ELECTRICITY MARKET ESTABLISHMENT
AND ITS CURRENT SITUATION IN EUROPE

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DOI: 10.32702/2306-6814.2020.21—22.48

Usage of electricity is drastically differ today that it was first introduced. With development and
industry, technology and raise of world population created new challenges and needs. Before he
establishment of electricity markets, the industry was long been regulated by utility companies that
had control the overall production, transmission and sales. Vertically integrated systems had one
producer that managed the whole process and prices mainly regulated by the tariffs set by authorities.
However, shifting from traditional method to a market theme has opened a new page in electricity
industry. Thus, deregulated markets started to introduce split independent players such as
producers, transmission companies and consumers. Starting from the 1980’s enormous changes
occurred in this field which reshaped today’s electricity liberal markets. Moreover, electricity itself
changed from being only commodity to a financial exchange instrument. Electricity Markets definition
itself is still considered a new terminolody in some parts of the world it’s been in use for several
decades in other parts. Liberal power markets brought new competition and higher utilization to the
sector. Investors started to show interest in energy production, transmission and trades. Europe is
one of the pioneers who implemented new liberal electricity markets shifting from traditional one.
Nowadays, there electricity trades happen using three main channels: bilateral agreements, physical
markets, and financial markets. Bilateral agreements is the one that has the highest trade volumes
among three. It is separate from regulated market conditions, and happen among the sellers and
buyers based on agreements. Unlike bilateral contract, physical markets or spot market is regulated
by dealers. Finally, financial markets of electiricy is similar to derivatives markets use financials for
trading. This article illustrates market integration, inter-market relations using experiences of
European countries. The aim of this articke to briefly discuss the points of successfull market
integration.

Використання електрики сьогодні сильно відрізняється від того, яким воно було з моменту
виникнення. Розвиток промисловості, технологій і зростання населення світу створили нові
проблеми і потреби. До створення ринків електроенергії галузь тривалій час регулювала
комуніальними підприємствами, які загалом контролювали виробництво, передачу та продаж.
У вертикально інтегрованих системах один виробник керував усім процесом, а ціни в основно-
му регулювалися тарифами, що встановлюються владою. Однак перехід від традиційного ме-
tоду до ринкового відкрив нову сторону в електроенергетиці. Таким чином, на деревуваних
ринках почали з’являтися окремі незалежні гравці, такі як виробники, передавальні компанії та
споживачі. Починаючи з 1980-х років у цій галузі відбулися величезні зміни, які змінили сьо-
годнішні ліберальні ринки електроенергії. Більш того, сама електроенергія з простого товару
перетворилася на інструмент фінансового обміну. Саме визначення “Ринки електроенергії” до
сих пір вважається новим терміном у деяких частинах світу, воно використовується вже кілька
Electricity markets had such a structure until the 1990s, in the electricity industry, which traditionally has a state-controlled monopoly structure, there have been reforms aimed at the separation of the vertically integrated monopoly structure that governing generation, transmission, distribution and retail together, and the liberalization of markets to gain a competitive character. There are three main tools of reforms to ensure efficiency in markets: free access to the network, restructuring and deregulation [7]. However, these stages are subject to intensive regulation in order to ensure and protect the conditions of competition throughout the industry. Thus, it is tried to prevent the abuse of market power by incumbent companies and to ensure fair access of all market participants to the transmission and distribution networks. For this purpose, the operation of the network system is carried out by an independent system operator.

In a vertically integrated monopoly structure, a single company manages the production, transmission, distribution and sale of electricity to the end consumer. The company’s field of activity can be a region or a city, or it can be a whole country. Early regulations to give the electricity markets a competitive edge focused on the decoupling of this vertically integrated structure and fair access of third parties to the grid.

Despite small differences, the motivation behind the liberalization of energy markets around the world has common ideological and political reasons. Especially, the expectation that the success achieved by liberalization in other markets can also be achieved in the energy sector and the need for the division of the monopoly structure. Despite small differences, the motivation behind the liberalization of energy markets worldwide has common ideological and political reasons. Especially, it can be mentioned that the success achieved by liberalization in other markets can be achieved in the energy sector and the need for the division of the monopoly structure. The competitive structure is expected to trigger technological innovations in the sector and increase economic efficiency [11]. However, the disruption of the monopoly structure has been possible with changes and developments in production, transmission and distribution technologies. In the electricity industry, this structure of the production process, which was accepted as a natural monopoly due to the economies of scale that required the use of large generation plants until the 1990s, could be disrupted as a result of the economic activity achieved by smaller generation plants thanks to new generation technologies. However, developments in information technologies and the operation of transmission
and distribution networks played an important role in decoupling the vertically integrated structure in generation, transmission and distribution. Thus, it has been possible to open the production, wholesale and retail markets to competition in the electricity industry.

**ELECTRICAL INDUSTRY MODELS**

Four basic models have been identified regarding the structure of the electricity industry: Monopoly, Single Buyer Model, Wholesale Competition, Retail Competition. Until the electricity industry reforms, the first model prevalent worldwide is a vertically integrated monopoly industry structure with no competition. All sequential market activities from the generation of electricity to the sale to the end consumer are carried out by a single firm [7].

In the single-buyer (purchasing agent) model, competition is only allowed in the electricity generation phase. New production capacities are free to participate in the market. However, there is only one authority in the purchase of electricity from the producer. This institution negotiates with producers on behalf of all registered consumers. That is, at this stage, price formation takes place on a competitive principle. After the sale is realized, the electricity is sold to the suppliers who will provide the distribution at an updated tariff. Electricity is delivered to the end consumer by the supplier company. At this stage, the consumer has no chance to choose the supplier company. Retail prices do not form as a result of the functioning of the market mechanism. In other words, there is a monopoly structure in the distribution phase. However, the model is advantageous at the initial stage of reforms due to its simplicity [7].

In markets where the retail market operates in a competitive manner, consumers have the opportunity to choose the company from which they will purchase electricity. Like the wholesale market, the retail market operates with the market mechanism [7]. Of course, building such a market requires a specialization process both physically and in terms of training market participants. Another difficulty of such markets is that they require some strict regulations to protect the consumer [7].

During the starting phase of the liberalization process in the European electricity markets, electricity trading only realized with bilateral agreements and in over-the-counter markets. Bilateral agreements allow traders to trade without any exchange markets. Following the period when the first electricity directive was implemented, electricity exchanges started to be established in several European countries and started from 2016, pooled wholesale electricity markets organized. In electricity exchange markets, electricity trades in spot markets, intraday markets and in derivatives markets.

**European Electricity Exchanges**

Nord pool that includes Scandinavian and Baltic countries is the first multinational organized electricity market in the Europe. Unlike NETA (New Electricity Trading) in England and Wales, participation is not a mandatory even though it is a pooled market. Nord Pool managed to organize the largest international electricity market by adding Sweden in 1996, Finland in 1998, Denmark in 1999, Estonia in 2010, Lithuania and Latvia in 2013 to its pool. Nord Pool has 380 members and its trade volume reached 485 TWh in 2015 (table 1). Electricity market is open to many buyers, a more realistic competition can be mentioned. On the other hand, in the retail sales phase, the consumer does not have the opportunity to choose the retailer to buy electricity [7].

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### Table 1. list of power exchanges in Europe

<table>
<thead>
<tr>
<th>Title</th>
<th>Involved countries</th>
<th>Established</th>
<th>Trade volume TW</th>
</tr>
</thead>
<tbody>
<tr>
<td>APX Power NL</td>
<td>The Netherlands</td>
<td>1999</td>
<td>44</td>
</tr>
<tr>
<td>APX Power UK</td>
<td>UK</td>
<td>2000</td>
<td>62</td>
</tr>
<tr>
<td>Belpex</td>
<td>Belgium</td>
<td>2002</td>
<td>24</td>
</tr>
<tr>
<td>BSP Southpool</td>
<td>Austria, Italy, Slovenia</td>
<td>2008</td>
<td>6</td>
</tr>
<tr>
<td>EEX</td>
<td>Germany</td>
<td>2002</td>
<td>2537</td>
</tr>
<tr>
<td>EPEX Spot</td>
<td>Austria, Belgium, France, Germany, Luxembourg, UK, the Netherlands, Switzerland</td>
<td>2008</td>
<td>566</td>
</tr>
<tr>
<td>EPIAS</td>
<td>Turkey</td>
<td>2015</td>
<td>99</td>
</tr>
<tr>
<td>EXAA</td>
<td>Austria, Germany</td>
<td>2001</td>
<td>8</td>
</tr>
<tr>
<td>EXIST</td>
<td>Turkey</td>
<td>2015</td>
<td>152.32</td>
</tr>
<tr>
<td>GME</td>
<td>Austria, France, Greece, Italy, Malta, Slovenia, Switzerland</td>
<td></td>
<td>312</td>
</tr>
<tr>
<td>HEinEX</td>
<td>Greece</td>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>HUPX</td>
<td>Hungary</td>
<td>2010</td>
<td>22</td>
</tr>
<tr>
<td>IBEX</td>
<td>Bulgaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nordpool Spot</td>
<td>Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Sweden, UK</td>
<td>489</td>
<td></td>
</tr>
<tr>
<td>OTE</td>
<td>Czech Republic</td>
<td>2001</td>
<td>20</td>
</tr>
<tr>
<td>OMIP</td>
<td>Netherlands, Malta, Belgium, Cayman Island, Denmark, Luxembourg</td>
<td>2006</td>
<td>30</td>
</tr>
<tr>
<td>OPCOM</td>
<td>Romania</td>
<td>2000</td>
<td>85</td>
</tr>
<tr>
<td>powernext</td>
<td>france</td>
<td>2001</td>
<td>1024</td>
</tr>
<tr>
<td>PXE</td>
<td>Czech Republic, Hungary, Poland, Romania, Slovakia</td>
<td>2007</td>
<td>24</td>
</tr>
<tr>
<td>TGE</td>
<td>Poland</td>
<td>1999</td>
<td>186</td>
</tr>
</tbody>
</table>

Source: Next Kraftwerke https://www.next-kraftwerke.com/knowledge/power-exchanges-list
The deregulation of the electricity markets in France started in 2000, but the transition to competition took place at the end of 2001. The French electricity exchange Powernext was established in November 2000 with the support of NordPool. In September 2008, EPEX SPOT was created with 50% EEX and 50% Powernext support. Powernext in January 2009; EEX was transferred to EPEX SPOT in September 2009.

In April 2015, the APX group which included Belpex, merged with EPEX SPOT, thereby covering central-western Europe and the UK region. Since the end of 2016, it has been operating under the name EPEX SPOT.

The Spanish electricity exchange OMIE (OMEL) was established in 1997 with a mandatory participation. OMIE, which started its operations in Spain in 1998, covers the entire Iberian Peninsula since 2007 and is currently operated in accordance with the Nord Pool model. As of 2016, 80% of the electricity supply in Spain and Portugal is traded in OMIE. Geographically separated from the rest of Europe, the Iberian Peninsula was connected to France with the Inelfe transmission line, which was decided in 2008 and the construction was completed in February 2015. This line, which provides the electricity trade between Spain and France, started commercial operation as of October 2015. In the electricity markets, the foreign trade balance of countries varies from year to year due to market coupling, cross-border transmission network capacity constraints and price fluctuations. The foreign trade balance of electricity markets (exchanges) is the balance between physical electricity input and output in countries. The balance in the physical electricity flow and the balance of commercial transactions (export and import difference) are generally not equal in a system where the physical electricity flow is provided by interconnection between the two countries (ENTSO-E, 2015).

Unless there is a capacity constraint in the electricity trade between the regions, a single price is formed in the system. In this case, the entire regions can be evaluated as a single market. If the transmission network capacity between the regions is insufficient, a separate equilibrium price will occur in each market in the absence of trade between regions. If the trade between the regions exceeds the transmission network capacity, market splitting will occur. In this case, the system operator (TSO) can perform arbitrage trade from the low price zone to the high price zone by using the capacity of the line to the maximum. Market price occurred as a result of this will be lower less than the average of prices that will occur when markets are balanced separately [1].

TSO’s profit obtained from arbitrage trade is called the “Constraint Management Fee” or the “Congestion rent”. If electric current transmitted from region B to region A is f_{b,a} provided that P_{b} > P_{a}. TSO’s profit is (P_{b} - P_{a}) f_{b,a}. This gain can be utilized in a way that contributes to increasing social welfare by transferring it to transmission network capacity investments or by sharing it among system users. On the other hand, TSO can also apply an optimization approach based on market balancing and market price formation separately. In European electricity markets, the market segregation method is applied in the North Pool. Accordingly, for example, while different prices may occur in each price zone determined according
to transmission network constraints in Sweden, it is possible for a single price to be formed in the remainder of the North pool.

In market matching, instead of dividing the market into sub-regions, more than one market is treated as a region connected by interconnections. In fact, transmission network capacity management applied in market divergence is also applied in market matching.

In market segregation, the fact that market participants only bid for the region they are affiliated to provides various advantages in terms of market operation. However, its implementation for networks covering a wide geography is difficult as it requires a structure that governs the transmission network capacity management of all price zones together [1].

Hence, the solution carried out for the integration of electricity markets in Europe is based on market matching. Examples of market matching include the central-western European region that includes France, Belgium, Germany/Austria and the Netherlands. Here, each country is a separate market that is part of a whole.

The fact that the right to access the cross-border transmission network is based on the auction between market participants creates an opportunity for arbitrage between markets. Short-term arbitrage supports price convergence and therefore market integration. On the other hand, as in North Pool, an approach that simultaneously clears the electricity markets and is based on optimization of transmission network sharing also supports the integration of markets.

Transmission network constraints are a factor that strengthens the fragmented structure of electricity markets and therefore the market power of producers in the region. In this context, market matching makes important contributions to the formation of a competitive market environment. With market matching, the number of firms competing in the market increases, and the opportunities for incumbent firms to apply market power are restricted. Here, it is important to target the independence of the system operator and the level of efficiency that maximizes social welfare in balancing the market. The efficiency level that can be achieved by market matching can be realized below the theoretical level due to differences in market design of participating markets, energy policies and the authority and responsibility of regulatory boards. Therefore, the success of market matching and therefore the construction of a fully integrated market depends on the harmonization of differences at national level or the establishment of an inclusive legal framework across Europe [1].

Market matching provides more competitive results in the market. However, market integration will increase the likelihood of competitive results. Market integration implies that the opportunities for firms to exercise market power are not possible, that firms compete in a single integrated market, not in discrete markets. Thus, market power will depend not on the shares of firms in their national markets but on their share in the integrated market, which will reduce the market power of firms in national markets.

Price Matching Zones (PCR)

Price Matching Zones (PCR) is a market matching solution initiated by European electricity exchanges to be implemented across Europe. A common algorithm that takes into account the capacity constraints of the transmission network is applied in the calculation of day-ahead electricity prices in PCR member markets. Central-western Europe (CWE), central-eastern Europe (CEE), central-south Europe (CSE), South-western Europe (SWE), France–United Kingdom–Ireland (FUI), Baltic and Scandinavian (Northern Europe) within the framework of PCR 7 regions are defined as NE) regions. Accordingly, the regions defined and the countries within the relevant region are as follows:

- CWE: Germany/Austria, Belgium, France, Netherlands, Switzerland, Luxembourg.
- CEE: Germany/Austria, Czech Republic, Poland, Hungary, Slovenia, Slovakia.
- CSE: Germany/Austria, France, Italy, Slovenia, Greece.
- SWE: France, Spain, Portugal.
- FUI: France, UK, Ireland.
- NE: Sweden, Norway, Denmark, Finland.

The PCR initiative started in 2009, the parties signed their partnership agreement in June 2012. An important component of the PCR project was the development of a common price matching algorithm called EUPHEMIA (Pan-European Hybrid Electricity Market Integration Algorithm).

Originally developed for the Belgian electricity exchange Belpex, COSMOS was expanded into the CWE region in 2010 and became a pioneer in the development of EUPHEMIA. EUPHEMIA is an algorithm that solves the market coupling problem in day-ahead electricity markets within the framework of PCR. With EUPHEMIA, supply and demand are balanced for every period of the day in day-ahead electricity markets and market price. While calculating, the structural features of participating markets and transmission network capacity constraints are also taken into account. The algorithm calculates the market price, net positions and interregional electricity by processing the purchase and sale offers given to participating markets (national or regional). However, as a result of optimization, it is also possible for different prices to occur in different price zones. In case of price differences between EUPHEMIA and neighboring markets, an optimization problem designed to ensure full capacity utilization of the transmission network is solved. The most important advantage of EUPHEMIA over other algorithms, which is its predecessor, is that it can combine not only markets with the same or similar characteristics but also markets with different requirements under a single algorithm.

In this way, market matching can be successfully applied in regions with different market designs; Inefficiencies arising from national differences are minimized. The three main objectives of EUPHEMIA are listed as creating competitive prices in the market, improving public welfare and ensuring efficient allocation of capacity [4].

When compared to the market, the maximization of social welfare is achieved by comparing the demand and supply of electricity. In intermarket transmission, more consumers and producers coincide, but there is
less consumer or producer surplus. EUPHEMIA optimizes social welfare defined as a function of consumer surplus producer surplus and constraint return variables to be greater than or at least equal to the scenario of no electricity transfer between markets [4].

In February 2014, the PCR project was expanded to include the Central Western Europe (CWE) and UK electricity markets as well as the Nordic and Baltic electricity markets (Nord Pool). Thus, the price matching region defined was named as North-West Europe (NWE). EUPHEMIA was first introduced in the NWE region. In May 2014, the South-western European region (SWE) matched with the NWE, with the participation of the Spanish and Portuguese electricity markets (OMIE). The Central and Eastern European (CEE) Electricity Markets Integration Initiative was implemented in November 2014 with the participation of the Czech Republic, Slovakia, Hungary and Romania under the multi-regional mapping (MRC) framework. In February 2015, the matching of Italy with the electricity markets of France, Austria and Slovenia was realized. Thus, the PCR project and thus the EUPHEMIA implementation have been expanded to cover approximately 85% of the trade in the European electricity markets at the beginning of 2016.

CONCLUSION

The aim of this study is to investigate the presence / extent of market integration in European electricity markets within the framework of the objective of a European common electricity market, the legal infrastructure of which is determined by the European Commission directives on electricity. To this end, it aims to investigate short-term movements of volatility between markets and long-term matching relationships by analyzing the relationships and interactions between market prices. The study also aims to explain inter-market interactions with a focus on market integration. In other words, the study aims to shed light not only on the problem of integration in European electricity markets, but also on the process of overall market dynamics characterized by mutual interaction.

References: