Polskie Sieci Elektroenergetyczne

EU electricity market: the good, the bad and the ugly

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Polskie Sieci Elektroenergetyczne S.A.
ul. Warszawska 165
05-520 Konstancin-Jeziorna
Poland

Author:
Konrad Purchała, Ph. D., Director for European Integration Policy PSE S.A.

Introduction

Liberalization of EU electricity markets, initiated at the end of XX century, has led to substantial changes to the way electricity is generated and consumed. Introduction of competition into the traditionally monopolistic and rather conservative industry has allowed for emergence of new business models, with new entrants challenging incumbent utilities. Concurrent policy shift towards more sustainable and environment-friendly energy supply, accompanied with important financial incentives for investors in renewable generation technologies, has led to tremendous innovation in this field.

After some 20 years of liberalized electricity markets functioning, market conditions are now completely different than those at the end of XX century. Efficiency improvement brought by competition is accompanied by new types of challenges faced by today's players, including generators, system operators and traders. Against this background, it is worthwhile to reflect on the main achievements of the liberalization of the European market, as well as on the key challenges facing the industry in these times of change.

The good

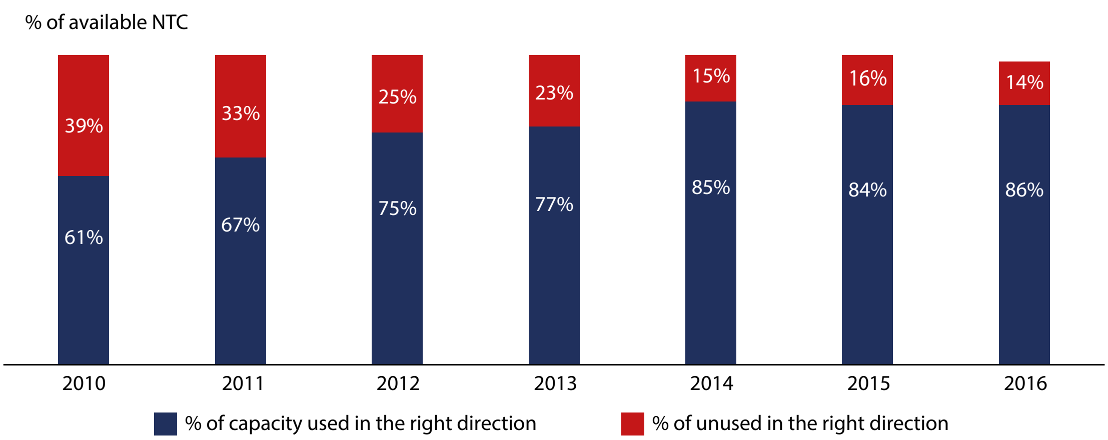
No barriers to electricity trade among all European countries

European electricity market is a unique construction. It is quite unprecedented to see 28 EU member states willing to significantly redesign the way the vital services for all sectors of economy, as energy supply, is organized. National electricity markets are being progressively harmonized across all market segments to form a single electricity market to the benefit of over 500 million EU citizens. European legislation has mandated the creation of the Network Codes, facilitating transition towards more efficient and more harmonized market and system operation solutions. Market integration and market maturity is not identical across all EU countries, but there is a clear trend towards market-based mechanisms, allowing to create more welfare for all Europeans. Cross-border capacity allocation mechanisms have evolved from explicit auctions, where transmission rights and energy were traded separately, towards market coupling, where cross-border capacity is allocated implicitly in function of energy prices, facilitating thereby energy trade via power exchanges. As a result, available cross-border capacities are used more efficiently, as showed on **Figure 1** below.

Coordinated price formation under European-wide market coupling mechanism

Integrated cross-national electricity market is indeed an important achievement of EU. It is noteworthy that **apart from the technical ones**, i.e. the need to acquire cross-border capacity rights albeit explicitly or implicitly, **there are no restrictions on cross-border trade of electricity between the European countries.** Exchange possibilities are determined by available cross-border capacities calculated by TSOs according to progressively more and more harmonized cross-border transmission capacity calculation methodologies. Cross-border capacity allocation takes place under European-wide coordinated processes, covering practically the whole continent (see **Figure 2**). Multi-Regional Coupling MRC organized by European power exchanges is clearing day-ahead markets and determining in a coordinated manner the day-ahead prices in all involved countries, contributing to more efficient price formation and thereby more efficient use of energy resources. Similar mechanisms concern long-term hedging organized by Joint Allocation Office JAO, acting as European Single Allocation Platform for such products, as well as XBID, being the single intra-day platform for all EU member states. Upcoming balancing platforms, which are currently being developed by European Transmission System Operators, strive at reaping the benefits of integration also at the real-time market segment.

Fig. 1 Percentage of cross-border capacity nominated in the direction of Day-Ahead price differences on 37 European interconnectors, 2010-2016. [Source: ACER Market Monitoring Report 2016].

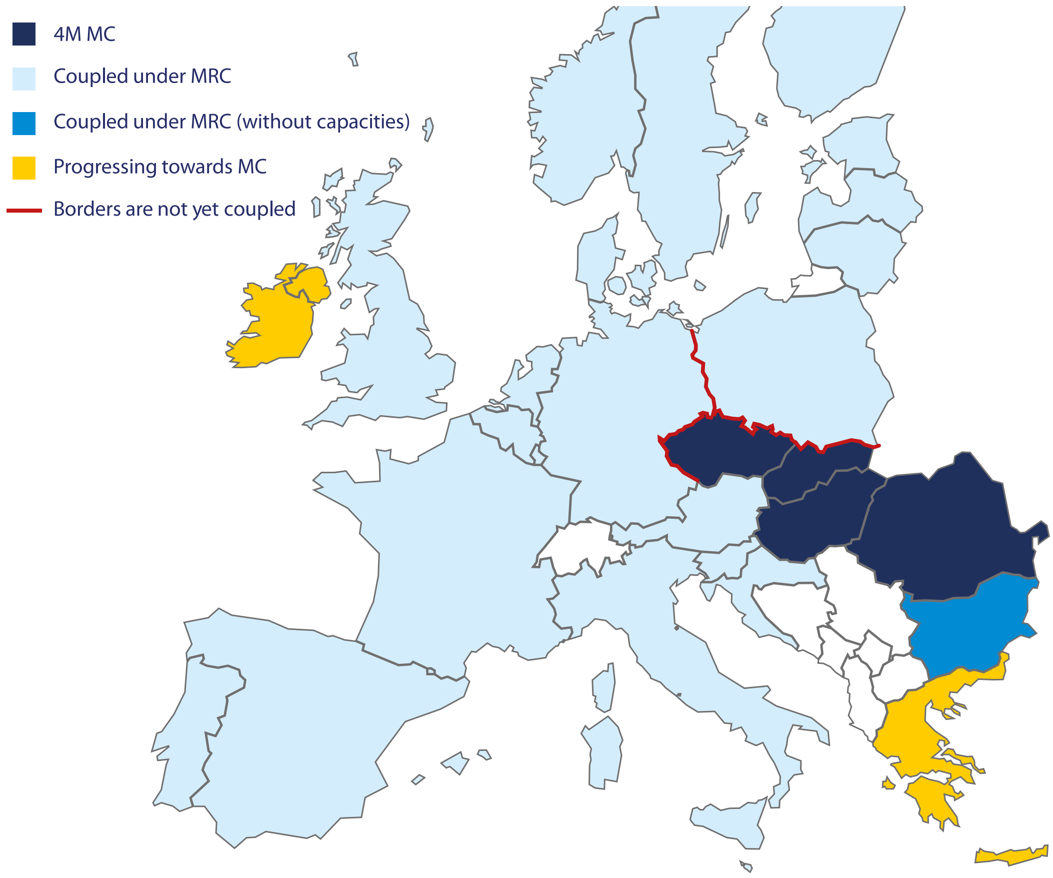


The bad

More market integration and more transmission investments, but cross-zonal capacities remain quite low

European electricity industry can be indeed proud of the achievements of last two decades. However, electricity market design in Europe is by no means flawless. Europe employs zonal market concept, which is based on the fundamental assumption that trading opportunities within bidding zones are unlimited, while trade between bidding zones is allowed only up to the level given by cross-border capacities[1]. Cross-border capacities are thus the means of expressing market boundaries for cross-border trading, allowing trade up to the level which is technically feasible without affecting secure power system operation. In contrast to cross-border trade, internal trade within bidding zones does not see such limitations, even though both types of transactions use the same generation and transmission resources. This different treatment of internal and cross-zonal trade has recently became an issue of particular attention of European Regulators and policy makers. Although it is an inherent feature of the zonal market design[2], implicit prioritization of internal trade over cross-border trade might raise concerns over foreclosure of national markets and impediment to competition. This is reflected in recent Recommendation on Capacity Calculation No 02/2016 issued by the Agency for the Cooperation of Energy Regulators (ACER) on 11 November 2016[3] followed by draft revision of the Electricity Regulation proposed by the European Commission under legislative package "Clean Energy for all Europeans" in November 2016[4]. Heated discus-

Market Coupling in Europe. [Source: ENTSO-E, PKEE]. Fig. 2



1 In continental Europe, bidding zones are generally equal to political country borders (with some exceptions).
2 Under zonal market, there are no restrictions for internal trade within bidding zones (copper plate approach), while trade between bidding zones requires acquisition of cross-border capacity rights and is by definition restricted (cross-border capacity is a scarce good).
3 https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Pages/Recommendations.aspx
4 https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

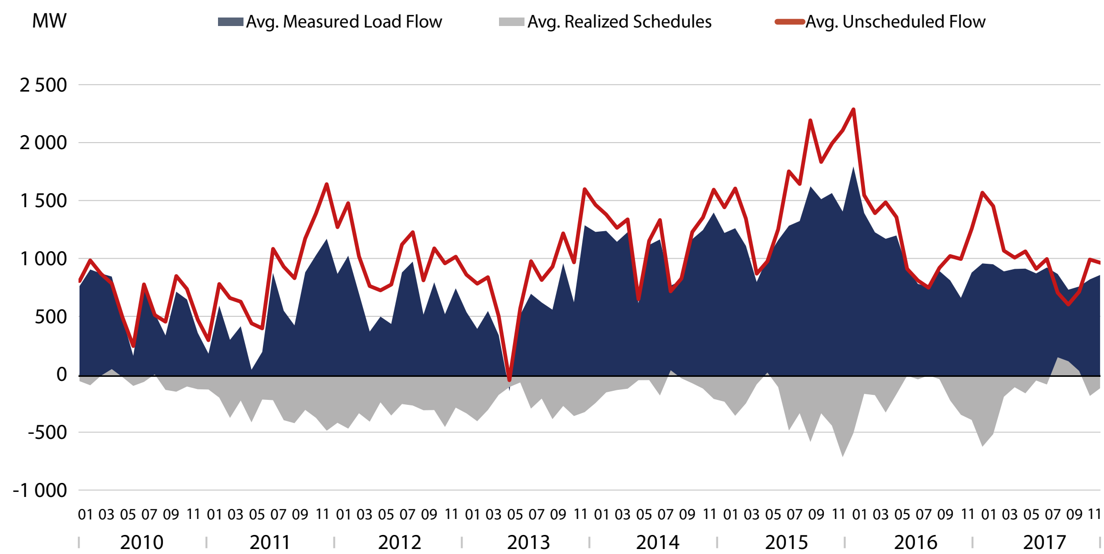
sion about calculation of cross-border capacities that followed might eventually change the way European zonal market is organized.

Inability to achieve significant progress in this field is one of the greatest challenges for the European market, impeding the integration process. Although the need for coordination during capacity calculation process and efficient use of transmission infrastructure is legally embedded in the European Network Codes, these provisions are yet to be implemented in practice. As a result, loopflows[5] and unscheduled transit flows[6] are undermining the efficiency of cross-border trade. According to ACER Market Monitoring Report 2016 published in October 2017, availability of European transmission infrastructure for cross-border trade is very low. In order to assess congestion management efficiency, ACER established the notion of "benchmark capacities" that should be made available for market participants' cross-border trading activities given the current legal-regulatory framework. For AC synchronous grid, available cross-border capacities reach not more than 40-60% of ACER benchmark capacities, while for DC dominated Nordic power system this utilization ratio is higher, exceeding 80%. While the methodology applied by ACER to establish benchmark capacities can be questioned, discussions around this issue are an indication, that cross-border capacity calculation approach applied currently throughout Europe is challenged.

Zonal market model leads to decoupled market and system operations

Well defined bidding zones should constitute or at least be close to copper plates, so that internal transactions should be technically realisable without significantly affecting neighbouring zones. This is the theory. However, in practice, bidding zones in Europe are not designed based on technical criteria, but rather by political country borders. Nonetheless, administrative regulations guarding the zonal market architecture have little relevance for power flows in interconnected European power system. Physical power flows result from the laws of physics, i.e. Kirchhoff's laws. In meshed grids, internal transactions within bidding zones will inevitably cause power flows in neighbouring bidding zones and cross-zonal market transactions will cause power flows across multiple paths and borders. Moreover, cross-zonal transactions can be realized in many different ways depending on the location of generation and load resources involved. By means of example, energy transaction between Germany and Poland can have a complete different effect for power flows in Czech grid depending on whether its sources are located in Southern or in Northern Germany. As a result, cross-zonal market trading and resulting exchange schedules in Europe significantly diverge from the observed power flows (see **Figure 3**).

Fig. 3 Unscheduled power flows[7] on German-Polish border. [Source: PSE].



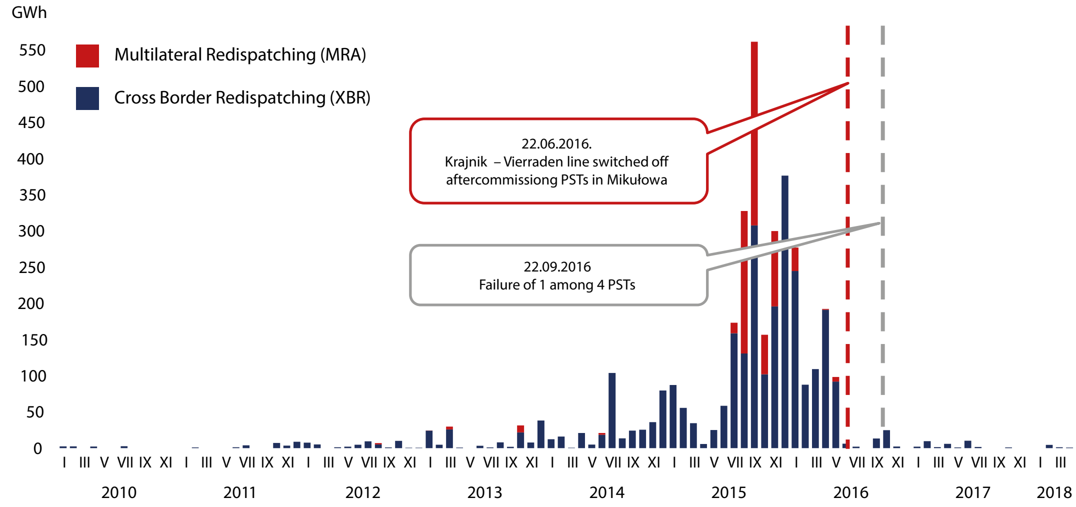
5 "Loopflows" can be defined as physical flows on a line located in a particular zone (i.e. in Poland), caused by transactions of which both the source and sink are located in another zone (i.e. in Germany). In Clean Energy Package, loopflows are defined as "power flows leaving and re-entering the given bidding zone without being scheduled".

6 "Unscheduled transits" are power flows caused by cross-border transactions between bidding zones (i.e. between Germany and France), which are not scheduled for the use of cross-border capacity in other bidding zones (i.e. in Belgium and Netherlands).

7 Both loopflows and "unscheduled transits" are commonly referred to as "unscheduled power flows".

Cross-border redispatching (bilateral XBR and multilateral MRA) measures necessary to ensure secure operation of the German-Polish border, monthly volumes. [Source: PSE].

Fig. 4



Technically infeasible market outcome requiring large-scale redispatching measures

Externalities of the zonal system, manifested by unscheduled power flows, cause physical power flows to significantly diverge from the market schedules on most European borders. In many cases these unscheduled power flows not only exceed market-based flows by an order of magnitude, but are often in different directions. This is for example the case of Polish synchronous borders, where cross-border market schedules are marginal compared to the observed unscheduled power flows. Consequently, TSOs need to anticipate such uncoordinated power flows and are often forced to reduce available cross-zonal capacities to keep the power system secure, which confines cross-border exchange possibilities and negatively affects market efficiency. In 2014-2016, significant power flows observed on Polish synchronous borders caused the need to initiate TSO remedial measures in form of cross-border redispatching[8] on a massive scale. Since costs of such remedial measures are transferred via grid tariffs to all Polish end-customers, they bear costs of supporting trading activities outside Poland[9], while not being able to benefit from market integration due to Polish export and import capacities being used by unscheduled transits and loopflows. **Figure 4** shows the volume of redispatching activated over the course of last few years. Clearly visible upward trend of these measures was contained thanks to installation of Phase Shifting Transformer (PST) in one of the border substations in Poland, allowing to reduce the level of loopflows and other unscheduled power flows through the Polish power system. Similar issues, though with lower impact in terms of available capacities and redispatching costs, are experienced on other European borders, leading to deployment of similar PSTs in other parts of European grid.

Zonal market does not facilitate correct incentives for efficient behavior

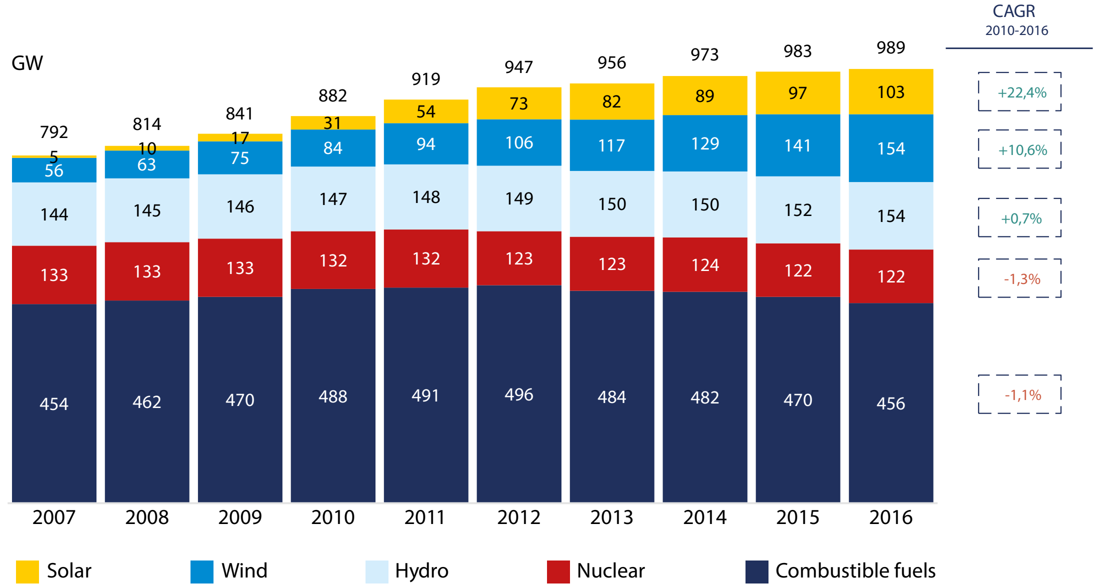
The ability to game against system operator to exploit zonal market inefficiencies is a very important deficiency of the European market model. What is even more worrying is that gaming can be quite profitable for market participants, as it can allow to exercise market power without manifesting it on the quite transparent and publicly scrutinized wholesale market. Implementation of the European Network Codes, especially improved coordination of cross-border capacity calculation and allocation aimed for under flow-based approach will address the issue of unplanned transits, but will not address the issue of loopflows and changing generation patterns inside bidding zones. In zonal models and under portfolio bidding[10], one is not able to know what will be the

[8] Measures activated by the concerned TSOs outside of the wholesale markets, resulting in increasing generation in Poland and decreasing in Germany.

[9] These costs can reach significant amounts, i.e. in 2015 the redispatching costs to ensure secure operation of the Polish-German interconnector exceeded 100 mln EUR.

[10] Portfolio bidding means, that the bids and offers submitted to Power Exchanges and other organized trading platforms come from combined portfolios of generation and load resources (instead of individual resources), so that it is impossible to know where the energy will be physically generated or consumed.

Fig. 5 Installed generation capacity in Europe (EU-28). Source: PSE analysis based on Eurostat data.



impact of market transaction cleared under market coupling – one is only able to estimate how market participants might use their generation fleet to ship energy across the zones, but market participants are by no means bound by these. On the contrary, financial commitments related to balancing obligations concern portfolios only and market participants can change the generation schedules used to fulfill their commitments at any time without restrictions. If restrictions are imposed, the financial consequences of such restrictions are borne by the TSO, not by market participants. All the above uncertainties related to cross-border capacity calculation process render it more like a task to be conducted by using a crystal ball, than a technically sound, engineering process.

Insufficient price signals to facilitate generation adequacy

Finally, another important issue of the EU market is low quality of price signals and their inability to trigger market-based generation investments to ensure long-term generation adequacy. At the eve of liberalization, Europe was generally speaking characterized by generation overcapacity. Over the last decades, big chunk of new generation investments was renewable, mainly wind and solar. This capacity was build based on various incentive schemes (financial supporting mechanisms), reducing risk for project developers and attracting capital, allowing for this sector to flourish and driving down the technology costs. However, an important side effect of this renewable generation success story is that a significant part of energy generation in Europe does not react to market price signals because it has a different remuneration scheme. Moreover, conventional generation that is subject to energy price signals as their main source of revenue has difficulties to compete in this new market place, where wholesale prices are driven down by generous subsidies. As a result, Europe has not seen a lot of new stable, conventional generation capacity, except of the ones resulting from investment decisions taken before the renewable boom. This new conventional capacity is often immediately written-off or even mothballed due to inability to compete with very low wholesale prices. This raises important concerns regarding generation adequacy, since today there are less structurally exporting countries and more structurally importing countries than 20 years ago. **Figure 5** shows the evolution of installed generation capacities in EU over the last years. It is quite clear from that figure that net capacity additions in last years are basically only renewables, for which investment decision are taken based on dedicated support schemes. To some extent this reflects technology transitions and falling costs of renewable generation. However, limited conventional generation investments, quite important from security of supply point of view, at least until utility-scale seasonal storage is technologically and economically viable, reflect lack of sufficiently strong market based investment signals. This problem has been identified in many European countries, which took decisions to implement various generation capacity remuneration mechanism, such as capacity markets. In other countries, generation reserves are secured in form of dedicated strategic reserves contracted by TSOs.

The ugly

Course correction is very difficult, if possible at all

Unfortunately, the above European market design flaws are very difficult to overcome without fundamental market design changes. While generation adequacy can in principle be helped by improving scarcity pricing[11], demand flexibility and implementing dedicated adequacy-related remuneration schemes, utilization of transmission infrastructure and organization of cross-border trade remains and will most likely remain an issue in the future. Zonal market design has been relatively simple to implement and allowed quick wins to benefit from market integration. However, **it is increasingly more evident that zonal market is a dead-end path.** Market design simplifications that have been beneficial for initial integration are now becoming an obstacle to more efficient use of generation and transmission resources. Prominent example is the quality of bidding zones, which is a decisive factor for the success of zonal markets and flow-based allocation. Current bidding zones in Europe are unfortunately not designed on technical bases. With the noble exemption of a few countries like Norway, Sweden, Denmark and Italy, European zones are based on country political borders. Bidding zone definition is considered as a highly political issue, as many countries are not ready to consider splitting their national bidding zones even if this process is foreseen by EU legislation as fundamental to the efficiency of flow-based capacity allocation. Experience from the First Edition Bidding Zone Review published recently by ENTSO-E is that proposing new bidding zones is a highly challenging task, with multiple criteria to be weighed against each other so that no clear conclusion can be drawn. Successful bidding zone changes in Europe were implemented only by countries, which already decided to split their bidding zones and were just periodically reassessing optimal bidding zone configurations.

Given the above, it seems that the currently applied zonal market and cross-border trade organized based on ex-ante defined cross-border capacities has reached its efficiency limits. Substantial improvements in terms of more efficient use of generation and load resources and better price signals are simply not possible under large zones. Market and system operations will thus remain to be detached from each other, even more so in the light of increased intermittency driven by renewable generation and demand response. Regulatory attempts to artificially increase cross-zonal capacities by ignoring physical power flows phenomena will only give raise to this detachment. Experience from zonal market models in other parts of the world concerning efforts to evolve towards more efficient zonal configurations, in particular in United States, demonstrate that improving zones is nowhere an easy task and in many cases has proven to be impossible to realize in practice.

[11] In theory, well implemented scarcity pricing should allow prices to raise to high levels during supply shortages. However, practical evidence suggests that even moderately high prices trigger lots of controversies, so that acceptability of high prices by consumers should not be treated as a given.

New power system requires new market solutions!

Nonetheless, even if fixing zonal market model would be possible, there is evidence suggesting that it is already too late. Power system is changing. Renewable revolution, together with more customer empowerment and demand flexibility, is shaking the electricity industry. Advances in IT solutions allow for complete redefinition of the way electricity market and system operations are organized. New technologies challenge the traditional ones, for example, provision of primary frequency response services restricted for large synchronous generators with large rotating masses is now also possible by power electronics and batteries, with better response characteristics and already now moderate costs. All this innovating technologies are getting technically and economically viable, translating into business opportunities. It is however **crucial to ensure that new businesses can develop under correct regulatory framework, so that the resulting innovation serves the needs of all end users to the benefit of society at large**, without prioritizing particular sectors of the industry at the costs of others. New power system will require new market solutions. Price signals will become even more fundamental to system operations, as there will be no other way to manage the distributed generation resources than by means of locationally differentiated prices. In order to do so, these prices should reflect the needs of the power system and all its consumers. All activities contributing to satisfying these needs should be rewarded by getting higher prices, while all activities against the needs of the system should be financially discouraged, so that gaming against the system and against the needs of all its consumers becomes a bad business. Locational Marginal Pricing LMP applied in US (also referred to as nodal pricing) and price-based coordination, is long established in academic literature as *the reference* for efficient electricity market organization. In opinion of PSE, LMP is the precondition for managing future challenges related to operating new power system. LMP is the foundation, based on which other challenges can be efficiently addressed. Capacity markets to facilitate generation adequacy are best paired with efficient scarcity-pricing system to value energy and reserves at all locations, allowing all generation and load resources to compete with each other on equal footing without unnecessary differentiation between internal and cross-border transactions. Local congestion management required to improve operations of the distribution grid will be best paired with the market design where services from TSO grid could be efficiently used to help resolving DSO network problems and vice versa. Zonal markets are not able to tackle these challenges without fragmentation into special dedicated segments that are non-transparent and prone to gaming, while LMP supports all these developments thanks to inherent feature – coherent price formation across all market segments from forward until real-time. There is no need to re-invent the wheel. It would be much better to focus the talent and brainpower of European experts on effectively addressing existing EU market problems and finding ways to implement a new generation of markets suitable for the challenges and technological opportunities of the XXI century: LMP-based market.

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05-520 Konstancin-Jeziorna
ul. Warszawska 165
tel.: +48 22 242 26 00
fax: +48 22 242 22 33

www.pse.pl