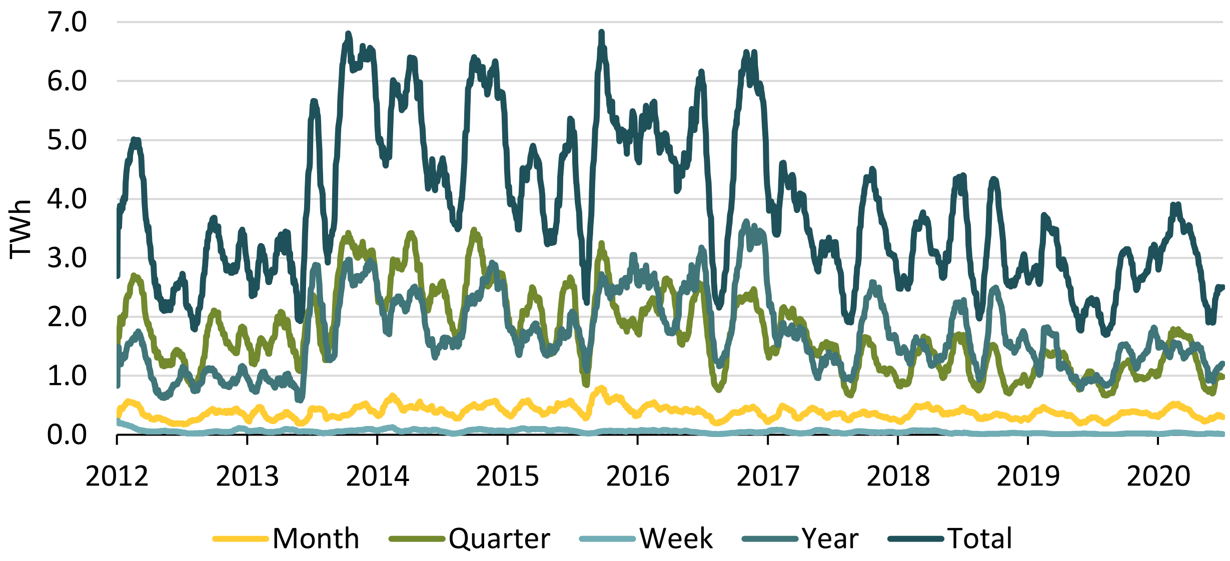
The analysis of traded volumes in the following section is done using end-of-day data covering the period 02.01.2012-30.06.2020. The traded volumes provided in the end-of-day data include exchange-traded volumes only and will therefore not include volumes traded Over the Counter, even if these volumes are cleared.

4.4.1 Traded volumes system price contracts

Figure 10 shows daily traded volumes (TWh) for monthly, quarterly and yearly Nordic system price contracts. Note that the traded volumes are averaged over a rolling time window of 30 days, backward from the date shown, so as to make trends easier to see.

The results show total daily traded volumes in Nordic system price contracts to be in the range of 2-6 TWh. Total volumes appeared to increase between 2014 to 2017 and to have fallen back in recent years, indicating falling liquidity.

Figure 10: Daily traded volumes (TWh) Nordic system price contracts

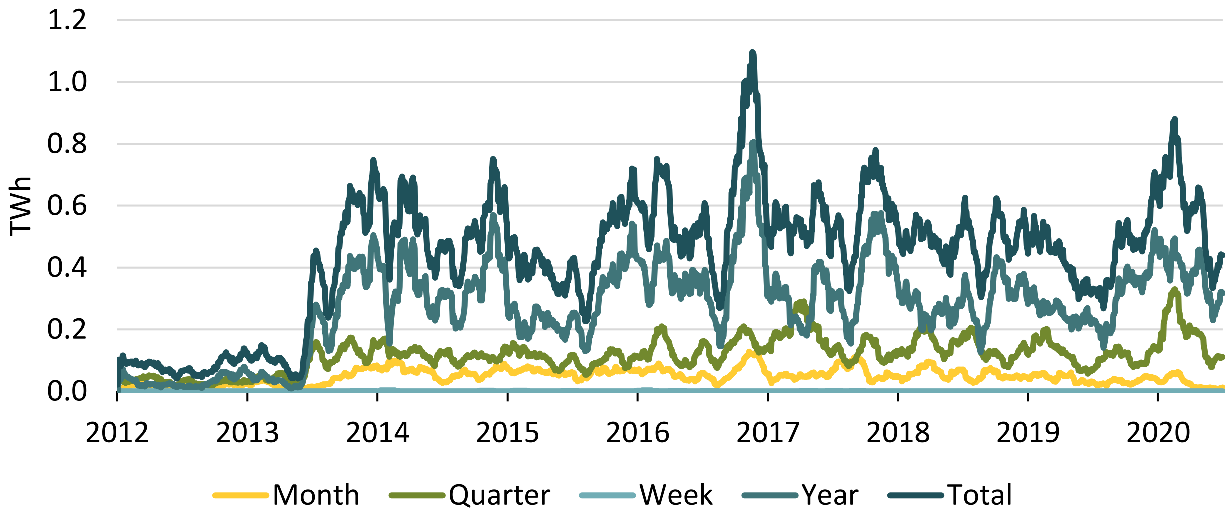


Data source: Nasdaq.
Note: The traded volumes are average over a rolling time window of 30 days, backward.

4.4.2 Traded volumes EPAD contracts

Figure 11 shows daily traded volumes (TWh) of EPADs for all bidding zones for weekly, monthly, quarterly and yearly contracts. The traded volumes are averaged over a rolling time window of 30 days, backward. Daily traded EPAD volumes have varied around 0.5 TWh in recent years.

Figure 11: Daily traded volumes (TWh) of EPADs (all bidding zones)

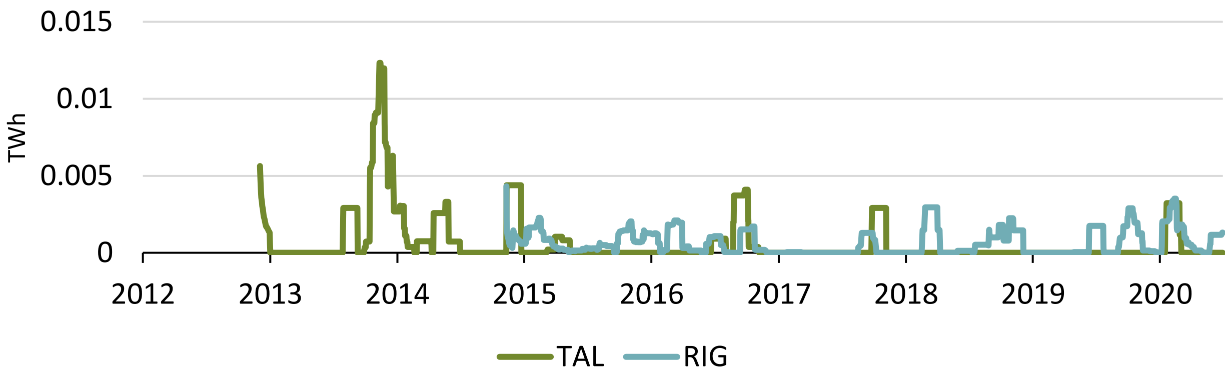


Data source: Nasdaq.

Note: Traded volumes are averaged over a rolling time window of 30 days, backward. There was a re-organization of the markets in 2013, in which EPADs were renamed; previously these contracts were named Contracts for Differences.

Figure 12**,** Figure 13 and Figure 14 show total daily traded volumes (TWh) for the relevant bidding zones. The traded volumes are averaged over a rolling time window of 30 days, backward. The results show that for the TAL and RIG EPADs, daily traded volumes have been stable at very low levels throughout the studied period. We see that there are no trade volumes for these EPADs for extended periods. This suggests that it may be difficult for market participants to get in and out of positions with these products using exchange trade. Unless these products are more actively traded Over the Counter, these products appear to be illiquid. HEL and STO EPADs have the highest traded volumes of the relevant bidding zones, with around 0.1-0.3 TWh. As such, liquidity in these products seems to be less of an issue. For LUL, MAL and TRO EPADs, traded volumes have also been stable, albeit at low levels, throughout the studied period.

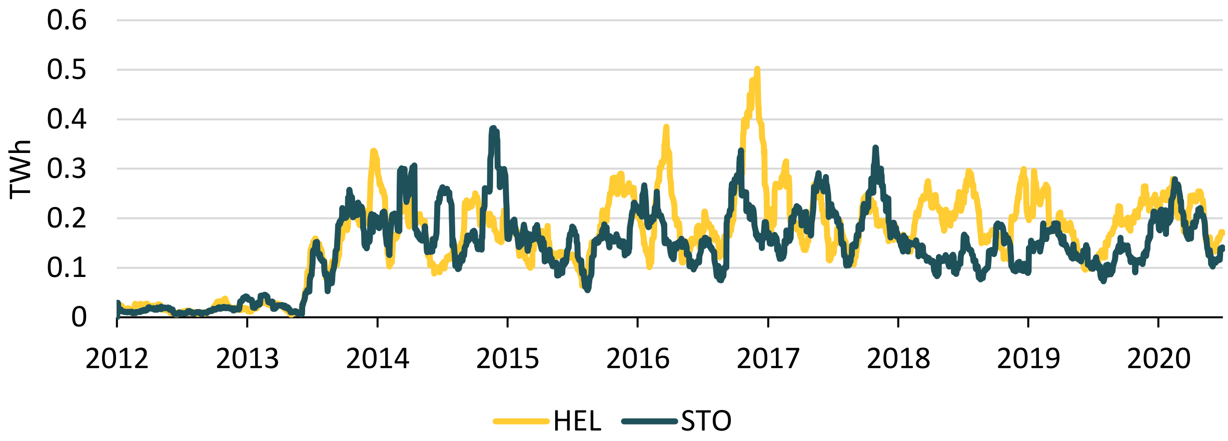
Figure 12: Total daily traded volumes (TWh) TAL and RIG EPADs



Data source: Nasdaq.

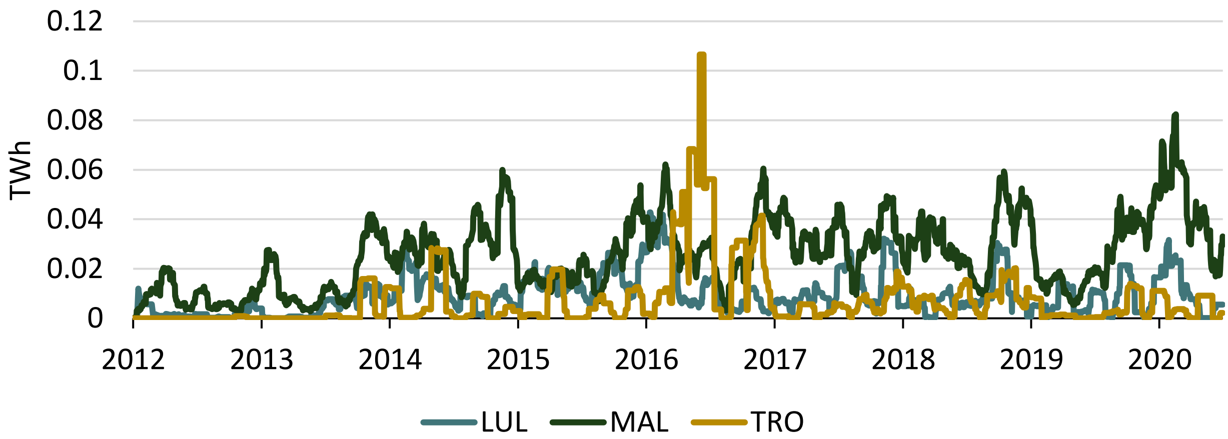
Note: The traded volumes are average over a rolling time window of 30 days, backward.

Figure 13: Total daily traded volumes (TWh) HEL and STO EPADs



Data source: Nasdaq.
Note: The traded volumes are average over a rolling time window of 30 days, backward.

Figure 14: Total daily traded volumes (TWh) LUL, MAL and TRO EPADs



Data source: Nasdaq.
Note: The traded volumes are average over a rolling time window of 30 days, backward.

4.4.3 Summing up daily traded volumes

Total traded volumes in system price contracts increased between 2014 and 2017 but have fallen back in recent years, indicating worsening liquidity. Daily traded volumes in EPADs have been varied around 0.5 TWh. For the specific EPADs, daily traded volumes have been stable throughout the period, albeit at very low levels in some areas, notably TAL and RIG. For these EPADs, we see extended periods without any trading activity, which almost certainly reflects low liquidity on the exchange. Daily traded volumes for the HEL EPAD are higher, at around 0.1-0.3 TWh.

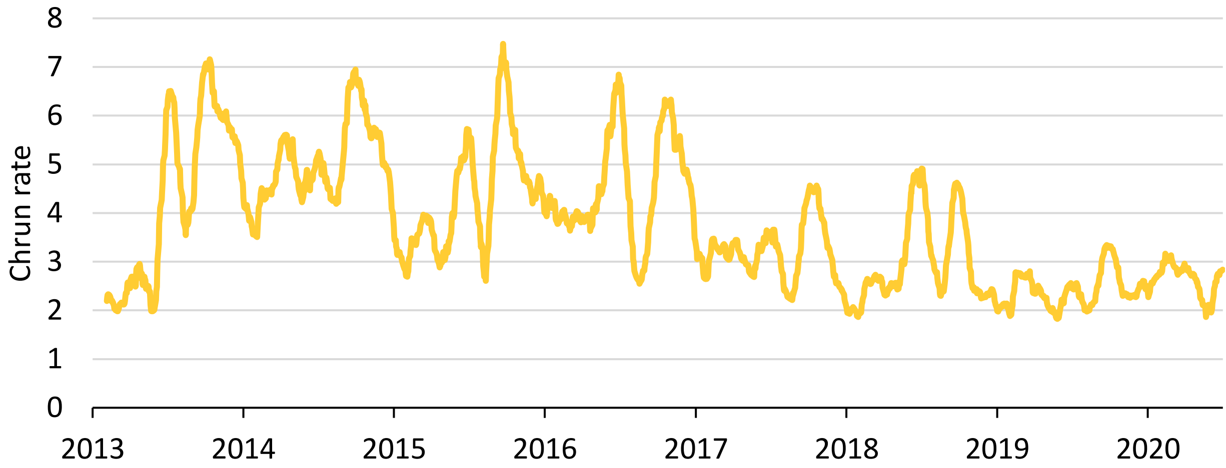
4.5 Traded volumes in relation to physical consumption/Churn rate

The ratio between total traded volumes of a power derivative and total electricity consumption in a given period gives the so-called 'churn rate'. This ratio provides an indication of how many times a MWh of power is traded before it is delivered to the final consumer. Again, a higher number suggests more liquid trading.

4.5.1 Traded volumes for system price contracts in relation to physical consumption/Churn rate

Figure 15 shows daily traded volumes in Nordic system contracts in relation to daily physical consumption in the Nordic price areas. This ratio is averaged over a rolling time window of 30 days, backward. The figure shows a decline in the churn rate over the last six years, reaching a level of around 2 in 2019. This reflects the decline in traded volumes noted above.

Figure 15: Traded volumes in relation to physical consumption (Churn rate), Nordic system



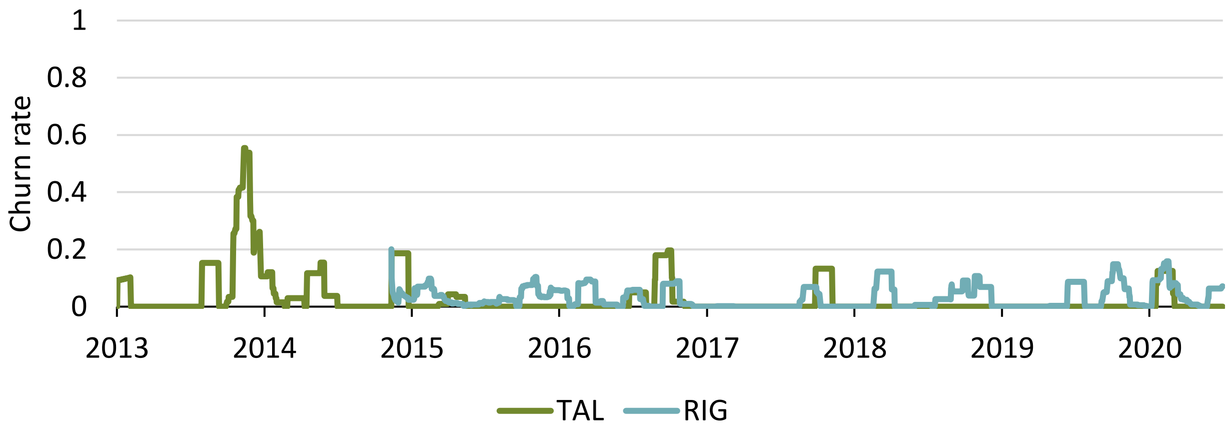
Data source: Nasdaq (for traded volumes) and Nord Pool (for physical consumption).
Note: The churn rate is averaged over a rolling time window of 30 days, backward.

4.5.2 Traded volumes for EPAD contracts in relation to physical consumption/Churn rate

Figure 16, Figure 17 and Figure 18 show total daily traded volumes in relation to daily physical consumption, the churn rate, for the relevant bidding zones. The churn rate is averaged over a rolling time window of 30 days, backward.

For both the TAL and RIG EPAD, the churn rate has been below 0.2 for the last five years. For HEL and STO EPADs, the churn rate has been varying around 0.5 to 1.5 throughout most of the studied period. For the LUL, MAL and TRO EPADs, the churn rate has been stable and below 1 in recent years, with the exception of a spike for the TRO EPAD in mid-2016. These levels reflect the underlying volumes of trade in the associated derivatives as discussed in section 4.4.

Figure 16: Total traded volumes in relation to physical consumption (Churn rate) TAL and RIG EPADs



Data source: Nasdaq (for traded volumes) and Nord Pool (for physical consumption).
Note: The churn rate is averaged over a rolling time window of 30 days, backward.

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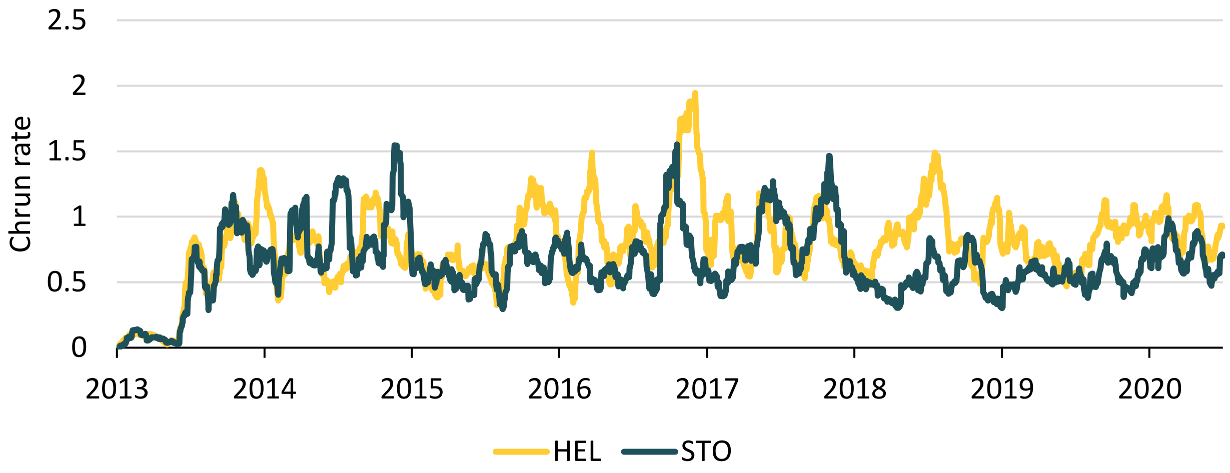
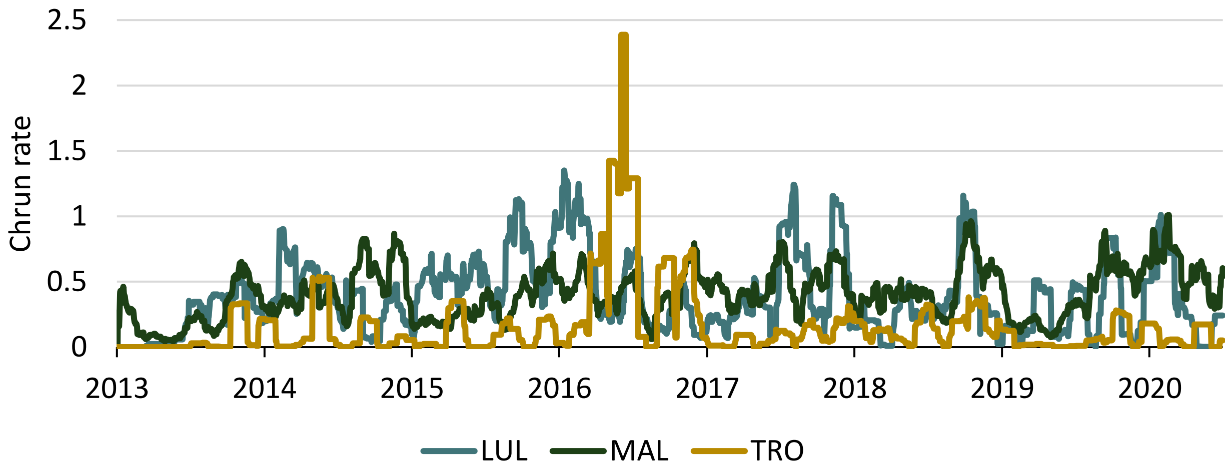
Figure 17: Total traded volumes in relation to physical consumption (Churn rate) HEL and STO EPADs



Data source: Nasdaq (for traded volumes) and Nord Pool (for physical consumption).
Note: The churn rate is averaged over a rolling time window of 30 days, backward.

Figure 18: Total traded volumes in relation to physical consumption (Churn rate) LUL, MAL and TRO EPADs



Data source: Nasdaq (for traded volumes) and Nord Pool (for physical consumption).
Note: The churn rate is averaged over a rolling time window of 30 days, backward.

4.5.3 Summing up churn rate

The churn rate for system price contracts has declined in the last six years, reaching a level of around 2 in 2019. This reflects declining volumes of trade. For both the TAL and RIG EPAD, the churn rate has been below 0.2 for the last five years. For HEL, the churn rate has varied around 0.5 to 1.5 throughout most of the studied period. These figures highlight that traded volumes for the TAL and RIG EPAD are comparatively low even when accounting for variations in the level of consumption between different bidding zones.

5 PRICE MEASURES

5.1 Ex-post risk premiums

One way of investigating any systematic biases in the pricing of power derivatives contracts is to calculate ex-post risk premiums. The ex-post risk premium for any contract is simply the difference between the contract's price and the spot price during its delivery period. By looking at these premia over time, we can see if there is a systematic difference between these two prices. The ex-post risk premium can be interpreted as a mark-up or reduction on the price of power that must be borne by traders, suppliers or consumers, in order to hold the price risk. Any such mark-up or discount may denote a natural behaviour of risk-averse market participants willing to pay (accept) a risk premium (discount) for transferring the risk of unfavourable spot price movements. However, it could also denote inefficiency in the market. From the available data and empirical analysis, we cannot distinguish the two directly, but we can study the magnitudes, persistency, direction, and significance of risk premiums, which then shed light on the accuracy of the market to price power derivatives.

It is important to note that there will typically be a difference between the value of a futures contract and resultant spot prices that is due purely to forecasting error. This error is captured in the calculated ex-post risk premia. As such, we can only infer the size of any ex-ante risk premium by looking at the ex-post premia over time and assuming that forecasting errors are not systematically different from zero.

To test whether the ex-post risk premia are different from zero, i.e. whether there is a systematic mark-up or reduction in prices, we use a t-test. Statistically significant results suggest that futures prices appear to be systematically different from the underlying spot prices during the delivery period.

The results from these t-tests are shown below. The ex-post risk premia for system price futures are calculated as the difference between the contract price on the last trading day before the delivery period and the average spot price over the delivery period. For the EPAD-contracts, we use the difference between the contract price on the last trading day before the delivery period and the average spread between the system price and the area price over the delivery period. We have tested whether these premia are significantly different from zero in either direction. The most interesting results from this analysis are summarised in Table 3, Table 4 and Table 5.

We have done tests for autocorrelation with Durbin Watson statistics. Some of the contracts had significant autocorrelation at a five percent level of significance. We have therefor corrected for autocorrelation by using GLS estimates and robust standard deviations for both the quarterly and monthly contracts. Since we have so few observations on the yearly contracts, we have decided to use OLS estimates and done conventional t-test for these contracts.

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Table 3: Ex-post risk premia monthly contracts, GLS estimates and robust standard errors

Area	Type	Obs.	Df	Mean	GLS est.	Min	Max	Robust St.Dev	Robust st. error	t stat	t crit (5%)	p value	Sign. 5% level	95% CI lower	95% CI upper
System	*DS*	102	101	0.40	0.40	-7.80	10.67	3.37	0.33	1.19	1.98	0.24	No	-0.27	1.06
System	*Not Ds*	58	57	0.31	0.29	-7.80	10.67	4.44	0.58	0.50	2.00	0.62	No	-0.87	1.46
Helsinki	*DS*	86	85	0.94	0.92	-9.86	12.14	2.21	0.24	3.85	1.99	0.00	Yes	0.44	1.39
Helsinki	*Not Ds*	58	57	1.13	1.07	-9.86	12.14	1.99	0.26	4.09	2.00	0.00	Yes	0.55	1.59
Riga	*DS*	61	60	1.75	1.70	-11.59	8.12	5.52	0.71	2.41	2.00	0.02	Yes	0.29	3.11
Riga	*Not Ds*	58	57	1.23	1.19	-14.22	7.34	5.42	0.71	1.67	2.00	0.10	No	-0.24	2.61
Tallin	*DS*	85	84	0.84	1.10	-16.61	21.61	9.13	0.99	1.12	1.99	0.27	No	-0.86	3.07
Tallin	*Not Ds*	58	57	0.35	0.29	-16.61	6.44	6.99	0.92	0.32	2.00	0.75	No	-1.54	2.13
Luleå	*DS*	90	89	0.19	0.18	-5.13	4.22	1.98	0.21	0.86	1.99	0.39	No	-0.24	0.59
Luleå	*Not Ds*	58	57	0.25	0.25	-5.13	4.22	1.78	0.23	1.07	2.00	0.29	No	-0.22	0.72
Stockholm	*DS*	98	97	0.52	0.51	-13.20	5.43	1.94	0.20	2.60	1.98	0.01	Yes	0.12	0.90
Stockholm	*Not Ds*	58	57	0.34	0.33	-13.20	5.43	1.88	0.25	1.33	2.00	0.19	No	-0.17	0.82
Malmø	*DS*	96	95	0.55	0.55	-12.81	4.89	2.66	0.27	2.01	1.99	0.05	Yes	0.01	1.09
Malmø	*Not Ds*	58	57	0.28	0.28	-12.81	4.66	2.69	0.35	0.79	2.00	0.43	No	-0.43	0.98
Tromsø	*DS*	85	84	-0.30	-0.30	-4.28	3.90	2.22	0.24	1.25	1.99	0.21	No	-0.78	0.18
Tromsø	*Not Ds*	58	57	-0.50	-0.49	-4.28	3.90	2.21	0.29	1.69	2.00	0.10	No	-1.07	0.09

Data source: Nasdaq

Table 4: Ex-post risk premia quarterly contracts, GLS estimates and robust standard errors

Area	Type	Obs.	Df	Mean	GLS est.	Min	Max	Robust St.Dev	Robust st. error	t stat	t crit (5%)	p value	Sign. 5% level	95% CI lower	95% CI upper
System	*DS*	34	33	0.50	0.50	-6.67	19.71	5.82	1.00	0.50	2.03	0.62	No	-1.53	2.53
System	*Not Ds*	20	19	-0.41	-0.41	-6.67	19.71	7.12	1.59	0.26	2.09	0.80	No	-3.74	2.93
Helsinki	*DS*	30	29	1.02	1.01	-6.67	5.56	2.69	0.49	2.06	2.05	0.05	Yes	0.01	2.02
Helsinki	*Not Ds*	20	19	1.30	1.30	-6.67	5.56	3.18	0.71	1.83	2.09	0.08	No	-0.18	2.79
Riga	*DS*	20	19	2.37	2.37	-6.65	7.18	3.43	0.77	3.09	2.09	0.01	Yes	0.76	3.97
Riga	*Not Ds*	20	19	1.36	1.32	-6.65	7.18	4.41	0.99	1.34	2.09	0.20	No	-0.75	3.38
Tallin	*DS*	29	28	0.99	1.22	-7.44	13.64	7.61	1.41	0.86	2.05	0.40	No	-1.68	4.11
Tallin	*Not Ds*	20	19	0.64	0.22	-7.44	6.23	8.76	1.96	0.11	2.09	0.91	No	-3.88	4.32
Luleå	*DS*	29	28	0.05	-0.08	-4.81	2.53	2.74	0.51	0.15	2.05	0.88	No	-1.12	0.97
Luleå	*Not Ds*	20	19	0.05	-0.28	-4.70	2.53	4.95	1.11	0.25	2.09	0.81	No	-2.60	2.04
Stockholm	*DS*	33	32	0.39	0.36	-6.52	3.01	2.63	0.46	0.78	2.04	0.44	No	-0.57	1.29
Stockholm	*Not Ds*	20	19	0.19	0.09	-6.52	3.01	3.70	0.83	0.10	2.09	0.92	No	-1.65	1.82
Malmø	*DS*	33	32	0.42	0.12	-8.31	5.62	5.07	0.88	0.13	2.04	0.90	No	-1.68	1.91
Malmø	*Not Ds*	20	19	-0.05	-1.63	-8.31	3.50	16.42	3.67	0.44	2.09	0.66	No	-9.31	6.06
Tromsø	*DS*	29	28	-0.03	-0.03	-4.48	4.29	1.73	0.32	0.11	2.05	0.92	No	-0.69	0.62
Tromsø	*Not Ds*	20	19	0.01	0.00	-2.51	4.29	1.80	0.40	0.00	2.09	1.00	No	-0.85	0.84

Data source: Nasdaq

Table 5: Ex-post risk premia yearly contracts, OLS estimates and standard errors

Area	Type	Obs.	Df	Mean	Min	Max	Std. Dev	Std. Err	t stat	t crit (5%)	p value	Sign. 5% level	95% CI lower	95% CI upper
System	*DS*	7	6	-0.88	-18.56	10.27	9.89	3.74	0.24	2.45	0.82	No	-10.03	8.26
System	*Not Ds*	4	3	-4.86	-18.56	8.29	11.35	5.67	0.86	3.18	0.45	No	-22.92	13.20
Helsinki	*DS*	6	5	2.09	-2.18	6.40	3.19	1.30	1.61	2.57	0.17	No	-1.25	5.44
Helsinki	*Not Ds*	4	3	3.56	0.00	6.40	2.68	1.34	2.66	3.18	0.08	No	-0.70	7.81
Riga	*DS*	5	4	2.87	-4.22	9.17	4.99	2.23	1.29	2.78	0.27	No	-3.33	9.06
Riga	*Not Ds*	4	3	4.64	0.00	9.17	3.50	1.75	2.65	3.18	0.08	No	-0.93	10.21
Tallin	*DS*	6	5	2.10	-2.03	7.42	3.85	1.57	1.34	2.57	0.24	No	-1.94	6.15
Tallin	*Not Ds*	4	3	3.83	-1.02	7.42	3.55	1.77	2.16	3.18	0.12	No	-1.82	9.47
Luleå	*DS*	6	5	0.27	-1.24	1.61	1.13	0.46	0.59	2.57	0.58	No	-0.92	1.46
Luleå	*Not Ds*	4	3	0.16	-1.24	1.50	1.12	0.56	0.28	3.18	0.80	No	-1.63	1.95
Stockholm	*DS*	6	5	1.25	0.00	2.78	0.96	0.39	3.20	2.57	0.02	Yes	0.25	2.26
Stockholm	*Not Ds*	4	3	1.33	0.00	2.78	1.20	0.60	2.22	3.18	0.11	No	-0.58	3.24
Malmø	*DS*	7	6	1.56	-0.37	3.08	1.17	0.44	3.52	2.45	0.01	Yes	0.48	2.65
Malmø	*Not Ds*	4	3	1.25	-0.37	2.69	1.36	0.68	1.84	3.18	0.16	No	-0.91	3.41
Tromsø	*DS*	6	5	0.18	-1.78	1.65	1.47	0.60	0.29	2.57	0.78	No	-1.36	1.72
Tromsø	*Not Ds*	4	3	0.30	-1.07	1.60	1.25	0.63	0.48	3.18	0.67	No	-1.69	2.29

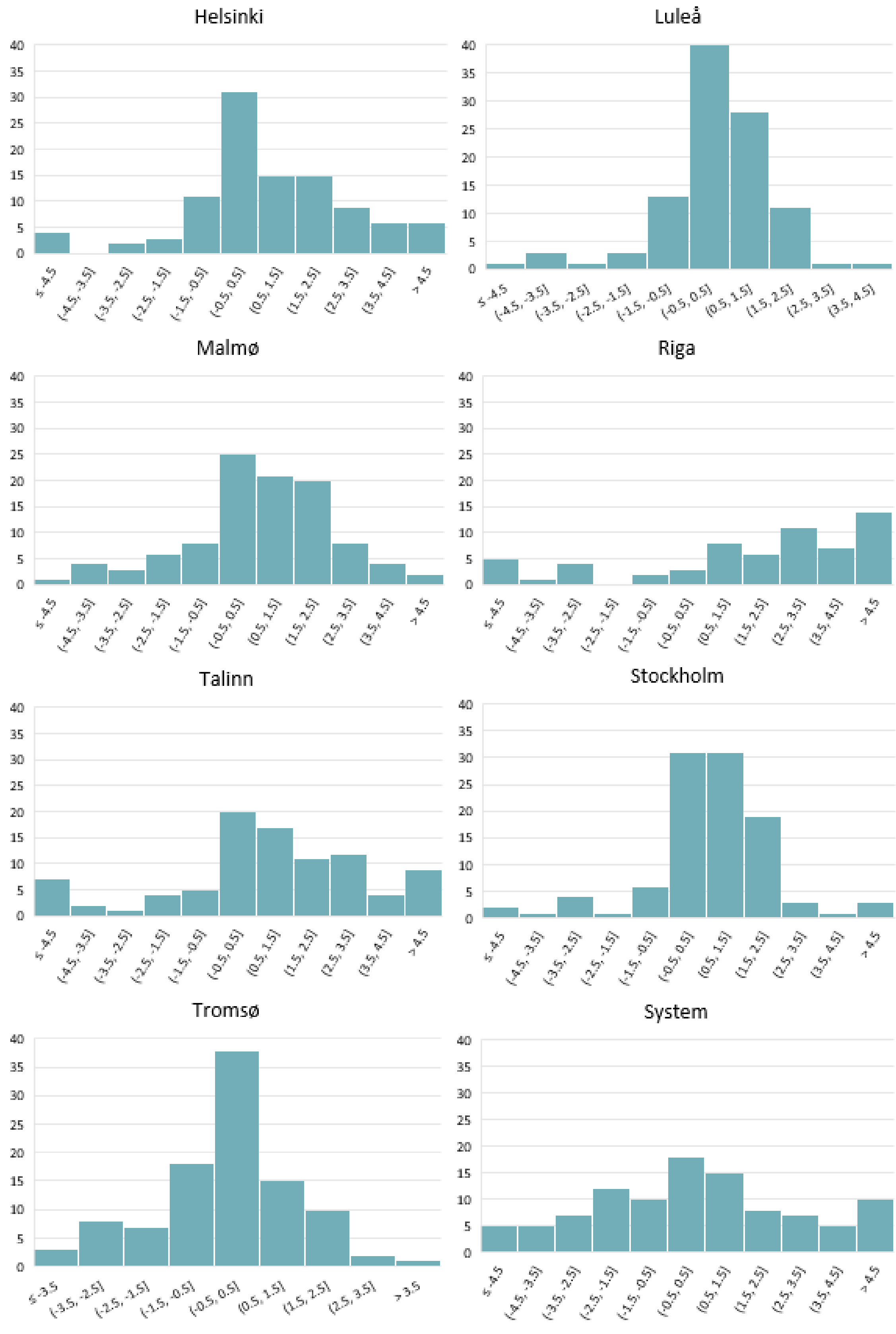
Data source: Nasdaq

As can be seen from the tables, none of the system price contracts show premia that are significantly different from zero at a five percent level of significance. Hence, there is no systematic bias in the derivative prices compared to the underlying spot prices. The same is true for the TAL EPAD.

Both the RIG and HEL EPADS show premia that are statistically greater than zero for the monthly contracts. The same is true of the quarterly RIG EPADs. This suggests that one needs to pay a premium to buy power forward in these areas. This premium reflects the relative risk aversion of consumers and generators, as well as the volumes that consumers and generators wish to hedge in the relevant zones. A positive premium suggests that consumers are generally more risk-averse or wish to hedge a larger volume relative to generators and are therefore willing to paying a premium on power to trade forward with generators.

We include histograms for the monthly DS contracts for the price areas where we get significant risk premiums. Figure 19 to Figure 22 shows how the calculated ex-post risk premia for these areas are distributed around zero.

Figure 19 Ex-post risk premia Monthly DS contracts



Data source: Nasdaq

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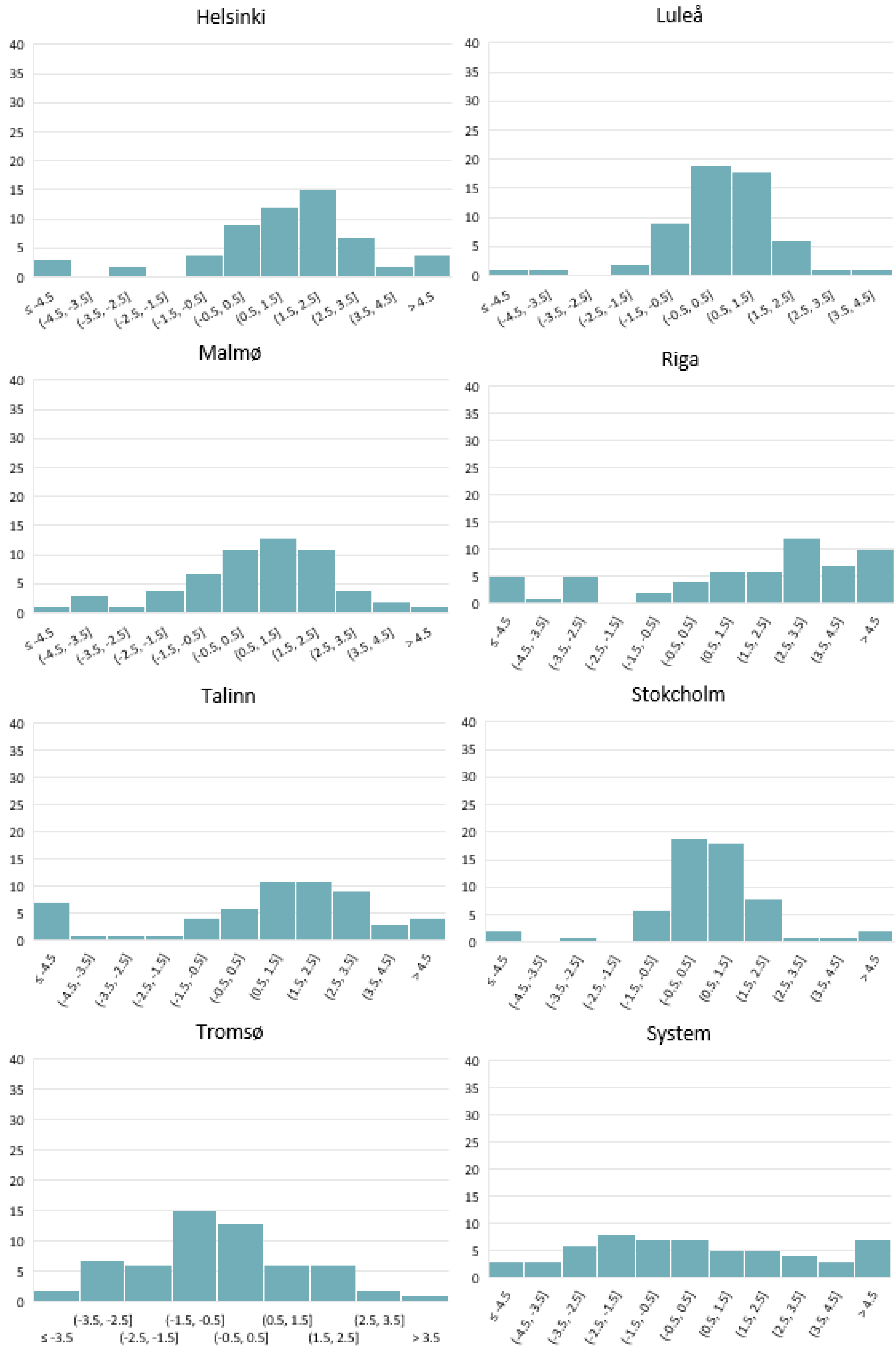
Figure 20 Ex-post risk premia Monthly non-DS contracts



Data source: Nasdaq

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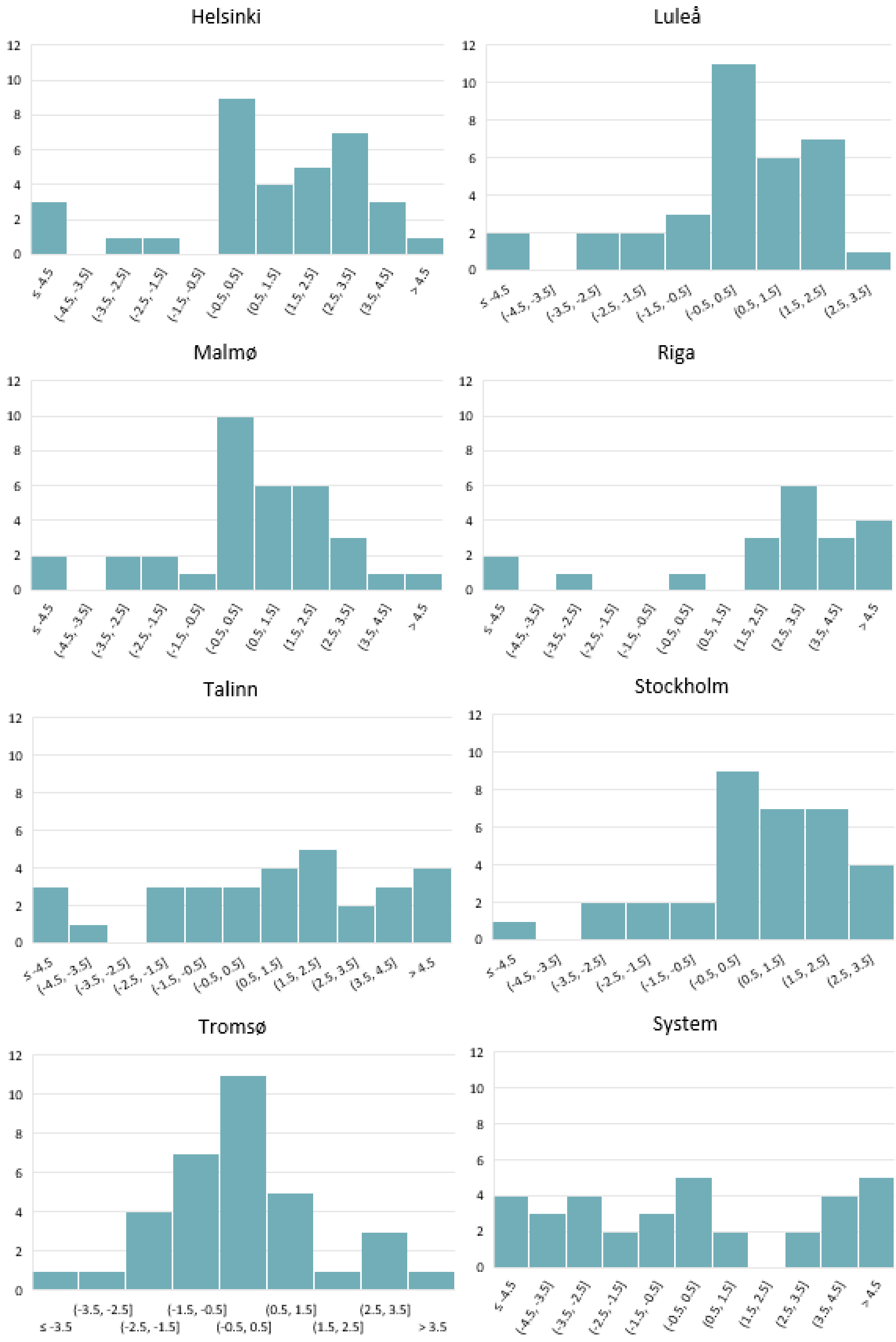
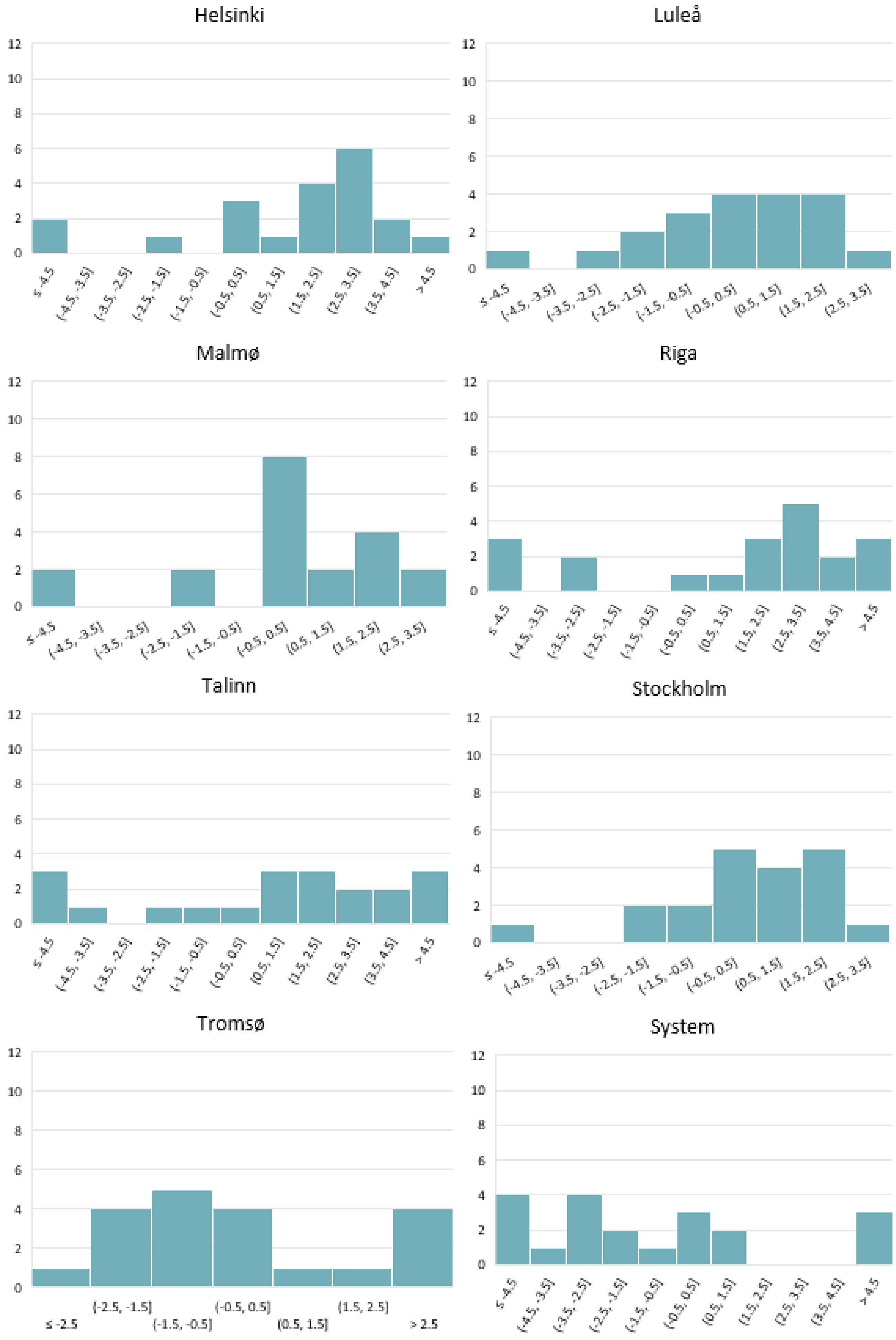
Figure 21 Ex-post risk premia Quarterly DS contracts



Data source: Nasdaq

Figure 22 Ex-post risk premia Quarterly non-DS contracts



Data source: Nasdaq

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5.1.1 Summing up Ex post risk premiums

None of the system price contracts have ex-post risk premia that are significantly different from zero at a five percent level of significance. We, therefore, conclude that there is no systematic difference in these derivatives' prices compared to the underlying spot prices. The same is true for the TAL EPAD.

Both the RIG and HEL EPADS have premia that are statistically different from zero for the monthly contracts. The same is also true of the quarterly RIG EPAD contract. Consumers appear to pay a premium to buy forward in these areas.

5.2 Amihud Illiquidity ratio

The Amihud illiquidity ratio is intended to capture the sensitivity of prices to larger volumes of trade and therefore to provide an indication of market liquidity. This is one of the most widely used proxies in empirical asset pricing. If contract prices move a lot in response to a small traded volume, this will lead to a high Amihud illiquidity ratio, suggesting that the asset is illiquid, and vice versa.

The Amihud illiquidity ratio is calculated daily by taking the difference between the open and closing price, expressed as an absolute value, and dividing this by the monetised volume of trade that day. These daily Amihud illiquidity ratios are then averaged over time. Due to low trading activity in some contracts, especially some of the EPADs, the calculation of the Amihud illiquidity ratio has been done in a more general way, by looking at the overall trend in the ratio across all traded contracts, meaning calculating the daily average of Amihud illiquidity of all trades, including contracts of all durations (monthly, quarterly and yearly) and both types (DS Futures and Futures).

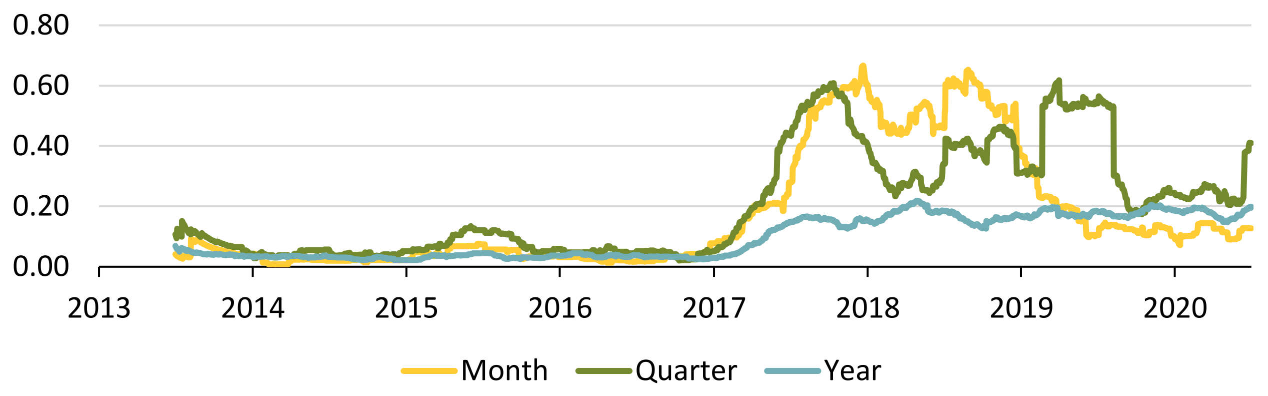
It is important to note that while the Amihud illiquidity ratio is based on the idea that large volumes of trade push greater price changes in illiquid markets, this assumed causal chain might not underpin the changes picked up in the data. For example, new fundamental information about the power system might lead to a price correction on a day with very little trade and give rise to large illiquidity ratio even in a liquid market.

The EC Group's "Methods for evaluation of the Nordic forward market for electricity" prepared for NordREG concludes that the empirical and theoretical application of the Amihud measure for electricity derivatives markets is limited[2] and the report recommends against using the measure assessing liquidity due to the lack of empirical evidence from commodity/electricity markets. We include the calculations here for reference only.

Figure 23 shows the Amihud illiquidity ratio for the Nordic system price contracts by contract duration. We see a marked increase (worsening) in the ratio for all durations from 2017, particularly among monthly and quarterly contracts. These contracts see the ratio decrease again (improving) from 2019.

[2] http://www.nordicenergyregulators.org/wp-content/uploads/2016/10/161208-Methods-for-evaluation-of-the-Nordic-forward-market-forelectricity.pdf

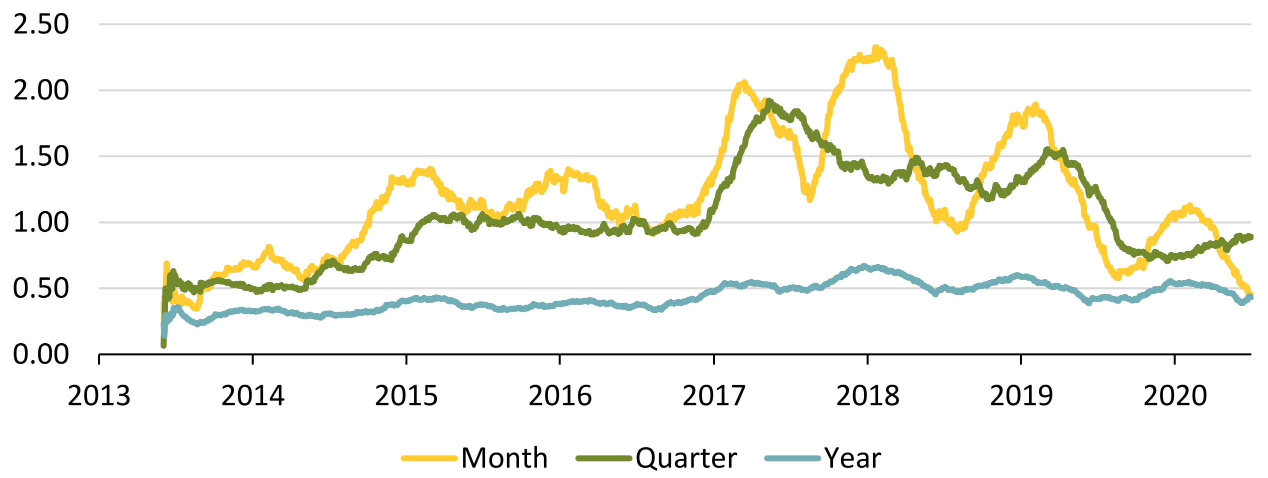
Figure 23: Amihud Illiquidity ratio, Nordic System price contracts



Data source: Nasdaq.
Note: The Amihud Illiquidity Ratio is multiplied by 1 000. Both Futures and DS Futures are included. The ratio is averaged over a time window of 120 days, backward.

Figure 24 shows the Amihud illiquidity ratio of the EPAD contracts for all bidding zones by contract duration. As for the system price contracts, we observe an uptick in the Amihud ratio for monthly and quarterly contracts from late 2016/early 2017. These ratios fall back again from around 2018.

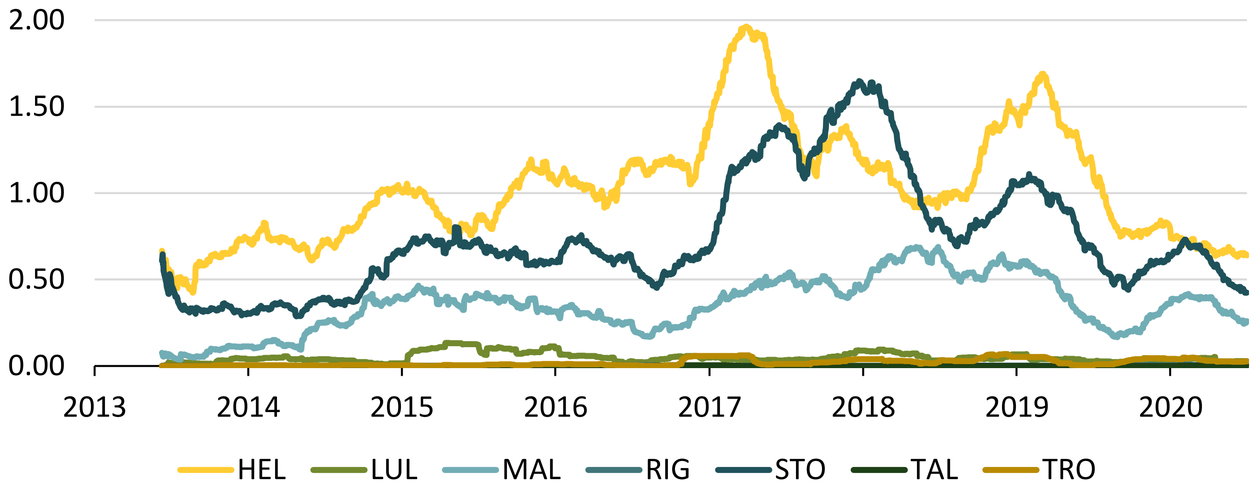
Figure 24: Amihud Illiquidity ratio, EPADs, all bidding zones



Data source: Nasdaq.
Note: The Amihud Illiquidity Ratio is multiplied by 1 000. Both Futures and DS Futures are included. The ratio is averaged over a time window of 120 days, backward.

Figure 25 shows the Amihud illiquidity ratio of the EPAD contracts for the relevant bidding zones. The Amihud illiquidity ratio increases from 2013 to 2017 for the HEL EPAD, before it declines. The RIG and TAL EPADs are relatively stable at a very low level. Naively, these figures would seem to suggest that the RIG and TAL EPAD are much more liquid than the HEL EPAD, clearly in contradiction to the results of the other indicators in this report. This underlines the difficulty in meaningfully comparing this metric across areas.

Figure 25: Amihud Illiquidity ratio, total, EPADs, relevant bidding zones



Data source: Nasdaq.

Note: Each line represents the Amihud Illiquidity Ratio of all trading, including all durations and contract types. The Amihud Illiquidity Ratio is multiplied by 1 000 and averaged over a time window of 120 days, backward.

5.2.1 Summing up the Amihud illiquidity ratio

The Amihud measure should be used with caution when assessing liquidity because of the lack of empirical evidence on its use from commodity/electricity markets. The calculated ratios provide results that are counter-intuitive and conflict with some of the other indicators in this report.

6 TRANSACTION COST MEASURES

6.1 Bid-ask spreads

Bid-ask spreads are the difference between the highest bidding (buying) price and the lowest asking (selling) price. This spread represents a direct transaction costs for market participants. In markets with low bid-ask spreads, a contract can be bought and then sold at very little cost. Conversely, in markets with large bid-ask spreads, buying and then immediately selling a contract will result in a significant loss.

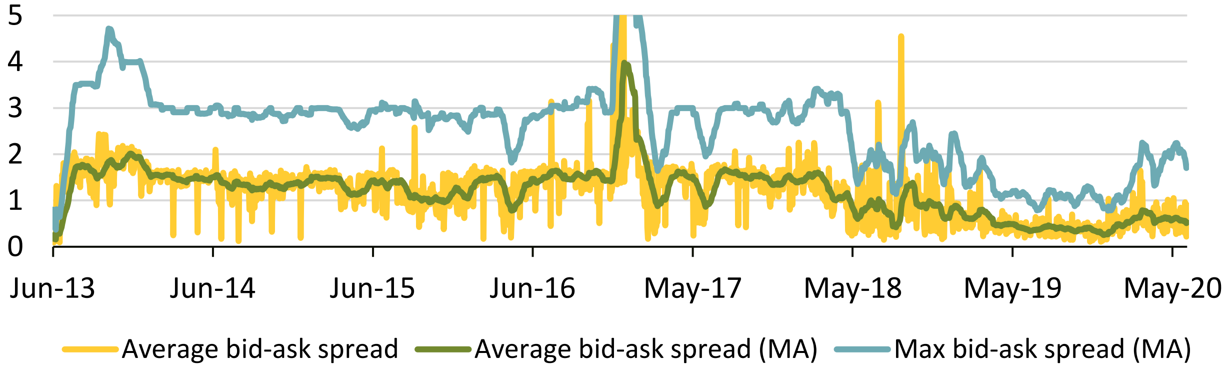
High bid-ask spreads may both cause and be due to low liquidity. In general, high transaction costs discourage active trading and therefore harm liquidity. Conversely, illiquidity increases the inventory management costs that traders must bear and results in them requiring a larger bid-ask spread to be encouraged to trade.

In general, lower bid-ask spreads are therefore indicative of more liquid markets.

6.1.1 Bid-ask spreads system price contracts

The bid-ask spreads below are calculated using data on daily best bids and best asks for each traded contract. For each date within each contract category (daily, weekly, monthly, quarterly and yearly contracts), the data is averaged over all traded contracts (with varying time to delivery). Then, for the remaining dates with no trading, spreads are inferred by (linear) interpolation. Figure 27 to Figure 30 show the absolute bid-ask spread for yearly, quarterly, monthly, weekly and daily power base futures and DS futures. The figures also show 30-day (backward) rolling averages of the bid-ask spread (averaged over all contracts quoted on a particular day) and show the 30-day (backward) rolling average of the *maximum* bid-ask spreads (maximum over all contracts quoted on a particular day).

Figure 26: Absolute bid-ask spread, Nordic yearly power futures (EUR/MWh)



Data source: Nasdaq.

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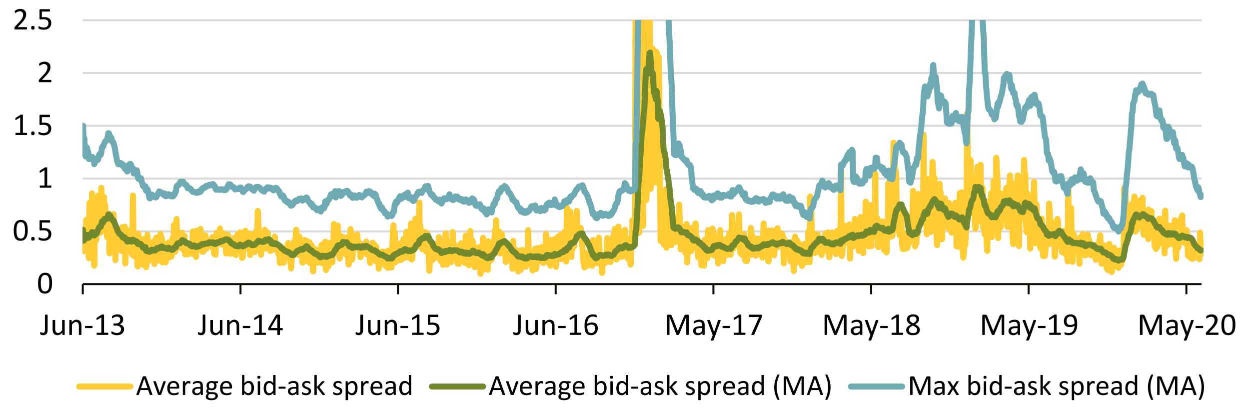
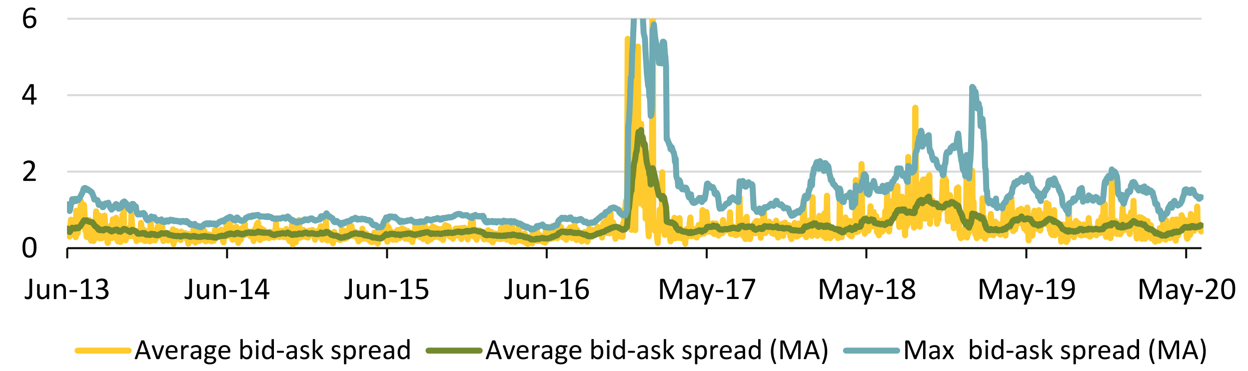
Figure 27: Absolute bid-ask spread, Nordic quarterly power futures (EUR/MWh)



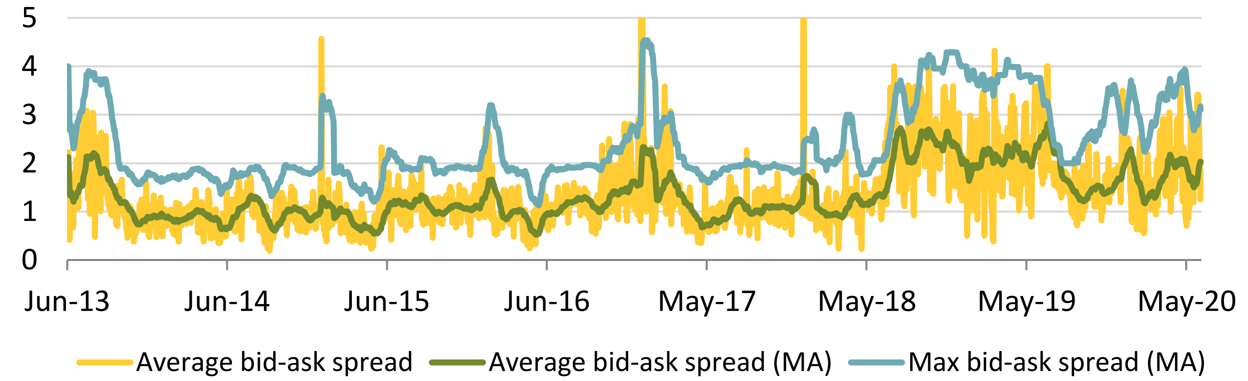
Data source: Nasdaq

Figure 28: Absolute bid-ask spread, Nordic monthly power futures (EUR/MWh)



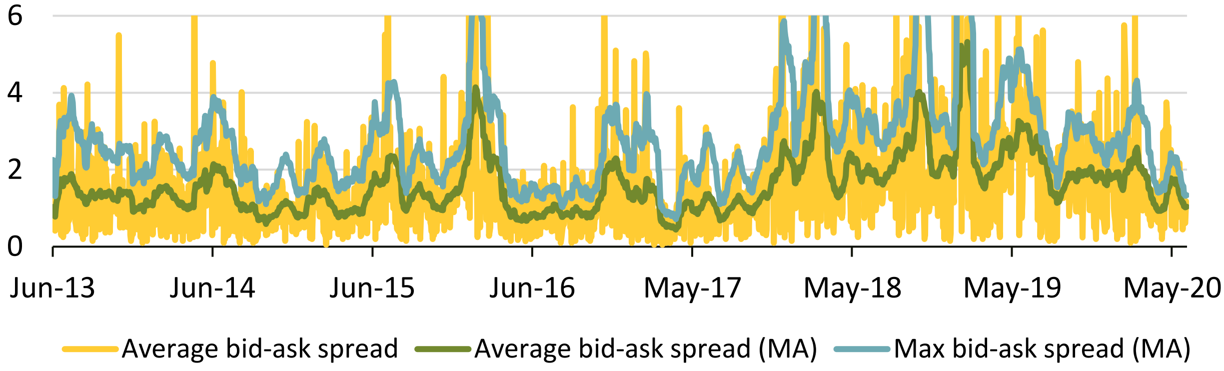
Data source: Nasdaq

Figure 29: Absolute bid-ask spread, Nordic weekly power futures (EUR/MWh)



Data source: Nasdaq

Figure 30: Absolute bid-ask spread, Nordic daily power futures (EUR/MWh)



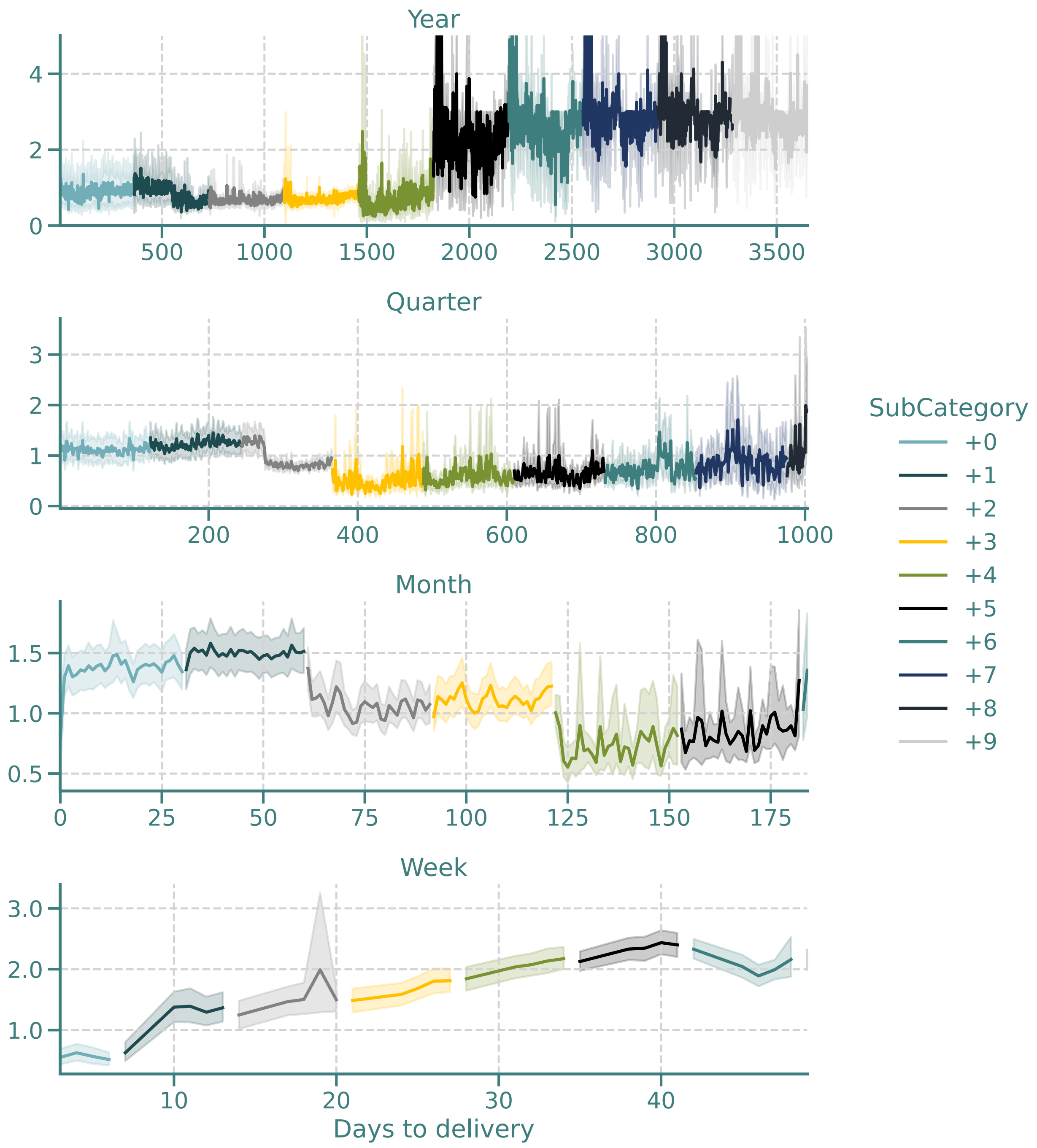
Data source: Nasdaq

Bid-ask spreads clearly experienced a shock around November 2016. The spreads on yearly contracts appear to have declined since 2018, suggesting the transaction costs for such contracts are lower.

Figure 31 shows bid-ask spreads vs. time to delivery for each type of system price contract. In each figure the colour hue indicates different contract durations. The solid dark lines indicate the median value, whilst the lighter shaded region indicates an estimated 95% confidence interval.

In general, we would expect the spread to decline as we approach delivery as the predictability of prices during the delivery window improves. While this effect is visible for weekly contracts, it is not obvious for other durations.

Figure 31 Bid-ask spread vs. time to delivery for Nordic power futures (EUR/MWh)



Data source: Nasdaq

6.1.2 Bid-ask spreads EPAD contracts

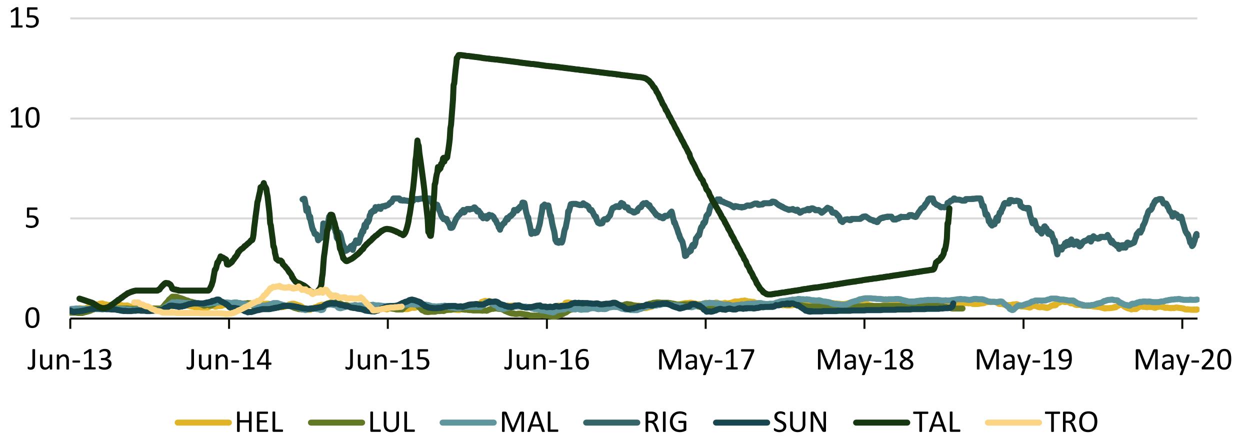
Figure 32, Figure 33 and Figure 34 show the average bid-ask spreads for yearly, quarterly and weekly Finnish and Baltic EPAD contracts. Figure 35, Figure 36 and

Figure 37 show the maximum bid-ask spreads for the same contracts. Similar to the power base futures, the bid-ask spreads are averages over all contract types and linearly interpolated for days without trading. The results shown in Figure 32 to

Figure 37 are averaged over a (backward) rolling time window of 30 days.

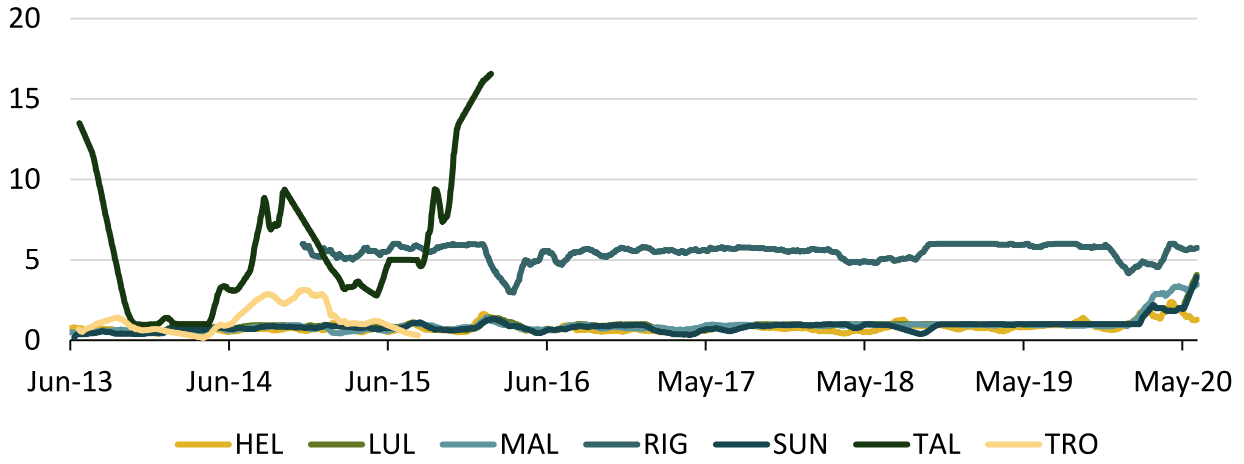
We see that for all durations the RIG and TAL EPADs have relatively high, but variable, bid-ask spreads. The HEL EPAD has a significantly lower spread that is comparable with that for some of the other areas analysed. The bid-ask spread of monthly HEL EPAD increases markedly in the first half of 2020, along with spreads for several other EPAD contracts. This could potentially reflect a loosening of market making obligations for these contracts.

Figure 32 Average best bid-ask spread for yearly EPAD contracts (EUR/MWh)



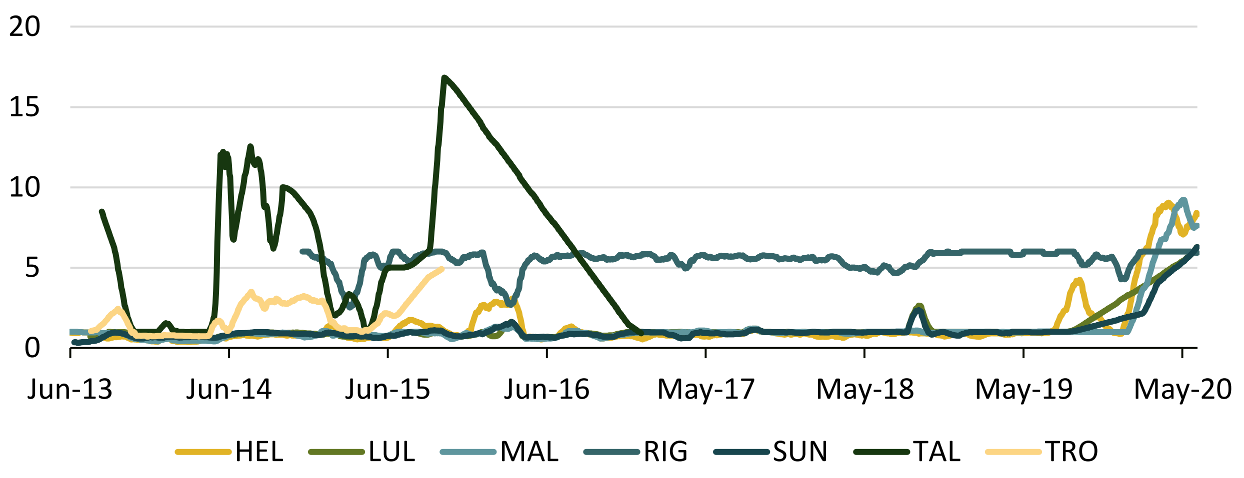
Data source: Nasdaq

Figure 33 Average best bid-ask spread for quarterly EPAD contracts (EUR/MWh).



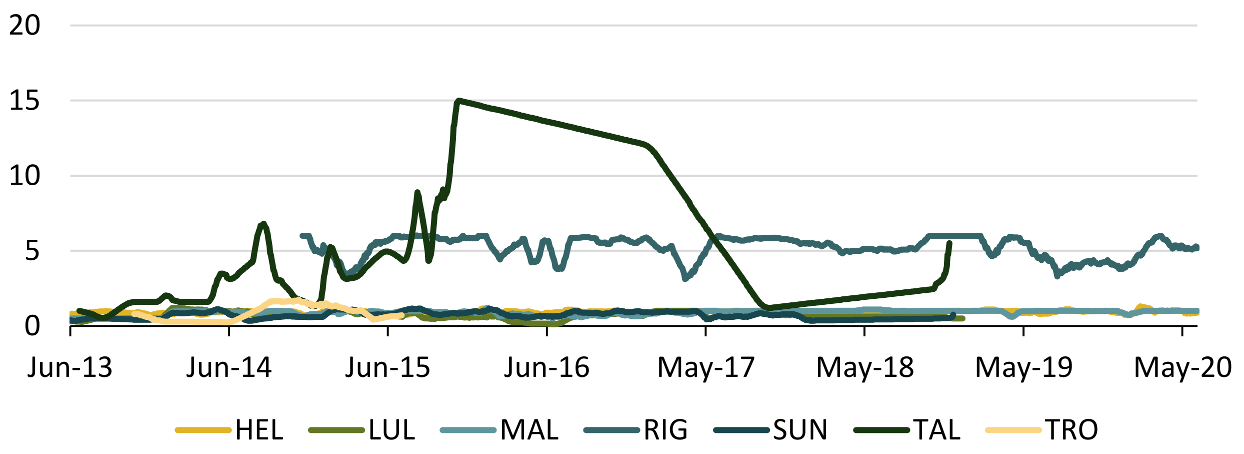
Data source: Nasdaq

Figure 34 Average best bid-ask spread for monthly EPAD contracts (EUR/MWh)



Data source: Nasdaq

Figure 35 Maximum best bid-ask spread for yearly EPAD contracts (EUR/MWh)



Data source: Nasdaq

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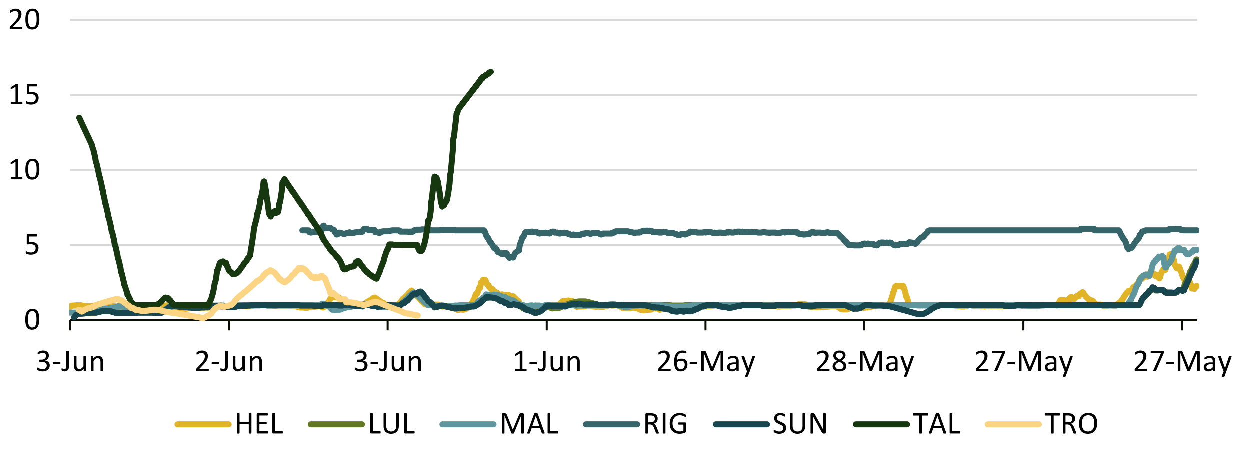
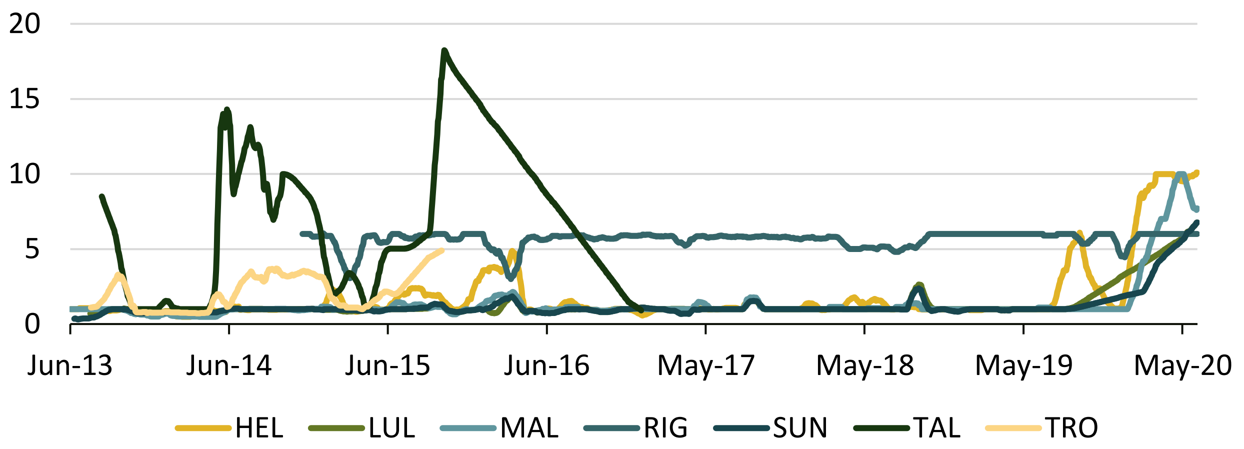
Figure 36 Maximum best bid-ask spread for quarterly EPAD contracts (EUR/MWh).



Data source: Nasdaq

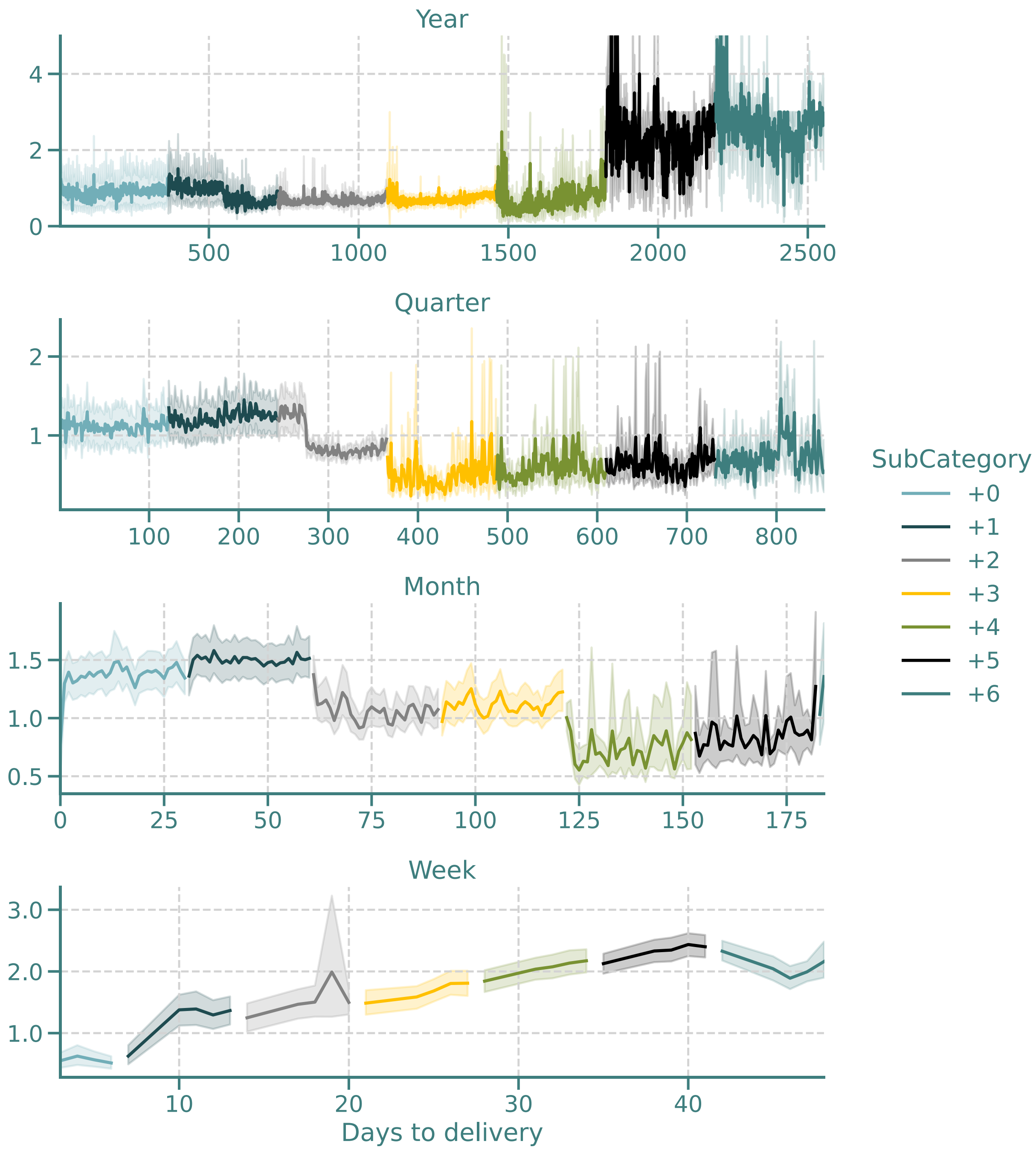
Figure 37 Maximum best bid-ask spread for monthly EPAD contracts (EUR/MWh)



Data source: Nasdaq

Figure 38 shows bid-ask spreads vs. time to delivery for each type of system price contract. In each figure, the colour hue indicates different contract durations. The solid dark lines indicate the median value, whilst the lighter shaded region indicates an estimated 95% confidence interval.

Figure 38 Bid-ask spread vs. time to delivery for EPAD contracts (EUR/MWh)



Data source: Nasdaq

6.1.3 Summing up Bid-ask spreads

There seems to be no clear trend in the development of bid-ask spreads for system price products, although yearly products do appear to have had lower average spreads after 2018. The system price contracts show tight bid/ask spreads for the longer contracts (year, month quarter), but higher spreads for the near-term contracts. This likely reflects the relative illiquidity near-term contracts.

We see that for all durations, the RIG and TAL EPADs have relatively high bid/ask spreads, indicating both poor liquidity and high transaction costs for market participants. The HEL EPAD has lower spreads comparable to some of the other EPADs studied. It should be noted that these spreads may be limited by the presence of market making arrangements on the exchange, where used. A market maker for the HEL EPAD, for example, would be obliged to post bids and offers within a maximum bid-ask spread, thereby limiting the observed spread and contributing to liquidity.

7 CORRELATION

The correlation analysis below helps to show the extent to which different instruments represent reasonable proxies for hedging exposure to a specific power price. Thus, we can get a sense of to what extent one can hedge the price risk of a specific zone using the EPAD of another bidding zone by examining the correlation between power prices in both zones. Good proxy hedges provide market participants with additional opportunities to hedge power price risk.

There is no clear cut-off for how high the correlation needs to be to provide market actors with sufficient hedging opportunities. Hedging opportunities that are poorly correlated may nevertheless be attractive if they enable hedging at very low costs and, conversely, proxy hedges with high correlation may be of little benefit if they are only available at high cost. That said, proxy hedges must have a correlation coefficient of at least 0.8 to qualify for hedge accounting[3] and so hedging instruments with lower correlations are unlikely to be particularly good proxies.

Table 6 shows the correlation of calendar-month-average spot prices. It covers the Norwegian, Swedish, Finish, Estonian, Latvian and Lithuanian bidding zones and the Nordic System price for the period 01.01.2015 to 31.12.2020. The use of monthly average prices reflects an assumption that market participants are not concerned about deviations in prices over shorter periods and will therefore be satisfied if prices are well correlated from month to month.[4]

It is critical to note that this analysis is exclusively backward-looking and limited to the stated period between 2015 and 2020. It is entirely possible that changes in pricing dynamics brought about by the commissioning of new interconnectors and the development of new generation capacity will alter the extent of price correlation between zones in the future.

The results show a high degree of correlation between Finland and the Baltic states, with a correlation of 0.81 for Latvia and Lithuania, and even 0.94 for Estonia. There is also a high degree of correlation between the Baltic states, with a correlation coefficient of 0.83 between Estonia and each of the other two states and what appears to be a perfect correlation between Latvian and Lithuanian monthly average prices. The correlation between the Nordic system price and that in Finland is relatively high, whereas the zonal prices in the Baltic states are less correlated with the system price.

Table 6: Correlation, monthly average spot prices, last five years

	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.94	1.00							
LV	0.81	0.83	1.00						
LT	0.81	0.83	1.00	1.00					
SE1	0.89	0.77	0.62	0.62	1.00				
SE3	0.94	0.86	0.68	0.68	0.96	1.00			
SE4	0.93	0.90	0.79	0.70	0.90	0.97	1.00		
NO4	0.83	0.73	0.61	0.61	0.94	0.88	0.82	1.00	
SYS	0.86	0.75	0.61	0.61	0.97	0.92	0.86	0.98	1.00

Data source: Montel

[3] Hedge accounting allows accounting entries and their offsetting hedge to be treated as one as part of an organisation's financial accounts and thereby helps to reduce overall volatility in accounting profits and losses. In contrast, not practicing hedge accounting or relying on illegible proxies will result in swings in the value of these hedges in the accounts that impact accounting profit and losses, potentially increasing their volatility.

[4] See section 3.2.4 of Bjørndalen et al., "Methods for Evaluation of the Nordic Forward Market for Electricity" for a discussion of the appropriate time thresholds for the correlation analysis.

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Table 7 shows the correlation of calendar-month averages in the difference between the system price and the bidding zone price for each of the relevant bidding zones for the period 01.01.2015 to 31.12.2020. The difference or spread is the underlying reference of EPAD contracts.

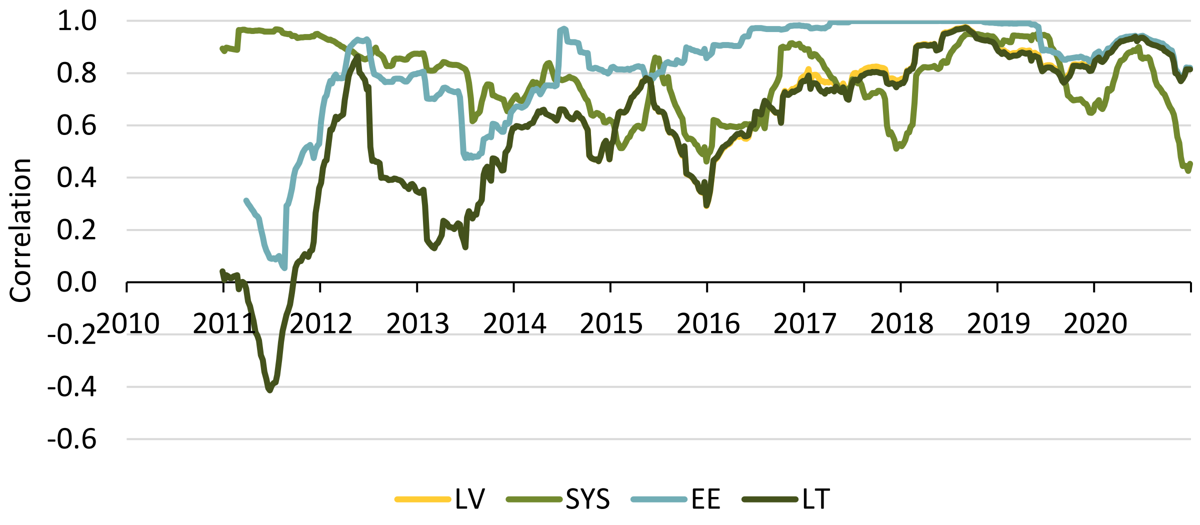
Table 7: Correlation, monthly average spot price differences (area price – system price), last five years

	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.95	1.00						
LV-SYS	0.87	0.88	1.00					
LT-SYS	0.86	0.87	1.00	1.00				
SE1-SYS	0.55	0.45	0.35	0.35	1.00			
SE3-SYS	0.82	0.78	0.61	0.61	0.74	1.00		
SE4-SYS	0.81	0.83	0.65	0.65	0.62	0.94	1.00	
NO4-SYS	-0.11	-0.07	0.03	0.02	-0.35	-0.28	-0.21	1.00

Data source: Montel

To give further insight into the trend of the correlations between the relevant price areas, we expand this analysis by looking at the development of the correlation over the last decade. First, we show in Figure 39, Figure 40, Figure 41 and Figure 42 the correlation in weekly average spot prices between the Finnish, Estonian, Latvian and Lithuanian bidding zones, respectively, and the other relevant bidding zones, for the period 2010 to 2020. The figure shows the correlation in the weekly average spot prices over a rolling time window of one full year, backward, meaning the data point for the last week of 2010 shows the correlation of the full year of 2010. Figure 43 adds the same metric for the Nordic System price. In addition, we include the equivalents of tables Table 6 and Table 7 for each separate year from 2010 to 2020 in appendix 8.1.2.

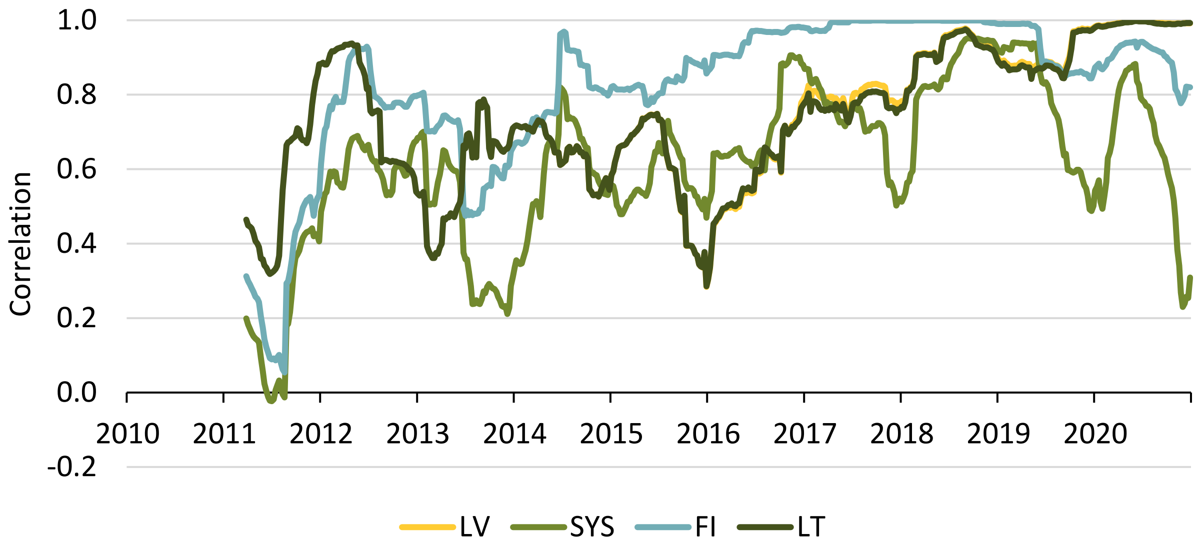
Figure 39: Correlation, weekly average spot, between Finland (FI) and relevant bidding zones



Data source: Montel
Note: The correlation covers a rolling time window of one year (52/53 weeks), backward.

There are no clear trends in how the correlations for the Finnish bidding zone and the other zones have developed over time. Correlations was very low prior to Estlink2 coming into operation in 2014. The correlations have improved thereafter.. It should also be noted that, looking at the last months of 2020, there has been a sharp decrease in the correlation between the Finnish price and the system price.

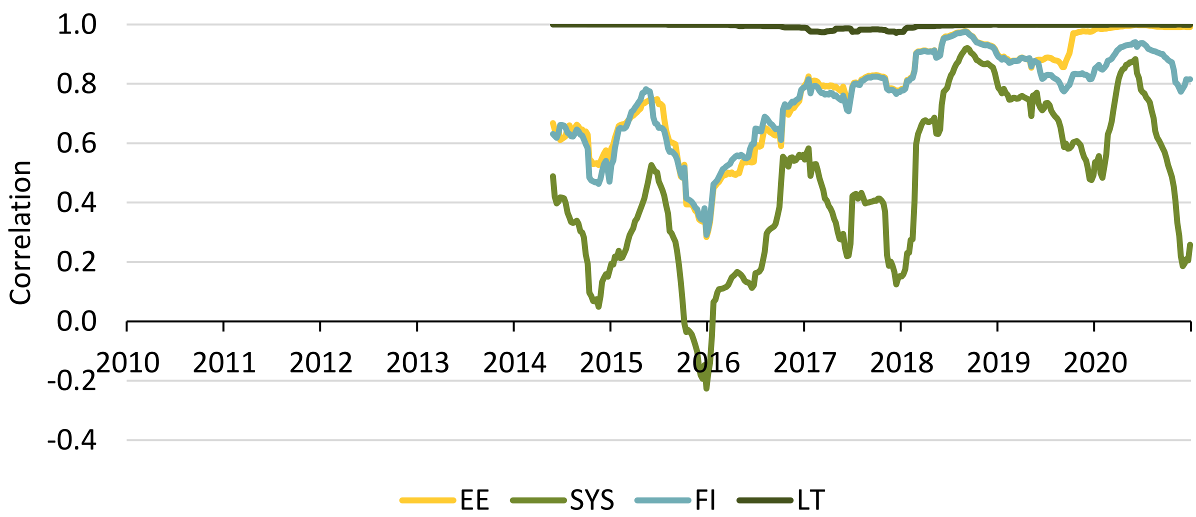
Figure 40: Correlation, weekly average spot, quarterly, between Estonia (EE) and relevant bidding zones



Data source: Montel
Note: The correlation covers a rolling time window of one year (52/53 weeks), backward.

There are large variations in the correlations between the Estonian bidding zone and the surrounding bidding zones as well as the system price. It seems like the price the correlation between the price in Estonia and the system price has increased over time, indicating that the system price products are becoming more relevant for proxy hedging. The same is also true for the correlations with Finland, Latvia and Lithuania. Looking at the most recent development, the correlation between the Estonian bidding zone and the system price has fallen dramatically the last few month of 2020.

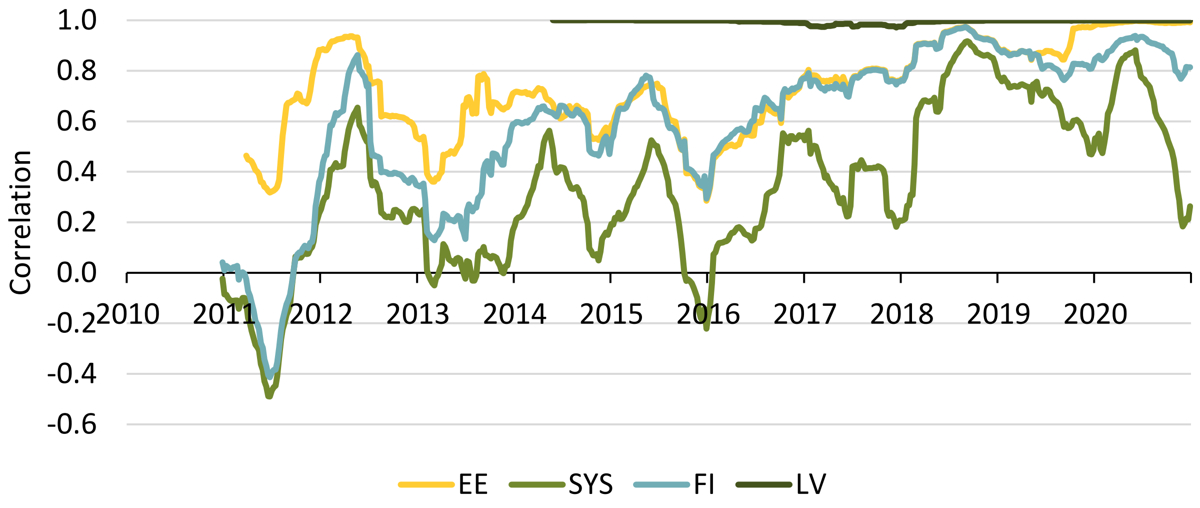
Figure 41: Correlation, weekly average spot, quarterly, between Latvia (LV) and relevant bidding zones



Data source: Montel
Note: The correlation covers a rolling time window of one year (52/53 weeks), backward.

As can be seen in Figure 41 Latvia is extremely well correlated with Lithuania during the whole period. Correlations with Estonia, the system price and to some degree the Finnish price also seems to have been increasing over time. The recent trend of decreasing correlation to the system price is also present for the Latvian bidding zone, as seen in the figures above.

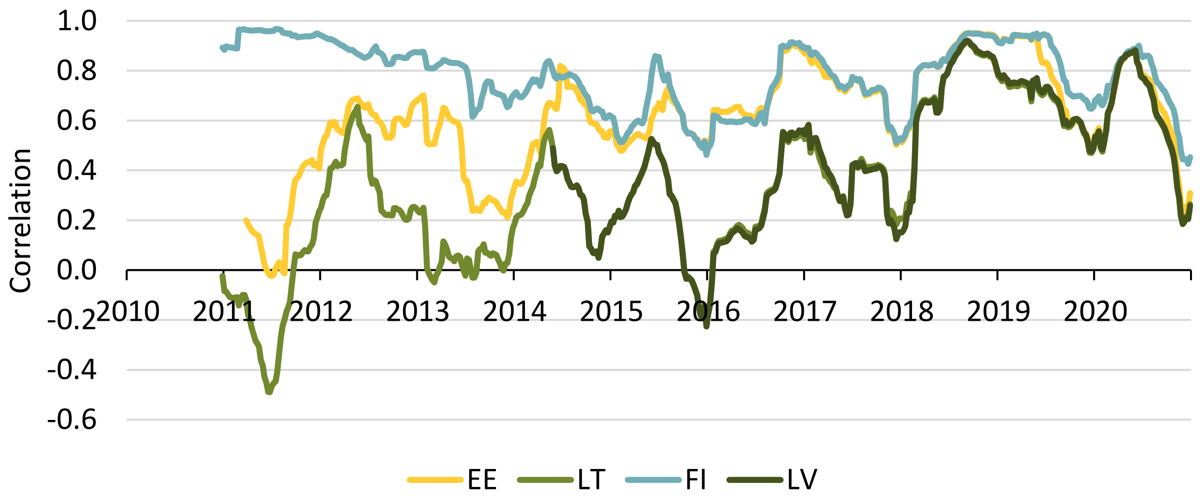
Figure 42: Correlation, weekly average spot, quarterly, between Lithuania (LT) and relevant bidding zones



Data source: Montel
Note: The correlation covers a rolling time window of one year (52/53 weeks), backward.

Lithuania is well correlated with Latvia. The correlations with Estonia have also increased over time as has the correlation with Finland and the system price. There is a sharp decrease in the correlation with the system price.

Figure 43: Correlation, weekly average spot, quarterly, between Nordic System price (SYS) and relevant bidding zones



Data source: Montel
Note: The correlation covers a rolling time window of one year (52/53 weeks), backward.

Figure 43 adds that the most recent development of a sharp decrease in correlation to the system price is common for the Finnish and the Baltic bidding zones.

7.1.1 Summing up the correlations

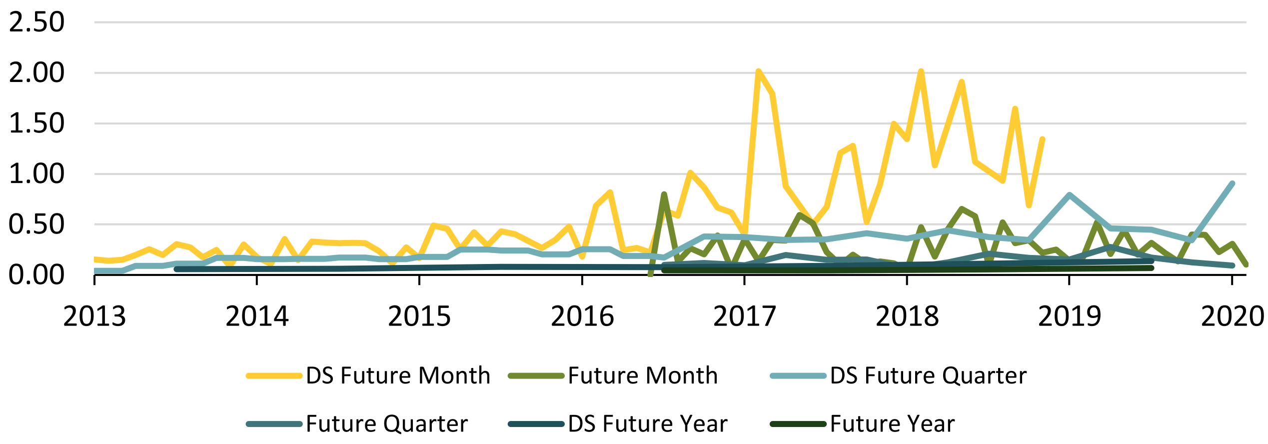
The results show that, looking at the trend over the last five years, there has been a high degree of correlation between Finland and the Baltic states. There is also a high degree of correlation among prices within the Baltic states. The correlation between the Nordic system price and that in Finland is relatively high, while zonal prices in the Baltic states are markedly less correlated with the system price. The correlation between prices in the Baltic states, Finland and the system price seems to have been increasing over time. It should be noted that if we focus on the last few months of 2020, there was a dramatic decrease on correlation between the system price and the Finnish and Baltic bidding zones most likely as a result of the very high precipitation pushing the Norwegian as well as the system price down.

8 APPENDIX

8.1 Additional metric calculations

8.1.1 Amihud Illiquidity Ratio – EPADs

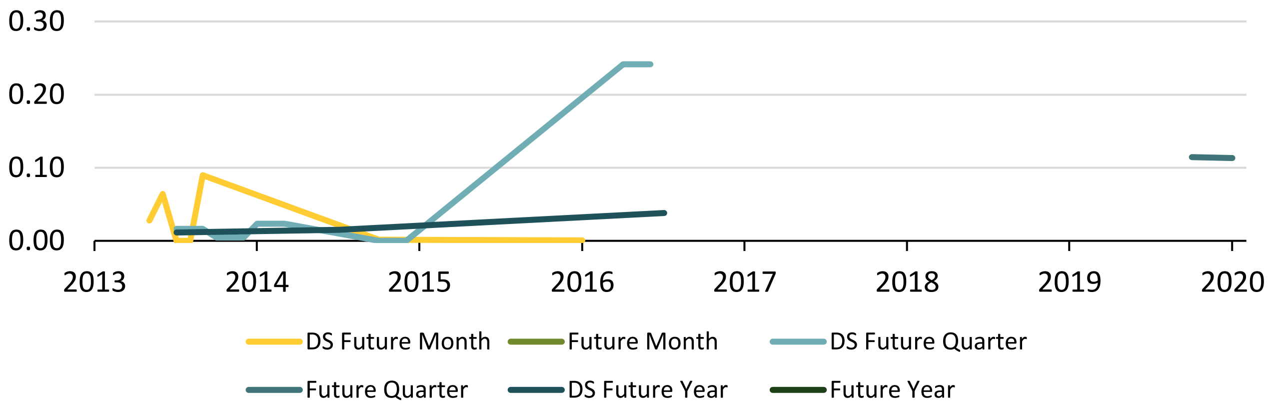
Figure 44: Amihud Illiquidity ratio, HEL EPAD, individual contracts



Data source: Nasdaq.

Note: Each line represents the Amihud Illiquidity Ratio of trading in individual contracts. The Amihud Illiquidity Ratio is multiplied by 1 000.

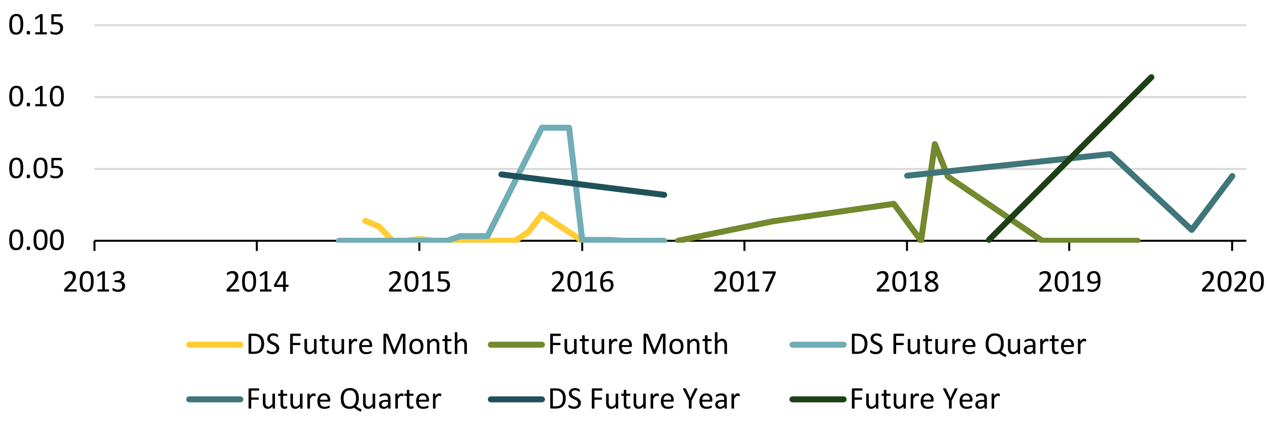
Figure 45: Amihud Illiquidity ratio, TAL EPAD, individual contracts



Data source: Nasdaq.

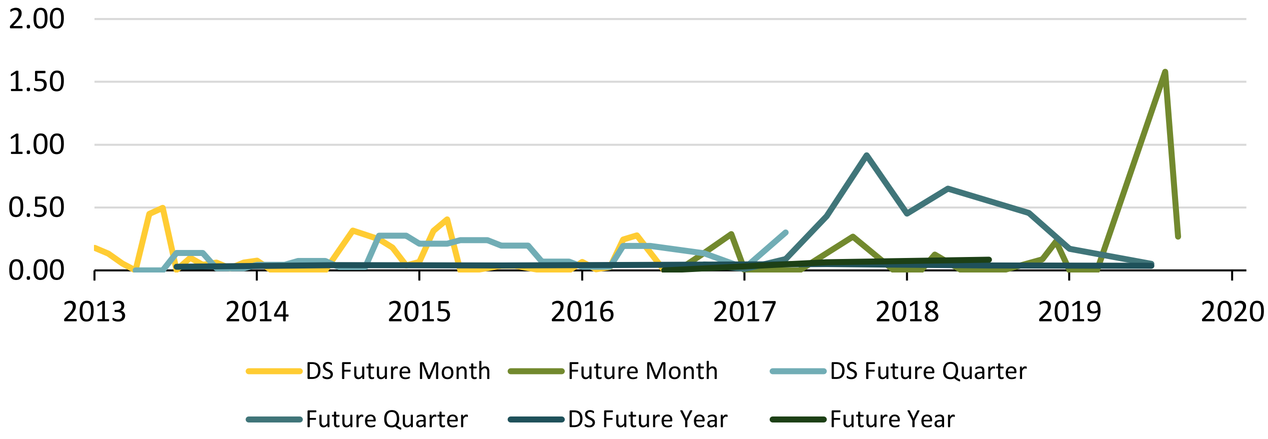
Note: Each line represents the Amihud Illiquidity Ratio of trading in individual contracts. The Amihud Illiquidity Ratio is multiplied by 1 000.

Figure 46: Amihud Illiquidity ratio, RIG EPAD, individual contracts



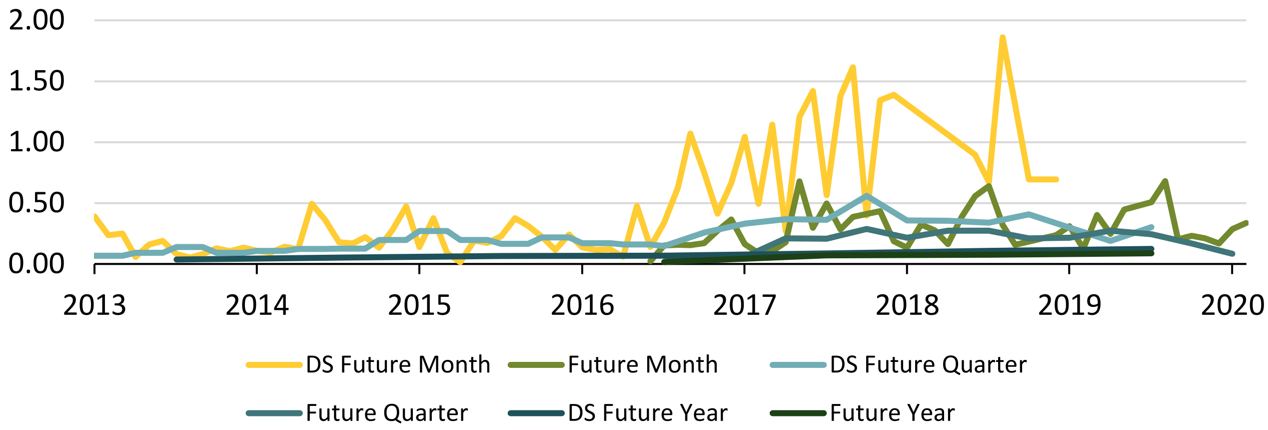
Data source: Nasdaq.
Note: Each line represents the Amihud Illiquidity Ratio of trading in individual contracts. The Amihud Illiquidity Ratio is multiplied by 1 000.

Figure 47: Amihud Illiquidity ratio, LUL EPAD, individual contracts



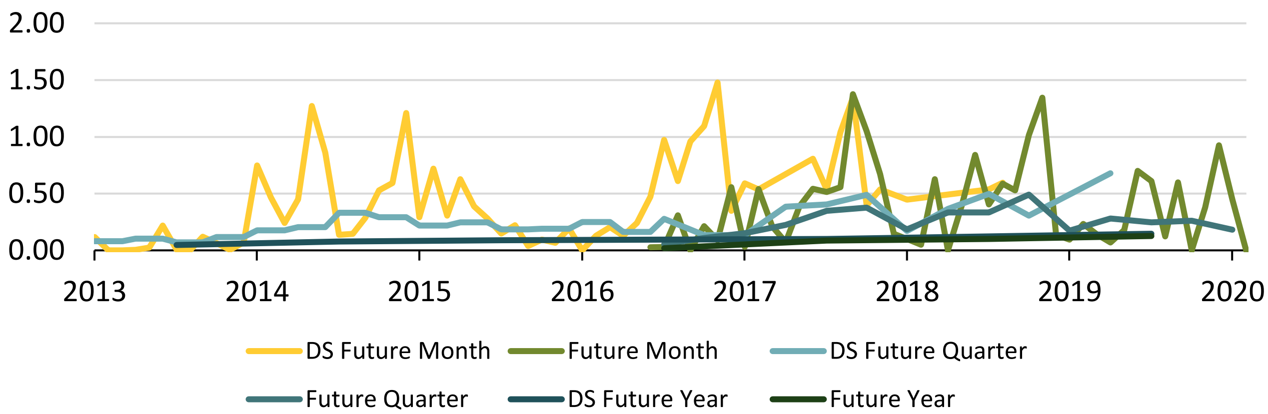
Source: Nasdaq. Each line represents the Amihud Illiquidity Ratio of trading in individual contracts. The Amihud Illiquidity Ratio is multiplied by 1 000.

Figure 48: Amihud Illiquidity ratio, STO EPAD, individual contracts



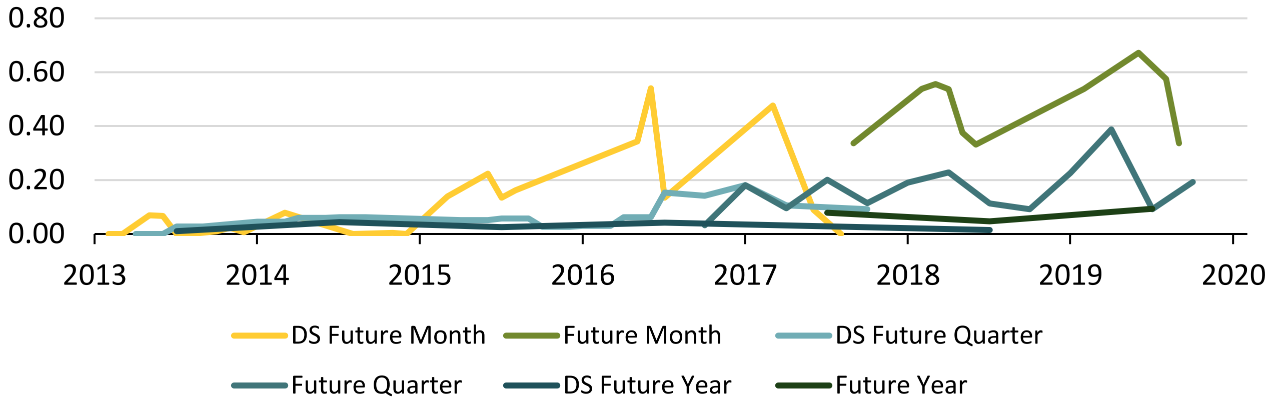
Data source: Nasdaq.
Note: Each line represents the Amihud Illiquidity Ratio of trading in individual contracts. The Amihud Illiquidity Ratio is multiplied by 1 000.
Source: Nasdaq

Figure 49: Amihud Illiquidity ratio, MAL EPAD, individual contracts



Data source: Nasdaq.
Note: Each line represents the Amihud Illiquidity Ratio of trading in individual contracts. The Amihud Illiquidity Ratio is multiplied by 1 000.

Figure 50: Amihud Illiquidity ratio, TRO EPAD, individual contracts



Data source: Nasdaq.
Note: Each line represents the Amihud Illiquidity Ratio of trading in individual contracts. The Amihud Illiquidity Ratio is multiplied by 1 000.

8.1.2 Correlation analysis

Correlation, monthly average spot prices, by year

2010	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	#N/A	#N/A							
LV	#N/A	#N/A	#N/A						
LT	-0.08	#N/A	#N/A	1.00					
SE1	1.00	#N/A	#N/A	-0.12	1.00				
SE3	1.00	#N/A	#N/A	-0.12	1.00	1.00			
SE4	1.00	#N/A	#N/A	-0.12	1.00	1.00	1.00		
NO4	0.99	#N/A	#N/A	-0.16	1.00	1.00	1.00	1.00	
SYS	0.94	#N/A	#N/A	-0.14	0.95	0.95	0.95	0.96	1.00

2011	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.63	1.00							
LV	#N/A	#N/A	#N/A						
LT	0.36	0.90	#N/A	1.00					
SE1	0.98	0.55	#N/A	0.26	1.00				
SE3	0.98	0.55	#N/A	0.26	1.00	1.00			
SE4	0.95	0.51	#N/A	0.24	0.98	0.99	1.00		
NO4	0.98	0.53	#N/A	0.24	1.00	0.99	0.97	1.00	
SYS	0.96	0.52	#N/A	0.23	1.00	1.00	0.99	1.00	1.00

2012	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.80	1.00							
LV	#N/A	#N/A	#N/A						
LT	0.30	0.57	#N/A	1.00					
SE1	0.92	0.71	#N/A	0.15	1.00				
SE3	0.92	0.72	#N/A	0.19	1.00	1.00			
SE4	0.82	0.61	#N/A	0.19	0.95	0.96	1.00		
NO4	0.89	0.70	#N/A	0.11	1.00	0.99	0.95	1.00	
SYS	0.87	0.68	#N/A	0.11	0.99	0.99	0.95	0.99	1.00

2013	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.52	1.00							
LV	#N/A	#N/A	#N/A						
LT	0.65	0.74	#N/A	1.00					
SE1	0.91	0.28	#N/A	0.34	1.00				
SE3	0.93	0.29	#N/A	0.38	1.00	1.00			
SE4	0.89	0.27	#N/A	0.36	0.98	0.98	1.00		
NO4	0.79	0.23	#N/A	0.21	0.94	0.93	0.92	1.00	
SYS	0.60	0.07	#N/A	-0.08	0.84	0.81	0.80	0.95	1.00

2014	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.84	1.00							
LV	0.49	0.67	1.00						
LT	0.49	0.67	1.00	1.00					
SE1	0.81	0.63	0.57	0.57	1.00				
SE3	0.83	0.61	0.57	0.57	0.99	1.00			
SE4	0.81	0.58	0.52	0.52	0.98	0.99	1.00		
NO4	0.79	0.62	0.50	0.51	0.95	0.94	0.93	1.00	
SYS	0.73	0.63	0.17	0.17	0.57	0.56	0.59	0.67	1.00

2015	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.80	1.00							
LV	0.28	0.35	1.00						
LT	0.29	0.35	1.00	1.00					
SE1	0.57	0.67	-0.32	-0.31	1.00				
SE3	0.61	0.68	-0.27	-0.27	0.99	1.00			
SE4	0.50	0.64	-0.25	-0.25	0.97	0.98	1.00		
NO4	0.53	0.62	-0.40	-0.40	0.99	0.97	0.95	1.00	
SYS	0.53	0.62	-0.34	-0.34	0.99	0.98	0.96	0.98	1.00

2016	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.98	1.00							
LV	0.80	0.78	1.00						
LT	0.78	0.76	0.99	1.00					
SE1	0.91	0.88	0.56	0.52	1.00				
SE3	0.95	0.92	0.64	0.61	0.99	1.00			
SE4	0.95	0.91	0.62	0.59	0.99	1.00	1.00		
NO4	0.93	0.88	0.69	0.67	0.93	0.95	0.95	1.00	
SYS	0.93	0.92	0.61	0.59	0.91	0.93	0.94	0.95	1.00

2017	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	1.00	1.00							
LV	0.63	0.64	1.00						
LT	0.63	0.64	0.97	1.00					
SE1	0.86	0.86	0.38	0.41	1.00				
SE3	0.90	0.90	0.38	0.41	0.97	1.00			
SE4	0.85	0.85	0.37	0.46	0.91	0.95	1.00		
NO4	0.02	0.02	-0.23	-0.10	0.15	0.22	0.44	1.00	
SYS	0.30	0.29	-0.28	-0.17	0.59	0.58	0.69	0.75	1.00

2018	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.99	1.00							
LV	0.91	0.91	1.00						
LT	0.90	0.91	1.00	1.00					
SE1	0.99	0.97	0.88	0.88	1.00				
SE3	0.99	0.98	0.89	0.88	1.00	1.00			
SE4	0.96	0.96	0.94	0.94	0.95	0.96	1.00		
NO4	0.96	0.95	0.88	0.88	0.98	0.97	0.94	1.00	
SYS	0.98	0.98	0.87	0.86	0.99	0.99	0.95	0.98	1.00

2019	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.84	1.00							
LV	0.79	0.99	1.00						
LT	0.78	0.98	1.00	1.00					
SE1	0.76	0.51	0.49	0.48	1.00				
SE3	0.77	0.52	0.50	0.49	1.00	1.00			
SE4	0.81	0.61	0.58	0.57	0.98	0.99	1.00		
NO4	0.64	0.36	0.36	0.35	0.98	0.97	0.93	1.00	
SYS	0.64	0.42	0.41	0.40	0.98	0.98	0.95	0.99	1.00

2020	FI	EE	LV	LT	SE1	SE3	SE4	NO4	SYS
FI	1.00								
EE	0.88	1.00							
LV	0.88	0.99	1.00						
LT	0.88	1.00	1.00	1.00					
SE1	0.69	0.45	0.44	0.43	1.00				
SE3	0.96	0.85	0.85	0.84	0.72	1.00			
SE4	0.91	0.93	0.94	0.94	0.54	0.89	1.00		
NO4	0.09	-0.08	-0.13	-0.11	0.49	0.19	0.00	1.00	
SYS	0.46	0.26	0.21	0.22	0.77	0.51	0.33	0.88	1.00

Correlation, monthly average spot price differences (area price – system price), by year

2010	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	#N/A	#N/A						
LV-SYS	#N/A	#N/A	#N/A					
LT-SYS	-0.53	#N/A	#N/A	1.00				
SE1-SYS	0.98	#N/A	#N/A	-0.61	1.00			
SE3-SYS	0.98	#N/A	#N/A	-0.61	1.00	1.00		
SE4-SYS	0.98	#N/A	#N/A	-0.61	1.00	1.00	1.00	
NO4-SYS	0.95	#N/A	#N/A	-0.66	0.98	0.98	0.98	1.00

2011	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.82	1.00						
LV-SYS	#N/A	#N/A	#N/A					
LT-SYS	0.80	0.99	#N/A	1.00				
SE1-SYS	0.98	0.77	#N/A	0.77	1.00			
SE3-SYS	0.88	0.76	#N/A	0.77	0.91	1.00		
SE4-SYS	0.37	0.48	#N/A	0.51	0.40	0.74	1.00	
NO4-SYS	0.64	0.32	#N/A	0.31	0.69	0.41	-0.23	1.00

2012	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.44	1.00						
LV-SYS	#N/A	#N/A	#N/A					
LT-SYS	0.36	0.94	#N/A	1.00				
SE1-SYS	0.79	0.45	#N/A	0.42	1.00			
SE3-SYS	0.75	0.27	#N/A	0.32	0.89	1.00		
SE4-SYS	0.07	0.37	#N/A	0.54	0.43	0.52	1.00	
NO4-SYS	0.56	0.31	#N/A	0.21	0.87	0.74	0.40	1.00

2013	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.72	1.00						
LV-SYS	#N/A	#N/A	#N/A					
LT-SYS	0.91	0.83	#N/A	1.00				
SE1-SYS	0.93	0.50	#N/A	0.77	1.00			
SE3-SYS	0.92	0.48	#N/A	0.77	0.99	1.00		
SE4-SYS	0.88	0.50	#N/A	0.76	0.94	0.96	1.00	
NO4-SYS	0.85	0.53	#N/A	0.86	0.83	0.87	0.84	1.00

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2014	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.68	1.00						
LV-SYS	0.62	0.75	1.00					
LT-SYS	0.62	0.75	1.00	1.00				
SE1-SYS	0.79	0.45	0.65	0.65	1.00			
SE3-SYS	0.81	0.44	0.65	0.65	0.99	1.00		
SE4-SYS	0.78	0.38	0.60	0.60	0.98	0.99	1.00	
NO4-SYS	0.72	0.38	0.61	0.61	0.95	0.94	0.92	1.00

2015	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.91	1.00						
LV-SYS	0.87	0.93	1.00					
LT-SYS	0.87	0.93	1.00	1.00				
SE1-SYS	0.50	0.50	0.39	0.39	1.00			
SE3-SYS	0.55	0.47	0.45	0.45	0.82	1.00		
SE4-SYS	0.26	0.39	0.44	0.44	0.65	0.69	1.00	
NO4-SYS	-0.07	-0.09	-0.30	-0.30	0.61	0.17	0.08	1.00

2016	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.89	1.00						
LV-SYS	0.84	0.72	1.00					
LT-SYS	0.81	0.73	0.99	1.00				
SE1-SYS	0.27	0.05	-0.07	-0.12	1.00			
SE3-SYS	0.43	0.14	0.15	0.09	0.96	1.00		
SE4-SYS	0.37	0.09	0.07	0.01	0.96	0.99	1.00	
NO4-SYS	0.60	0.62	0.54	0.56	0.09	0.10	0.07	1.00

2017	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	1.00	1.00						
LV-SYS	0.87	0.87	1.00					
LT-SYS	0.84	0.84	0.99	1.00				
SE1-SYS	0.92	0.92	0.78	0.75	1.00			
SE3-SYS	0.94	0.94	0.74	0.71	0.96	1.00		
SE4-SYS	0.89	0.89	0.72	0.74	0.86	0.92	1.00	
NO4-SYS	-0.32	-0.32	-0.11	-0.06	-0.54	-0.42	-0.19	1.00

2018	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.81	1.00						
LV-SYS	0.58	0.63	1.00					
LT-SYS	0.56	0.62	1.00	1.00				
SE1-SYS	0.13	-0.15	0.27	0.27	1.00			
SE3-SYS	0.03	0.05	0.29	0.29	0.86	1.00		
SE4-SYS	0.19	0.39	0.73	0.74	0.37	0.54	1.00	
NO4-SYS	0.09	-0.11	0.32	0.33	0.08	-0.17	0.14	1.00

2019	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.82	1.00						
LV-SYS	0.79	0.99	1.00					
LT-SYS	0.78	0.99	1.00	1.00				
SE1-SYS	0.68	0.24	0.17	0.17	1.00			
SE3-SYS	0.66	0.21	0.14	0.13	0.96	1.00		
SE4-SYS	0.83	0.64	0.57	0.56	0.69	0.78	1.00	
NO4-SYS	0.19	-0.03	-0.02	-0.01	0.15	0.01	-0.12	1.00

2020	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1.00							
EE-SYS	0.91	1.00						
LV-SYS	0.92	1.00	1.00					
LT-SYS	0.92	1.00	1.00	1.00				
SE1-SYS	0.61	0.43	0.46	0.44	1.00			
SE3-SYS	0.94	0.85	0.86	0.86	0.61	1.00		
SE4-SYS	0.92	0.92	0.94	0.94	0.50	0.90	1.00	
NO4-SYS	-0.38	-0.21	-0.19	-0.20	-0.47	-0.38	-0.32	1.00