ENERGY MARKETS

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This document describes the key aspect of the energy markets, with a particular focus on electricity markets and is developed as a supporting/reading material for participants of the Energy Community Summer School 2018

1. Introduction

Energy trading markets have developed rapidly since the growth of oil spot markets four decades ago. The liberalization of energy markets across Europe has led to the emergence of gas and electricity trading markets in many countries. Coal trading has also developed in recent years and the trading of carbon emissions has grown following the creation of the EU Emissions Trading Scheme and the sustainability agenda.

Natural gas and electricity in the wholesale market are traded as all other commodities. However, due to their nature[1], the framework around delivery differs a lot compared to other commodities.

Electricity is traded on forward and also spot basis and only produced when it needs to be consumed. The network is natural monopoly and is used by all market participants that trade electricity which involves physical delivery. As the industry cannot function purely on bilateral arrangements the role of the transmission system operator (TSO) emerged. In most countries in Europe, the TSOs own and operate the transmission network (high-voltage grid) and operate the system, i.e. ensure non-discriminatory third party access, manage the scheduling of deliveries, operate ancillary services and ensure balancing of the system.

The role of the TSOs became even more important with cross-border trading and the need to cooperate and coordinate in establishing and operating cross-border mechanisms that and facilitate market and liquidity. Cross-border competition is particularly important for creating a pan-European internal electricity market. Where market entrance in generation is difficult to be achieved in a particular country, cross-border competition shall serve as a means of introducing competition on the relevant market in question.

The Third Energy Package, including the subsequently developed network codes and guidelines set the frame of the electricity market design and natural gas market design. Most of the mechanisms prescribed in this design are already in implementation as industry and regulatory initiative. The results show significant efficiency gains due to increased cross-border trading and efficient use of generation and network capacities.

The design suggested for electricity market is a forward market, with explicit forward physical or financial transmission rights, day-ahead implicit auctions, intraday continuous implicit allocation and cross-border exchange of reserves and balancing services.

[1] Electricity can only be stored on insignificant volume and as such it is generated and consumed instantaneously. This means that it requires an entire industry build specifically for generation, transport and related electricity services. Natural gas in many aspects is similar. The key difference is that it can be stored and as such storages play an important role in the industry.

2. Overview of wholesale electricity markets – national and cross-border

Electricity is a commodity, and in order for the electricity system to function properly, the generation has to equal consumption in addition to grid losses to prevent deviation of grid frequency from its reference value. The design of national but also European electricity markets is adapted to this specificity. Different types of electricity markets are established and function in a sequential order, starting years before the actual delivery and ending after the actual delivery. The electricity market in Europe is (mainly) an energy-only market, meaning that generators are paid for generated electricity that they sell or offer as a service.

Physical delivery of a commodity contract implies that a market player has to arrange a physical receipt or delivery in a defined point (i.e. to physically schedule the exchange). In most financial electricity markets on the other hand, there is no physical delivery. Financial markets are also not a subject of this paper and would be referred to below only to the extent relevant for explaining the other concepts.

2.1. National wholesale electricity markets

2.1.1. Forward v spot markets

Electricity markets could be forwards/futures or spot markets.

Forward/futures market. Commodities are traded on forward/futures markets for delivery in the future, and are taking place before the day-ahead market. Forwards and futures are contracts to deliver/consume a certain amount of electricity at a certain time in the future for a price agreed upon on the date of the contract conclusion.

Forwards represent a duty to buy or sell a fixed-time profile and amount of electricity at a predetermined or determinable contract price at a specified time in the future. They are customized contracts for the supply of electricity between the buyer and the seller, where the buyer is obliged to receive and the seller to submit the electricity. Futures have a similar structure as forwards but are, in contrast to the former, highly standardized in defining contract terms, trading location, transaction requirements and financial settlement procedures. Future contracts are traded exclusively on organized exchange markets, and forward contracts are usually traded in bilateral electricity markets, therefore giving more flexibility to the parties.

Prices from future contracts are a better indicator of transparency and market alignment than prices from forward contracts as they are settled only through financial payments of the price differences between the price specified in the futures contract and the daily (spot) price, which reduces the operating costs of these contracts. In addition, credit risks and monitoring costs for futures contracts are much lower than for forward contracts, as exchange markets implement strict entry requirements to ensure the smooth financial performance of all engaged trading participants. Bilateral transactions are, on the other hand, vulnerable to financial defaults. Future contracts profits and losses are settled on a daily basis, contrary to the cumulative total pay-out at forward contracts.

In forward and future markets, electricity can be traded between different market zones or within a single market zone. The allocation of the transmission capacity between two market zones in forward and future markets happens explicitly, meaning that transmission capacity is traded separately from electricity. This implies that market players first have to buy the right to use the transmission capacity between two market zones before buying or selling electricity in another zone.

Cross-border transmission capacity is also allocated in forward basis. The allocation managed by TSOs (Auction Office) results with physical transmission rights (PTRs) to use the cross-border capacity or the financial transmission rights (FTRs) on the cash settlement. The value

of forward transmission rights is settled via explicit auctions. In case there is no congestion (demand is lower than what is made available), the forward transmission rights are prices at price zero.

The forward market is the key in commodity trading. It represents the platform where market generators and suppliers to end users manage their forward positions on long-term basis. The aim is to manage market risk and avoid exposure on short-term prices. Market then trades based on risk appetite of market participants. Those that manage generation firms face different costs and want to make sure that they can cover most, if not all, of their costs on forward basis. Trading firms specialise on their activity in the market to take over and mitigate those risks.

On forward market, market participants trade on bilateral basis or via organised markets (screen based OTC or exchange). Purely bilateral trading involves negotiation of bespoke contracts, whereas trading on organised market is continuous trading of standard forward contracts. Forward contracts are agreements to buy or sell a commodity on a specified date in the future. Forward trading offset risks (hedge) in storing or transporting commodities by allowing producers and consumers to fix prices in advance.

Spot market. Commodities are traded in spot markets for immediate delivery. There is no perfect equivalent of a perfect spot market in the current electricity market designs but day-ahead power exchanges are often referred to as electricity spot markets.

While one of the main objectives of the liberalization process is to ensure long-term efficiency, short-term markets are critical for the purpose of optimisation and sending the adequate signals for long-term investment decisions in transmission and generation. Hence, there is a need to design adequate short-term markets to achieve long-term efficiency gains. For this purpose, power exchanges that facilitate short term trading represent an important tool for ensuring the creation of competitive electricity markets at wholesale level nationally and across borders.

2.1.2. Bilateral v organized markets

In **bilateral trading**, a generator and consumer or supplier agree on a trade contract by directly interacting with each other and agreeing on a price, which could also be referenced to a price published by a power exchange. The bilateral markets are predominant in all Contracting Parties of the Energy Community and their important role is expected to be maintained.

In **organized over-the-counter (OTC) trading**, market participants submit generation and demand bids to a market platform which is cleared continuously; one market player can bilaterally accept the bid of another market player, resulting in different prices for each trade. The platform does not act as intermediary party between the parties that at the end of the process conclude bilateral contracts.

In a power exchange or multilateral trading platform, market participants submit generation and/or generation and demand bids. The power exchange acts as an intermediary (a central counterparty) between the seller and the buyer, and each of them has a contract with the power exchange.

2.1.3. Types of day-ahead organised markets

Liberalization of the electricity industry has created a need for organized markets at the wholesale level. Two main kinds of organized day-ahead markets have emerged: **power pools** and **power exchanges**.

Both power pools and power exchanges in Europe organize spot (day-ahead and sometimes intraday) markets and some power exchanges organize derivatives (forwards/futures) markets. The latter do not take form of pool models.

Pool market model. A power pool is both a marketplace and an institution/operator of the respective market, and it is very often mandatory. In a mandatory pool, the entire electricity trading has to be transacted via the pool and, in most cases, only the supply side bids actively into the pool, while the demand is estimated (i.e. there is a necessary input of quantity without a price curve from supply side). The price determination mechanism is complex and not very transparent.

The power pool is mostly the result of a public initiative; a governmental decision on introducing some competition at the wholesale level making participation mandatory (and sometimes not allowing trade outside the pool). Pool models require close monitoring of the market, its institutions and of the market participants.

Power exchanges (PX). Power exchanges are also both a marketplace and an institution / operator of the market. As a marketplace they facilitate the trading of electricity and determine an equilibrium price. As an institution, they offer the service of running such neutral marketplace to facilitate the transaction between a seller and a buyer, where all trading participants trade anonymously. Power exchanges have trading rules, which cover the setting of prices, delivery, clearing, type of product, timing, etc. Nowadays, most organized markets in the EU are based on the PX model.

A power exchange could be either launched on a private initiative, for instance by a combination of generators, distributors and traders, and participation in the exchange is voluntary for market participants. However, establishing a power exchange could also be a regulatory or governmental decision, based on a legislative requirement. The Governments usually stand behind the idea of establishing national PX in (almost) all Contracting Parties. In some markets, the coexistence of more than one exchange is possible, but due to the small sizes of the Contracting Parties' national electricity markets, the viability of even one PX per market is questionable.

Power exchanges provide a public price index, which could be used by the whole electricity market as a reference price.

All transactions between market participants on the organized power exchange market are cleared and settled by a central counterparty, being power exchange itself or independent entity performing clearing and settlement service on behalf of a power exchange. The core roles of the central counterparty is thus to act as an intermediary for transactions between the sellers and the buyers. With robust clearing and settlement system design with utilizing different types of collaterals, market participants are always fully secured, and the risk of late payment and insolvency of the counterparty is reduced to a minimum.

2.1.4. Market segments

Depending on the price-setting principle and physical products, segments of an organised market vary from:

- day-ahead market based on double-sided auction (DAM);
- day-ahead market based on continuous trading (DAM continuous);
- intra-day market based on continuous trading plus complementary auctions (intra-day market);
- forward market
- Balancing & balancing reserves market.

a. Day-ahead market (DAM)

In the DAM, electricity is traded one day before actual delivery. This allows both the market participants and the TSOs a reasonable timeframe for arranging the physical aspects of delivery. The genuine role of a power exchange is to match the supply and demand of electricity to determine a public market-clearing price. The price in a DAM, which amounts to a reference or strike prices for the longer-term electricity markets, may be determined through double-side auction (for hourly products), or on a continuous trading (hourly or block products).

DAM continuous is similar to forward market. Market participants list their will to buy or sell certain day-ahead volume with a defined profile. Interested parties to buy or sell click-and-trade the listed contracts.

b. Intra-day market

In the intra-day market, electricity is traded on the delivery day itself although it starts on day-ahead after the day ahead market is closed. The intra-day market enables market participants to correct their portfolio in their day-ahead nominations due to better wind forecasts, unexpected power plant outages, etc. Intra-day markets are organised as continuous trading but complementary auctions are also possible (and applied in some European markets). The trading phase on this market segment takes place starting at 3pm on the day before the delivery day till 60 minutes prior to delivery.

c. Balancing and balancing reserves market

The final responsibility for maintaining the instantaneous generation-consumption balance lies with the TSO. The TSO employs a range of products and services, collectively referred to as *ancillary services,* to be able to keep the system on-line and operating reliably. The balancing mechanism or market,[2] means the entirety of institutional, commercial and operational arrangements that establish market-based management of balancing mechanism. In general, the balancing market encompasses automatic and manual frequency restoration reserves, imbalance netting, replacement reserves as well as frequency containment reserves.

On the one hand, the market participants need to strive to keep their own portfolio in balance as they shall be (financially) responsible for deviations from their schedule (this role is usually referred to as a BRP – balance responsible party). On the other hand, they may also provide their services to the TSO on the balancing market as a BSP (balancing service provider). Market participant may thus use the balancing market as a source of revenue as a BSP, but it will also be liable as a BRP. The process through which the costs of balancing are (entirely or in part) allocated to BRPs is referred to as Imbalance Settlement and is performed by the TSO or the Market Operator.

In the last few years, market participants tend to do more business also in the intra-day phase, thereby correcting their schedules close to real time. Increasing amounts of volatile RES generation (e.g. wind power plants) have also been a reason for this as some of these production sources can be better forecasted closer to real time. Consequently, the amount of balancing energy needed is also increasing.

2.1.5. Types of power exchanges: Merchant v cost-of-service regulated

There are two types of power exchanges:

[2] In a narrower sense the term “balancing market” may also refer to a specific platform the TSO uses for procurement of (part of) these services.

- **merchant** type - a profit-making entity with a core business to provide trading services. It makes investments in infrastructure (platform, IT solutions), and its return on investment depends on various users' fees (i.e. user registration fees, and annual membership fees) as well as on the volume of trade executed for its users.
- **cost-of-service regulated** - not-for profit or a regulated profit institution, the income of which depends on approved costs or approved tasks, and fees it charges are approved by the regulator. In such a model, cooperating with other PX on eliminating cross-border trade inefficiencies would in principle be another regulated task.

A merchant PX appears to be a better governance structure for an exchange, as it has incentives to provide efficient trading service, or to innovate in trading systems, as well as it is more incentivized to better cooperate in the implementation of cross-border implicit auctioning, as this generates additional trade volumes and revenues for it.

2.1.6. Operators of the market – MO, PX operator, NEMO

Market Operator. Using the term "market operator" is at many times confusing. The term market operator mostly refers to an entity which performs certain roles in the electricity market, which may not even exist in every country (usually some tasks performed by the TSO), such as balancing management, recording of contracts and operational forecast, imbalance settlement. Although not universal, establishing a market operator as a separate entity (outside the TSO) is quite common.

Based on the experience, the market operators' tasks can be summarized in the following areas:

- the administration of the bilateral electricity market,
- calculation of the imbalances of the balancing responsible parties in accordance with the final daily schedule and the measurements obtained from the electricity transmission system operator and the operators of the electrical distribution systems,
- timely submission to the operator of the electricity transmission system all information necessary for the preparation of the final daily schedules for the purchase and sale of electricity,
- keeping records of all contracts for market participation concluded with the participants in the electricity market,
- keeping records of all agreements for the establishment of balance groups concluded between the participants in the electricity market and the operator of the electricity market,
- preparation of a daily market plan,
- keeping a register of market participants,
- keeping a register of balance groups on the market,
- timely submission to the electricity transmission system operator of all information for the registered participants in the electricity market,
- concluding purchase and sale contracts, as well as taking a balanced responsibility for the electricity generated by privileged producers using a feed-in tariff.

Power Exchange (operator). Power exchange operator (of a national PX) is the organized market place (the power exchange itself). Organized market places are recognized as a key factor for creating a competitive environment and are a driving force to increase the competitiveness of the electricity sector.

In terms of electricity trading, organized market places complement bilateral physical contracting, (OTC). OTC markets shall remain larger in size, since market participants might always need to have tailor-made contracts and products. However, an organized trading place brings many advantages to the market as well as provides market participants with:

- hourly / bespoke profile trading
- reliable electricity price index,
- transparency offers more possibilities and higher security for investors,
- it enables a more efficient procurement or sale of electricity (compared to classic public procurement tendering),
- reduced counterparty risk and risk mitigation opportunities,
- a supplementary tool for managing trading risk (creation of a price signal allows operators to take economically rational decisions - buy/sell allowances, production modulation, choice of production),
- a key role in managing transmission system congestion,
- trading activities are more efficient because there is less work involved in closing deals over the trading platform compared to bilateral trading.

There are several options for establishing and operating a PX in terms of regulation, ownership, partnership and provision of trading and clearing services. In terms of operation, the same operator may act as a market operator, and as a PX operator.

Nominated electricity market operator – NEMO. The CACM introduced the term "nominated electricity market operator" (NEMO), meaning *de facto* a power exchange in connection to market coupling. This created further confusion, especially since traditional "market operators" were not recognized in EU legislation.

NEMO could be designated as **monopoly** (where only one NEMO is nominated) or as **competitive**[3] (where more than one NEMO may be nominated in a Member State and more than one NEMO can offer the day-ahead and intraday trading services for respective bidding zone). Even a monopoly NEMO could be designated in a competitive procedure, or the authorities may decide to only appoint an existing market operator for performing that function.

2.2. Cross-border wholesale electricity markets

2.2.1. Pan-European single electricity day-ahead market (market coupling)

The objective at the EU as well as at the Energy Community is to create a pan-European electricity market to improve the efficient use of energy across national borders. The EU electricity market defines a number of market design elements to facilitate integration and cross-border trade, while leaving several elements to the discretion of Member States. This electricity market model is based on two main principles: establishing energy-only regional markets based on marginal price **and market coupling,** as a way of linking zonal day-ahead markets through the implicit cross-border capacity allocation.

The EU target model has involved working for the delivery of the **Price Coupling of Regions (PCR)** and the North-Western European Price Coupling (NWE) launched in February 2014. Since then two extensions of the PCR-coupled area have taken place. This full area is called **Multi-Regional Coupling (MRC)** and now covers 19 countries, standing for about 85% of European power consumption.

2.2.2. Implicit (market coupling) vs explicit auctions

Market coupling refers to integration of two or more national markets through cross-border trading and capacity allocation mechanism. Main principle of the market coupling mechanism is that cross-border capacities are allocated together with electricity traded at the power exchanges. The PXs are cooperating in market coupling. The difference between coupled and

[3] The authority, responsible for NEMO nomination, shall nominate the applicant which best meets the criteria for NEMO nomination, if there are several applicants to be designated as the only NEMO in the Member State.

non-coupled bidding zones are:

- In **isolated** mode, bids and offers are matched only inside one bidding zone (which has no congestion and thus no capacities needed for delivery of such traded electricity between buyer and seller).
- In **coupled** mode, bids and offers are matched not only inside one isolated bidding zone, but also with bids and offers from the adjacent bidding zone, up to the quantity defined by cross-border capacity on the interconnector between the coupled bidding zones. So the available cross-border capacity is a constrain to the level of matching between the two or more zones.

With market coupling cross-border capacity is allocated implicitly (implicit auctions) together with the purchase or sale of electricity which single algorithm. In implicit cross-border allocation, a buyer or seller of electricity have thus automatically access to transmission capacity by submitting orders to the power exchange since energy and transmission capacity are traded together. This is contrary to ***explicit*** capacity allocation method, where market participants apply for obtaining interconnection capacity (that is necessary for carrying out the transacted electricity) separately from the transacted electricity, *via* explicit auctions.

Market coupling through implicit auctions promotes market integration and more importantly ensures effective utilization of networks and generation capacities, and provides relevant price signals for investment in cross-border transmission capacities/. Electricity prices across the larger (coupled) markets are expected to converge if there are no bottlenecks (scarce interconnection capacity) and in case of bottlenecks they correlate with a greater percentage