Analysis of Electricity Forward Market Hedging Opportunities in Lithuania – Latvia Bidding Zone Border

2025

Vilnius Lithuania

Rīga Latvia

SUMMARY

The purpose of Article 30 of FCA regulation[1] is to ensure that electricity market participants have adequate opportunities to manage future price risk in the bidding zones where they operate. Initially, Article 30 of FCA regulation states that the TSOs on a bidding zone border shall issue long-term transmission rights between bidding zones as a tool for price hedging. However, regulatory authorities can decide not to implement transmission rights if sufficient price hedging opportunities exist within the bidding zone or if other hedging products are made available.

By electricity energy price fluctuation and difference of prices between the bidding zones, market players face the market risk[2]. To manage this risk, market participants often enter into bilateral contracts (within bidding zone) or participate in the market of financial derivatives for hedging. The main objective of the evaluation report is to assess hedging opportunities in the *Nasdaq Commodities* market (Article 30(4b) of FCA regulation). In this report, we examine possible measures of the sufficiency of hedging opportunities in Latvian and Lithuanian cross-border as well as the bordering bidding zones.

One way to manage market risk - bilateral contracts - is not possible in international trade, therefore market participants have less opportunities to manage it in the international market, where part of the risk is formed not only by price fluctuations, but also by the difference of prices between the bidding zones.

Also, market suppliers avoid part of the risk by passing it on by offering variable price plans to end users. In addition, it is likely that the introduction of flexibility and similar services and new previous products (15 min, 30 min) in the market will help stabilize market price fluctuations.

In the case of the Latvian and Lithuanian bidding zones, the part of market risk related to the difference of prices between respective bidding zones is not significant, as most of the time electricity prices either coincide or the differences between them are not significant and do not last long. This was also emphasized by market participants who provided their insights in the public consultation.

This work includes the analysis of open interest (hereinafter - OI), the trading horizon, traded volumes, bid-ask spreads, and the churn rates of the period 2020.01.01-2024.12.31. The analysis of these indicators is in line with the requirements in Article 30(4b) of FCA regulation.

We find that after an energy crisis the stabilization or moderate growth of open interest in system price and in EPAD contracts of all durations during the period of 2023-2024 years. Total open interest in EPAD contracts has been stable throughout the period 2020-end of 2022. After that period, one can observe the moderate increase in 2023 year and the stabilization in 2024 year. This implies in the size of exposures being hedged using such contracts and may suggest stable and often quite limited liquidity. Looking at the relevant EPAD contracts, open interest in TAL (Tallin) remained low until the termination, and RIG (Riga) EPAD increased and achieved the level of HEL (Helsinki) and MAL (Malmö) open interest for EPADs during the 2021-2022 years. However, liquidity is likely to be poor for these products.

Open interest in relation to physical consumption means the results for open interest. For system price contracts, open interest in relation to physical consumption has remained stable until the mid-2021 and have decreased slowly until the end of analysed period. The results show that open interest in relation to physical consumption for system price contracts has remained stable during the 2023-2024 years at around 0,09-0,2 and then decreased slowly until 0,1-0,25 at the end of analysed period. Similarly, for the HEL and MAL EPADs, since the beginning of 2017 this indicator basically remained stable after the usual fluctuations at around 0,2-0,25 until mid-2021. Levels of trade for RIG and TAL EPADs remained irrelevant.

Mainly due to serious geopolitical changes and tensions, unstable macroeconomic situation, and the need to ensure operational stability in the future market participants felt the need to hedge their electricity supply contract against sudden and unusual price increases (see also Figure 6 and Figure 12).

Trade in financial products in 2020-2024 was strongly fluctuating, significantly dependent on the impact of various external factors. Like all trading in systemic financial transactions, daily traded volumes in EPADs have been fluctuated strongly in 2020, and from approximately in the mid-2021 began to decrease. Thus, trade

---

[1] Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation.

[2] Following the classification of Basel III, for more details see https://www.bis.org/bcbs/basel3.htm.

in EPAD contracts decreased from 0,8 TWh in the beginning of 2021 to 0,2 TWh in the end of analysed period. For the EPADs of RIG and TAL, one can see extended periods without any trading activity, which almost certainly reflects low liquidity on the exchange. Daily traded volumes for the HEL and STO EPADs also were significantly decreased but higher, at around 0,025-0,05 TWh at the end of analysed period. We see that during the period of 2023-2024 years the trade of systemic products and EPADs have a growth trend for all durations however the volatility remained increased at the same time mainly due to remining geopolitical tensions and uncertainties.

The churn rate for system price contracts fluctuated around 3 from the mid-2023 to the end of 2024 years. This reflects increased volumes of trade from 2022 years. The trade in the RIG EPAD in 2020-2022 was fragmented, close to zero for a large part of the last year and a half, except for periods of trade intensification due to significant changes in the energy market, which were largely due to geopolitical reasons. For HEL, the churn rate has varied around 0,5 to 1,5 throughout most of the period of 2022-mid-2023 years. Starting from the mid-2023 the churn rate of HEL EPAD reached and fluctuated around 0,5-1 for 2024 years reflecting intensified trade. In addition, the recent development of these figures highlights those traded volumes for the TAL and RIG EPAD are relatively low even when accounting for volatility in the level of consumption between different bidding zones.

In all bidding zones, the bid-ask spread reveals the nervousness of trading, related to the strongly increased volatility of electricity prices and uncertainty due to the continuing tense geopolitical situation. Therefore, without these fundamental changes, it is quite complicate to see clearer trends in yields in trade (ex-post premium). There seems to be no clear trend in the development of bid-ask spreads for system price short term contracts, although monthly, quarterly and yearly contracts do appear to have had stable average spreads after the energy crisis from the mid of 2023 years. The system price contracts show tight bid/ask spreads for the longer contracts (year, month, and quarter), but higher spreads for the near-term contracts (daily and weekly). This possible means the relative illiquidity of near-term contracts. Also, it can be stated that during this stabilization volatility and risk premium remained higher than in the pre-crisis period.

The Lithuanian bidding zone does not have a Vilnius EPAD created specifically for Lithuania. Furthermore, from 3 October 2022 operators of *Nasdaq Commodities* has decided to suspend with effect EPAD series from trading and clearing: all series in the Nordic EPAD Electricity Base Year Future for area price Tallinn, all series in the Nordic EPAD Electricity Base Quarter Future for area price Tallinn, all series in the Nordic EPAD Electricity Base Average Rate Month Future for area price Tallinn, Nordic EPAD Electricity Base Year Future for area price Riga – Year 2024.

CONCLUSIONS

1. The uncertainty in the markets decreased in comparison with the period of evident energetic crisis in 2022 year. The demand of hedging opportunities through derivative instruments remains stable for LT-SE4 interconnections and no need on LT-LV interconnection.
2. Specific problem in Baltic countries is that the local market participants and new market entrants are relatively small, so their opportunities to participate in the current setup of the financial markets by hedging their electricity purchase or supply contracts are quite limited.
3. The increasing relative share of renewable energy in Latvia and Lithuania, together with other significant factors (e.g. significant failures of the transmission system or generation facilities), forces market participants to look for ways to more effectively hedge the risk of electricity supply transactions. On the one hand, this means that electricity production in Latvia and Lithuania is increasingly less dependent on fossil fuel prices and their development. On the other hand, the price of fossil fuels (gas) has an indirect impact on the price of electricity in the Latvian and Lithuanian bidding zones due to the Merit Order effect. Also, it is worth to emphasize that the level of electricity prices in Latvia and Lithuania is highly dependent on the operation and technical state of the interconnections between the Baltic and Nordic regions.
4. In the long term, the prices of electricity returned yet to the previous level before electricity crisis mainly due to intensive government action, across the EU The serious changes of electricity prices after the synchronization of Baltic countries with CESA did not occur. Due to remaining increased volatility (uncertainty), it is complicated to determine a clearer trend in the development of the bid-ask spread.
5. Open interest in the RIG EPAD achieved the level of HEL and MAL EPADs during the 2021 year. However, financial market liquidity dropped in 2022 to amid high market uncertainty caused by the European energy crisis, as well as record price spreads that have made it more expensive to hedge risk.
6. RIG and TAL EPADs seem to be unattractive to market participants, and therefore *Nasdaq Commodities* exchange operators due to their light trading, and their delisting limits trading opportunities in the open market.
7. It is possible to construct the hedging strategies for trading with Finnish bidding zone for Lavia's and Lithuania's market participants. The LTTRs on FI-EE and EE-LV bidding zone borders provide hedging for the price difference between FI and LT bidding zones. On the other hand, the price difference between Latvian and Lithuanian bidding zones in average for 2023 - 2025 H1 was less than 1 EUR/MWh, i.e. approximately from 0,05% - 2,6% of yearly hours in both directions therefore the need for risk mitigation is very low. The situation after synchronization has not changed fundamentally. The electricity price difference between LT and LV bidding zones are not enough relevant to hedge. As a results, there is no need to issue cross-border hedging instruments for LT-LV connection.
8. Following the results of public consultation in Lithuania, higher priority is given to the creation of a capacity auction mechanism between the Swedish SE4 and Lithuanian bidding zones and the Polish and Lithuanian bidding zones.
9. The optimal solution to ensure the public interest is to create innovative approach for hedging market risk that does not require TSOs' or public financial resources. For example, these could be trilateral transactions between a market participant wishing to hedge the risk of cross-zonal electricity trading price differences, a financial sector participant agreeing to hedge such risk, and a TSO providing all the necessary information for this transaction.

1. EXTERNAL CONDITIONS AND CURRENT SITUATION

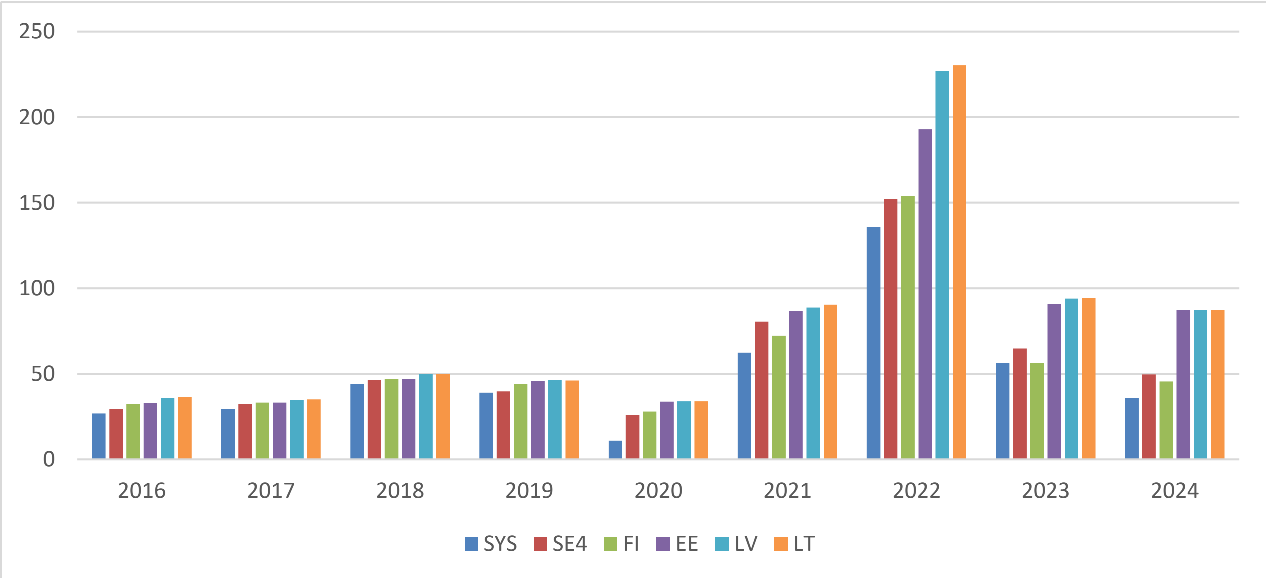
The prices of electricity depend on the price of inputs used in its generation and merit order principle. Electricity prices are generally correlated with commodities that are used in the generation of electricity. However, this correlation is not static and changes over time. With the increase of solar or wind energy in generation of electricity, it is likely that the correlation between generated renewable electricity prices and natural gas prices has changed over time.

EU Member States' electricity and gas sectors vary significantly based on their economic situation, energy market and cost structure, the generation mix and the levels of interconnection as well as geopolitical tensions. The most appropriate strategies for a crisis response consequently vary significantly between Member States and must consider the different national and local situations.

Russia's military invasion to Ukraine continues and preserves energy security concerns in Europe. Electricity prices stabilized in the last two years after a volatile 2022, but day-ahead prices and volatility remain higher than before the energy crisis. Lower gas prices, in turn, contributed to lowering day-ahead prices throughout 2023, complemented by a mild winter and energy-saving efforts. In 2022, the average day-ahead price was 226,91 EUR/MWh in Latvia and 230,23 EUR/MWh in Lithuania. In 2023, the average day-ahead price was 93,89 EUR/MWh in Latvia and 94,44 EUR/MWh in Lithuania, in 2024 years, 87,43 EUR/MWh and 87,34 EUR/MWh respectively. However, the average day-ahead price is still more than two times higher than in 2020. Similarly, the volatility of prices is still higher than pre-crisis. Despite falling wholesale prices, energy remains costly due to geopolitical uncertainty, supplier risk and market volatility. In 2022, the volatility of the hourly prices of electricity became very high reaching 227-235 EUR/MWh in Baltic countries.

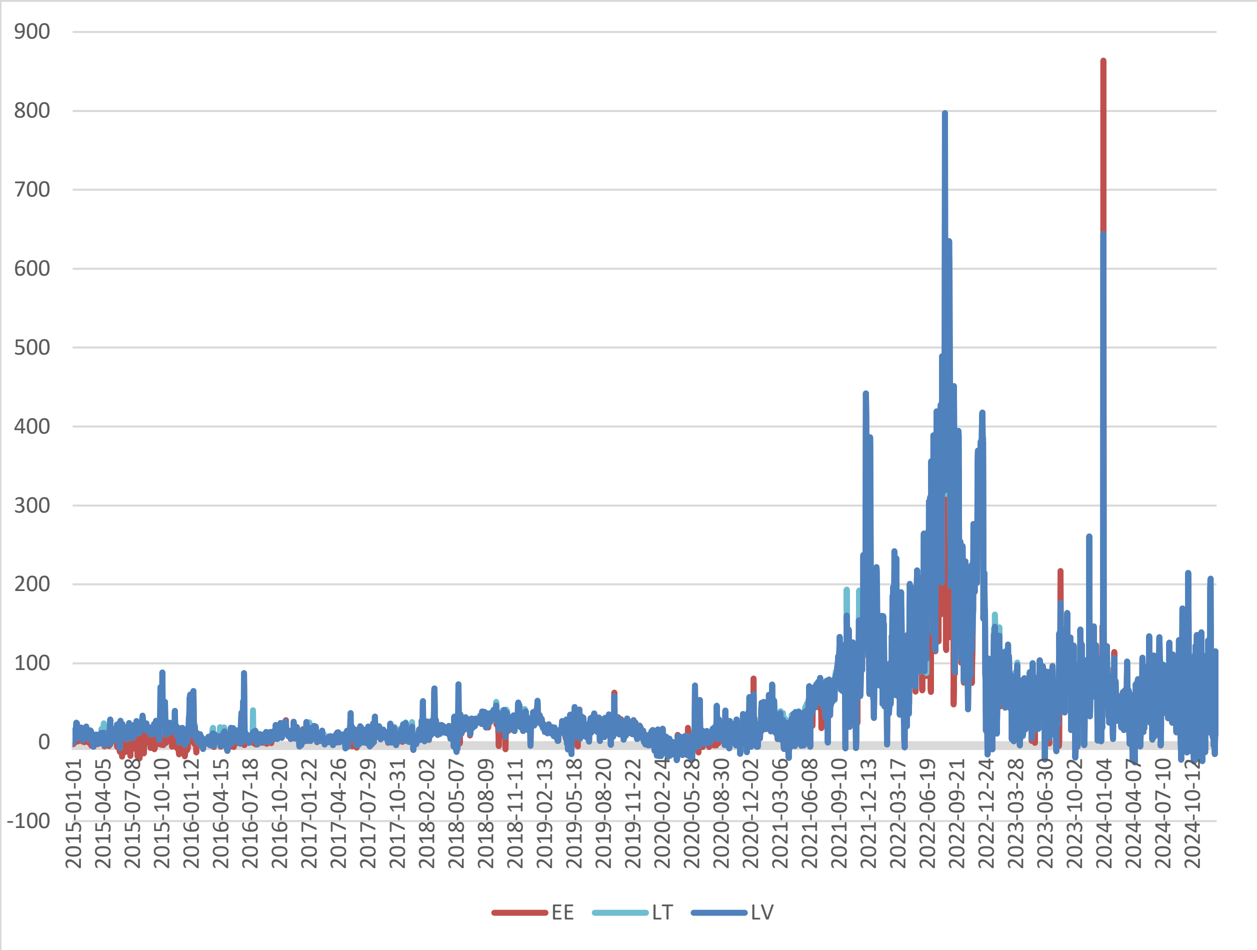
Since 2022, the prices of electricity and other energy resources have decreased but have not reached the pre-crisis level. The differences between the market prices of individual bidding zones and the systemic market price in 2023-2024 also exceeded the pre-crisis level. Also, in some cases, the differences between different prices in various bidding zones have increased. True, in the case of Lithuania and Latvia, price differences have essentially disappeared due to political decisions. All this means that the need to hedge against the risk of price differences remains relevant.

Figure 1: Development of average prices (EE, FI, LT, LV, SE4 and system prices), EUR/MWh



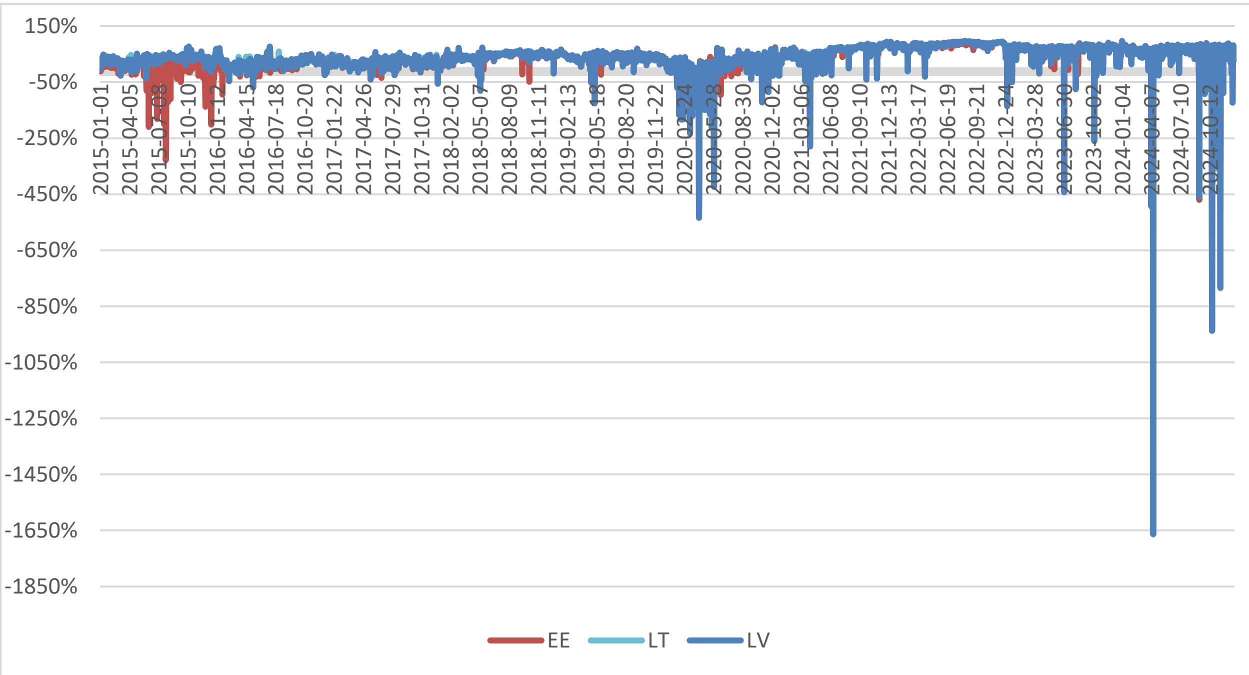
Data source: Nord Pool.

Figure 2: Development of difference (between EE, LV, LT and system prices), EUR/MWh



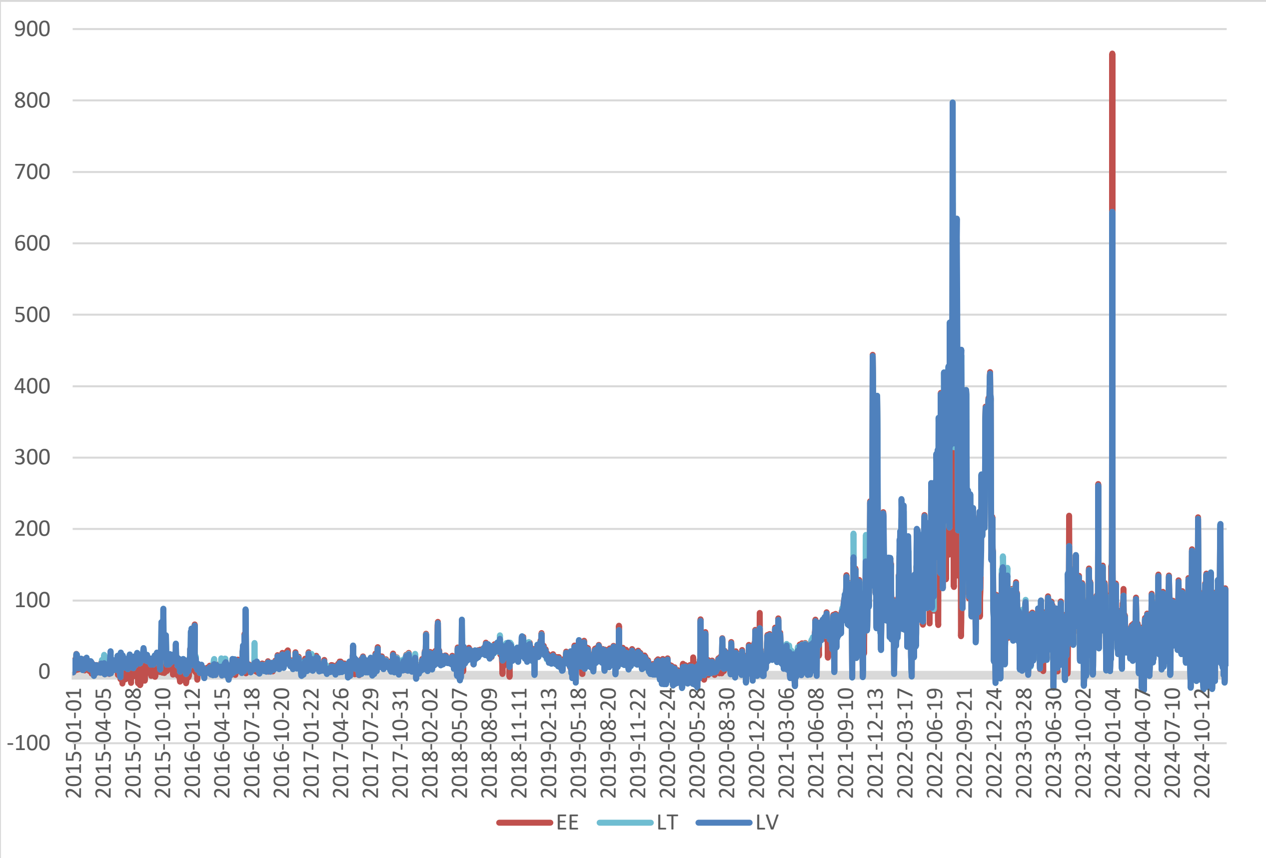
Data source: Nord Pool.

Figure 3: Development of normed difference (between EE, LV, LT and system prices)



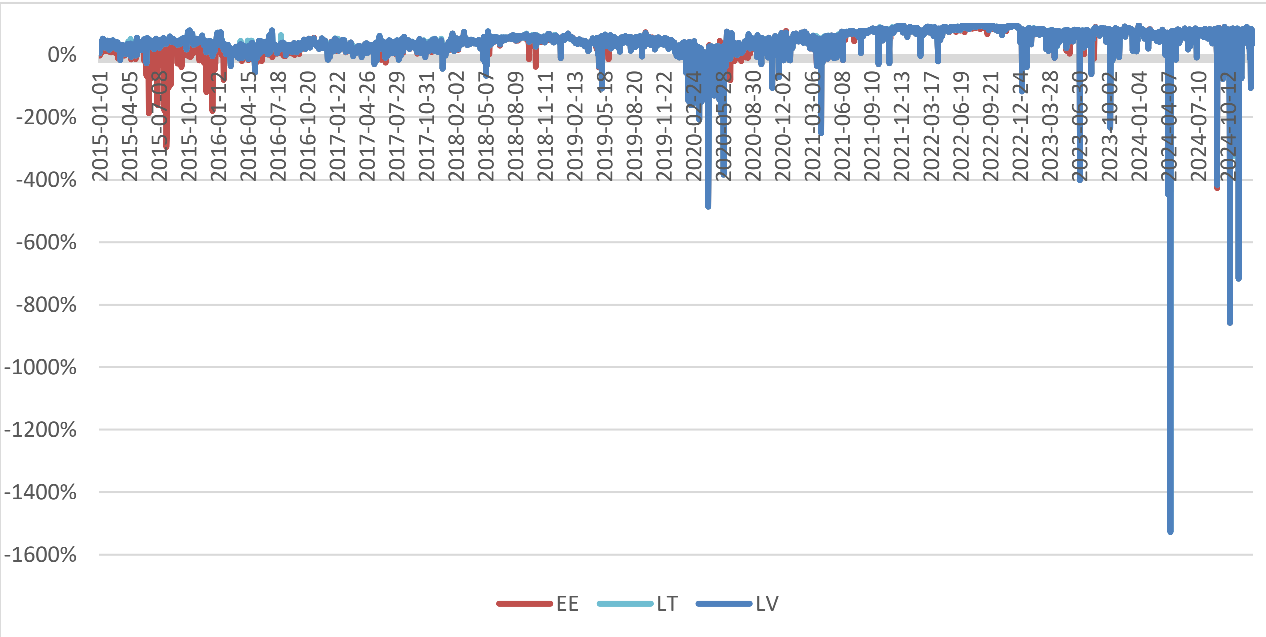
Data source: Nord Pool.

Figure 4: Development of difference (between EE, LV, LT and FI prices), EUR/MWh



Data source: Nord Pool.

Figure 5: Development of normed difference (between EE, LV, LT and FI prices)



Data source: Nord Pool.

Following the Baltic countries' desynchronization from IPS/UPS in February 2025 and synchronization with CESA, electricity prices have surged due to the reduction of 500 MW capacity available from Poland (now kept in reserve) and damage to the Estlink 2 interconnector in December 2024, which cut off access to cheaper Finnish electricity, raising concerns about energy affordability and infrastructure security in the region.

In Europe, the price of natural gas has almost tripled since the start of the war and reached. Gas and electricity prices have reached record levels in 2021 and hit all-time highs following the Russian invasion of Ukraine in the first weeks of March 2022. historic highs. On 13th May 2022 according to the data, gas prices were still about 30 percent higher than before the Russian invasion to Ukraine. Gas prices, historically below 30 EUR/MWh, were recently around 100 EUR/MWh, peaking occasionally at more than 200 EUR/MWh. Consequently, wholesale electricity prices also increased strongly over the same period, due to gas-fired power plants often driving the price in EU power markets. As energy prices rise more rapidly because of the Russian invasion to Ukraine, energy suppliers faced serious challenges due to potential difficulties in meeting increased financial liabilities.

Despite announced plans to cease operations in Nordics region the main trading platform for futures trading of electricity in the Nordics is *Nasdaq Commodities*. *Nasdaq Commodities* offers both trading and clearing. On the other side, Euronext and *Nord Pool* expand their activity in Nordic and Baltics region. NEMO is currently undergoing changes in the Baltic region. *Nasdaq Commodities* plans to withdraw from this market, EPEX SPOT plans to start developing its activities in this market in the future, and Euronext has also acquired *Nord Pool* and is developing its activities in the hedging market. This situation creates some uncertainties, and it remains unclear when NEMOs will start full-fledged operations in the Baltics, and when it would be possible to take advantage of the competition between these operators and ensure optimal operating costs. *Nord Pool* is planning to introduce the EPAD Vilnius product in 2026 which will be dedicated to all the Baltic countries (Estonia, Latvia and Lithuania) but only the Lithuanian TSO would be expected to assume obligations regarding risk hedging taking position with LT-SE4 EPAD combo product auctions. It is the transition period. In most Continental European electricity markets, electricity futures are referenced against the spot price of a specific bidding zone. In the Nordic market, most electricity futures are referenced against the Nordic system price, rather than the price of a specific bidding zone. The system price is calculated by *Nord Pool* as the price that would be obtained if the entire Nordic region was cleared as a single BZ, hence ignoring all transmission constraints between the Nordic bidding zones.

The experience of *Nasdaq Commodities* and the intention to sell the business in Baltic/Nordic regions also show this. Therefore, the future policy of the market operator regarding trading in secondary market is substantial (pricing applied to market participants, etc.). The trading results of EPAD Riga and EPAD Tallinn also confirm this. The sufficient number of market participants and a convenient financial infrastructure are essential factors that would help ensure the liquidity of the relevant products. Attracting potential market participants and selecting partner bank(s) in Baltic countries should be carried out by NEMO. Currently, *Nord Pool* does not have partner banks in the Baltic countries. *Nord Pool* has announced plans to introduce more favourable pricing for market participants in the hope of stimulating trading in hedging financial instruments on the secondary market, but there have been insufficient real actions to implement the EPAD Vilnius product so far. Without the market operator's actions, liquidity in the EPAD Vilnius market will be limited, therefore actions from the market operator are necessary (more favourable pricing for market participants, necessary agreements with banks in the Baltic countries). There is also a serious need to coordinate positions on terms with all potential market makers, banks, operators and regulators.

2. INTERNAL CONDITIONS AND CURRENT SITUATION

Electricity generation in Lithuania has nearly doubled in the last two years, driven by supportive policy for renewables, but the outlook is uncertain. Lithuania has introduced measures to improve permitting and subsidise investments in renewable electricity generation, which helped drive rapid growth. Even though this development is positive, the pace is not yet sufficient to meet its 2030 renewable electricity capacity targets of 4,5 gigawatts (GW) onshore wind, 1,4 GW offshore wind and 4,1 GW solar photovoltaic (PV) power plants. Onshore wind is being built without subsidies. Offshore wind progress is more uncertain in Lithuania. An offshore wind auction is cancelled in 2024 resulting from a lack of bidders. A rapid expansion of the electricity system will require a forward-looking approach that incentivises flexibility and proactive infrastructure buildout. Significant expansion and upgrading of transmission and distribution networks is crucial to accommodate the planned growth in renewable electricity generation and potential electricity demand.

Latvia's energy system is relatively well-diversified, with sizeable shares of renewables in the form of hydro and bioenergy. Its electricity system is dominated by hydropower. Latvia's electricity system is already heavily dominated by renewables (76% in 2022), mainly hydropower (55%). Given the volatility of water inflows into Latvia's hydropower plants, natural gas co-generation plants play an important balancing role in Latvia's power supply.

The electricity system faces intensive transition and expansion of generation from renewables in Latvia and Lithuania. Lithuanian and Latvian markets have a large and growing share of electricity generation from renewable sources. In 2023 in Lithuania the generation using of renewable energy sources amounted more than two-thirds of the total electricity generated. This means a significant increase compared to previous years, with renewable energy accounting for 48% in 2021 and 60% in 2022. This contributes to energetic independence, but on the other hand, it also poses additional risks especially due to completely unpredictable price fluctuations. Driven by the expansion of wind and solar, electricity generation increased from 4,5 TWh in 2022 to 7,5 TWh in 2024 in Lithuania. Latvia is undertaking its energy transition with some promising results to date. It has made inroads on the share of renewable energy in its fuel mix, with sizeable shares of bioenergy and hydropower. Approximately 76% of Latvian domestic electricity generation comes from renewable sources (mainly hydro), ranking it sixth among IEA countries. Though domestic generation capacity is sufficient to cover demand, for economic reasons, around one-third of electricity is imported, mainly from Estonia.

According to IEA, from 2010 to 2022, Latvia experienced significant growth in the share of renewables in electricity generation, from 55% to 76%. The bulk of renewable electricity generation in Latvia consists of hydro (55% of total generation in 2022), which fluctuates depending on water availability. Hydro experienced a peak in 2017 due to exceptional water availability due to high levels of precipitation during the summer. Generation from wind, on the other hand, grew steadily (with fluctuations due to wind availability) from 2010 to 2022, when it reached a record high of 190 MWh. Electricity generation from solar experienced a huge increase from 2011 to 2022, though still accounted for only 0,8% of total electricity generation.

IEA also observed that Latvia has supported technological neutrality in the development of its electricity sector, meaning that at present, state support is no longer offered to renewable electricity generators; rather, generation capacity investments are driven by market signals. As such, Latvia no longer offers any feed-in-tariffs or contracts for difference to producers for electricity produced from renewable energy resources. Generators sell electricity at the market price. Latvia does not plan to create a support scheme for renewables-based electricity, though an auctioning system is under consideration for offshore wind. Latvia is pursuing measures to facilitate the build out of wind and solar generation facilities. Given the country's fragmented system of land ownership, the government is looking into options to simplify permitting procedures and offer compensation to local communities for their support.

Uncertainties arising from renewable sources of electricity generation. The uncertainty in the markets remains stable as the demand for hedging through derivative financial transactions. Very important specific problem for Baltic countries is the significantly high costs of the entry to the market. It means that there are only three medium companies in European scale that financially can participate in financial markets and other market participants cannot use this market to realize their hedging strategies. For other market participants, especially for new market entrants that are relatively small it is too expensive, so their opportunities to participate in the current setup of the *Nasdaq Commodities* or other market of financial derivatives for hedging electricity purchase or supply contracts are quite limited. In addition, it is the transition period when *Nasdaq Commodities* has expressed its intention to leave the Baltic region, and other operators have still not fully taken over the operations.

In a weather-dependent power system electricity prices typically vary widely. Baltic sea region is one of the highest growth areas for wind energy production. In Lithuania, in 2024, the share of RES in total final energy consumption was 47,1%, the share of RES in total electricity generation was 69,7%. In 2024 electricity generation in wind power plants grew by 38,3 percent from 2023 and reached 3,491 TWh, solar energy generation increased by 101 percent and reached 1,273 TWh. It is complicated to predict climatic conditions and the amount of energy produced, so the amount of electricity generated from renewable sources is a serious source of uncertainty in the future. Orientation towards the generation of renewable energy potentially leads to the constant need to hedge electricity supply transactions to meet energy supply liabilities on time. Furthermore, as the share of renewable energy continues to increase in the future, the need to hedge the risks of both generation volatility and price volatility should increase.

3. REVIEW OF THE RECENT DEVELOPMENTS OF INFRASTRUCTURE IN LATVIA AND LITHUANIA

Latvia’s transmission network consists of 110 kV and 330 kV transmission lines and substations. Latvia’s transmission system has eight 330 kV interconnections with neighbouring countries: three with Estonia, four with Lithuania and one with Russia. In addition, there are also five 110 kV interconnections which are only used in case of repairs on the other systems. Latvia’s 330 kV power network is the transition point of the energy system of neighbouring Baltic countries. All 330 kV substations, except for Daugavpils, have dual power flows. Total capacities of cross-border interconnections with Estonia and Lithuania amount to 2780 MW. Technical losses on networks are around 7%.

In terms of installed wind power capacity, Latvia currently lags its neighbours on both sides of the Baltic Sea. Latvia's energy strategy includes increasing wind power capacity to 1500 MW by 2030, with the aim of generating 100% of Latvia's electricity from renewable energy sources. There are currently 63 planned wind farm projects in Latvia, with a total capacity of almost 14000 MW and a maximum number of turbines of 1828. To facilitate new renewables generation, though, the government has recently undertaken efforts to streamline the permitting process for wind generation and explore options for siting offshore wind.

Lithuania is interconnected with neighbouring electricity systems through several interconnectors to Latvia (total capacity of 1670 MW import and 1550 MW export), Poland via the *LitPolLink* (500 MW in both directions before the synchronization of Baltic countries with CESA. After the synchronization of Baltic countries with CESA the maximum TTC capacities are 250 MW and 260 MW in the PL-LT and LT-PL directions, respectively. The main limiting factor is frequency stability, which depends on the frequency support measures available in the Baltic region) and Sweden via the *NordBalt* asynchronous DC link (700 MW in both directions). This ensured to Lithuania an interconnectivity level of over 50% in 2022, estimated as the cumulative capacity of the interconnectors in relation to the total installed capacity. On the other hand, Lithuania targets an interconnectivity level of at least 23% with the European Continental System by 2030, while tripling its current installed capacity of solar and wind generators, which requires continued buildout of new interconnector capacity. The high level of interconnectivity ensures Lithuania’s electricity sustainable supply and provides access to transnational electricity trading and balancing services.

Lithuania faces an imbalance between the high potential for renewable electricity generation in the western part of the country and consumption clusters in the east. The connections of various parts of the electricity system needs to be strengthened to ensure a reliable operation and fast deployment of renewable electricity. There is also a need to further integrate Lithuania’s electricity system with the Latvian system.

On 7-9 February 2025, Estonia, Latvia and Lithuania permanently disconnected from the IPS/UPS interconnected system and joined CESA. This transition means an important step towards significantly enhancing regional energy security and reducing reliance on the Russian-controlled grid under the BRELL agreement (between Belarus, Russia, Estonia, Latvia and Lithuania) and at the same time thereby creating a common Baltic electricity balancing market. By joining CESA, Baltic countries gained full control over their electricity networks, further enhancing regional energy stability. The synchronisation with CESA will enhance capacity to balance variable wind and solar generation through access to a larger and more flexible energy market.

Lithuania will continue to strengthen its electricity security and connectivity with Poland by the 700 MW *Harmony Link* interconnector, scheduled for completion in 2030. The *Harmony Link* will perform a market integration function – electricity trade with Poland will take place through it. The *Harmony Link* interconnector with Poland will have a major impact on the system adequacy. Until the *Harmony Link* is commissioned, Lithuania needs to ensure that all the existing reliably available and controllable power plant capacity is operating to ensure adequacy of the system. Beyond 2030, it is necessary to develop a capacity mechanism to maintain existing and develop new electricity generation capacities in Lithuania.

Total interconnector capacity is set to increase from about 2150 MW in 2025 to 3150 MW by 2030 and 5400 MW by 2040. Furthermore, to meet the long-term electricity demand and balancing needs of the system, the Lithuanian government expects another doubling of interconnector capacity in ten years to reach 10650 MW by 2050. Compared to current levels, this means an additional 4700 MW of interconnectors between Lithuania and Central Europe (of which *Harmony Link* will provide 700 MW) and additional 3800 MW of interconnectors with the Baltic countries.

Substantial changes of the Baltic balancing markets. The Baltic balancing model, which the Baltic TSOs operate jointly since 2018, is changed from a reserve model to a balancing capacity market. In accordance with European regulation, imbalance settlement periods are shortened from 60 minutes to 15 minutes. Balancing capacity services in the Baltic market are purchased daily by auction, in 15-minute periods for the day ahead. The Baltic TSOs expect orders of up to 1512 MW in balancing capacity. The amount of balancing services is expected to grow by 60% to more than 2400 MW in 2032, driven by the growing generation from variable renewable electricity.

In preparation for synchronisation with the CESA, the Baltic TSOs joined the European balancing energy platform MARI in October 2024. This can bring additional opportunities for electricity generators and large consumers in the Baltic countries to provide balancing services. Furthermore, in March 2025, *Litgrid* became the 13th electricity TSO to join the pan-European Platform for the International Coordination of Automatic Frequency Restoration Reserves and Stable System Operation (PICASSO). The platform intends to enhance economic and technical efficiency integrating the European balancing markets.

The damage to the cable connecting Estonia and Finland means that geopolitical risk and the issue of infrastructure security have become even more pressing and it raises additional uncertainty in the electricity markets of Baltic countries.

4. ANALYSIS OF PUBLIC CONSULTATION RESULTS

Following the market participants, insufficient opportunities to hedge electricity supply transactions can lead to insufficiently justified and insufficiently effective management decisions, higher operating costs, and less favourable prices for final consumers. It's also unfavourable for investors too. Hedging options are not only a problem of the Lithuanian energy sector, but other countries also face problems of insufficient risk hedging.

There are currently no hedging opportunities between the LT-LV bidding zones in the market. Based on the 2024 annual day-ahead market results, the price difference between the LT and LV bidding zones, when considering the annual price average, was 0,1%, therefore the need for risk mitigation is very low. The situation after synchronization has not changed fundamentally. Some market players think that making hedging instruments available would be beneficial for the broader market. Expanding the availability of hedging tools across more interconnectors would enhance market participants' ability to manage risk effectively and contribute to the development of a more resilient and liquid forward market in the region.

Some market participants in Latvia and Lithuania uses the following products to manage their risks:

- Bilateral transactions with local producers or other independent electricity suppliers in the Lithuanian or Latvian bidding zones with physical delivery.
- Bilateral transactions with other independent electricity suppliers, brokers, banks or other legal entities trading futures without physical delivery.
- System price and HEL EPAD futures traded on the *Nasdaq Commodities* exchange and the FTR auction scheme organized by JAO, which allows market participants to purchase financial transmission rights on cross-border interconnections, for example, in the EE–LV and FI–EE directions, thus hedging against the risk of price differences between zones.

Since Vilnius, Riga and Tallinn EPADs are currently not available on the market, the possible way to hedge risks in Lithuania through EPADs is currently to use the Helsinki EPAD and participate in the FTR auctions in the FI-EE and EE-LV directions. The problem is that they are held at different times and for one period only once a year, and in addition, the FI-EE auction currently does not have a quarterly product (???), so hedging risks with this tool is quite expensive. If there were an FTR auction in the LT-SE4 and LT-PL directions, then the SE4 EPAD and the Polish FTR respectively would be useful risk hedging products.

Low EPAD liquidity does not help manage risks. In order to use the more liquid Polish and Swedish electricity markets to manage price risks, long-term hedging opportunities are needed on the LT-SE4 and LT-PL borders, for example, on the EE-FI cross-border (FTR). FTR options should allow companies to hedge not only short-term contracts, but also 3–5-year contracts.

Previously PPAs have served as useful long-term hedging instrument, but since Lithuanian authorities have prohibited the suppliers to collect termination fees for early termination of contracts, the PPAs market is in decline, and their importance has been significantly weakened. Without bilateral contracts, there are no hedging measures for Lithuanian bidding zone. In addition, long-term PPAs do not help solve the problem, as there are too few large customers in Latvia and Lithuania.

The price difference between the Lithuanian and Latvian bidding zones is relatively small, therefore higher priority is given to the creation of a capacity auction mechanism between the Swedish SE4 and Lithuanian bidding zones and the Polish and Lithuanian bidding zones. The price difference between the LT-LV bidding zones is not as significant as FI-EE or EE-LV, it is likely that this product would create added value only in certain periods (Q1 or Q4 or individual months), and an annual product would not be in demand among market participants, such as the FI-EE annual or monthly FTR. Hedging opportunities would open by creating a price difference product between the Swedish SE4 and LT bidding ones. The Lithuanian EPAD would be a more appropriate measure, as it allows for direct hedging against price fluctuations in the LT bidding zone, regardless of the dynamics of neighbouring zones. Following the insights of some market participants, if, for example, the Lithuanian EPAD existed, such a product would allow for direct hedging of a specific price. It is also a clear and transparent mechanism for indicating the market price level. From the perspective of market participants, this product is convenient and easy to use in managing portfolio risks in the long and short term. There are certainly reasonable doubts as to whether the Vilnius EPAD product would be sufficiently liquid in the market, when experience shows that the Riga EPAD and Tallinn EPAD were not. However, it is likely that NEMO and its policy change will help to at least partially address this problem.

The essential difference between LTTR and EPAD products is that in the case of LTTR, local price risk is not eliminated, since only the price difference between zones is insured, and not in the case of EPAD, when a specific bidding zone is hedged. Specific examples would be the Scandinavian countries, where the use of

EPAD is widespread. The closest EPAD to the Baltic countries would be the Finnish prices - HEL EPAD. However, this EPAD in no way reflects the level of the Lithuanian bidding zone and to hedge the Lithuanian bidding zone with this product, it is necessary to additionally use inter-zonal hedging instruments, which still leaves the hedged market participant with an uncertain risk.

Exchange-traded hedging instruments perform well in markets with sufficient liquidity. In illiquid markets, however, they tend to be less effective due to limited trading opportunities and unreliable price signals. EPADs have previously been introduced in Tallinn and Riga but due to smallness of Estonian and Latvian bidding zones and their high concentration these EPADs never achieved required liquidity and amounts. Although *Nord Pool* is considering the launch of Lithuanian EPAD there is no reason to believe that this instrument would obtain required liquidity and amounts.

The liquidity of the Lithuanian EPAD product would be boosted by the above-mentioned SE4-LT and PL-LT interconnection auctions. With liquid products, market participants would have a clear indication of the future price. The price discovery mechanism offers forward-looking information on monthly prices for the current and following year, which supports transparency and informed decision-making. Regarding specific interconnectors:

- The EE–LV interconnection exhibits minimal spreads and often displays auction prices that appear elevated relative to the underlying value.
- The EE–FI interconnection has the largest spreads in the region, making it more notable for hedging opportunities.
- On the LT–LV interconnection, auction prices exceed the economic value of the interconnector, reducing its attractiveness for auction participation and making OTC trades the more viable option.

Following the answers of the market participants, to ensure sustainable market functioning in the Lithuanian bidding zone, both products are needed, both Lithuanian EPAD and LTTR (SE4-LT and PL-LT). These products would contribute to ensuring sustainable market functioning and help form competitive prices for both end users, producers and independent electricity suppliers. Should such instruments be introduced, it is important that they are implemented consistently across all Baltic bidding zone borders to ensure a harmonised regional approach.

Some participants consider LTTRs to have the most significant positive impact on forward market development and therefore recommends their introduction in the LI-LT bidding zone border. Market participants agree that:

- LTTRs generally function well when offered through transparent and well-structured tenders. LTTRs instruments provide effective hedging opportunities for market participants and contribute to market confidence.
- EPAD auctions are also a positive tool for enhancing market liquidity, particularly when the auction design and volumes offered are aligned with market needs. However, for EPADs to be effective, it is essential that they are cleared and settled through a reliable exchange platform.
- Over the counter (OTC) trading can serve as a supplementary hedging method but presents challenges, particularly in markets with fewer counterparties. OTC trades require more bilateral negotiation and legal structuring, which typically favours larger market participants with the internal resources to manage the associated complexity and risk

To maximise effectiveness and market liquidity, it is important that hedging activity is not fragmented across multiple overlapping products. In addition, positive developments were observed in the forward markets in both Norway and Sweden during and following the LTTR pilot periods. In particular, the Nordic auction structure has proven highly valuable to market participants, as it provides clear signals on the value of electricity in the short-, medium-, and long-term horizons. This enables more accurate contract pricing, with the most pronounced benefits seen in renewable generation.

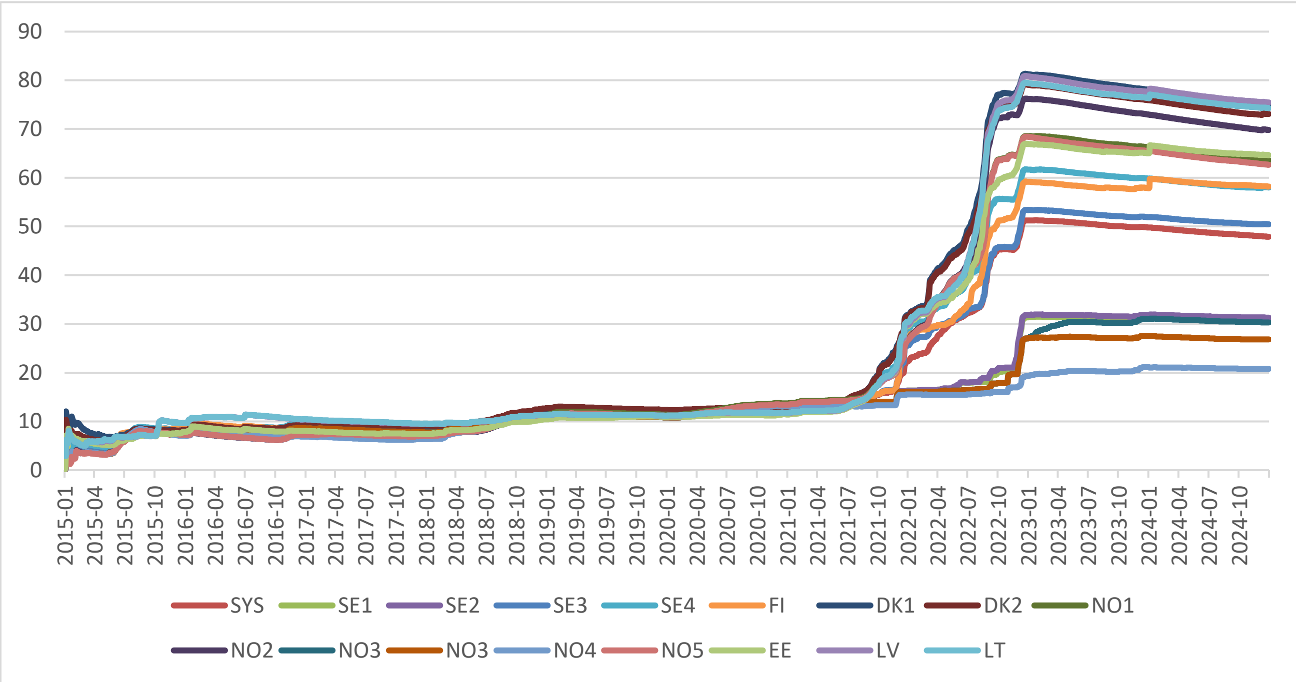
Following the opinion of one market participant, under the current circumstances, the only viable option for introduction of additional hedging instruments is introduction of SE4-LT FTR, which could be exploited by both, Lithuanian and Latvian market participants. Given the fact that the most popular electricity products in Lithuania and Latvia are 12 months long contracts, SE4-LT FTRs would ideally fit to Lithuanian and Latvian markets. FI-EE FTRs would continue to serve and in combination with SE4-LT FTRs would provide required price signals also for local PPA market.

Expanding the availability of hedging products across more interconnectors would enhance market participants' ability to manage risk effectively and contribute to the development of a more resilient and liquid forward market in the region. To ensure a well-functioning forward market across the Baltic region, it is important that hedging instruments—whether LTTRs, EPADs, or exchange-traded products—are designed to promote liquidity, accessibility, and transparency.

5. MORE MODERATE UNCERTAINTY AND VOLATILITY IN RECENT YEARS

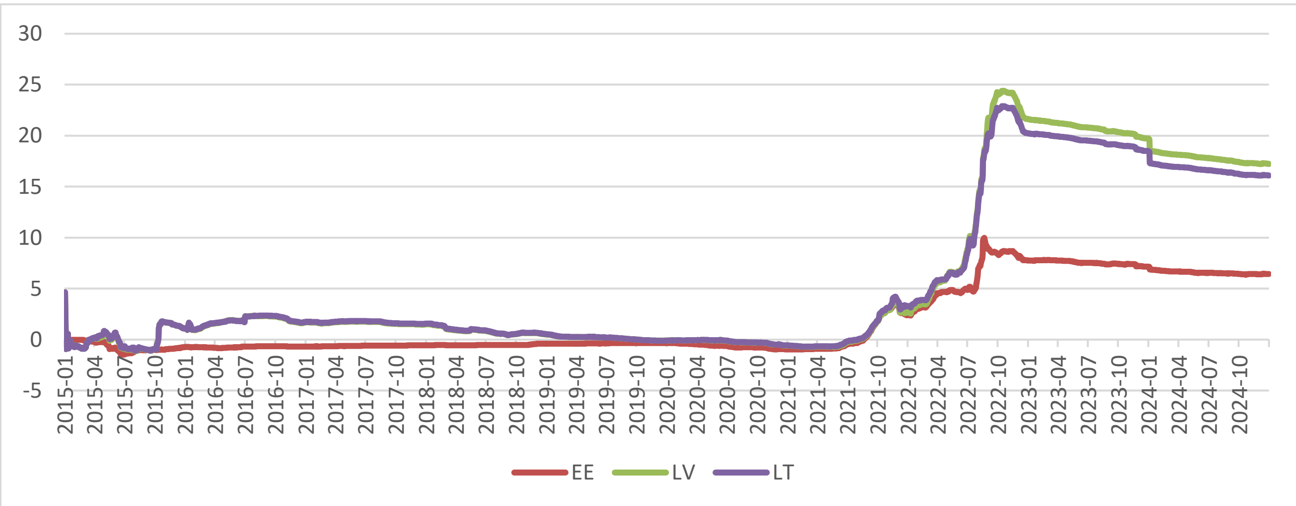
Geopolitical changes and increased tensions and military action in Ukraine have undoubtedly had a strong impact on financial, energy and commodity markets. Considering the high uncertainty regarding energy supply, sanctions and supply interruptions by Russia, market participants are forced to suddenly reorient their raw material and energy resource procurement channels, energy suppliers are faced with demand instability, etc. Naturally, electricity suppliers, whose activity is heavily dependent on the supply of energy resources from abroad, with the new challenges arising from the importing of energy resources, have grown and the need to hedge themselves even better against sudden price jumps. Due to all these reasons, uncertainty in the market has increased significantly, forcing investors to act more cautiously. It can be assumed that due to these reasons, much more moderate and cautious expectations of investors were formed in the market. In principle, the figures 6-12 reflect this changed conjuncture.

Figure 6: Development of difference (between EE, LV, LT and system prices volatilities)



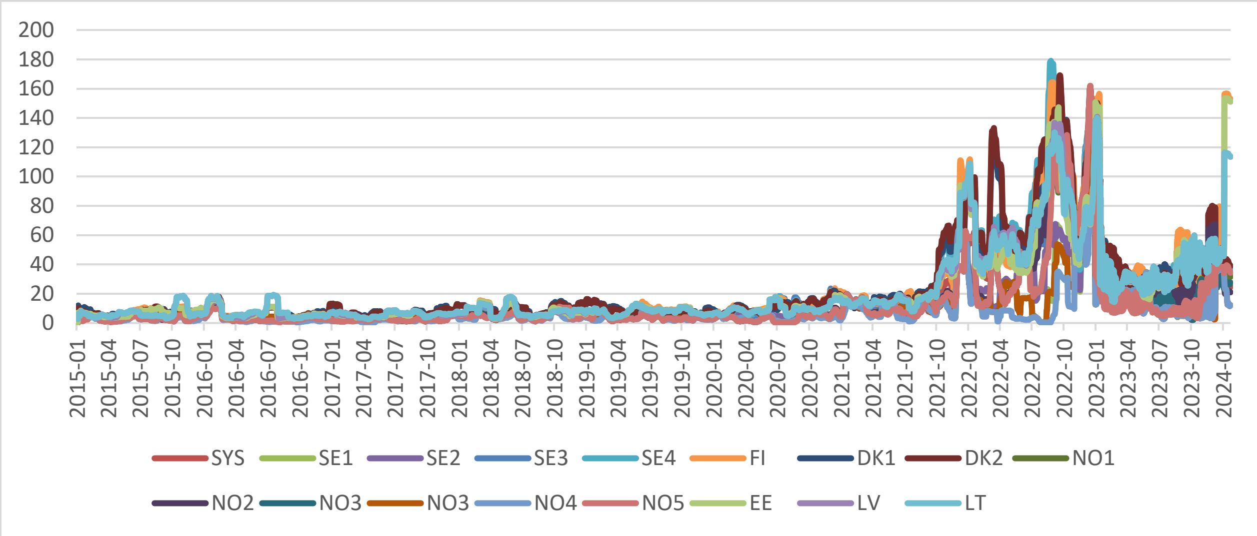
Data source: Nord Pool.

Figure 7: Development of difference (between EE, LV, LT and FI prices volatilities)



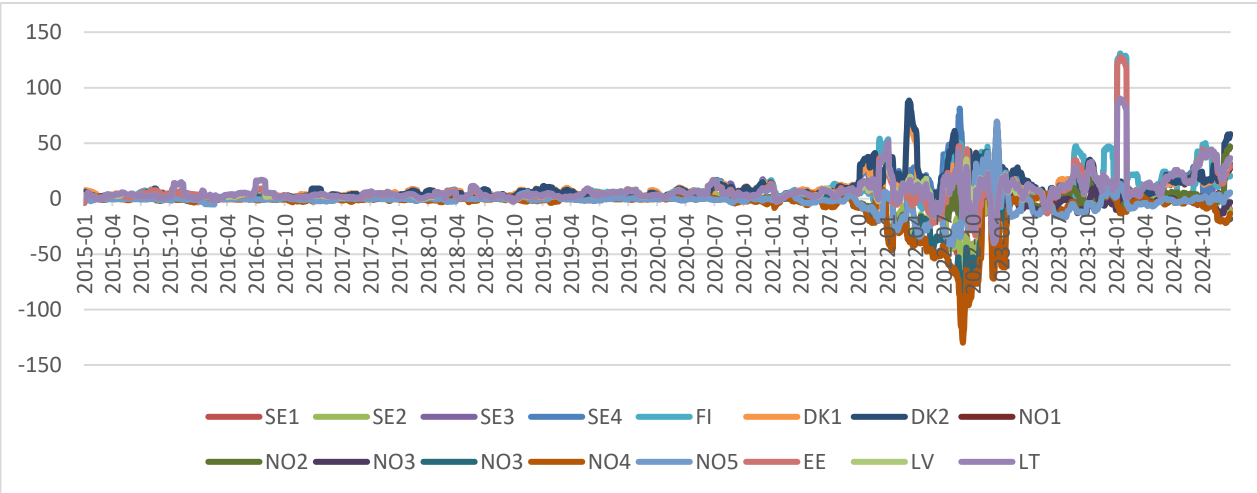
Data source: Nord Pool.

Figure 8: Development of difference (between EE, LV, LT and system prices 30 days volatilities)



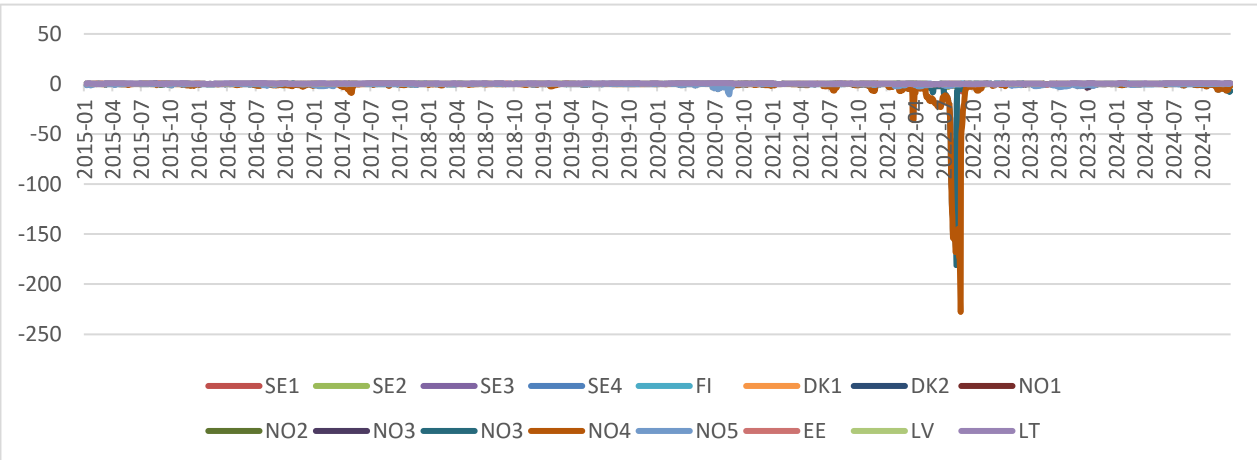
Data source: Nord Pool.

Figure 9: Development of difference (between EE, LV, LT and system prices 30 days volatilities)



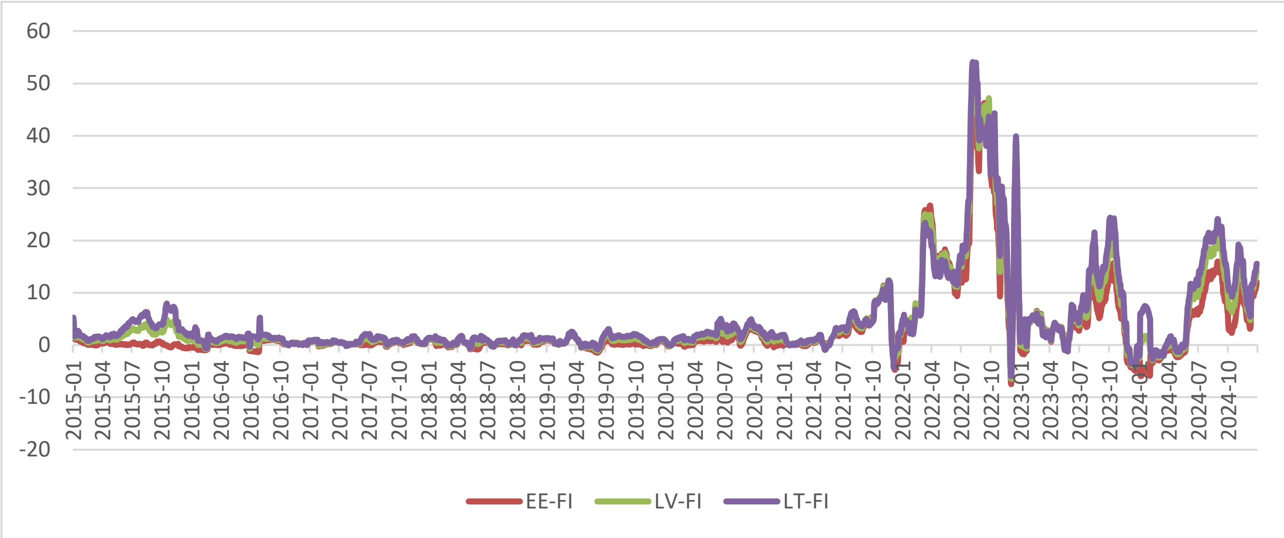
Data source: Nord Pool.

Figure 10: Development of normed difference (between EE, LV, LT and system prices 30 days volatilities)



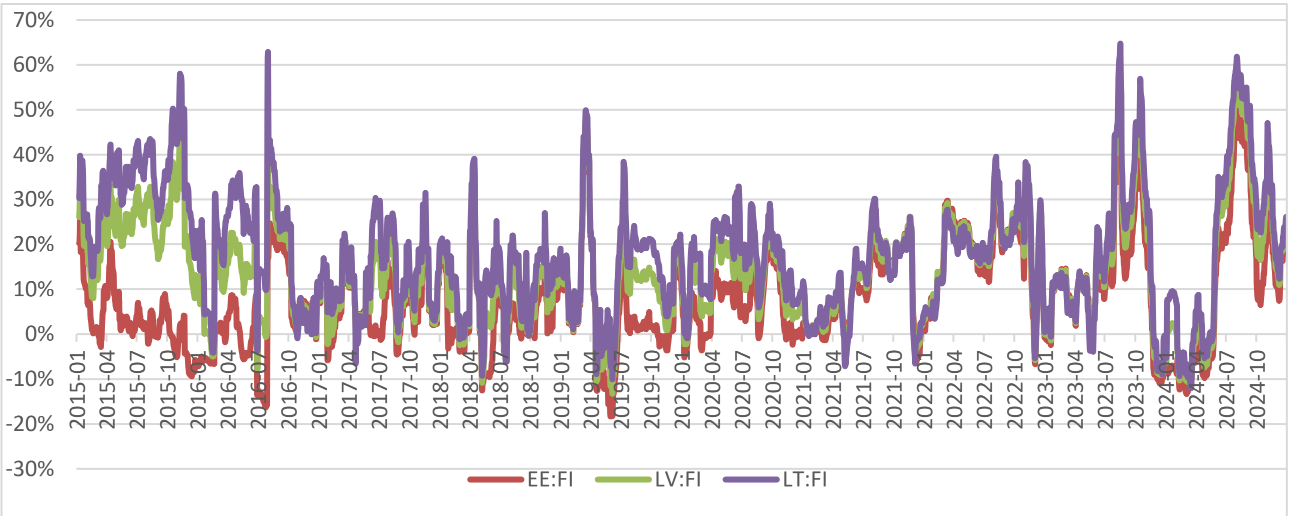
Data source: Nord Pool.

Figure 11: Development of difference (between EE, LV, LT and FI prices 30 days volatilities)



Data source: Nord Pool.

Figure 12: Development of normed difference (between EE, LV, LT, and FI prices 30 days volatilities)



Data source: Nord Pool.

6. ANALYSIS OF THE HEDGING OPPORTUNITIES

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 participants based on their hedging needs. The market participants in Latvia and Lithuania have not entered into bilateral risk hedging transactions.

6.1. Analysis of hedging instruments

To manage the risks related to electricity spot prices, market participants can hedge, or trade risk based on their individual preferences. Power price risk can be managed in a variety of ways, and, in this section, we outline the main tools used by market participants 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. Derivative products (including forwards, swaps, and options) have evolved to allow generators and retailers to exchange volatile spot exposures for more stable cashflows, including a suite of products catered towards variable renewables. However, obtaining contract of long term has been a concern since there are 'missing markets' for long-term contracts, which are seen as necessary to support capital-intensive generation investment when participants are risk averse.

It is important to mention that some price risks cannot be hedged in advance. There are some types of uncertainties related to volume changes caused by factors such as weather, shifts in consumer consumption and production behavior, electric vehicle (EV) charging patterns or consumers switching suppliers. Also, consumers can freely switch suppliers at any time. However, not all EU Member States allow the application of early termination fees, which are based on the real supplier economic loss and could partially recover the costs already incurred on behalf of the consumer[3].

6.1.1. 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 are referenced 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 obtained if clearing the entire Nordic region as a single bidding zone, ignoring transmission constraints between Nordic bidding zones.

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

6.1.2. Electricity Price Area Differential (EPADs)

The Nordic power market is made up of 15 bidding zones, which combine for a common benchmark system price, but also settle individual prices for each area. 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 (unless the price in the bidding zone is the same or close to the system price) EPADs are complementary financial contracts that

[3] For more details, see: https://www.eurelectric.org/wp-content/uploads/2024/10/Supplier-hedging-the-Eurelectric-Guidebook-3.pdf.

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 currently cover Estonia, Latvia and Lithuania. Most EPADs have low liquidity.

6.1.3. 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-bidding 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. In addition, EPAD combos above have the same hedging effect as FTR obligations.[4]

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).

6.1.4. 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. At the end of 2021, the share of bilateral agreements was 4,7 percent. 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. This is a reason that the traditional financial hedging products (futures and EPADs) are still relevant and complement hedging for PPA holders. In addition, the uncertainty due to unpredictability of quantity of generated energy by renewables leads to the constant need to hedge electricity supply transactions. Moreover, the price of PPAs is often based on the price of financial derivatives in the exchange. 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.

6.1.5. Coal, gas and (carbon) emissions futures

A variety of other commodity futures exist and are used by some market participants in their power price hedging activity. These futures are like 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 using 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

---

[4] See at the end of page 19 here: Area-price-hedging-and-the-Nordic-market-model-Ei-R2016-11.pdf

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.

6.1.6. Costs and related risks of hedging instruments implemented by TSOs

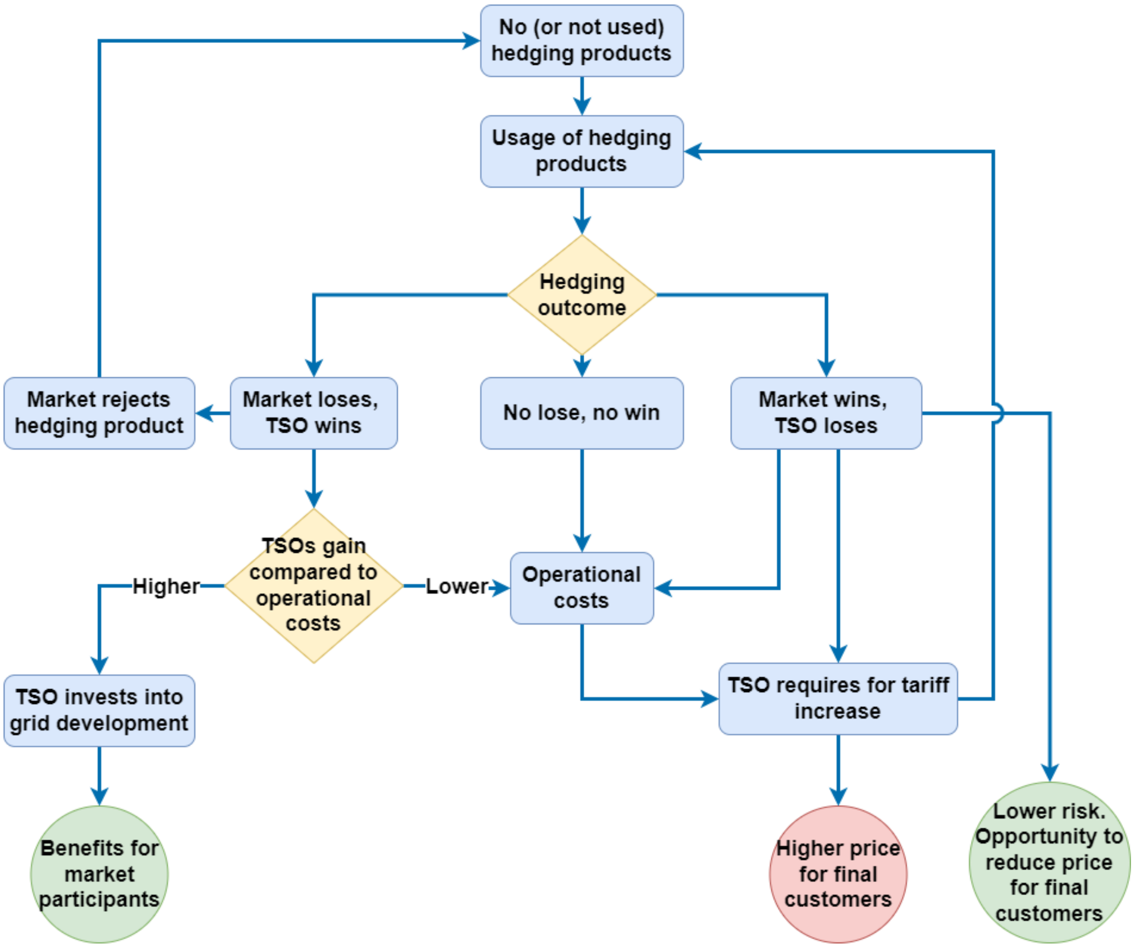
The implementation of hedging is a relatively expensive activity. This is especially disadvantageous in small markets, such as the Baltic countries. Due to the specific problem of the small size of the market, additional risks arise: the adequacy of liquidity and pricing of financial instruments in the secondary market, which determines the additional need for the market for these instruments to have market makers.

Generally, TSO's total costs consists of internal staff working time for implementation and operation, financial costs for collateral management, fees paid to the third-party platform and fees paid to the clearing house or collateral-management-service provider. The two most relevant cost components are likely to be:

- The financial costs of posting collateral.
- The third-party fees for the auction operator. The fees to the auction operator would be decided through a tendering process.

The use the clearing house services or else establish separate collateral arrangements can significantly affect TSO's total costs. The use of public guarantees could significantly reduce TSO's collateral costs but would impose a liability on state that substantially changes nothing. The use of such guarantees is not possible at present but potentially may be possible in the future.

Figure 13: Framework of hedging instruments implementation by TSOs



Data source: NERC.

TSO's costs to support a market maker role would consist of two parts:

- The cost of remunerating the market maker that are expected to take the form of:
  - A fixed cost per period. The fixed cost is expected to be the largest part of the total compensation.

  - A variable volume-related payment that is needed to cover the market-maker's variable trading cost.
- Any internal costs related to administrating the tendering process and the contract. TSO's internal costs are primarily staffing costs related to running the tendering process to acquire the market maker and then administering the contract. The internal costs are expected to be relatively small in comparison to the cost of remunerating the market maker.

The market maker's costs comprise staffing costs and the cost of managing the financial risk when taking an undesirable position. The risk element is a consequence of the fact that the market maker is obligated to be available to trade even if it does not desire to change its position in the market. It is therefore liable to end up with undesirable positions that need to be unwound and will be exposed to the risk of losses until this is done. The premium that the market-maker requires above its direct costs reflects the size of this risk. In addition, illiquidity contributes to the market-maker's risk since it makes it more difficult to exit any undesirable position. This means that the less liquid the market is, the more costly it will be to get a market marker. If liquidity were improved, for example using an auction, this risk and the associated costs of being the market maker would likely be lowered. As such, market-making could be seen as complementary to other interventions to improve liquidity[5].
It is also worth noting that much uncertainty remains regarding the impact of TSOs activities on the final consumers welfare:

1. Doubtful benefits for final consumers of electricity. It seems that the implementation of the hedging products by TSOs would create a self-serving submarket for hedging instruments, which would not provide sufficient benefits to local market participants, and which would mean an additional financial burden for final consumers.
2. There is a high risk that the TSOs, having implemented hedging products, will suffer huge losses. This will not be favorable for final consumers, since sooner or later there will be a need to increase the electricity tariff.
3. It is not clear whether and how the process of introducing hedging products onto the market would benefit final consumers. However, it is evident that TSOs would lose some of its assets and revenues, which it could invest in the development of the transmission system infrastructure and at the same time create added value and opportunities for market participants.

6.1.7. Uncertainty due to interpreting of *force majeure*

In the ACER's Opinion No 02/2025 of 9 April 2025[6] relating to the curtailment of financial transmission rights and interpretation of *force majeure* ACER understands that the concept of *force majeure* and its meaning must be determined by reference to the legal context in which it is to operate and that *force majeure* constitutes an exemption situation and therefore should be applied restrictively. The definition of *force majeure* provided in Article 2(2)(u) of the HAR[7] sets out the distinct cumulative conditions that each must be satisfied for an event to qualify as *force majeure*. Thus, each condition needs to be assessed and if any of the five conditions are not met, the event cannot be classified as *force majeure*. Therefore, based on the *force majeure* definition, ACER understands that when TSOs invoke *force majeure*, they must demonstrate that the relevant situation fulfils all conditions. This also includes the requirement that the situation is making it impossible for the TSO to fulfil temporarily or permanently, its obligations.

Estonian and Finnish TSOs *Elering* and *Fingrid* refuse to compensate market participants for losses incurred due to the *Estlink* 2 failure, claiming that it was a *force majeure* case. At that time, no congestion income was received, therefore, in their opinion, there is no reason to pay for financial instruments. However, market

[5] For more details, see: https://www.statnett.no/globalassets/for-aktorer-i-kraftsystemet/marked/options-to-support-power-price-hedging-in-the-norwegian-bidding-zones.pdf.

[6] For more details, see: https://www.acer.europa.eu/sites/default/files/documents/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER-Opinion-02-2025-FTR-force-majeure-%28FI-EE%29.pdf.

[7] For more details, see: https://www.acer.europa.eu/sites/default/files/documents/en/Electricity/MARKET-CODES/FORWARD-CAPACITY-ALLOCATION/01%20HAR%20main%20body/Approved/Action_07-HAR_ACER_Decision-Annex_I.pdf.

participants criticize this decision, calling it a violation of the rules and warning of damage to market confidence.

According to Article 56(5) of FCA regulation, national regulators have the right to decide on force majeure, but it is unclear whether the national legal framework for this is fully developed.

6.2. Approaches to hedging

Hedging needs and strategies vary among market participants. However, there are some commonalities in 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.

6.2.1. Suppliers, generators, and consumers

The hedging needs and objectives of any market participant 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 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. 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 production mix and expectations of future power price developments relative to the market.

When a supplier enters a contract with a final consumer, especially one with a fixed-term fixed price agreement, it should purchase the equivalent quantity of electricity on the forward markets, matching the delivery date. While requiring higher capitalization by the supplier, this approach ensures that it avoids leaving an open position vulnerable to market fluctuations (i.e., market risk), which is reflected in variability for consumers (and partially credit risk). However, final consumers' consumption patterns do not perfectly align with the standardized products available on the market, which are the primary hedging instruments for suppliers. Consumption varies in each 15-minute time unit and needs to be balanced on the market during the same period. To address these challenges, suppliers must closely monitor the actual consumption of their consumers and continuously adjust their initial hedging strategies.

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 several cost drivers. Like generators, hedging behaviour is impacted by expectations of future prices. However, hedging decisions by the energy intensive industries are also significantly impacted 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.

6.2.2. 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 and collaterals may be prohibitive and therefore third parties like banks or brokers will be used to help support hedging activity. Large consumers may have sufficient resources to run periodic hedging processes themselves but may still not wish to commit to the ongoing administrative costs of direct exchange membership. Therefore, it is meaningful to consider that an auction will support possible participation by smaller market participants. This results in a greater expected improvement in hedging opportunities. The belief, that smaller players will be more likely to participate in an auction, stems from the fact that there are expected to be additional costs to participate via continuous trade in the secondary market. These include the direct trading costs associated with access to the exchange, as well as the potential staffing costs related to continuous participation. Encouraging participation by smaller players not only supports liquidity but is also a benefit with respect to the discrimination criterion.

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 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 companies sometimes act as intermediaries, offering retail power price hedging services to smaller market participants, often alongside related services such as lines of credit or balancing management.

7. ANALYSIS OF DESCRIPTIVE MEASURES

7.1. Analysis of open interest

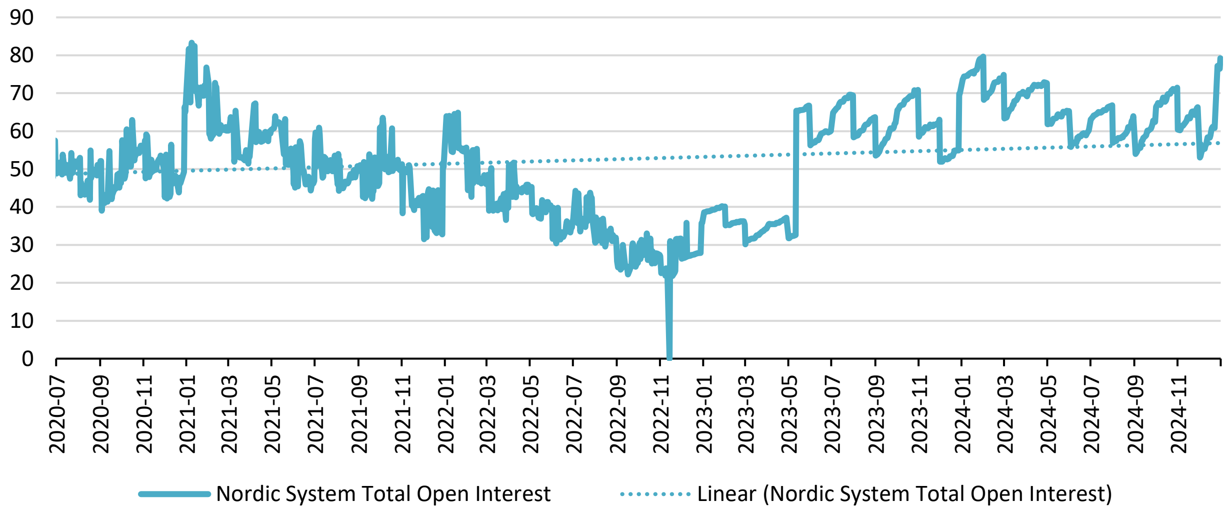
Open interest refers to the total size of open positions with a clearing house at a given point in time. When a market participant wishes to hedge a physical exposure to the power price using financial derivatives, they will create an open position for the relevant contract and keep this position until 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.

The cumulative amount of open positions implies the scale of hedging activity in each contact. If more market participants look to hedge or market participant wish to hedge a larger position, this means higher open interest. As a result, typically resolving asymmetry between supply and demand tends to increase open interest. However, open interest may also be affected by changes to the share of cleared hedging activity.

7.1.1. Analysis of open interest in system price contracts

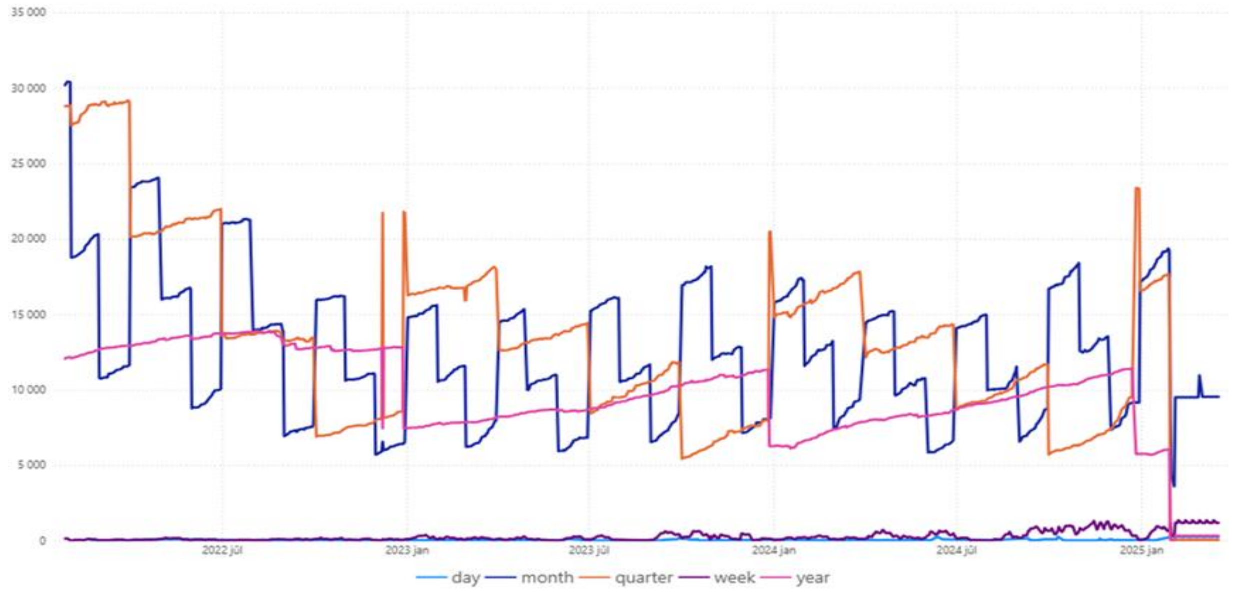
Figure 14: Open interest (TWh), Nordic system price contracts



Data source: Nasdaq Commodities.

From the mid-2020 until 2021 the middle OI level in the secondary market remained stable. Starting in 2021, OI Nordic system price contracts started to decrease significantly, and this trend continued until the end of the analysed period, when it reached the level of just over 20 TWh. In the first half of 2023, the OI level fluctuated between 30 and 40 TWh, and from mid-2023 this level increased to 60-70 TWh.

Figure 15: Open interest (GWh), Nordic system price contracts (by duration)

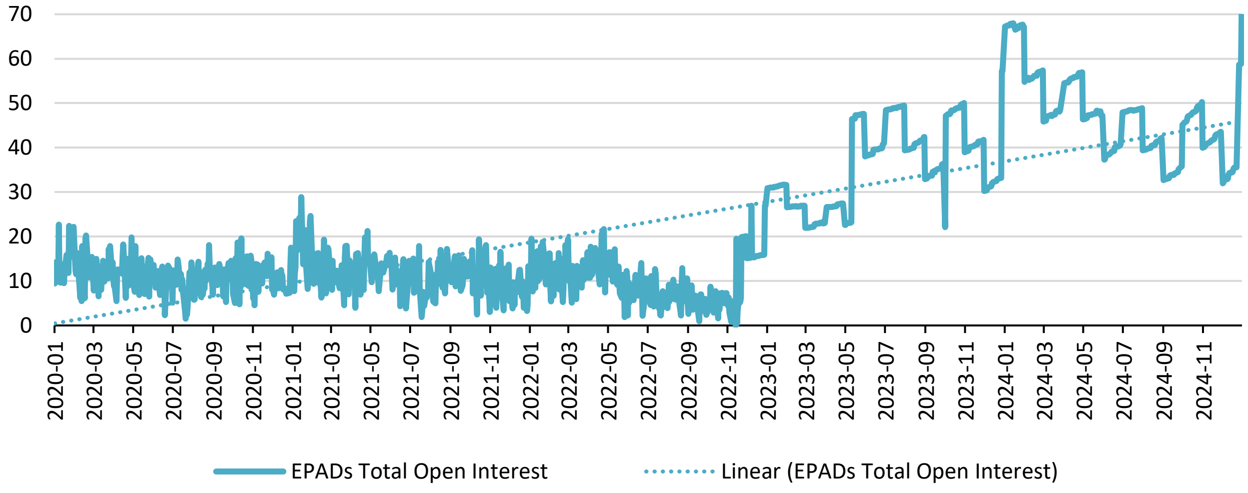


Data source: Nasdaq Commodities.

7.1.2. Analysis of open interest in EPAD contracts

Figure 16 shows the daily total open interest (TWh) in EPAD contracts, for all bidding zones. Since 2017 open interest in EPAD contracts was stable (except for a moderate decrease in 2018-2019). Total open interest in EPAD contracts has been stable throughout the period 2020-end of 2022. After that period, one can observe the moderate increase in 2023 year and the stabilization in 2024 year.

Figure 16: Total open interest (TWh) EPADs, all bidding zones

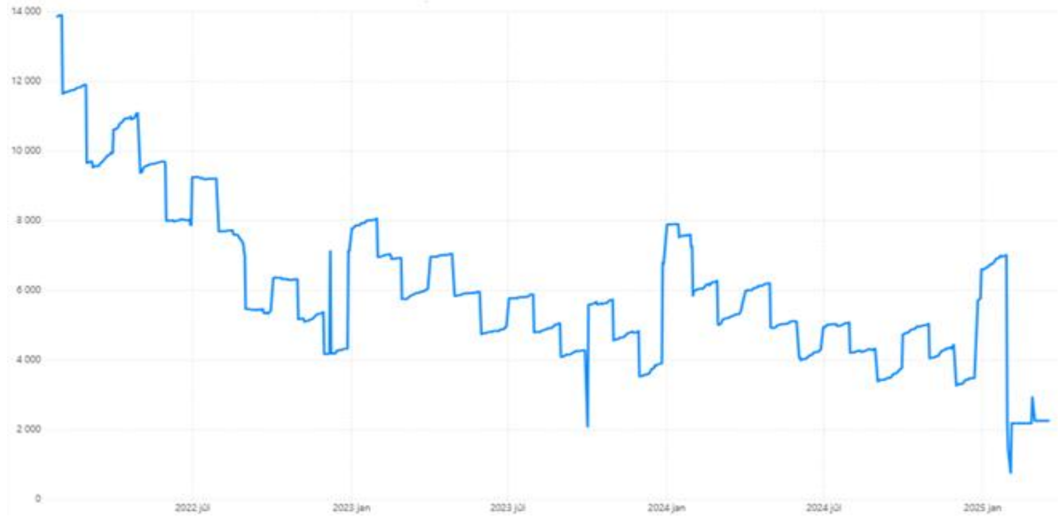


Data source: Nasdaq Commodities.

Figures 17-19 show the daily total open interest (TWh) in EPAD contracts for the relevant bidding zones.

Total open interest is however low for the TAL suggesting that they are not extensively used for hedging. Open interest in the RIG EPAD achieved the level of HEL and MAL EPADs. RIG EPAD appears to be used to hedge larger volumes, and this is likely to contribute to a more liquid market. For RIG (Riga) EPADs, open interest fluctuated approximately 0,1-0,2 TWh during the period of 2023 – 2024 years. Since the beginning of 2025 there are no trading of EPAD products related to Estonian or Latvian bidding zones.

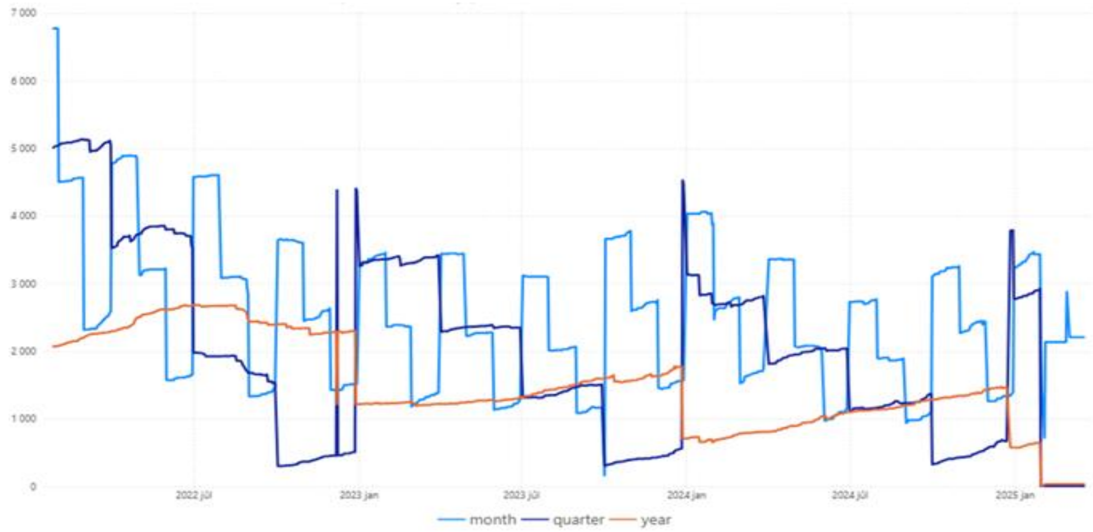
Figure 17: Open interest (GWh) EPADs, HEL



m.

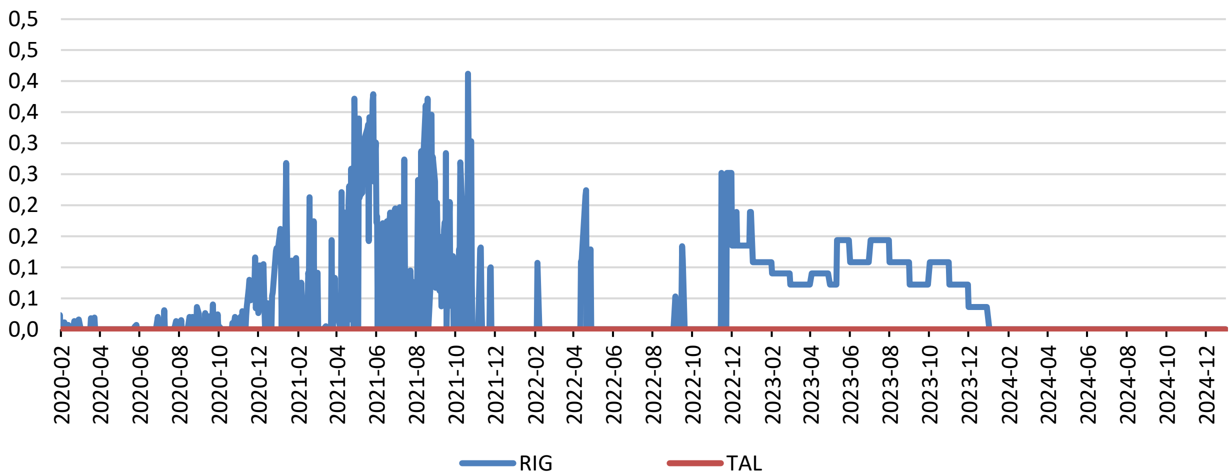
Data source: Nasdaq Commodities.

Figure 18: Open interest (GWh) EPADs, HEL (by duration)



Data source: Nasdaq Commodities.

Figure 19: Open interest (TWh) EPADs, RIG and TAL



Data source: Nasdaq Commodities.

7.1.3. Summing up open interest

From the beginning of 2020, open interest in system price contracts remained stable with usual fluctuations and started to decrease moderately from mid-2020. 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 increased almost three times from the beginning of 2020 to the ed of 2024. Nevertheless, in the opinion of the market operator, trading in RIG and TAL EPAD products was not sufficiently intensive, therefore it was decided to stop their trading on the secondary market from the end of 2024. It is likely that the stabilized uncertainty, mainly due to geopolitical reasons, had a significant impact on the expectations of market participants, as well as trading volumes and interest in the secondary market. In addition, it is likely that a similar situation will develop in the near future. There were no open interests for TAL products. The open interest of the Helsinki (HEL) EPAD has had a stable trend.

7.2. Analysis of open interest in relation to physical consumption

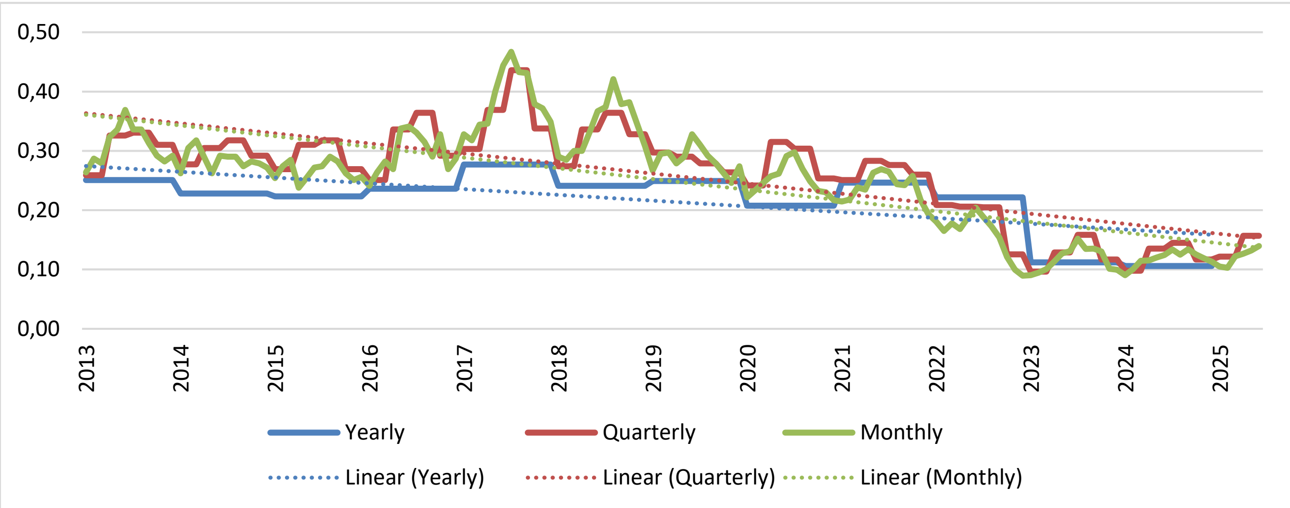
By dividing open interest by physical consumption, we can get an indication of the share of physical consumption that is hedged in the futures market.

7.2.1. Analysis of open interest in relation to physical consumption in system price contracts

Figure 20 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 period of 2023-2024 years at around 0,09-0,14. Again, this suggests that Nordic system price futures hedge something like 9-14% of physical consumption in the Nordics.

The contract‘s open interest is recorded at the end of its trading period, which is then divided by the physical consumption corresponding to the delivery period of the contract. The analysis of period 2013-2020 uses data from THEMA Consulting Group[8]. The analysis of period 2020-2025 uses data collected and processed by Gamybos optimizavimas, UAB (data sources: *Nasdaq Commodities* for open interest and *Nord Pool* for physical consumption).

Figure 20: Open interest in relation to physical consumption, Nordic system contracts



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

In the case of the system price product, it is worth noting that the yearly contracts maintained a stable ratio in the range of 0,1-0,2 throughout 2023-2024 years. However, monthly and quarterly contracts, which for a long time showed a slightly more volatile, but overall high ratio in the range of around 0,09-0,14, seem to have been losing interest recently (in 2024, the ratio remained at 0,11).

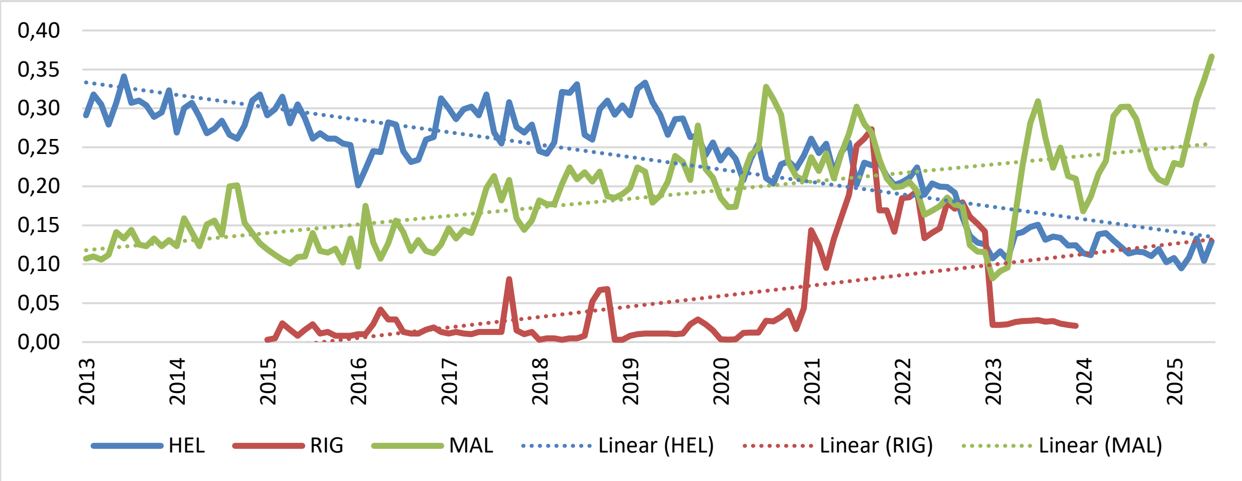
[8] See: https://www.vert.lt/SiteAssets/posedziai/2021-08-12/tarpzoninio_draudimo.pdf.

7.2.2. Analysis of open interest in relation to physical consumption in EPAD contracts

In Figure 21, we replicate the approach used in 5 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 MAL EPAD, this measure has remained stable throughout the studied period at around 0,1-0,25. On the other hand, the trade for RIG EPADs augmented starting from the beginning of 2021 to the similar level. This would imply that EPADs in these bidding zones hedge around 20% of the physical consumption in respective bidding zone.

Figure 21: Open interest in relation to physical consumption, monthly EPADs



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

In the case of EPAD products, the most interesting observation concerns the RIG product. Until almost 2021, it was highly unpopular, the open interest was quite low, with the ratio bounded in the range of 0-0,05 for most of the time. In recent years, however, the value of the ratio has almost equalled such normally liquid products as HEL and MAL. It is likely that the increase in open interest in RIG monthly EPAD contracts is related to the cautious and possibly pessimistic expectations of market participants regarding the prices of energy resources and significantly increased uncertainty in the market due to increased geopolitical tensions, due to which market participants mostly focused only on the short-term perspective in the future. In addition, market participants felt the need to hedge their electricity supply contract against sudden and unusual price increases. As for the HEL and MAL products, they have been in a certain downtrend since around 2021. Starting from the end of 2023, the open interest in relation to physical consumption of HEL and RIG products remained stable, the as the one of MAL product was increasing.

It should also be noted that despite the increased demand for the monthly RIG product, operators of *Nasdaq Commodities* decided to delist it since the annual contracts for suspension have no open interest[9].

7.2.3. 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 during the 2023-2024 years at around 0,09-0,2 and then decreased slowly until 0,1-0,25 at the end of analysed period. Similarly, for the HEL and MAL EPADs, since the beginning of 2017 this measure basically remained stable after the usual fluctuations at around 0,2-0,25 until mid-2021. After that the open interest in relation to physical consumption for the HEL and MAL EPADs decreased slowly throughout the studied period at around 0,03-0,15 at the end of November 2022. Level for TAL EPADs have remained low throughout the studied period, reflecting the low absolute levels of open interest in these contracts since there was no trading

[9] See related announcement http://www.nasdaqomx.com/transactions/markets/commodities/commodities-news-and-notices/show-release?id=bb2129ec1486c222d0b266602a54bebd2&displayLanguage=en

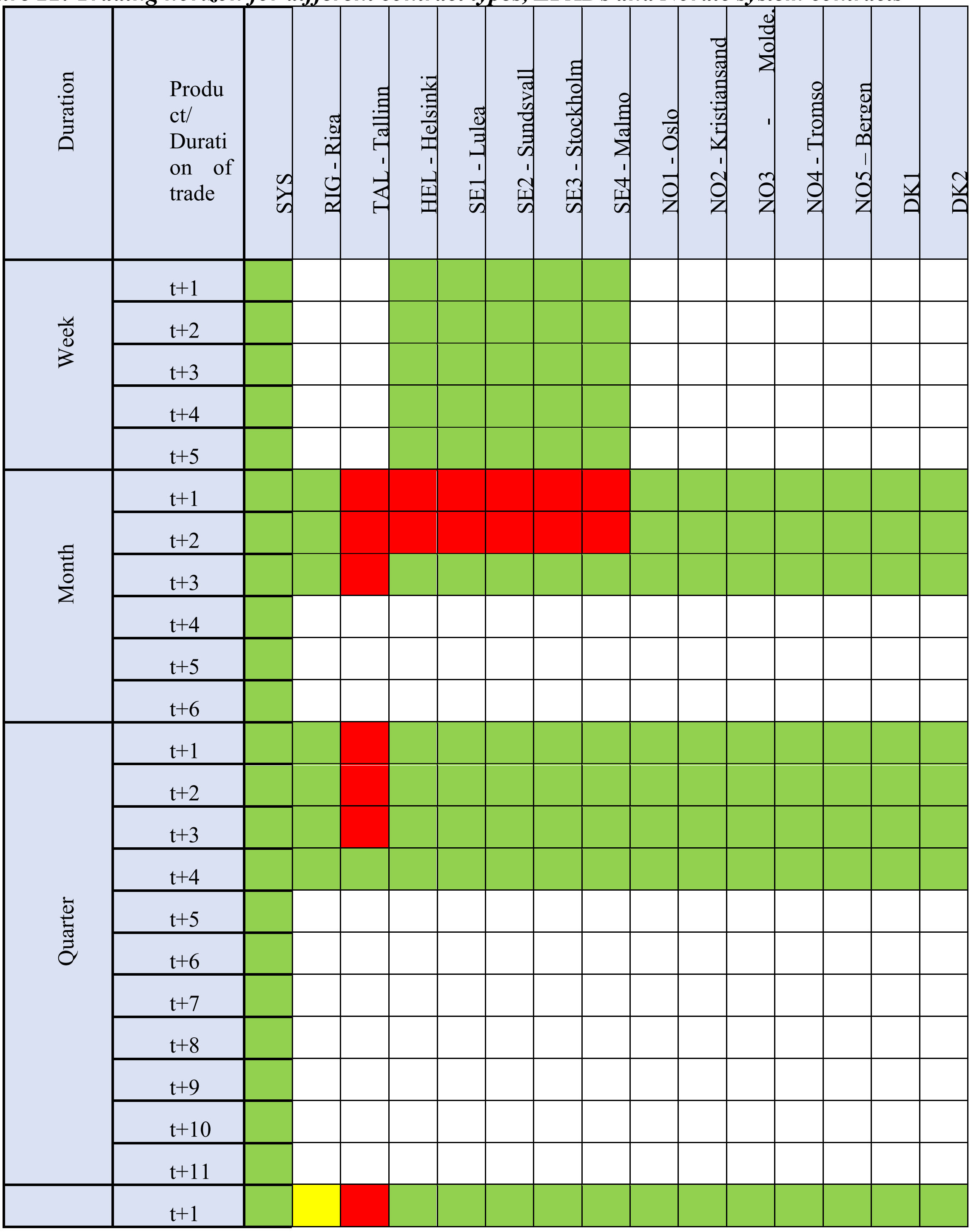
in these financial products. There is no clear cut-off point for determining a sufficient level for these metrics and attention needs to be paid to the presence of alternative opportunities to hedge. The values in the RIG EPADs varied between 0 and 0,05 in 2020 and between 0,1 and 0,2 in 2021-2022. Despite the huge change in trade, these figures indicate limited liquidity for these specific products.

7.3. 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 supply that exist via exchange-based derivatives and is not a measure of efficiency or liquidity per se.

Figure 22 shows the trading horizon for different contract types that can be traded on *Nasdaq Commodities*, including EPADs and Nordic system contracts.

Figure 22: Trading horizon for different contract types, EPADs and Nordic system contracts



	t+2															
	t+3															
	t+4															
	t+5															
	t+6															
	t+7															
	t+8															
	t+9															
	t+10															

Data source: Nasdaq (2022) Trading Appendix 2. Contract Specifications (https://www.nasdaq.com/docs/2022/11/24/Joint-Appendix2-Contract-Specifications.pdf.

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.*

The green color means that financial instruments of the corresponding duration exist in the secondary market and can be traded by market participants. The yellow color means that some of the previously issued financial instruments of the corresponding duration exist and can be traded. The red color means that instruments of the corresponding duration are no longer available on the secondary market. The white color means that such financial product is not available in the relevant bidding zone.

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.

7.4. Analysis of 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.

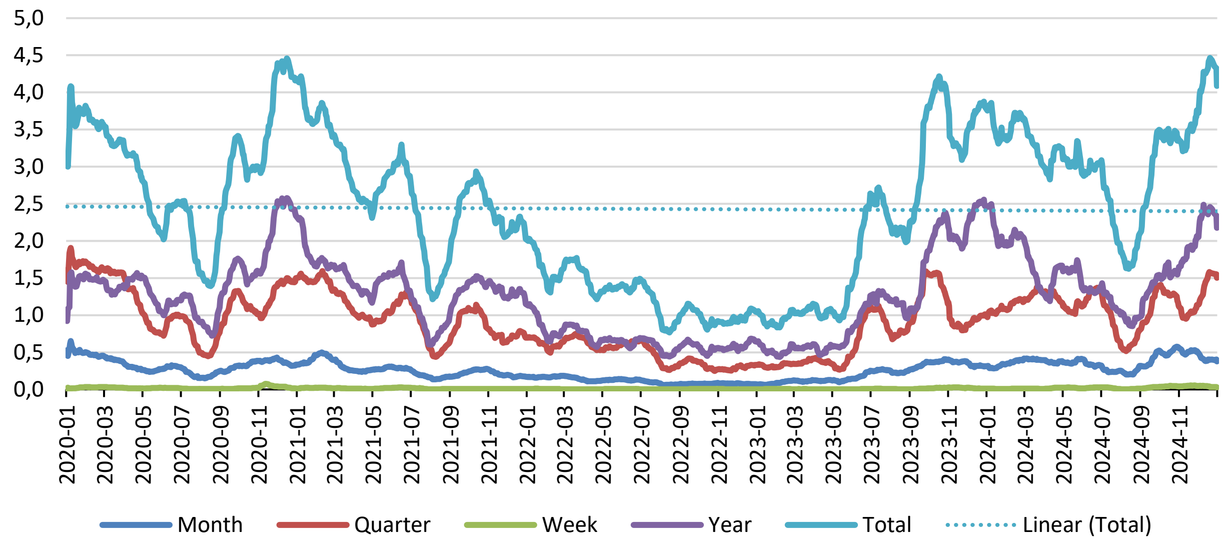
The analysis of traded volumes in the following section is done using end-of-day data covering the period 01.01.2020-31.12.2024. The traded volumes provided in the end-of-day data include exchange-traded volumes only and will therefore not include volumes traded Over the Counter, even if these volumes are cleared.

7.4.1. Analysis of traded volumes of system price contracts

Figure 23 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, to make trends easier to see.

The results show total daily traded volumes in Nordic system price contracts to be in the range of 1-4,5 TWh. Total traded volumes reached 4,5 TWh level in the mid in 2020 and since then appeared to decrease from around 4,5 TWh in 2020 to less than 1 TWh in the end of 2022, indicating falling liquidity. The decrease in trade volumes from May 2021 is especially obvious. During the first half of 2023 year the trade was stable and starting from the mid-ear of 2023 the trade increased significantly until 4 TWh. And remains at this level until the end of 2024 year. It is worth noting that the trading trend in the analysed period was the same for financial transactions of all durations.

Figure 23: Daily traded volumes (TWh) Nordic system price contracts

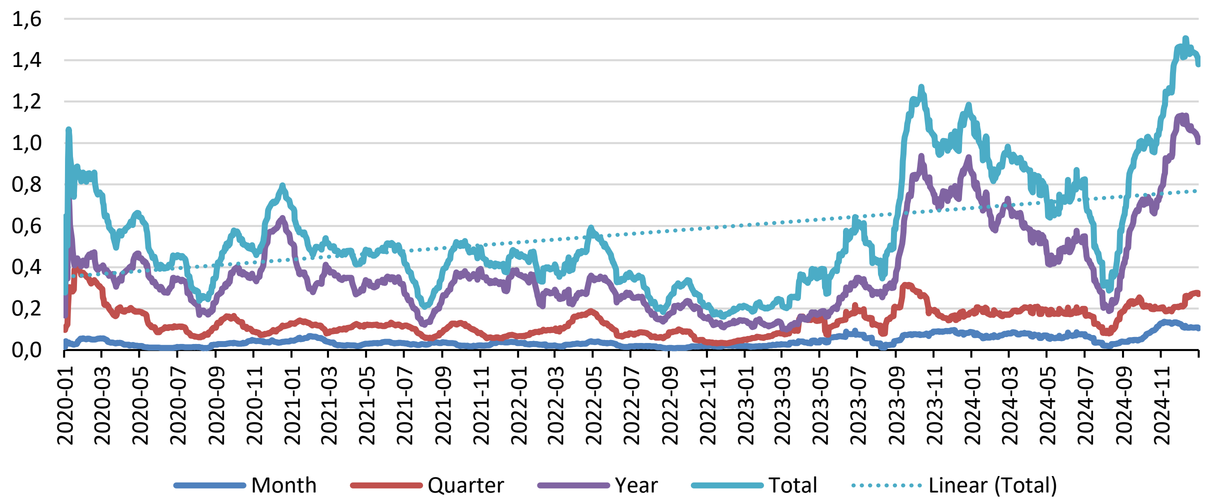


Data source: Nasdaq Commodities.
Note: The traded volumes are average over a rolling time window of 30 days, backward.

7.4.2. Analysis of traded volumes of EPAD contracts

Figure 24 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. Total daily traded EPAD volumes have varied around 0,5 TWh on average during the period of the 2020-mid of 2023 and 1 from the mid of 2023.

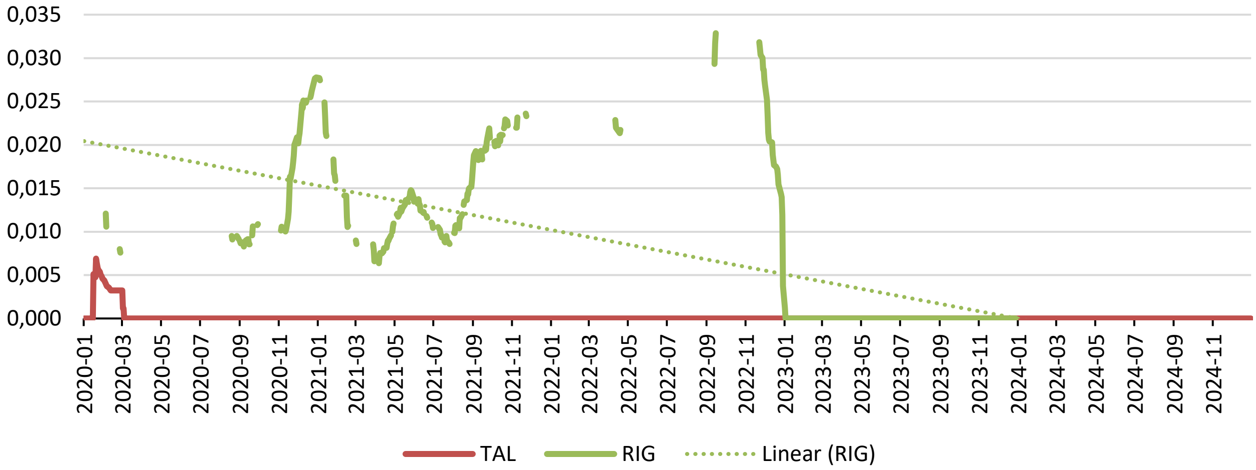
Figure 24: Daily traded volumes (TWh) of EPADs (all bidding zones)



Data source: Nasdaq Commodities.
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.

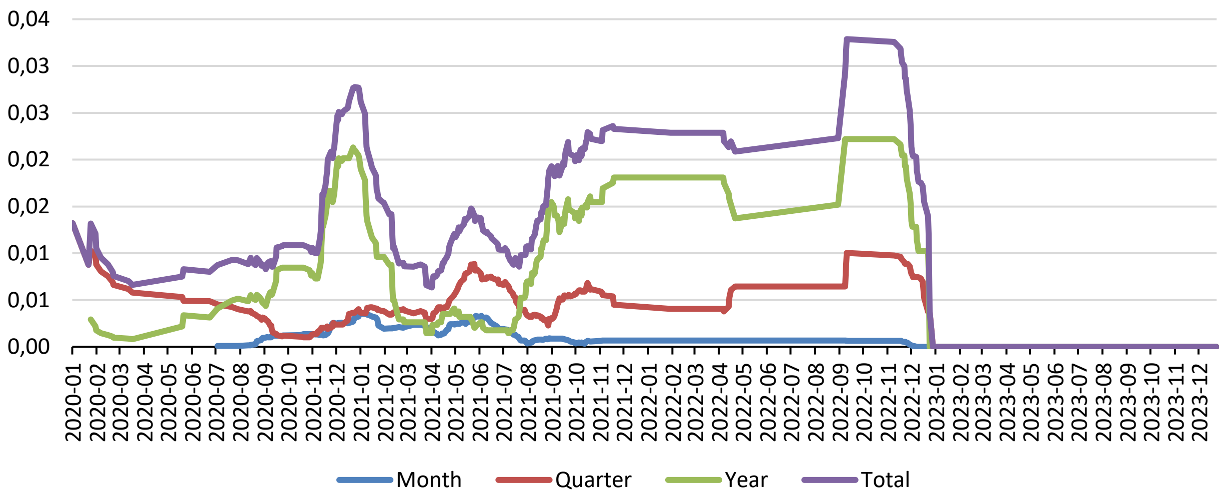
Figures 25-28 show total daily traded volumes (TWh) for the relevant bidding zones. The traded volumes are averaged over a rolling time window of 30 days, backward. The results show that for the TAL and RIG EPADs, daily traded volumes have been stable at very low levels throughout the studied period. 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 0,1-0,2 TWh in the period of 2020-2022 years. As such, liquidity in these products seems to be less of an issue. For LUL, MAL and TRO EPADs in 2020-2022 years and around 0,3-0,8 TWh in 2023-2024 years. Traded volumes of HEL EPAD has also been stable, albeit at low levels, throughout the period of the period of 2023-2024 years Traded volumes of STO EPAD was quite unstable in 2024 and sharply increased at the end of 2024.

Figure 25: Total daily traded volumes (TWh) TAL and RIG EPADs



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

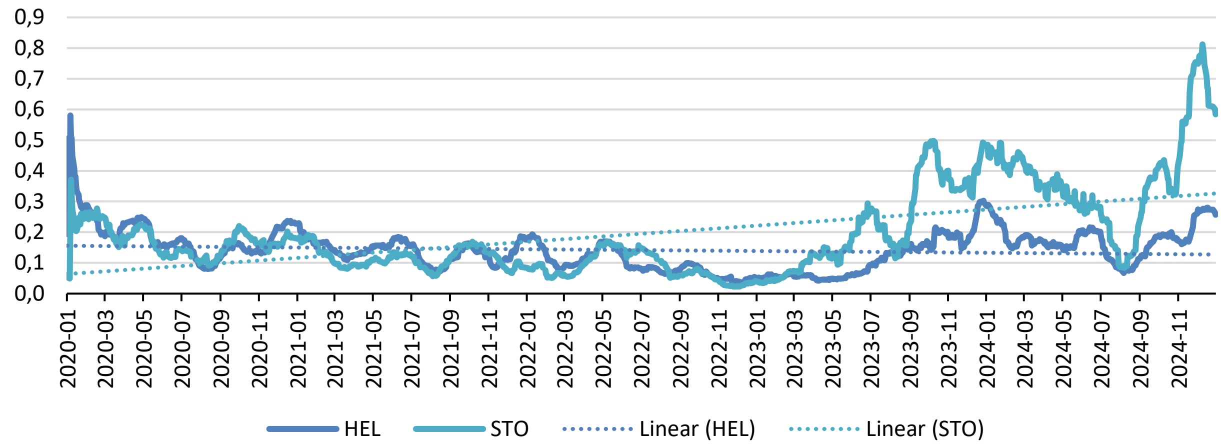
Figure 26: Total daily traded volumes (TWh) RIG EPADs



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

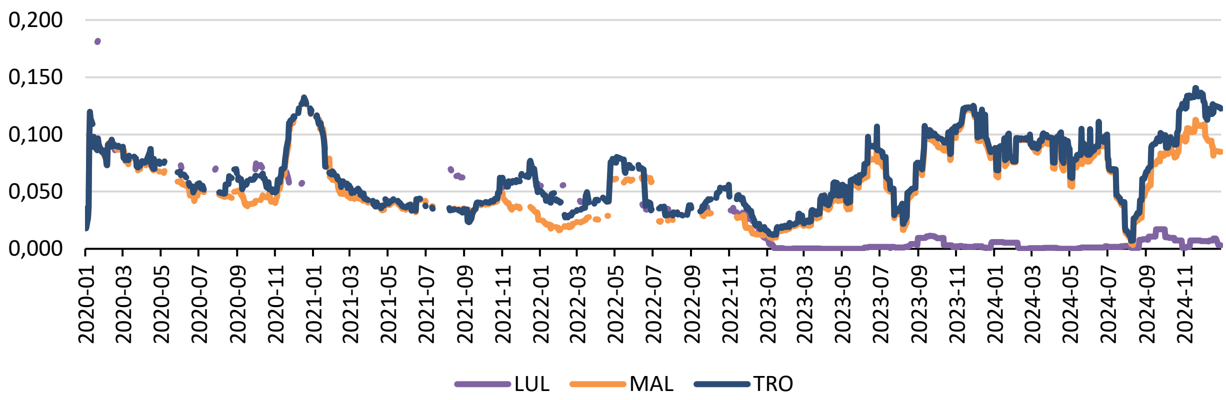
Figure 26 reveals that trading in the RIG EPAD secondary market intensified during the onset (and possibly respective expectations) of price shocks in the energy market until the 2023 year. Market participants felt the need to hedge their electricity supply contract against sudden and unusual price increases. Under normal conditions, RIG EPADs were sluggish in trading, resulting in insufficient liquidity.

Figure 27: Total daily traded volumes (TWh) HEL and STO EPADs



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

Figure 28: Total daily traded volumes (TWh) LUL, MAL and TRO EPADs



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

7.4.3. Summing up daily traded volumes

Total traded volumes in system price contracts decreased during the period of 2020-2022 indicating worsening liquidity and increased sharply starting from the mid of 2023 years and remained stable in 2024. Daily traded volumes in EPADs have been varied around 0,3-1,5 TWh in recent years. For the specific EPADs (HEL, LUL, MAL STO), daily traded volumes have been increasing throughout the period of mid 2023-2024, albeit at very low levels in some areas, notably TAL and RIG. These EPADs were not in trade for the 2024 year.

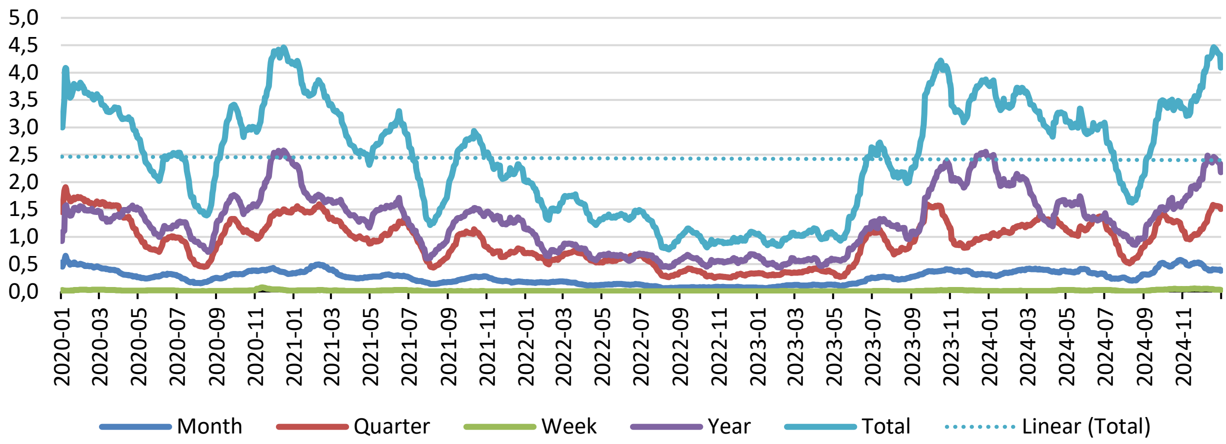
7.5. Analysis of traded volumes in relation to physical consumption (Churn rate)

The ratio between total traded volumes of a power derivative and total electricity consumption 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. Here we present some insights about the development of churn rates in 01.01.2020-31.12.2024.

7.5.1. Analysis of traded volumes for system price contracts in relation to physical consumption/Churn rate

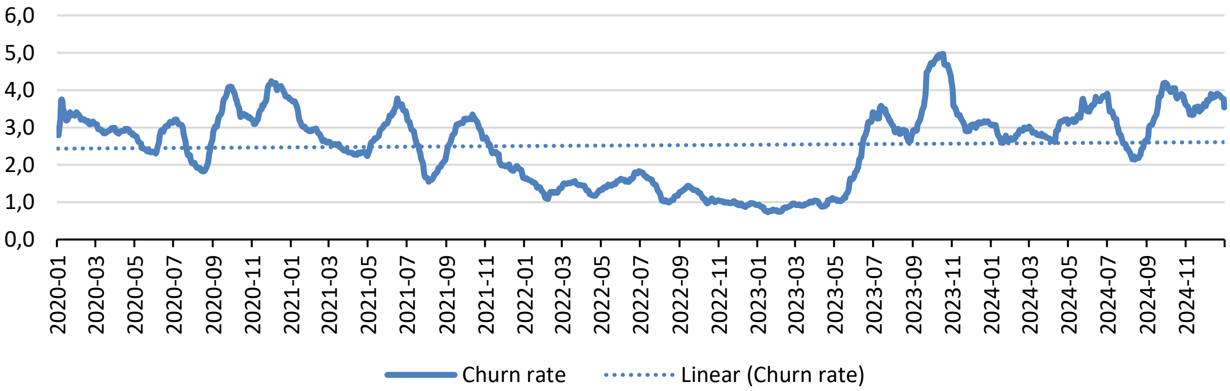
Figure 29 shows daily traded volumes in Nordic system contracts in relation to daily physical consumption in the Nordic price areas. This ratio is averaged over a rolling time window of 30 days, backward. The figures show a decline in the churn rate, reaching a level of around 1 from 2022 until the mid of 2023 year. This reflects the decline in traded volumes noted above. On the other hand, it increased sharply starting from the mid of 2023 years and remained at more or less stable in 2024.

Figure 29: Traded volumes in relation to physical consumption (Churn rate), Nordic system



Data source: Nasdaq Commodities (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 30: Total traded volumes in relation to physical consumption (Churn rate), Nordic system



Data source: Nasdaq Commodities (for traded volumes) and E N T S O - E (for physical consumption). Note: The churn rate is averaged over a rolling time window of 30 days, backward.

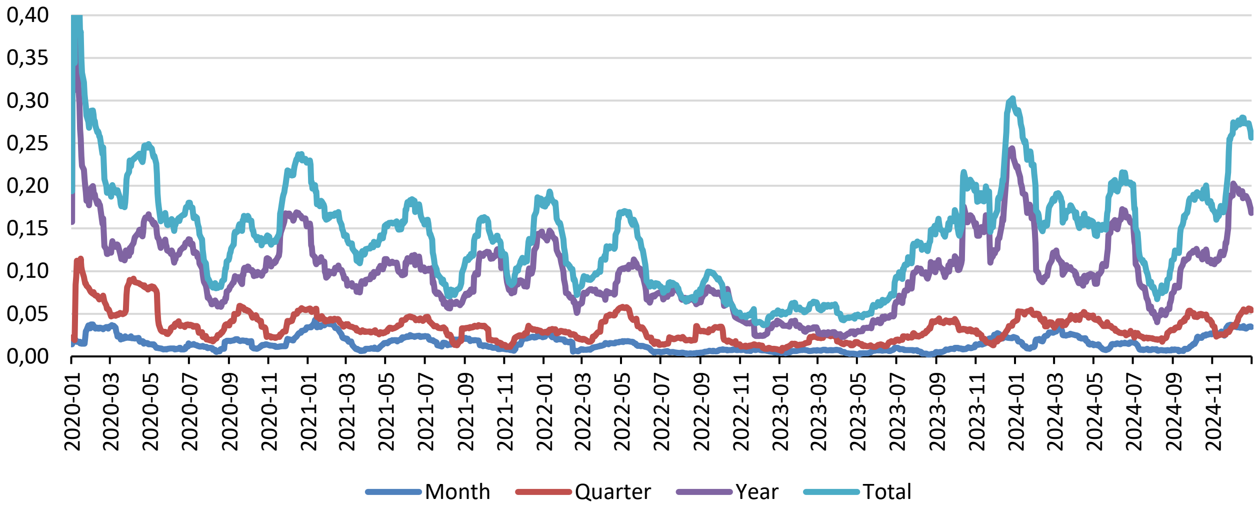
7.5.2. Analysis of traded volumes for EPAD contracts in relation to physical consumption/Churn rate

Figures 31-34 show total daily traded volumes in relation to daily physical consumption, the churn rate, for the relevant regional bidding zones. The churn rate is averaged over a rolling time window of 30 days, backward.

In the case of TAL, trading in derivative financial instruments did not take place from the beginning of 2023, so it is quite unfavourable for the Baltic electricity producers to apply market risk hedging measures. The operator of *Nasdaq Commodities* has decided to remove some financial products related to the RIG and TAL bidding zone from trading (mainly due to lack of trading and illiquidity), which only further complicates the situation (see also Trading horizons).

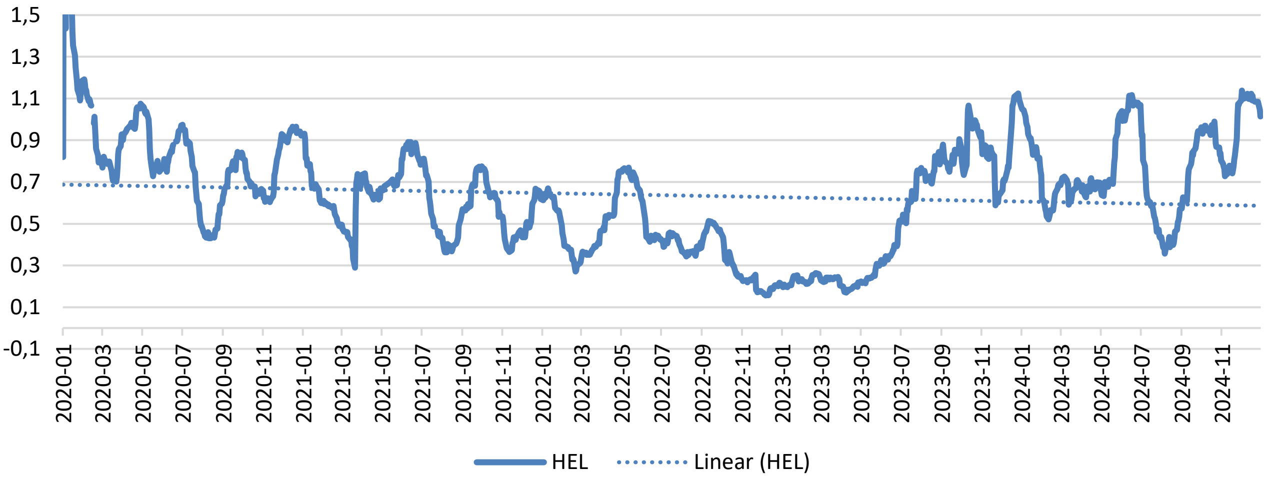
For the RIG EPADs, the churn rate has been below 1,5 for the period of 2020-2021 years and quite unstable at the end of 2022 year. For HEL EPADs, the churn rate has been varying around 0,1 to 0,15 throughout most of the studied period.

Figure 31: Total daily traded volumes HEL EPADs



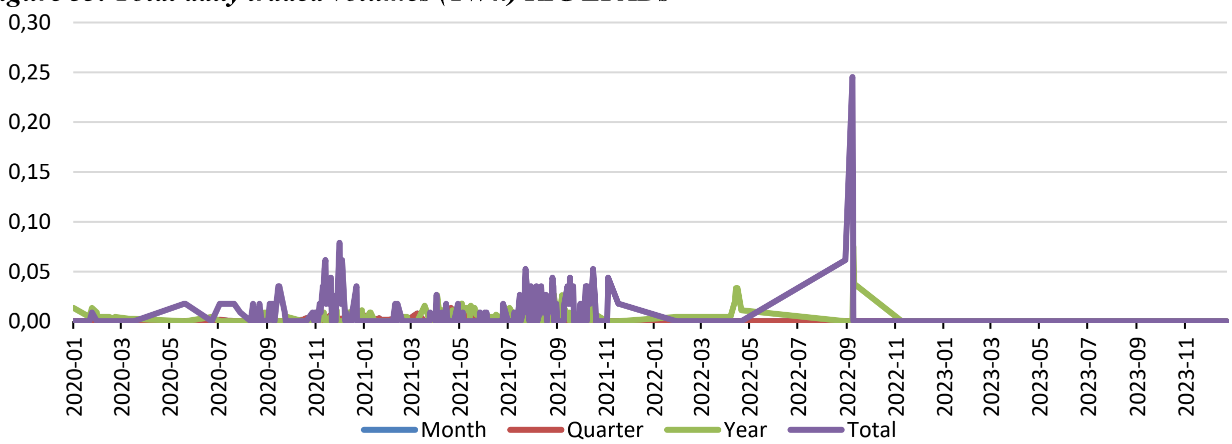
Data source: Nasdaq Commodities (for traded volumes) and E N T S O - E (for physical consumption). Note: The churn rate is averaged over a rolling time window of 30 days, backward.

Figure 32: Total traded volumes in relation to physical consumption (Churn rate) HEL EPADs



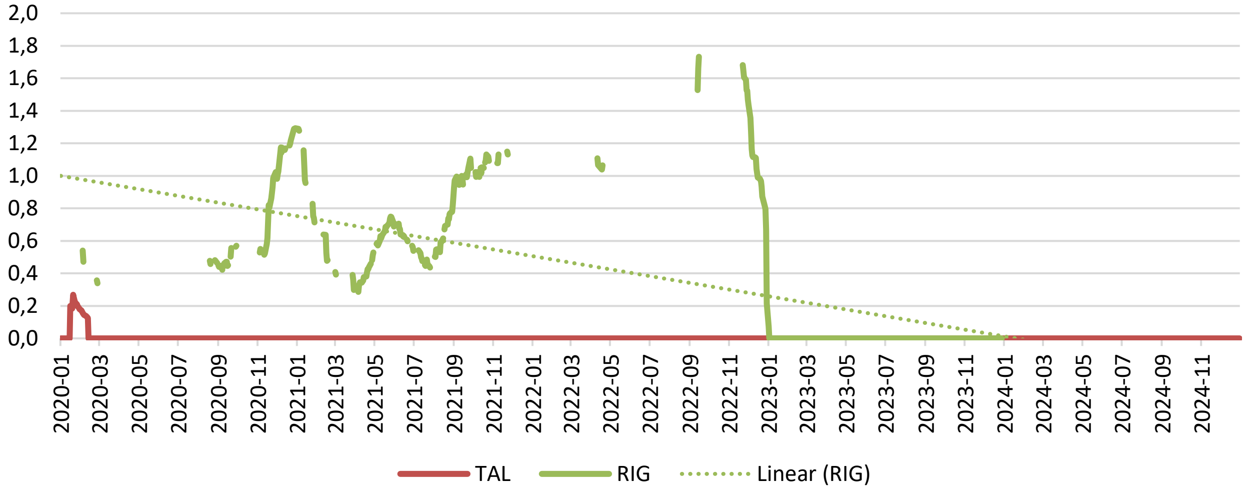
Data source: Nasdaq Commodities (for traded volumes) and E N T S O - E (for physical consumption). Note: The churn rate is averaged over a rolling time window of 30 days, backward.

Figure 33: Total daily traded volumes (TWh) RIG EPADs



Data source: Nasdaq Commodities (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 34: Total traded volumes in relation to physical consumption (Churn rate) RIG and TAL EPADs



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

7.5.3. Summing up churn rate

The churn rate for system price contracts fluctuated around 3 from the mid-2023 to the end of 2024 years. This reflects increased volumes of trade from 2022 years. The trade in the RIG EPAD in 2020-2022 was fragmented, close to zero for a large part of the last year and a half, except for periods of trade intensification due to significant changes in the energy market, which were largely due to geopolitical reasons. For HEL, the churn rate has varied around 0,5 to 1,5 throughout most of the period of 2022-mid-2023 years. Starting from the mid-2023 the churn rate of HEL EPAD reached and fluctuated around 0,5-1 for 2024 years reflecting intensified trade. In addition, the recent development of these figures highlights those traded volumes for the TAL and RIG EPAD are relatively low even when accounting for volatility in the level of consumption between different bidding zones.

8. ANALYSIS OF TRANSACTION COST MEASURES

8.1. Analysis of bid-ask spreads

The bid-ask spread is the difference between the highest bidding (buying) price and the lowest asking (selling) price for a given contract. It both affects and is affected by liquidity. This spread represents a direct transaction cost for market participants. The spreads' influence on liquidity is the result of its function as a transaction cost. A large spread implies that a large value must be paid to meet the expectations/costs of a counterparty. In markets with low bid-ask spreads, a contract can be bought and then sold at very small cost. Conversely, in markets with large bid-ask spreads, buying and then immediately selling a contract will result in a significant loss. The large transaction costs tend to harm liquidity by reducing the scope for profitable trade. On the other hand, liquidity itself influences the spread:

- poor liquidity means that holding a contract is relatively risky since positions cannot be easily changed. This means that counterparties demand more to enter into a position in the first place, which tends to push bid and ask prices apart.
- 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.

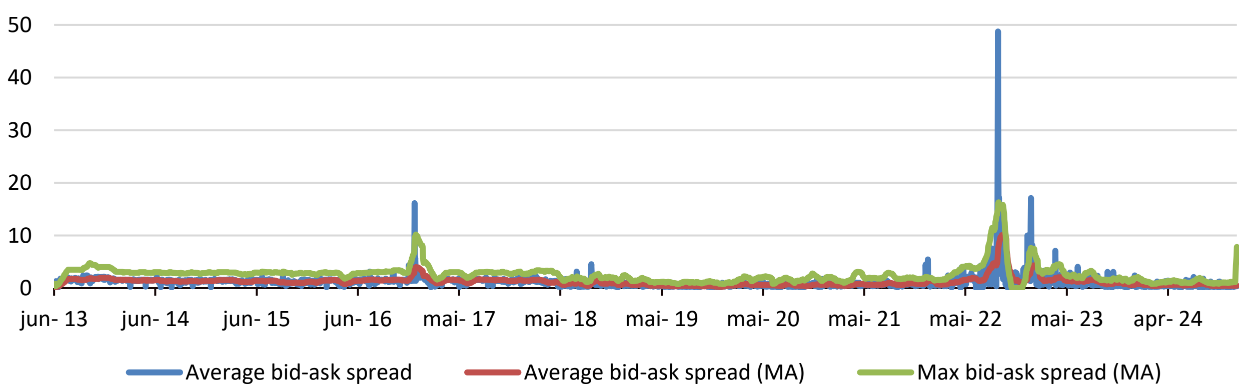
In general, lower bid-ask spreads are therefore indicative of more liquid markets. However, low liquidity does not mean that such hedging products are unnecessary. It may mean that their holders use these instruments directly and are not inclined to speculate with them.

The interaction of bid-ask spreads with liquidity, both as a cause and a result, make bid-ask spreads a potentially informative metric of market liquidity. On the other hand, it is necessary to pay attention that the bid-ask spread can be affected by other factors, such as lower market uncertainty of the underlying power prices, i.e. lower volatility in electricity markets. Therefore, the changes in the spread cannot be treated unambiguously.

8.1.1. Analysis of bid-ask spreads of system price contracts

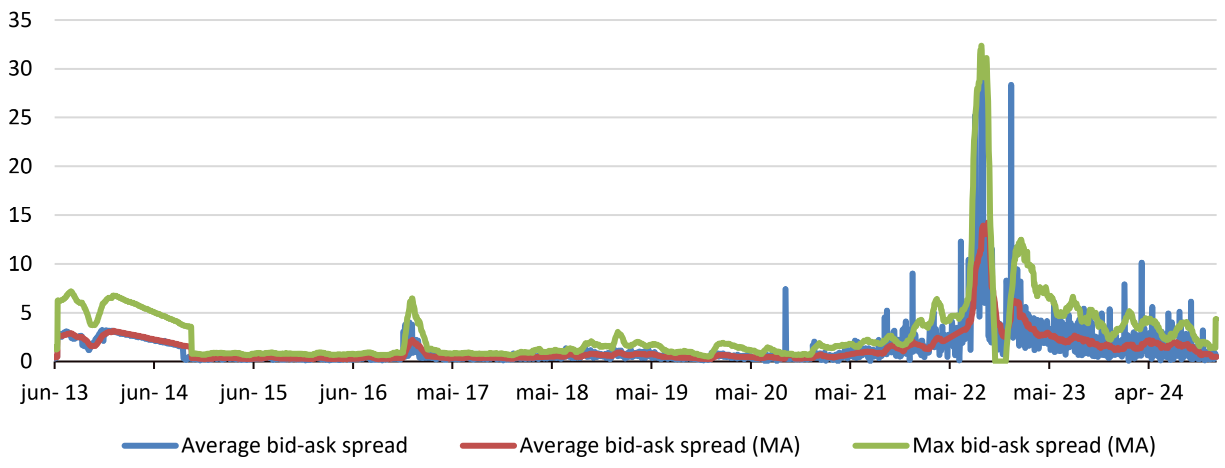
The bid-ask spreads below are calculated using data on daily best bids and best asks for each traded contract. For each date within each contract category (daily, weekly, monthly, quarterly, and yearly contracts), the data is averaged over all traded contracts (with varying time to delivery). Then, for the remaining dates with no trading, spreads are inferred by (linear) interpolation. Figures 35-39 show the absolute bid-ask spread for yearly, quarterly, monthly, weekly, and daily power base futures and DS futures (Deferred Settlement 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 35: Absolute bid-ask spread, Nordic yearly power futures (EUR/MWh)



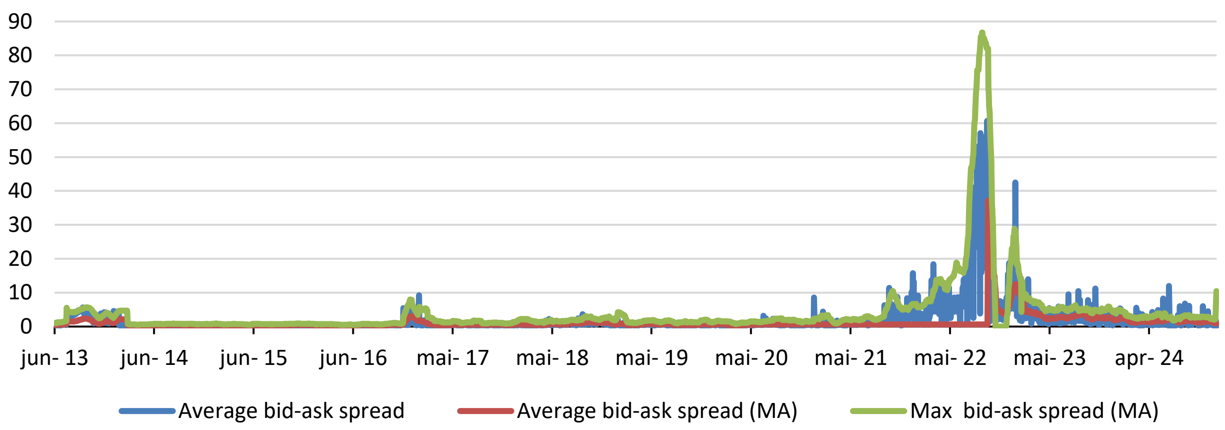
Data source: Nasdaq Commodities.

Figure 36: Absolute bid-ask spread, Nordic quarterly power futures (EUR/MWh)



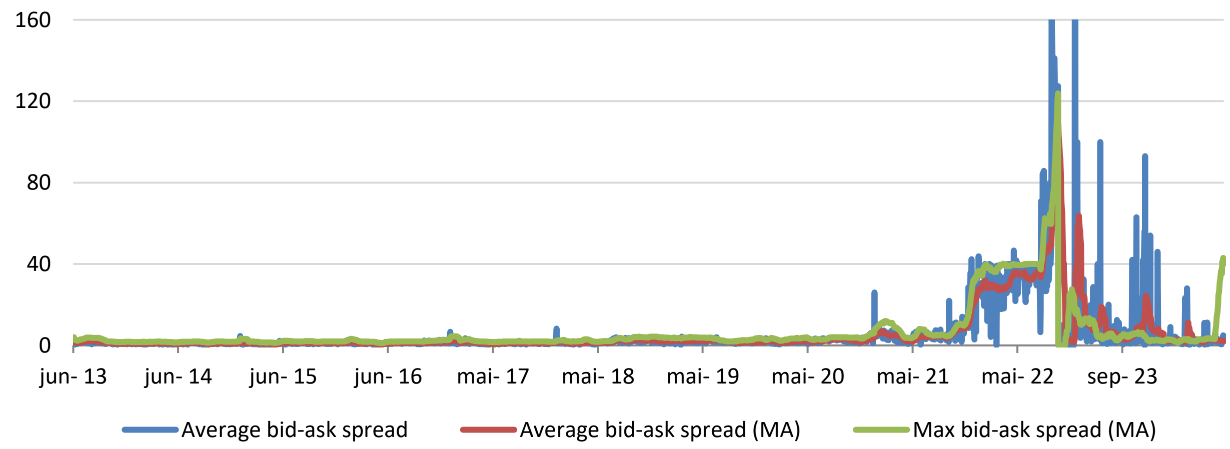
Data source: Nasdaq Commodities.

Figure 37: Absolute bid-ask spread, Nordic monthly power futures (EUR/MWh)



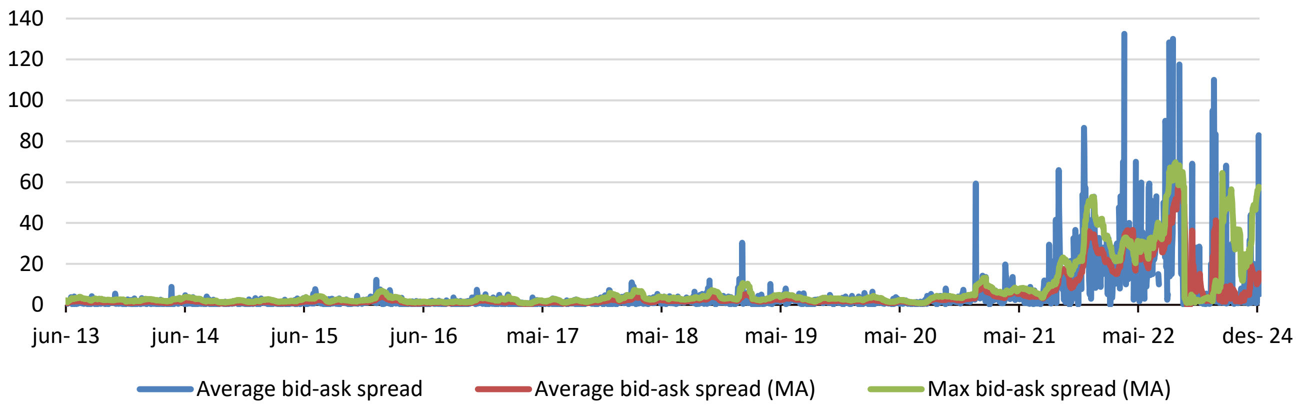
Data source: Nasdaq Commodities.

Figure 38: Absolute bid-ask spread, Nordic weekly power futures (EUR/MWh)



Data source: Nasdaq Commodities.

Figure 39: Absolute bid-ask spread, Nordic daily power futures (EUR/MWh)



Data source: Nasdaq Commodities.

Bid-ask spreads clearly decreased in mid-2023-2024 period and became more stable than during the 2021-2022 years. But in general, the level of bid-ask spreads did not achieve the level before the energy crisis due to geopolitical risk and related transformation in energy markets.

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.

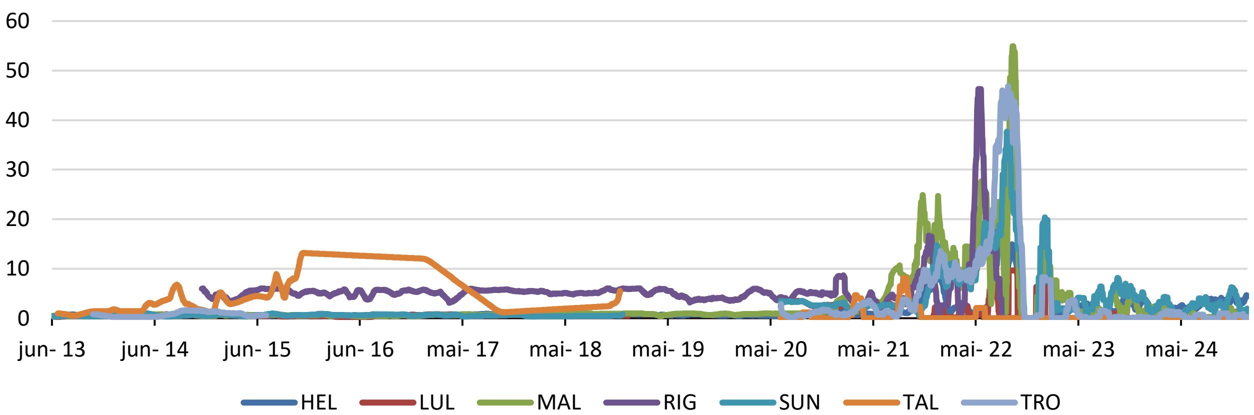
It can be noted that in 2013-2018 period bid-ask spreads were much more stable. Around the beginning of 2020 year, bid-ask spreads started to become less stable, and from around 2022 increased drastically. This may also mean that the derivatives markets have increased nervousness and the need for liquidity. The development of bid-ask spreads reflects the geopolitical risk and related uncertainty in energy markets.

8.1.2. Analysis of bid-ask spreads of EPAD contracts

Figures 40-42 show the average bid-ask spreads for yearly, quarterly and weekly Finnish, Swedish, Norwegian and Baltic EPAD contracts. Figure 43 and Figure 44 show the maximum bid-ask spreads for the same contracts. Like 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 40 to Figure 41 are averaged over a (backward) rolling time window of 30 days.

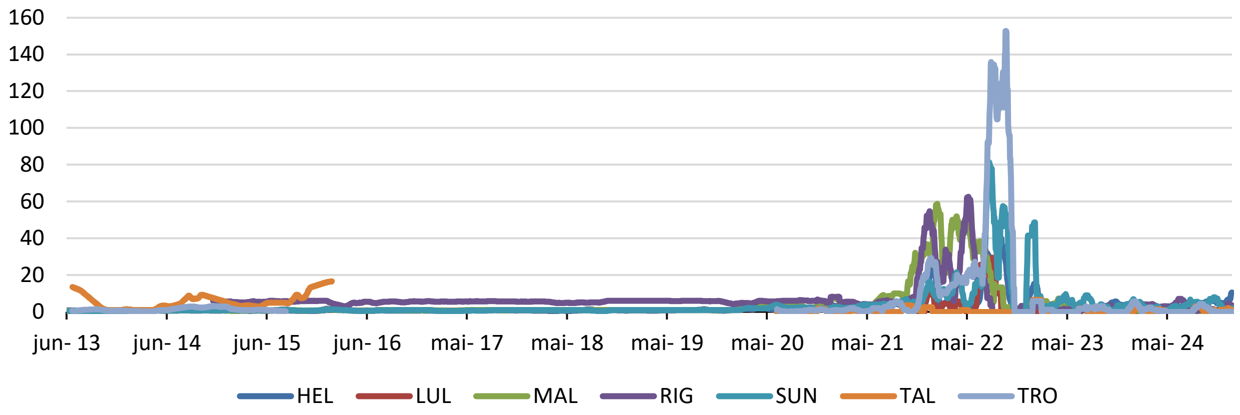
The HEL EPAD has a significantly lower spread that is comparable with that for some of the other areas analysed. The bid-ask spread of monthly HEL EPAD increases markedly in the first half of 2020, along with spreads for several other EPAD contracts. This could potentially reflect a loosening of market making obligations for these contracts. Starting form the end of 2022 years the average bid-ask spreads for EPADs of various durations decreased significantly but did not achieve the level before energy crisis in 2021-2022 years.

Figure 40: Average best bid-ask spread for yearly EPAD contracts (EUR/MWh)



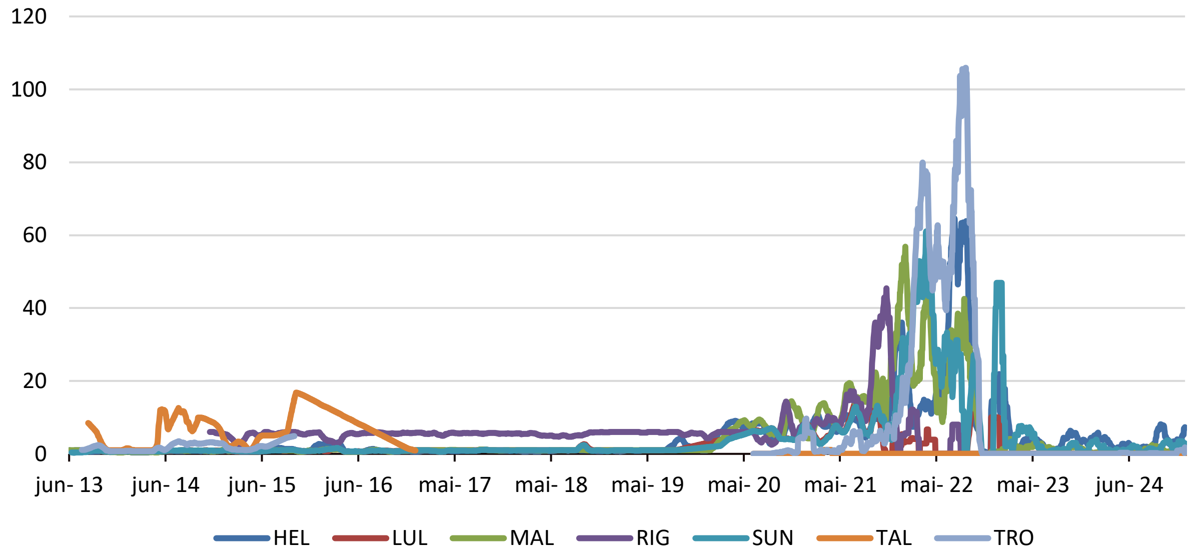
Data source: Nasdaq Commodities.

Figure 41: Average best bid-ask spread for quarterly EPAD contracts (EUR/MWh)



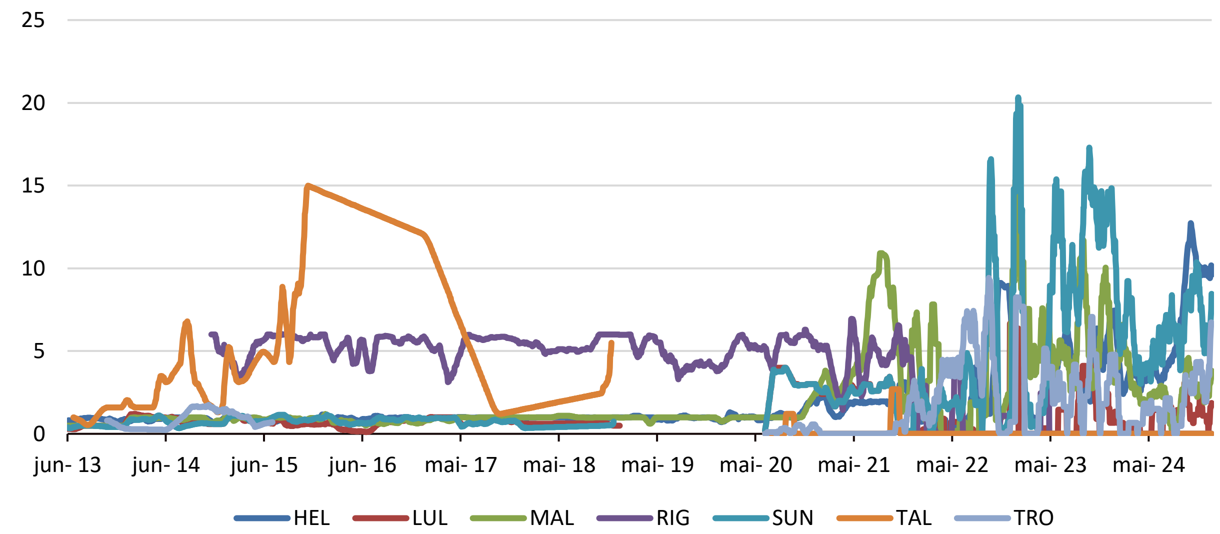
Data source: Nasdaq Commodities.

Figure 42: Average best bid-ask spread for monthly EPAD contracts (EUR/MWh)



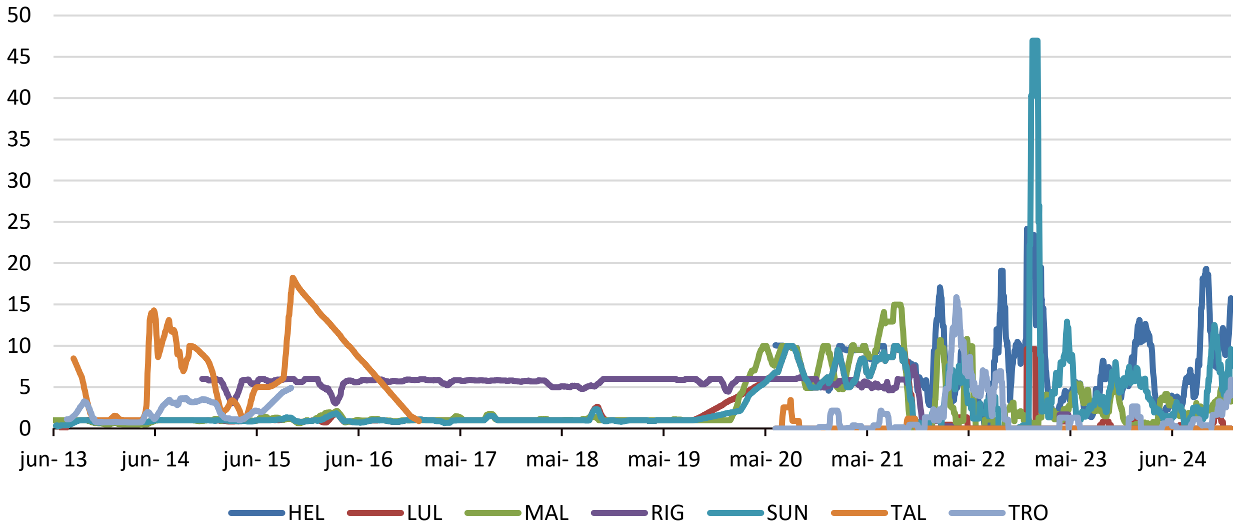
Data source: Nasdaq Commodities.

Figure 43: Maximum best bid-ask spread for yearly EPAD contracts (EUR/MWh)



Data source: Nasdaq Commodities.

Figure 44: Maximum best bid-ask spread for monthly EPAD contracts (EUR/MWh)



Data source: Nasdaq Commodities.

8.1.3. 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 until the mid of 2021. However, mainly due to geopolitical reasons, serious structural changes occurred in the electricity market, which led to a decrease in trading volumes and sharply increased the volatility. Due to the remained increased volatility it is complicated to determine a clearer trend in the development of the bid-ask spread in the future. It is also observed that the shorter the duration of the systematic product, the higher the risk premium applied in trading on the secondary market. 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 can be impacted by the presence of market makers on the exchange and related trading actions, 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.

9. ANALYSIS OF CORRELATION OF PRICES AND CONSUMPTION QUANTITIES IN VARIOUS BIDDING ZONES

To determine some of bidding zone prices generality in 2020-2022, correlation analysis of electricity spot prices is performed. This allows to conclude about interdependence relation of these prices. Time-varying correlation can become an important source of risk with wide ranging economic implications. The correlation analysis helps to show the extent to which different financial products represent reasonable proxies for hedging exposure to a specific power price. Thus, one can get a knowledge of to what extent one can hedge the price risk of a specific bidding 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 participants with sufficient hedging opportunities. In contrast to volatility risk, correlation risk has much higher impact on optimal portfolio weights. This impact is larger for high average correlations and for large correlation variances. Hedging opportunities that are poorly correlated can 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 and so hedging instruments with lower correlations are unlikely to be particularly good proxies.

9.1. Analysis of correlations of electricity prices

Tables 1 a-d reflect the correlation of calendar-month-average spot prices and Tables 2 a-d show the correlation of calendar-month-average spot price differences. It covers the Norwegian, Swedish, Finish, Estonian, Latvian, and Lithuanian bidding zones, and the Nordic System price for the period 01.01.2020 to 31.12.2024. 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.

This analysis is backward-looking and limited to the stated period between 2020 and 2024. It is possible that changes in pricing dynamics brought about by the commissioning of new interconnectors and the development of new generation capacity will alter the level of price correlation between zones in the future.

The results show decreasing correlation between Finland and the Baltic countries in 2024 years. There is also almost absolute positive correlation between the Baltic countries, with a correlation coefficient of 0,98-0,99 each of the states and what appears to be a perfect correlation between Latvian and Lithuanian monthly average prices in the period of 2020-2024 years. The correlation between the Nordic system price and that in Finland is relatively high, whereas the zonal prices in the Baltic countries are less correlated with the system price. However, it should be noted that the correlation between the systemic price and the electricity prices of the Baltic countries decreased approximately 3 times in 2024 until around 0,3.

Table 1a: Correlation, monthly average spot prices, 2020-2024 years

2020	FI	EE	LV	LT	SE4	SYS
FI	1,00					
EE	0,88	1,00				
LV	0,88	0,99	1,00			
LT	0,88	0,99	1,00	1,00		
SE4	0,91	0,93	0,94	0,94	1,00	
SYS	0,46	0,26	0,21	0,21	0,33	1,00

Data source: Nord Pool.

Table 1b

2021	FI	EE	LV	LT	SE4	SYS
FI	1,00					
EE	0,96	1,00				
LV	0,95	1,00	1,00			
LT	0,95	1,00	1,00	1,00		
SE4	0,94	0,99	0,99	0,99	1,00	
SYS	0,97	0,97	0,97	0,97	0,98	1,00

Data source: Nord Pool.

Table 1c

2022	FI	EE	LV	LT	SE4	SYS
FI	1,00					
EE	0,94	1,00				
LV	0,89	0,95	1,00			
LT	0,88	0,95	1,00	1,00		
SE4	0,82	0,81	0,81	0,81	1,00	
SYS	0,72	0,67	0,68	0,69	0,94	1,00

Data source: Nord Pool.

Table 1d

2023	FI	EE	LV	LT	SE4	SYS
FI	1,00					
EE	0,36	1,00				
LV	0,22	0,97	1,00			
LT	0,25	0,97	1,00	1,00		
SE4	0,62	0,20	0,16	0,20	1,00	
SYS	0,84	0,05	-0,10	-0,06	0,83	1,00

Data source: Nord Pool.

Table 1e

2024	FI	EE	LV	LT	SE4	SYS
FI	1,00					
EE	0,22	1,00				
LV	0,10	0,98	1,00			
LT	0,10	0,98	1,00	1,00		
SE4	0,51	0,12	0,12	0,12	1,00	
SYS	0,80	-0,04	-0,15	-0,15	0,70	1,00

Data source: Nord Pool.

Table 2a: Correlation, monthly average spot price differences (area price – system price), 2020-2024 years

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

Data source: Nord Pool.

Table 2b

2021	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	0,45	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	-0,19	-0,47	-0,38	-0,32	1,00

Data source: Nord Pool.

Table 2c

2022	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1,00							
EE-SYS	0,88	1,00						
LV-SYS	0,69	0,85	1,00					
LT-SYS	0,72	0,87	1,00	1,00				
SE1-SYS	0,32	-0,03	-0,42	-0,38	1,00			
SE3-SYS	0,57	0,41	0,26	0,28	0,39	1,00		
SE4-SYS	0,49	0,62	0,70	0,70	-0,39	0,45	1,00	
NO4-SYS	0,20	-0,01	-0,44	-0,40	0,85	0,13	-0,51	1,00

Data source: Nord Pool.

Table 2d

2023	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1,00							
EE-SYS	0,58	1,00						
LV-SYS	0,64	0,99	1,00					
LT-SYS	0,64	0,99	1,00	1,00				
SE1-SYS	0,36	0,55	0,58	0,57	1,00			
SE3-SYS	0,47	0,88	0,87	0,86	0,60	1,00		
SE4-SYS	1,00	0,58	0,64	0,64	0,36	0,47	1,00	
NO4-SYS	0,24	0,68	0,69	0,67	0,82	0,83	0,24	1,00

Data source: Nord Pool.

Table 2e

2024	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	0,53	0,99	1,00					
LT-SYS	0,52	0,99	1,00	1,00				
SE1-SYS	-0,43	-0,16	-0,22	-0,21	1,00			
SE3-SYS	0,60	-0,14	-0,06	-0,06	-0,78	1,00		
SE4-SYS	1,00	0,44	0,53	0,52	-0,43	0,60	1,00	
NO4-SYS	-0,17	-0,34	-0,36	-0,37	-0,48	0,42	-0,17	1,00

Data source: Nord Pool.

Table 2f

2020-2022	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1,00							
EE-SYS	0,79	1,00						
LV-SYS	0,57	0,88	1,00					
LT-SYS	0,60	0,90	1,00	1,00				
SE1-SYS	0,19	-0,36	-0,66	-0,64	1,00			
SE3-SYS	0,48	0,07	-0,14	-0,12	0,63	1,00		
SE4-SYS	0,52	0,57	0,57	0,57	-0,22	0,44	1,00	
NO4-SYS	0,07	-0,41	-0,68	-0,66	0,94	0,53	-0,24	1,00

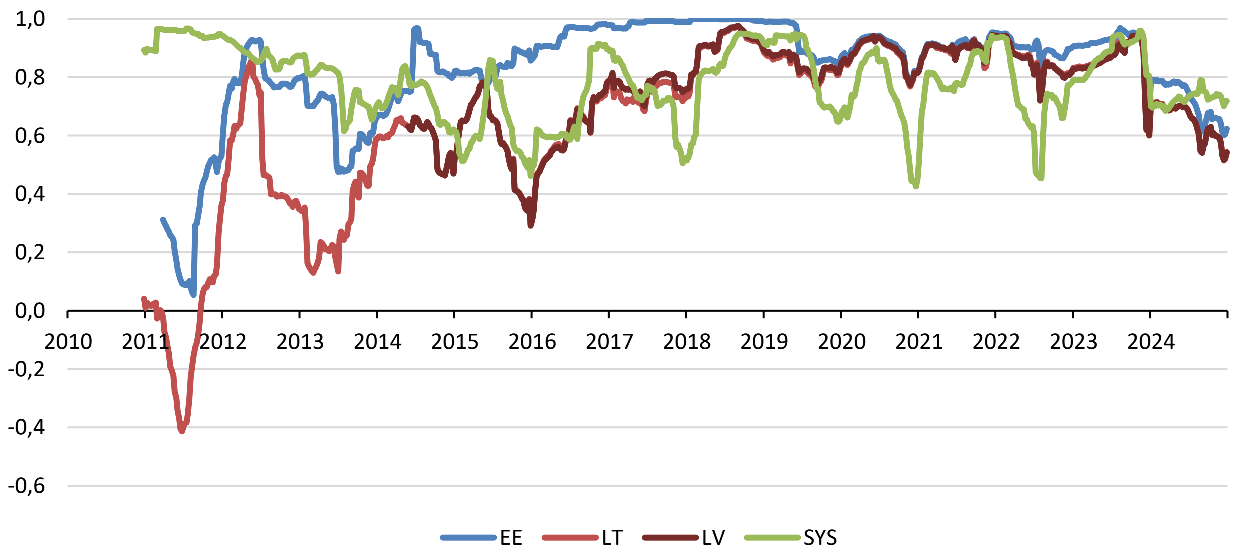
Data source: Nord Pool.

Table 2f

2022-2024	FI-SYS	EE-SYS	LV-SYS	LT-SYS	SE1-SYS	SE3-SYS	SE4-SYS	NO4-SYS
FI-SYS	1,00							
EE-SYS	0,54	1,00						
LV-SYS	0,61	0,99	1,00					
LT-SYS	0,61	0,99	1,00	1,00				
SE1-SYS	0,20	0,42	0,42	0,41	1,00			
SE3-SYS	0,54	0,35	0,38	0,37	0,14	1,00		
SE4-SYS	1,00	0,54	0,61	0,61	0,20	0,54	1,00	
NO4-SYS	0,22	0,48	0,44	0,43	0,64	0,53	0,22	1,00

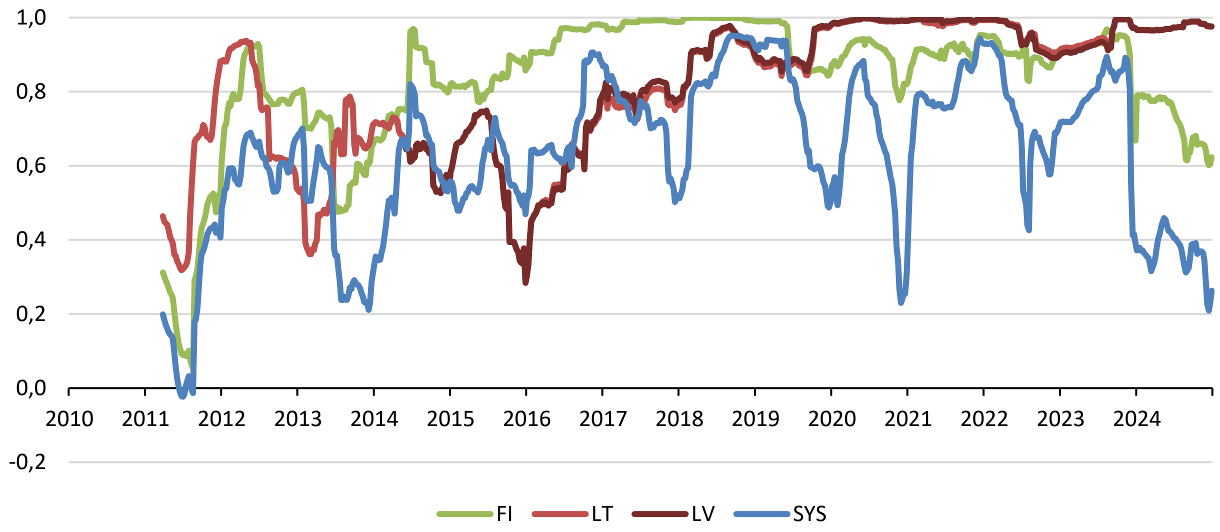
Data source: Nord Pool.

Figure 45: Correlation, monthly, between Finland (FI) and relevant bidding zones



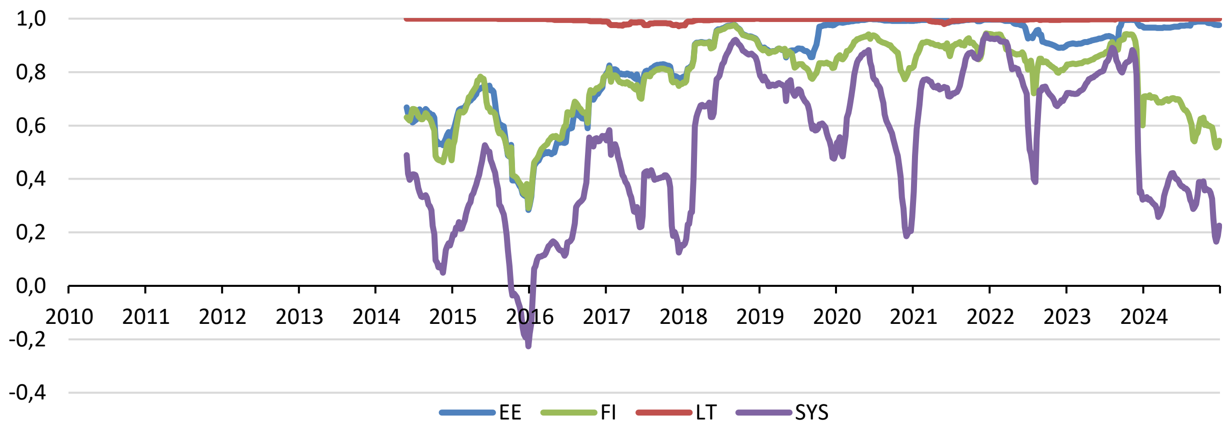
Data source: Nord Pool.

Figure 46: Correlation, monthly, between Estonia (EE) and relevant bidding zones



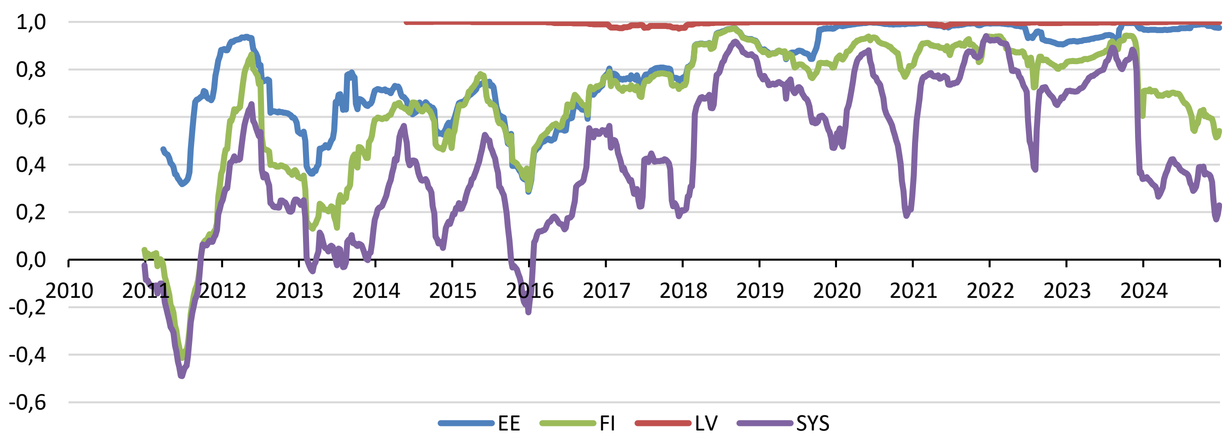
Data source: Nord Pool.

Figure 47: Correlation, monthly, between Latvia (LV) and relevant bidding zones



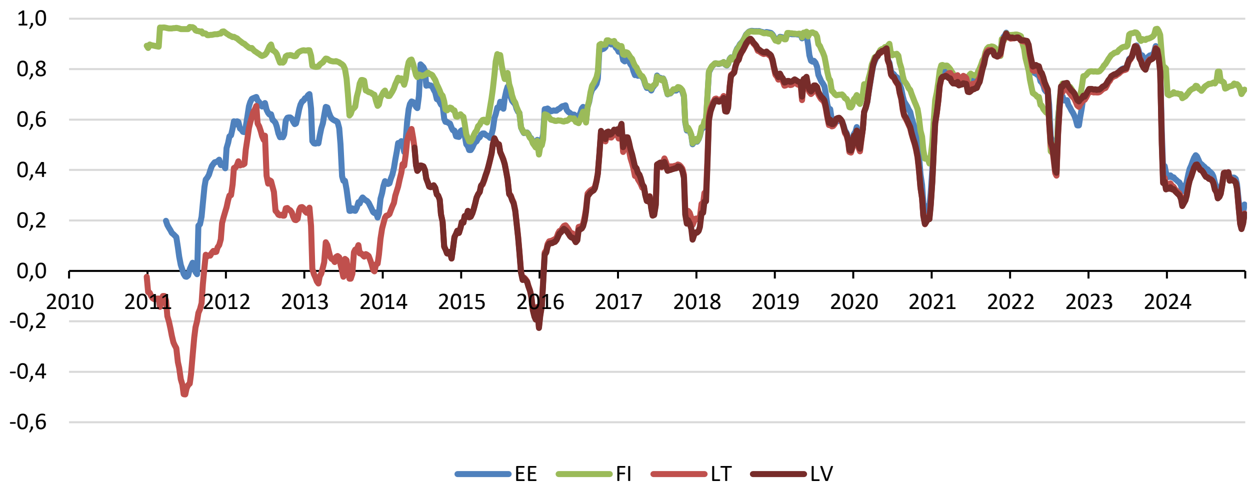
Data source: Nord Pool.

Figure 48: Correlation, monthly, between Lithuania (LT) and relevant bidding zones



Data source: Nord Pool.

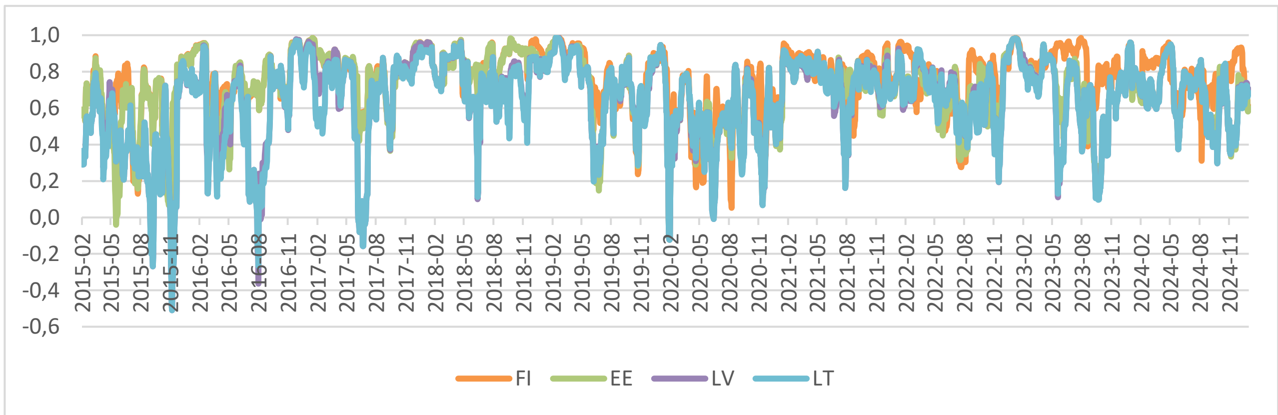
Figure 49: Correlation, monthly, between Nordic System price (SYS) and relevant bidding zones



Data source: Nord Pool.

It seems that the similarity of the development of correlations in the period of 2020-2024 and hedging is not unambiguous in the context of risk management. On the one hand, it has become easier for risk managers to predict the development of electricity prices in the future. On the other hand, it may not be useful for risk diversification of the investment portfolio.

Figure 50: Correlation, daily, between Nordic System price (SYS) and relevant bidding zones, 30 days backward



Data source: Nord Pool.

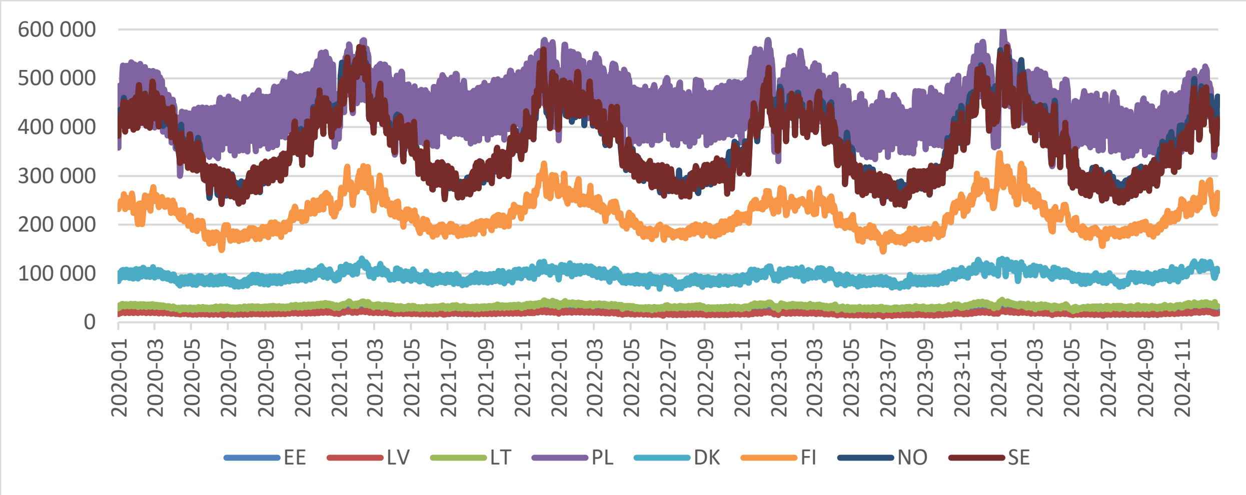
9.2. Analysis of physical consumption

9.2.1. Analysis of the development of the structure of the physical consumption in the Baltic countries

The consumption of electricity and the demand related to it affect the transactions on the *Nord Pool* exchange and the prices fixed in the transactions. It can be stated that fluctuations in the correlations of electricity consumption in different bidding zones indirectly affect the risk associated with the interzonal price difference. Below is a graphical analysis of correlations between different bidding zones. In conclusion, the correlation of volumes of physical consumption in different bidding zones tends to acquire temporary deviations but remained stable and quite predictable even in the presence of significant price changes. On the other hand, the stability and predictability of physical electricity consumption and its correlations in different bidding zones means that the greater sources of risk are not in the demand for electricity, but in the supply.

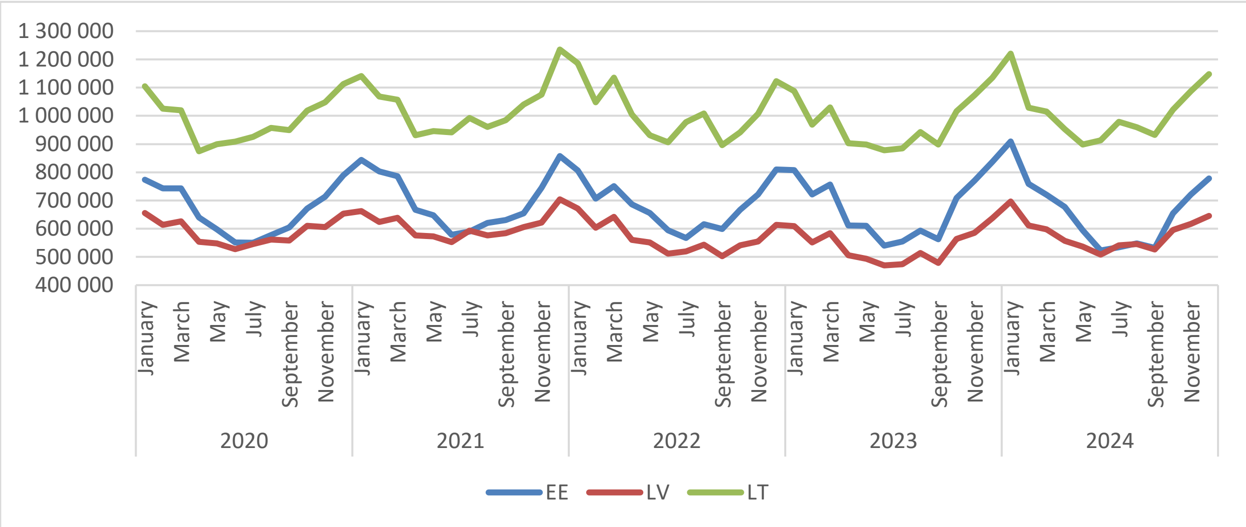
Since the Baltic countries and the Nordic countries are in the same climate zone, the seasonality and other fluctuations of physical electricity consumption are very similar (see Figures 51-52).

Figure 51: Physical consumption of electricity, MWh



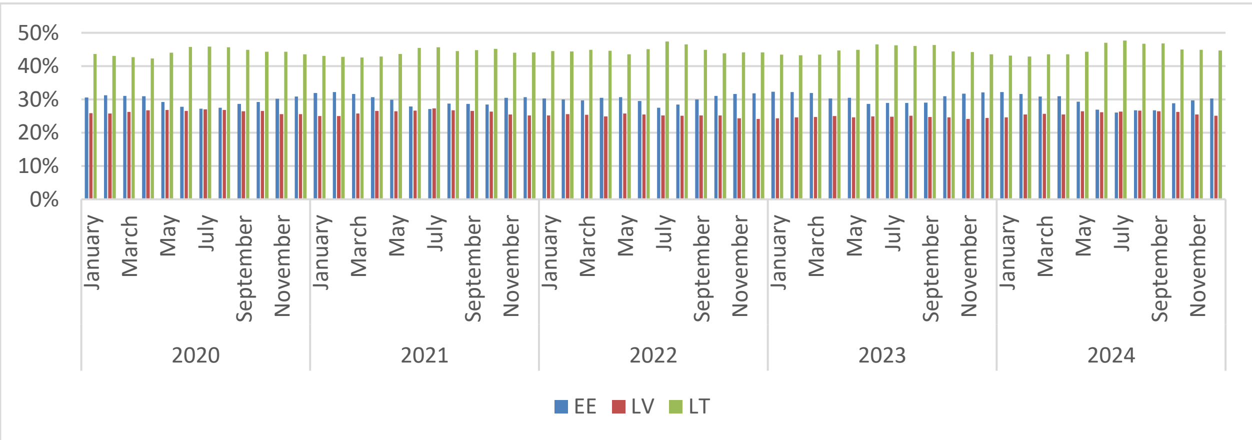
Data source: ENTSO-E.

Figure 52: Development of physical consumption of electricity in the Baltic countries, MWh



Data source: ENTSO-E.

Figure 53: Development of the structure of physical consumption of electricity in the Baltic countries



Data source: ENTSO-E.

9.2.2. Analysis of the correlation of physical consumption of electricity

Tables 3 a-h show the correlation of daily consumption. It covers the specific Norwegian, Swedish, Finish, Estonian, Latvian, and Lithuanian bidding zones for the period 01.01.2020 to 31.12.2024.

Table 3a: Correlation of physical consumption, 2020-2022 years

2020	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,9175	0,8630	0,7433	0,8684	0,9152	0,9159	0,9378	0,9366
LV		1,0000	0,9361	0,8808	0,9115	0,7827	0,7608	0,8090	0,7947
LT			1,0000	0,9189	0,9098	0,7253	0,7028	0,7490	0,7352
PL				1,0000	0,8568	0,6011	0,5518	0,6166	0,5950
DK					1,0000	0,7562	0,7420	0,8125	0,7835
FI						1,0000	0,9430	0,9432	0,9658
NO							1,0000	0,9758	0,9921
SE								1,0000	0,9923
Nordic									1,0000

Data source: ENTSO-E.

Table 3b

2021	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,8923	0,8640	0,7240	0,8983	0,9516	0,9154	0,9438	0,9432
LV		1,0000	0,9431	0,8723	0,8786	0,8206	0,7343	0,7963	0,7836
LT			1,0000	0,8543	0,8456	0,8164	0,7281	0,7818	0,7744
PL				1,0000	0,7924	0,6308	0,5574	0,6259	0,6051
DK					1,0000	0,8471	0,8272	0,8776	0,8599
FI						1,0000	0,9471	0,9616	0,9728
NO							1,0000	0,9825	0,9927
SE								1,0000	0,9955
Nordic									1,0000

Data source: ENTSO-E.

Table 3c

2022	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,8854	0,8445	0,7303	0,8751	0,9040	0,8987	0,9191	0,9189
LV		1,0000	0,9212	0,7965	0,9193	0,8614	0,8212	0,8778	0,8623
LT			1,0000	0,8301	0,8732	0,8360	0,7916	0,8522	0,8349
PL				1,0000	0,7853	0,6178	0,5820	0,6521	0,6253
DK					1,0000	0,8493	0,8303	0,8814	0,8653
FI						1,0000	0,9549	0,9570	0,9754
NO							1,0000	0,9703	0,9908
SE								1,0000	0,9919
Nordic									1,0000

Data source: ENTSO-E.

Table 3d

2023	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,9332	0,8894	0,7357	0,8823	0,9417	0,9212	0,9461	0,9441
LV		1,0000	0,9425	0,8468	0,9237	0,8674	0,8442	0,8930	0,8764
LT			1,0000	0,8742	0,8804	0,8098	0,7904	0,8462	0,8241
PL				1,0000	0,7796	0,6241	0,6156	0,6957	0,6551
DK					1,0000	0,8602	0,8630	0,9024	0,8865
FI						1,0000	0,9615	0,9608	0,9783
NO							1,0000	0,9784	0,9935
SE								1,0000	0,9930
Nordic									1,0000

Data source: ENTSO-E.

Table 3e

2024	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,9053	0,8158	0,7228	0,8724	0,9445	0,9438	0,9578	0,9614
LV		1,0000	0,9136	0,8535	0,8847	0,8432	0,8380	0,8714	0,8630
LT			1,0000	0,7966	0,7938	0,7581	0,7677	0,7876	0,7832
PL				1,0000	0,7482	0,6264	0,6412	0,7021	0,6706
DK					1,0000	0,8264	0,8590	0,8823	0,8722
FI						1,0000	0,9436	0,9465	0,9684
NO							1,0000	0,9797	0,9924
SE								1,0000	0,9931
Nordic									1,0000

Data source: ENTSO-E.

Table 3f

2020-2022	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,8700	0,8578	0,7353	0,8753	0,9242	0,9076	0,9314	0,9318
LV		1,0000	0,9030	0,8120	0,8965	0,8138	0,7621	0,8183	0,8047
LT			1,0000	0,8663	0,8687	0,7963	0,7376	0,7935	0,7811
PL				1,0000	0,8028	0,6203	0,5578	0,6259	0,6049
DK					1,0000	0,8302	0,8005	0,8567	0,8393
FI						1,0000	0,9427	0,9495	0,9682
NO							1,0000	0,9770	0,9917
SE								1,0000	0,9932
Nordic									1,0000

Data source: ENTSO-E.

Table 3g

2022-2024	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,8626	0,8328	0,7282	0,8372	0,9322	0,9286	0,9501	0,9489
LV		1,0000	0,9201	0,7891	0,9094	0,8420	0,8151	0,8483	0,8435
LT			1,0000	0,8125	0,8367	0,7842	0,7753	0,8092	0,7998
PL				1,0000	0,7195	0,6109	0,6231	0,6948	0,6566
DK					1,0000	0,8369	0,8432	0,8689	0,8621
FI						1,0000	0,9490	0,9494	0,9709
NO							1,0000	0,9786	0,9928
SE								1,0000	0,9927
Nordic									1,0000

Data source: ENTSO-E.

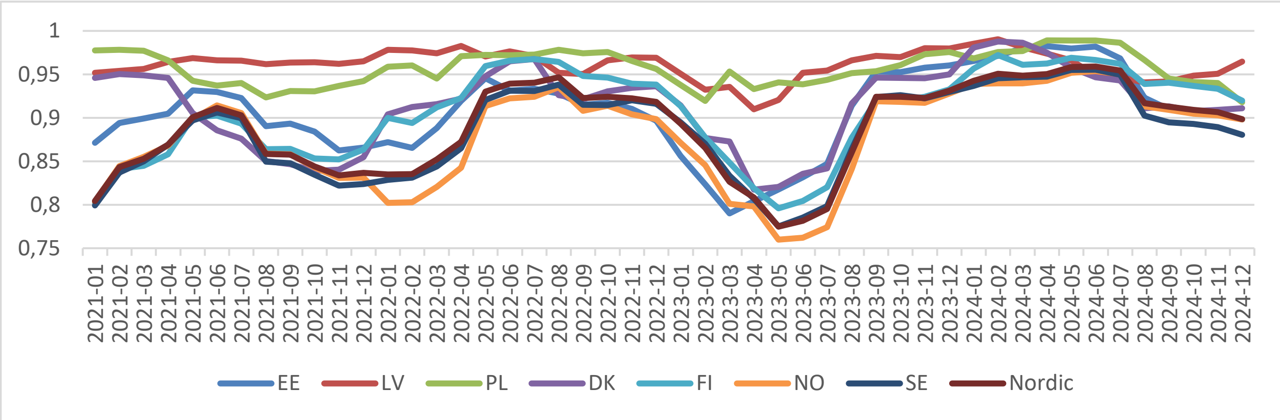
Table 3h

2020-2024	EE	LV	LT	PL	DK	FI	NO	SE	Nordic
EE	1,0000	0,8596	0,8459	0,7301	0,8473	0,9266	0,9124	0,9378	0,9375
LV		1,0000	0,9030	0,8059	0,8639	0,8119	0,7642	0,8251	0,8085
LT			1,0000	0,8429	0,8433	0,7893	0,7501	0,8009	0,7885
PL				1,0000	0,7422	0,6103	0,5749	0,6553	0,6222
DK					1,0000	0,8293	0,8178	0,8504	0,8441
FI						1,0000	0,9444	0,9469	0,9688
NO							1,0000	0,9736	0,9913
SE								1,0000	0,9918
Nordic									1,0000

Data source: ENTSO-E.

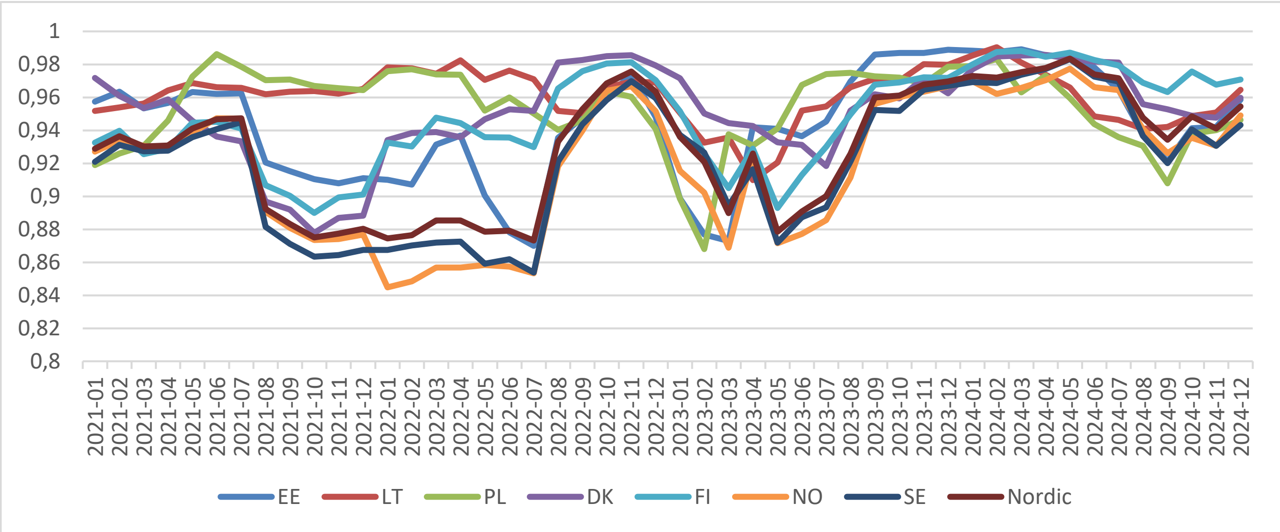
It seems that the stability of electricity consumption correlations, clear cyclicality, seasonality, etc. corresponds to a relatively stable and predictable demand. In addition, this predictability of which is favourable for the development of hedging strategies. On the other hand, changes in the amount of electricity consumption and the price of electricity simultaneously pose a much higher risk.

Figure 54: Development of the monthly correlation of physical consumption of electricity between LT and EE, LV, PL, DK, FI, NO, SE



Data source: ENTSO-E.

Figure 55: Development of the monthly correlation of physical consumption of electricity between LV and EE, LT, PL, DK, FI, NO, SE



Data source: ENTSO-E.

ABBREVIATIONS

ACER - European Union Agency for the Cooperation of Energy Regulators.

BRELL - Belarus, Russia, Estonia, Latvia, Lithuania.

CESA - Continental Europe Synchronization Area.

EPAD - Electricity Price Area Differential.

FCA - Forward Capacity Allocation.

FTR - Financial Transmission Right.

HAR - Harmonised Allocation Rules (for Long-Term Transmission Rights).

IEA - International Energy Agency.

IPS/UPS - Integrated Power System/ United Power System.

JAO - Joint Allocation Office.

LTTR - Long-Term Transmission Right.

MARI - Manually Activated Reserves Initiative.

NEMO - Nominated Electricity Market Operator.

NERC - National Energy Regulatory Council.

PICASSO - Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation.

PPA - Power Purchase Agreement.

RES - Renewable Energy Sources.

TSO - Transmission System Operator.