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Capacity markets and cogeneration facilities: recommendations for Poland

ABSTRACT: For over a decade, there has been a heated debate across all EU Member States in regard to the ambitious project of developing an integrated EU energy market, the design and implementation of internal capacity remuneration mechanisms, and the current situation of electricity generation and resource adequacy of each Member State. According to the Agency for Cooperation of Energy Regulators and the European Commission, approximately 11 Member States are considering or have implemented some form of capacity remuneration mechanism. In view of the recent debate on the possible market reform and implementation of a capacity market in Poland, this paper (1) presents an overview of two capacity market designs presently implemented in the US and in the UK and (2) examines how these capacity markets have incorporated autogeneration units in their capacity market model. Furthermore, this paper proposes a set of recommendations (based on lessons learned from the US and UK) aimed to minimize the level of regulatory uncertainties associated with the introduction of a capacity auction mechanism in Poland.

KEYWORDS: capacity remuneration mechanisms, cogeneration facilities, autogeneration

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Introduction & Background

For over a decade, there has been a heated debate across all EU Member States (MSs) in regard to the ambitious project of developing an integrated EU energy market, proposed by the European Commission and referred to as “Electricity Target model” (ETM), the design and implementation of internal capacity remuneration mechanisms (CRMs), and the current situation of electricity generation and resource adequacy of each Member State.

Capacity remuneration mechanisms have been described extensively in literature; however, little consensus exists on what constitutes an optimal CRM design and to what extent a CRM can contribute to the well-functioning of a Member State power market. The motivating factors for the selection and possible implementation of a CRM vary from country to country; nonetheless, for several Member States, it has become clear that the current functioning of EU energy-only markets is inadequate. Energy-only markets present a number of deficiencies and design flaws. They are insufficient to provide enough incentives for investment in new generation capacity, which has come to be known as the “missing money” problem, and incapable of rewarding capacity for its contribution to adequacy (Cramton et al. 2013) (see Fig. 1).

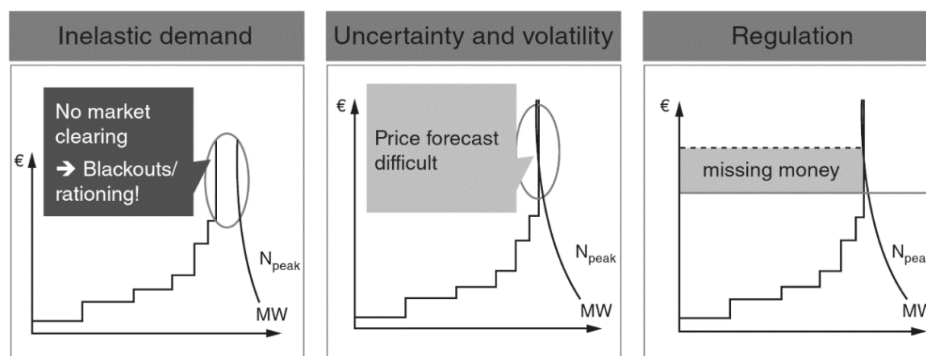


Fig. 1. Market failures in an energy-only market (Hancher et al., ed. 2015)

Rys. 1. Niedoskonałości jednotowarowego rynku energii (Hancher i in., red. 2015)

Since 1996, with the Directive 96/92/EC of the European Parliament and the Council of 19 December 1996 and the following EU liberalization of the electricity markets, the European electricity market has evolved in a period with significant excess generation capacity (Cramton i Ockenfels 2012). Nevertheless, the economic downturn, increasing electricity demand, fuel prices fluctuations, aging of existing power plants, and increasing share of renewable energy sources have shown that the liberalized wholesale electricity markets in Europe can no longer fulfil their functions and they are in need of reforms and remedies to market failures (Keay 2016).

For instance, France and Germany, two of the largest power markets in Europe, face major adequacy challenges and both have identified the need for fundamental reforms. Due to the structural differences between the French and German power sector, threats to the security of electricity supply have been reflected in different ways. In Germany, energy-only deficiencies have been reflected in the declining wholesale market prices at the time of raising costs and the flattening of the intraday price curve due to the rising renewable energy deployment (Keay 2016) (see Fig. 2 and Fig. 3). In France, power demand is highly temperature-sensitive; thus, peak demand has grown faster than power demand. This was observed in winter of 2012, when low temperatures had a significant impact on the country's peak load (DNV GL 2014; RTE 2014).

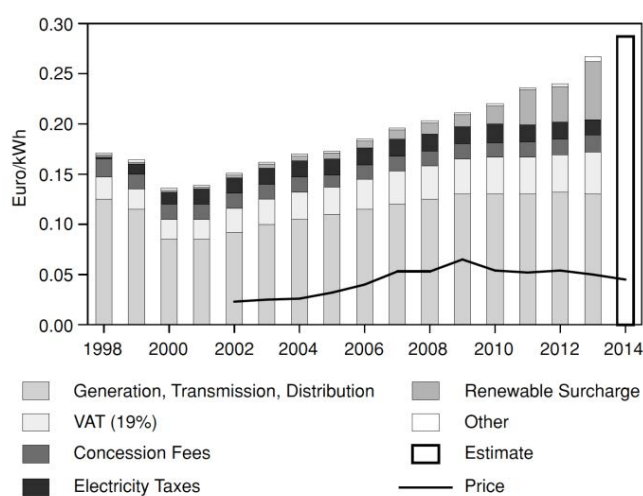


Fig. 2. Declining wholesale market prices across Europe (Keay 2016)

Fig. 2. Spadek hurtowych cen energii elektrycznej w Europie (Keay 2016)

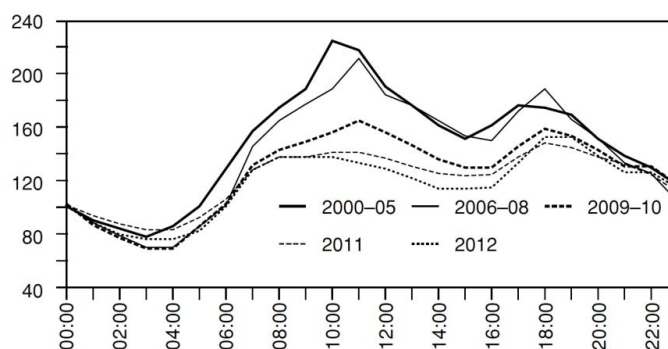


Fig. 3. Average intraday price profile in Germany 2000–2012 (Keay 2016)

Rys. 3. Średnie ceny rynku dnia bieżącego w Niemczech w latach 2000–2012 (Keay 2016)

An issue of particular interest for the European Commission and Member States is the possible inefficiencies that may arise after the selection and implementation of a specific capacity remuneration mechanism within a country and its possible incompatibility with neighboring power markets, also known as “seams issues” or “cross-border effects” (Bhagwat et al. 2016). According to the Agency for Cooperation of Energy Regulators (ACER) and the European Commission, approximately 11 Member States are considering or have implemented some form of capacity remuneration mechanism (European Commission 2016).

In order to anticipate any inadequate levels of generation and avoid the risk of capacity shortages, Poland has been one of the Member States that has considered the possibility of introducing a market-wide capacity remuneration mechanism (Zamasz et al. 2014; Zamasz 2015). In Poland, the capacity debate took on another dimension on August 2015, when the power system experienced “the biggest reliability event in 30 years” (FAE 2015). On August 10, 2015, the Polish Transmission System Operator (PSE) was forced to impose power consumption restrictions to industrial consumers. According to the Polish Forum for Energy Analysis (FAE), the capacity shortage was mainly attributed to operational constraints (e.g., hot and dry weather conditions, modernization and renovations, summer low capacity factors of wind farms, combined heat and power (CHP) plants offline or operating at minimum load, emergency shutdown of a unit in Bełchatów power plant, the largest power plant in Poland) rather than a lack of total capacity of the system; however, this experience showed the high degree of vulnerability of the Polish power system and its low demand flexibility (FAE 2015).

In July 2016, the Polish Ministry of Energy opened a public consultation with respect to the possible implementation of a Capacity Market (CM) in Poland (based on the UK and US capacity auction models) and the development of a legislative proposal that could be ultimately adopted by the end of 2016. The measures proposed by the ministry have already increased political and regulatory uncertainties, raising questions on the short and long-term effects of the potential policy intervention. Furthermore, small-scale and independent power producers with small cogeneration power installations (hereinafter referred to as autogeneration units) have raised serious concerns on the potential impact of a centralized capacity market on their investments and revenue prospects. Such concerns are particularly fueled by the need for greater clarity in regard to their participation in the proposed market model.

Thus, in view of the recent debate on the possible market reform and implementation of a capacity market in Poland, this paper presents an overview of two capacity market designs presently implemented in the US and in the UK and examines how these capacity markets have incorporated autogeneration units in their capacity market model. Furthermore, most importantly, this paper develops a set of recommendations (based on lessons learned from the US and UK) aimed to minimize the level of regulatory uncertainties associated with the introduction of a capacity auction mechanism in Poland.

The next section presents a description of two capacity markets and discusses how autogeneration is defined under each capacity market model. In Section 3, recommendations and conclusions are made regarding the implementation of a CM in Poland and the interaction of regulatory mechanism with autogeneration units (small-scale independent power producers).

1. Capacity markets in the North America

For more than a decade, capacity markets have demonstrated that they are able to mitigate energy-only market failures. In the United States, they have provided resource adequacy, reduced investment risks and increased competition (Spees et al. 2013). Capacity markets have evolved over the years, going from a mechanisms aimed to create a fair and efficient market and retail competition, to a sound market model designed to strengthen demand side response (DSR) and investment incentives, and meet the targeted resource adequacy level imposed by a Load Serving Entity (LSE) (Bowring 2013; Spees et al. 2013). Even though capacity markets differ regionally and by country; the intention of the Polish government to introduce in the next following years a capacity auction mechanism makes the study of capacity market principles and designs relevant for Poland. In this contexts, the following sub-sections provide an overview of two capacity market designs, one implemented in the US and one in the UK and their interaction with autogeneration and small-scale CHP facilities. Fig. 4 maps the Regional Transmission Operators (RTO) and Independent System Operators (ISO) throughout North America, including Canada.

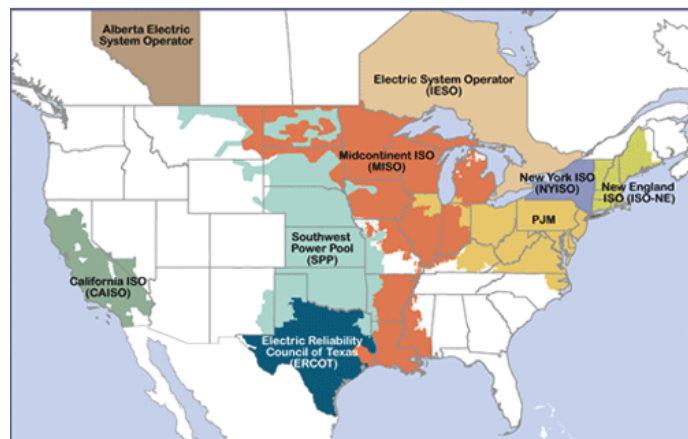


Fig. 4. Regional Transmission Organizations (RTO) and Independent System Operators (ISO) in North America (FERC 2016a)

Rys. 4. Operatorzy sieci dystrybucyjnych i przesyłowych w USA (FERC 2016a)

1.1. PJM and its reliability pricing model

PJM Interconnection (Pennsylvania-New Jersey-Maryland) is a regional transmission organization (RTO) that operates on the East Coast of the US and serves more than 61 million customers located in thirteen states. It is part of the eastern interconnection grid, operating approximately 19% of the transmission infrastructure, the largest centrally dispatched grid in North

America with a total installed capacity of 178,492 megawatts (MW) (PJM 2016a; Sueyoshi i Goto 2013). PJM's capacity market mechanism is called Reliability Pricing Model (RPM), a centralized market that was firstly introduced in 2007. RPM is a three-year forward capacity market with capacity procured through a three-year Base Residual Auction (BRA) and multiple short-term Incremental Actions (IA) held at three different time periods (20, 10 and 3 months) before the established delivery year (Pfeifenberger et al. 2014; Rose 2011). Due to transmission constraints and different demand and supply conditions, PJM divides its region into Locational Deliverability Areas (LDAs) (Bhagwat et al. 2016). Each LDA has its own variable resource requirement (VRR) curve that is directly dependent on the price of NetCONE (Cost of New Entry) and the installed reserve margin (Spees et al. 2011).

Contrary to the usual vertical daily demand curve used in power markets, the VRR curve is a downward sloping curve that incorporates a scarcity price, which, at the same time, works as a price cap (see Bowring 2013; Pfeifenberger et al. 2014; Spees et al. 2013). In PJM's capacity market, load serving entities (LSE) are able to meet their capacity obligations by utilizing 'self-supply' resources or through bilateral contracts with generators (Bhagwat et al. 2016; Rose 2011). Capacity can be procured from generation resources, load management resources, energy efficiency resources and qualified transmission upgrades (PJM 2016b).

All LSEs and resource providers, with available UCAP (unforced capacity), that are physically located in the PJM region must participate in the RPM auctions, except entities that have opted for the Fixed Resource Requirement. Participation is voluntary for those resource providers with existing and planned external generation, existing and planned demand resources and qualifying transmission upgrades (PJM 2016b). Fig. 5 illustrates the PJM's market structure and Fig. 6 shows the variable resource requirement curve for the years 2014–2015.

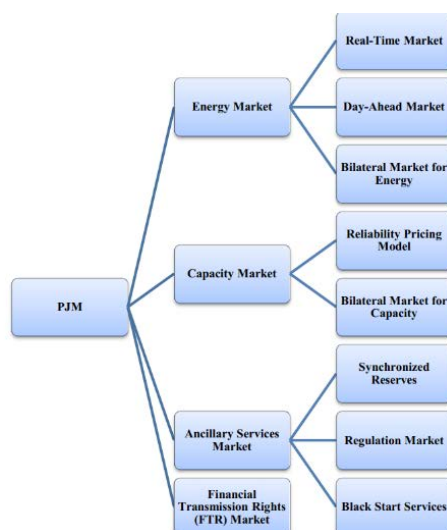


Fig. 5. PJM Market Overview (Soden and Aldina 2013)

Rys. 5. Struktura rynku PJM (USA) (Soden i Aldina 2013)

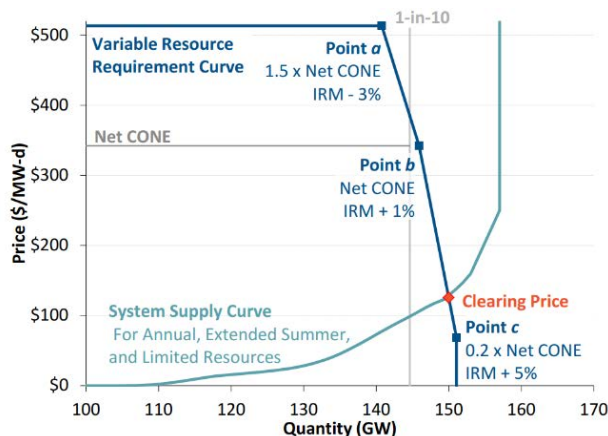


Fig. 6. PJM's Variable resource requirement curve 2014–2015 (Pfeifenberger et al. 2014)

Rys. 6. Krzywa popytu na moc dla PJM w latach 2014–2015 (Pfeifenberger i in. 2014)

1.2. Cogeneration qualifying facilities in PJM's capacity market

PJM follows federal, state and regional regulations. Over the years, these regulations have increased the level of complexity of PJM's capacity market procedures, obligations and reporting requirements. In 1978, the US implemented The Public Utility Regulatory Policies Act (PURPA). PURPA's main goals were to foster and promote the development of a "new class of generating facilities which would receive special rate and regulatory treatment" and would create a market for power from non-utility power producers (FERC 2016b). Moreover, PURPA aimed to protect non-utility generators from monopolies, enabling small scale generators to sell electricity into the power grid, and requiring utilities to buy power from non-utility generators.

PURPA established the creation of two categories of generating facilities within federal law: qualifying small power production facilities and qualifying cogeneration facilities, both commonly referred to as Qualifying Facilities (QFs). A facility with an installed capacity no larger than 80 MW and whose primary energy source is hydro, wind, solar, biomass, waste or geothermal sources is considered a small power production facility. This facility, in order to qualify as a small power production facility, must meet size, fuel use, and other requirements established under the provisions §§ 292.203(a), 292.203(c) and 292.204 of PURPA. The Federal Energy Regulatory Commission (FERC) defined a cogeneration facility as: "equipment used to produce electric energy and forms of useful thermal energy (such as heat or steam), used for industrial, commercial, heating, or cooling purposes, through the sequential use of energy". Under FERC's and PURPA's definition of cogeneration facilities, generators that provide steam for industrial facilities or that provide hot water for domestic use could obtain a certification as a qualifying cogeneration facility. The facility should not exceed 80 MW, pass a fundamental test and meet operating and efficiency standards (depending on the type of cogeneration: topping or bottoming-cycle facilities). The fundamental

test validates if the facility’s thermal and electric output are mainly intended for industrial, commercial, residential or institutional purposes and verifies that 50 percent (aggregate) of the total output is used for the aforementioned purposes (FERC 2016c).

In 2005, PURPA was amended by the Energy Policy Act (EPAAct). The EPAAct (18 C.F.R. §§ 292.309 (d)) eliminated the mandatory purchase obligation for QFs of 20 MW and below when qualifying facilities (rebuttable presumption) have access to a functional and competitive energy market (PJM, ISO-NE, NYISO) (DOE 2005). EPAAct, along with the implementation of an Open Access Transmission Tariff (OATT) allowed non-utilities to have access to the grid. Unfortunately, many argue that EPAAct and OATT created an obstacle for QFs to participate in the power market since QFs are treated similar to large merchant power plants (IECA 2016; Kowalczyk 2008).

A generator, in order to participate in any RPM auction needs to verify ahead of time the characteristics of the generation unit, zone assignment, unit type, unit location, and confirm the modeling of each of their capacity resources (PJM 2016b). Even though, PJM addresses buyer-side market power through its Minimum Offer Price Rule (MORP), which “ensures that all new resources are offered into the RPM Auctions on a competitive basis”, the requirements established by PURPA and PJM’s Market rules have made impractical and expensive for small-scale generators to bid as generation resources in RPM auctions (PJM 2016b). Frequently, qualifying cogeneration facilities do not have the expertise and the economic resources to navigate the sophisticated regulations established by PJM and FERC. Moreover, for on-site cogeneration units, which are mainly designed for steam generation and electricity generation is considered a by-product, PJM’s “deliverability” standards have become a barrier to entry (IECA 2016; Kowalczyk 2008). As a result, manufacturing and industrial cogeneration units have limited themselves to take part in the RPM auction clearing process as load management resources or curtailment service providers. In addition, often seen, on-site generators participate in emergency load and economic load response programs. Fig. 7 shows the percentage of demand response and energy efficiency in the first seven PJM RPM Base Residual Auctions.

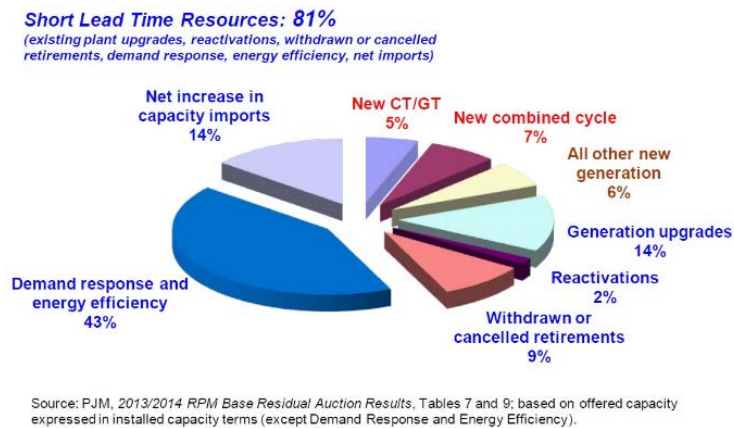
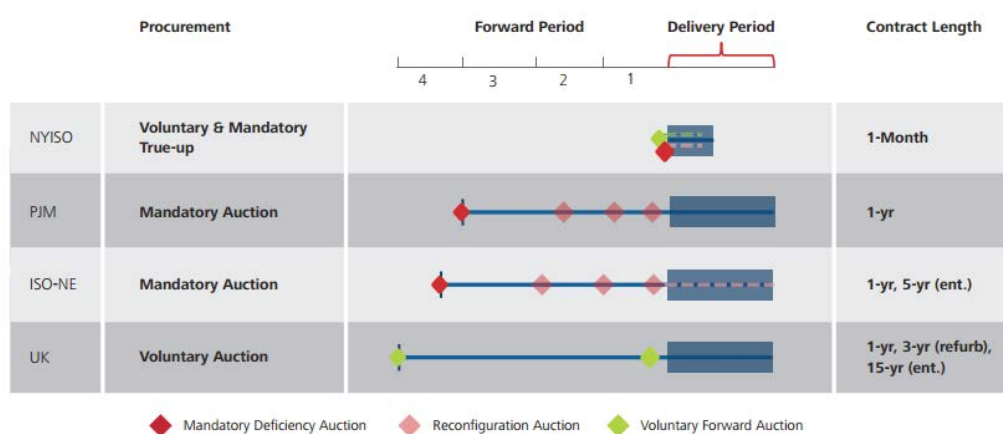


Fig. 7. Incremental Capacity Resources: First Seven PJM RPM Base Residual Auctions (Wilson 2010)

Rys. 7. Aukcje przyrostowe – pierwsze siedem aukcji na rynku PJM (Wilson 2010)

2. The Great Britain capacity market

In December 2014, the United Kingdom held its first capacity auction for delivery year 2018/19. National Grid, the Great Britain System Operator, procured approximately 49.2 gigawatts (GW) of capacity with a clearing price of £19.40/year (Deloitte 2014). The UK became the first EU Member State to introduce a capacity market, also referred to as ‘GB capacity mechanism’, that was authorized by the European Commission for a maximum period of 10 years. The capacity market, proposed by the Department of Energy & Energy Climate Change (DECC), covers England, Wales and Scotland (Hancher et al., ed. 2015). Since 2010, the British government had been evaluating and considering different capacity remuneration mechanisms that would effectively address the inefficiencies of the GB energy-only market. After a series of public consultations, the DECC presented to the Parliament an Electricity Market Reform (2013) package that included a capacity market design similar to those existing in the US (see Fig. 8).



Source: Spees et al (2013) and NERA Analysis.¹⁸ Notes: "Refurb" stands for refurbishment and "ent" stands for entrant, i.e. new build plants.

Fig. 8. Similarities of the GB capacity market to US capacity markets (NERA 2014)

Rys. 8. Podobieństwa rynku mocy w Wielkiej Brytanii i USA (NERA 2014)

The GB capacity mechanism consists of two types of auctions. A four-year ahead of delivery capacity auction (T-4 auction) followed by an incremental one-year ahead of delivery capacity auction (T-1 auction). All new and existing generation capacity, including combined heat and power (CHP) units, demand side response (DSR) (e.g. embedded generation) and electricity storage are eligible to participate in the capacity market. Generators that receive support through Contracts for Difference (CfD), Feed-In-Tariff (FIT), Renewable Obligations (RO) or Renewable Heat Incentives (RHI) are not allowed to participate in the GB capacity market. For generators that are eligible, participation in the capacity auctions is voluntary; however, all generators must be pre-qualified (DECC 2014).

The government employs a descending-clock auction on a pay as clear basis, also known as Dutch auction. The auction starts at the highest price of the demand curve, in this case a price equal to 1.5 times the NetCONE and decreases in £5 increments. Additional rounds are held and the bidding continues until the most competitive participants are left and an equilibrium of supply and demand is reached (DECC 2014). Fig. 9 shows the demand and possible supply range of the capacity market auction for 2019–2020. Since its implementation in 2014, the GB capacity mechanism is constantly being monitored and continues to evolve over time. Improvements in regard to the participation of DSR and Smart metering are presently ongoing.

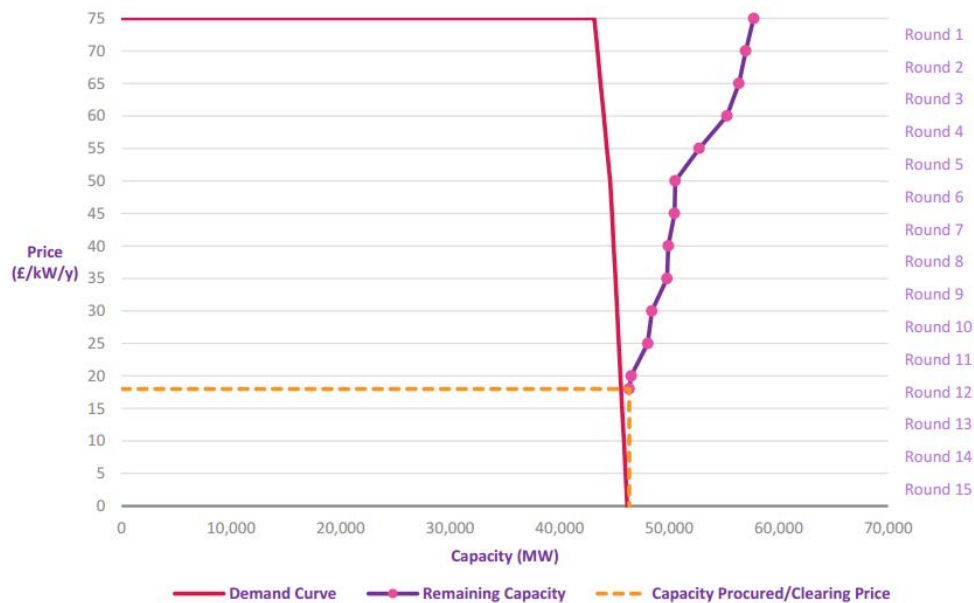


Fig. 9. Demand and possible supply range of CM auction for 2019–2020 (National Grid 2015)

Rys. 9. Popyt i możliwy zakres podaży na aukcjach mocy dla sezonu 2019–2020 (National Grid 2015)

2.1. CHP and autogeneration in the GB capacity mechanism

In contrast to PJM’s capacity market design, which does not significantly distinguish between large merchant power plants and small-scale cogeneration facilities, the GB capacity mechanism ensures the participation of small scale capacity, including combined heat and power (CHP) and embedded generation, as capacity generation resources and DSR resources.

As previously stated, existing and new generation capacity, along with DSR and storage, are able to participate in the capacity market. The British government has defined resources participating in the capacity market as capacity market units (CMU). The definition of a CMU plays an important role since it gives the opportunity to capacity below 2 MW to participate in the

CM if it is aggregated (up to 50 MW) with other eligible generating units (European Commission 2016). Three types of CMUs have been defined by the DECC: Transmission CMU, CMRS (Central Meter Registration Service) distribution and Non-CMRS distribution CMU. Embedded generation and small-scale CHPs that are connected to the distribution system and participate in the balancing mechanism fall into the CMRS definition (DECC 2014).

Further, the DECC acknowledged that small-scale generators face significant disincentive to participate in the mechanism when they have to commit their capacity four years ahead of delivery. Thus, in the GB capacity mechanism, a year-ahead action (T-1) takes place the year immediately prior to the delivery year of the T-4 action. In the T-1 auction, small-scale generators are able to participate in the mechanisms as DSR capacity. As a way to mitigate market power in the auctions, capacity providers are classified into two categories: ‘price takers’ and ‘price makers’ (DECC 2013). New capacity and DSR resources are classified as ‘price makers’ and they are allowed to bid up to the overall action price cap without providing a justification of their bid. On the other hand, for existing capacity or ‘price takers’, the government has set a threshold of £25/KW or 50% NetCONE. According to British government, the established price taker threshold captures approximately 80% of existing plants and increases competition (European Commission 2016).

In order to ensure that capacity payments are in line to the actual performance of the generation units, the DECC has published de-rating factors for specific generating technology classes. Combined heat and power plants (large and small-scale) and autogeneration have been aggregated into one generating technology class. Similar to FERC’s definition of qualifying cogeneration facility, the British government has defined autogeneration as “generation of electricity by a person whose main business is not electricity generation, the electricity being produced mainly for that person’s own use” (DECC 2014). Fig.10 shows T-4 auction outcomes (2015) and the cleared and exited capacity by fuel type (GW).



Fig. 10. Cleared and exited capacity fuel by type (OFGEM 2016a)

Rys. 10. Wyniki aukcji mocy według paliw (OFGEM 2016a)

Since the publication of the Capacity Market Rules in 2014, the GB capacity mechanism has evolved. Organizations and individuals have proposed amendments and requested additions or substitutions to the CM rules. The experience of the North American CMs, which have been in operation for a decade, show that changes in regulations are needed in order to address evolving design issues. In recent months, an issue of particular interest to GB capacity mechanism participants is the transmission charging arrangements for embedded (distributed) generation (EG). In July 2016, the Office of Gas and Electricity Markets (OFGEM) published an open letter encouraging stakeholders to provide views in regard to, inter alia, the potential distortions that embedded generation is causing to the outcomes of the capacity market (see OFGEM 2016b).

Recommendations and conclusions

The Polish Ministry of Energy faces a number of challenges that need to be carefully addressed before the proposed capacity market can be implemented. Cramton and Ockenfels (2012) note that “no capacity market can function well if there are impediments to long-term investment, such as political uncertainties, regulatory imperfections causing poor implementation, insufficient development of locational and real-time pricing, etc.”

Significant lessons can be drawn from the implementation of capacity markets in the US and the UK. A capacity market is a long-term solution to the resource adequacy problem and a sound wholesale market is crucial for its proper functioning (Cramton and Ockenfels 2012). In order to implement a well-functioning capacity market, an appropriate technical assessment of resources is required (e.g. demand-side resources, energy efficiency, renewable resources) and periodical reliability assessments are needed. Periodical assessments provide consistent modeling data required for analyzing the reliability of the power grid and improve the modelling capabilities of the system.

Furthermore, the study of PJM’s reliability pricing model and the GB capacity mechanism, as well as the analysis of their regulatory experience in small-scale CHP generation and autogeneration, provide practical guidelines to countries where similar capacity market schemes may be implemented in the future. Even though regulatory and policy objectives need to be tailored based on the peculiarities of each power system, some design features and elements of the reliability pricing model and the GB capacity mechanisms can offer support for the implementation of a capacity market in Poland.

In regard to small-scale CHPs and autogeneration resources, it is essential to provide clear guidelines and detailed rules on the prequalification process that are needed for their participation in the capacity market, either as a capacity generation resource or a DSR resource. The complexity of capacity market procedures, obligations and reporting requirements will only increase uncertainty for market participants, and could become a major deterrent for CHPs and autogeneration resources to participate in capacity auctions. In some of the capacity markets

implemented in the US, lengthy and extensive processes for environmental permits and deliverability standards have created economic and technical barriers to entry. As a result, it would be beneficial if special provisions addressing small-scale CHPs and autogeneration resources are included into the policy measures proposed by the Polish Ministry of Energy.

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Rynki zdolności wytwórczych a kogeneracja: rekomendacje dla Polski

Streszczenie

Praktycznie we wszystkich państwach członkowskich Unii Europejskiej, od ponad dziesięciu lat, trwa gorąca debata dotycząca ambitnego projektu rozwoju zintegrowanego, wspólnego rynku energii, projektowania i wdrażania mechanizmów wynagradzania mocy wytwórczych oraz aktualnej sytuacji w sektorze wytwarzania energii elektrycznej, w kontekście adekwatności zasobów. Według Agencji Współpracy Organów Regulacji Energetyki (ACER) oraz Komisji Europejskiej, około 11 państw członkowskich Unii Europejskiej rozważa lub już wprowadziło pewną formę mechanizmu wynagradzania mocy wytwórczych. W świetle niedawnej debaty na temat ewentualnej reformy rynku energii elektrycznej oraz wdrożenia w Polsce rynku mocy, w artykule (1) przedstawiono dwa podstawowe typy rynkowych mechanizmów zdolności wytwórczych funkcjonujących w Stanach Zjednoczonych i w Wielkiej Brytanii oraz (2) przeanalizowano jak w ramach tych modeli rynków uwzględniona została energetyka przemysłowa. Ponadto, w artykule zaproponowano szereg zaleceń (na podstawie wniosków wyciągniętych z funkcjonowania rynków mocy w USA i Wielkiej Brytanii), których celem jest zminimalizowanie niepewności regulacyjnych związanych z wprowadzeniem mechanizmu aukcyjnego w Polsce.

SŁOWA KLUCZOWE: mechanizmy wynagradzania zdolności wytwórczych, jednostki kogeneracyjne, energetyka przemysłowa

