

## High-efficiency Gas Cogeneration – an Assessment of the Support Mechanism

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cogeneration, support system, efficiency

### Abstract

The development of a single European energy market implies the need to harmonise national laws and the directions of the sector's growth to EU determinants. One of these elements was the introduction of a system to support the development of high-efficiency cogeneration, including gas cogeneration. Several years of the mechanisms' performance allows for analysis of the advisability and correctness of the support model format, and assessment of its impact on the sub-sector's development and the cost of its operation. Against the background of the support system introduction origins, the paper presents results of volumetric and price analyses, trends, and assessment of the balance of property rights and of the mechanism's effectiveness.

### 1. Introduction

Combined heat and power generation was one of the first areas of the energy market in Poland to receive targeted support. Promotion of combined heat and power generation took place across many layers and based on various legal standards. As part of tariffs submitted for the approval of the President of the Energy Regulatory Office (ERO), the prices which guaranteed entities representing that sector coverage of justified costs and return on investments were being shaped in an arbitrary manner. Concurrently in the years 2004–2006, there applied statutory provisions which required energy retailers to ensure that a certain mandatory share of the electricity sold originated from high-efficiency cogeneration. The preferences also applied to the administrative and technical issues related to the connection of CHP plants to the network.

An increase in the number of support instruments was the consequence of more than just in-market demands, but also a result of the need to implement community directives. In the analysed case this was in particular Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004. Pursuant to point (1) of the preamble to directive [1]: "Promotion of high-efficiency cogeneration based on a useful heat demand is a Community priority given the potential benefits of cogeneration with regard to saving primary energy, avoiding network losses and reducing emissions, in particular of greenhouse gases". Giving priority to combined heat and power generation, in compliance with the provisions of art. 194 of the Treaty on the Functioning of the European

Union [10], facilitates the improvement of energy supply safety, growth of competitiveness and meeting set environmental targets – and in particular, reducing the CO<sub>2</sub> emissions. The directive, being only a guidance document, outlined permissible forms and profiles of support mechanisms, including primarily as in point (26): "investment aid, tax exemptions or reductions, green certificates and direct price support schemes". For the purpose of the implementation of these directional specifications, the Member States were obliged to perform analyses of technical and economic potential of cogeneration within their local markets and to identify developmental obstacles in that subsector. In accordance with the recommendations of the directive, the support mechanism was to be selected independently, in compliance with point (32) (...) "allowing each Member State to choose the regime, which corresponds best to its particular situation (...)".

From the Polish legislator's point of view it was optimal to select a mechanism based on a certification system. The required provisions were introduced by the amendment to the Energy Law Act in January 2007. This mechanism focused on a multi-layered support aiming primarily to ensure a stable economic environment, minimise administrative barriers and to create a market – i.e. demand and supply – for the product in the form of transferable property rights resulting from certificates of origin for energy from promoted generation sources. In line with the original assumptions, six-year duration of the mechanism was considered substantial. This mechanism was to facilitate the modernisation and construction of new

generation capacities, and its costs were to be sustainably covered by electrical energy recipients. The analysis performed on the basis of the conclusions drawn from several years of operation of the support mechanism systems of highly-efficient cogeneration has enabled the formulation of opinions and assessments of the efficiency of the systems applied. The results of these conclusions, formed on the basis of highly-efficient gas cogeneration, are presented in this article.

## 2. Effectiveness of the support mechanism

Effectiveness may be analysed as a certain economic category used as a criterion for the assessment of the functioning and developmental potential of the mechanism assessed. In regard to the case analysed, this term may be identified with the principle of sustainable management in the following variants: relating to capacity – where maximizing the effectiveness is of primary importance – and relating to savings – where minimizing outlays and expenditures is the ultimate objective. Therefore, an effective support mechanism should facilitate the modernisation of the existing capacities and create new capacities and, at the same time, limit the fiscal, administrative and technical barriers while minimizing the expenditure assigned to energy recipients. In the context of this definition it is essential to mention the most crucial assumptions of the mechanism which affect the assessment of its efficiency.

### 2.1. Equivalent fee

Calculation of the value of the property rights on the market takes place with the participation of the following parties: the supply side, i.e. cogeneration producer, and the demand side, i.e. energy retailers, which are obliged to purchase and cancel a suitable

share of property rights (PMGM), equivalent with the share of electrical energy sold to end users. In the event of a withdrawal from a purchase and cancellation of property rights, the obliged retailer is entitled to pay the so-called equivalent fee, i.e. a certain

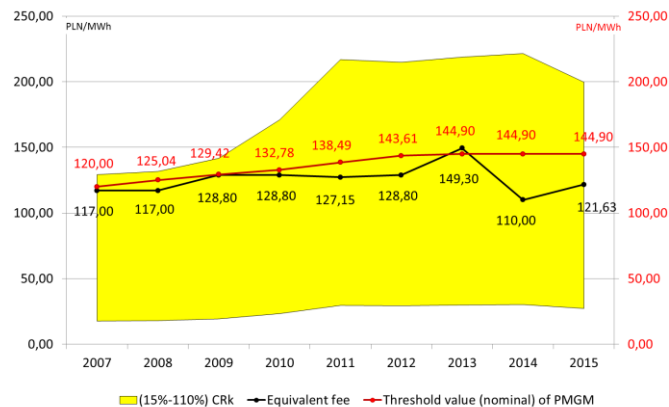


Fig. 1. Equivalent fee level, own work

substitute, which ensures the fulfilment of the retailer's obligations, preventing the issuance of a penalty. Therefore, the amount of the equivalent fee and the algorithm for determining the fee constitute the most vital determinants of the support mechanism. Its amount has an impact on the behaviour of the market players, on the number of property rights included in the exchange registers and is also a crucial reference point in the creation of investment projections.

When implementing the provisions of the directive [1] to Polish law, the legislator made sure to provide the algorithm used to determine the equivalent fee with certain flexibility and assigned the President of the Energy Regulatory Office (ERO) with competencies for its calculation.

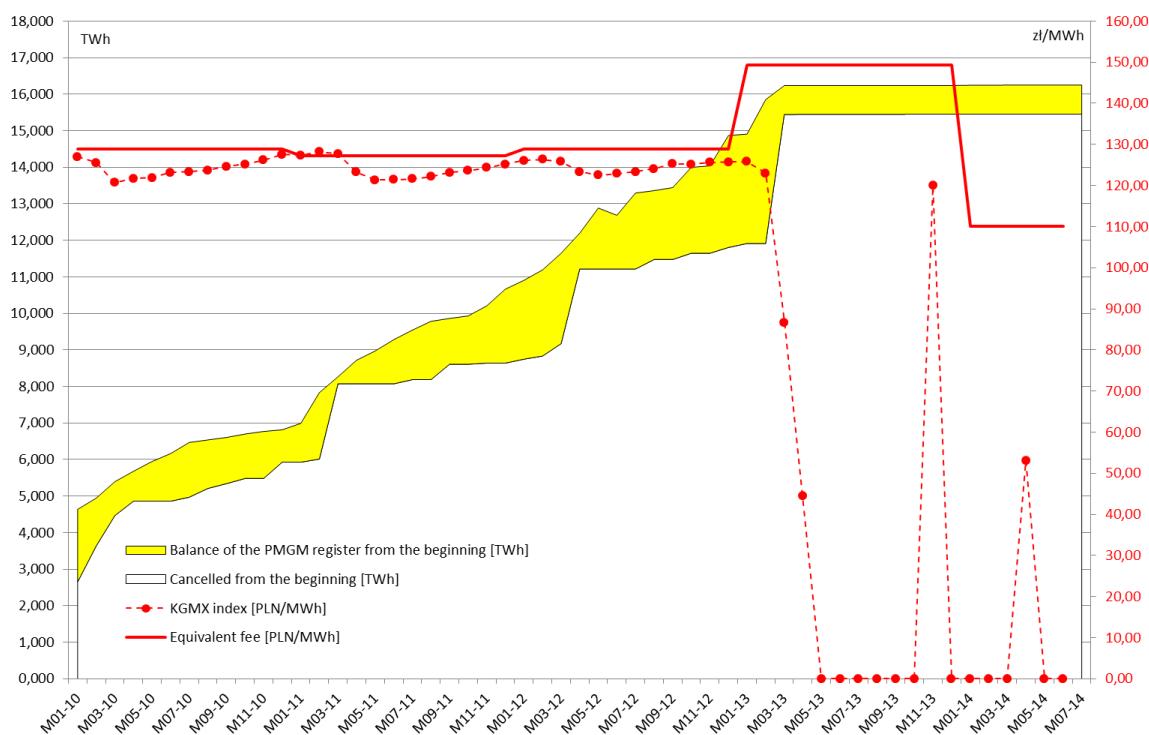


Fig. 2. Value of the price index and balance of the PMGM registers, own work on the basis of data [2]

For cogeneration units fired with gas or units with total installed electrical capacity not exceeding 1 MW, the equivalent fee should vary between 15% and 110% of the competitive market's price. This formula, calculated in the 'n' year, defined the value of the fee for year 'n + 1' on the basis of data from the competitive market from year 'n - 1'. Consequently, the mechanism did not reflect the current requirements, market developments, and pricing trends, but instead displayed strong inertia. The faulty design of this algorithm was also identified in the report assessing the six-month period of functioning of this support mechanism [6], published in December 2007.

In accordance with economic assumptions used as the framework for the support mechanism's design, the

minimum threshold value of a certificate of origin, guaranteeing the obtainment of the IRR index at the level of 10%, considered sufficient when implementing new investments, achieved the level of 120 PLN/MWh for gas sources. Despite the sufficient flexibility of the algorithm, in none of the years from the first period of functioning of the mechanism (2007–2012) did the equivalent fee equal or exceed the threshold value of the property right nominal for that particular year. The potential investment incentive could have occurred in 2013, however, the support mechanism no longer applied in that year. The years 2014–2015 were, in turn, a period when the support mechanism again entered into operation with its principle form unchanged.

PMGM		ISSUED FOR THE PERIOD						TOTAL
		1.01– 31.12.2007	1.01– 31.12.2008	1.01– 31.12.2009	1.01– 31.12.2010	1.01– 31.12.2011	1.01– 31.12.2012	
issued in 2013	[MWh]					6 050	1 356 843	1 362 892
issued in 2012					80 371	1 535 444	2 665 015	4 280 830
issued in 2011		238 104	256 695		1 330 797	2 276 765		4 102 362
issued in 2010				631 583	1 809 023			2 440 605
issued in 2009			754 868	2 438 229				3 193 097
issued in 2008		1 089 574	2 223 517					3 313 091
<b>TOTAL</b>		<b>1 327 679</b>	<b>3 235 081</b>	<b>3 069 812</b>	<b>3 220 191</b>	<b>3 818 259</b>	<b>4 021 858</b>	<b>18 692 878</b>
value of PMGM	[million PLN]	155.3	378.5	395.4	414.8	485.5	518.0	2 347.5

Tab. 1. Number and value of issued PMGM property rights. Own work on the basis of [8]

Within that period, the amount of equivalent fees was 55% and 67%, respectively, of the competitive market's price, which also had a negative effect on the investment moods.

These risks were indicated in the conclusions to the report [6], where it was underlined that “the support system based exclusively on the certificates of electricity origin from high efficiency cogeneration will fail to create sufficient investment incentives. The level of the early equivalent fees [...] has been set much below the certificate prices assumed for evaluating economic potential of the cogeneration. Moreover, in practice the certificate price may prove much lower than the set value of the equivalent fee. [...] in the case of an excess of certificates (too small a market) their value could even drop to nearly zero”. The risks identified in the document, particularly relating to the incorrect calculation of value of equivalent fees and generation of demand, came to fruition and had an impact on the balancing of register states at the end of the period of the mechanism's validity.

## 2.2. Status of registers

The support mechanism valid in the years 2007–2012 did not limit the validity of the property right only to the year in which the right was issued.

In the event of incorrect calculation of demand indices, the algorithm resulted in the accumulation of property rights at the registers of the market participants, which increased the supply in an artificial manner and caused the drop in prices. The collapse of the market was also due to the lack of legible signals from the legislator pointing clearly to an interruption or continuation of the support mechanism's functioning. This policy of disinformation and, consequently, termination of support, resulted in the drop of the value of PMGM property rights to zero, as illustrated in Fig. 2.

The surplus held in the registers became worthless which primarily resulted in the actions undertaken by interested industry sectors aiming at the reactivation of the support mechanism. As a result, the Energy Act Law [9] was revised in March 2014, reinstating the support system for highly-efficient cogeneration

plants. The functioning of the mechanism was limited, with 30 June 2019 specified as the final deadline for the cancellation of property rights or payment of an equivalent fee. The most crucial change introduced to the original model was awarding the certificates of

origin with a time limit, which made their validity limited to one year from the production of energy. This limit was introduced in order to eliminate the aggregation of rights in the registers and to decouple their value from the surplus in the system.

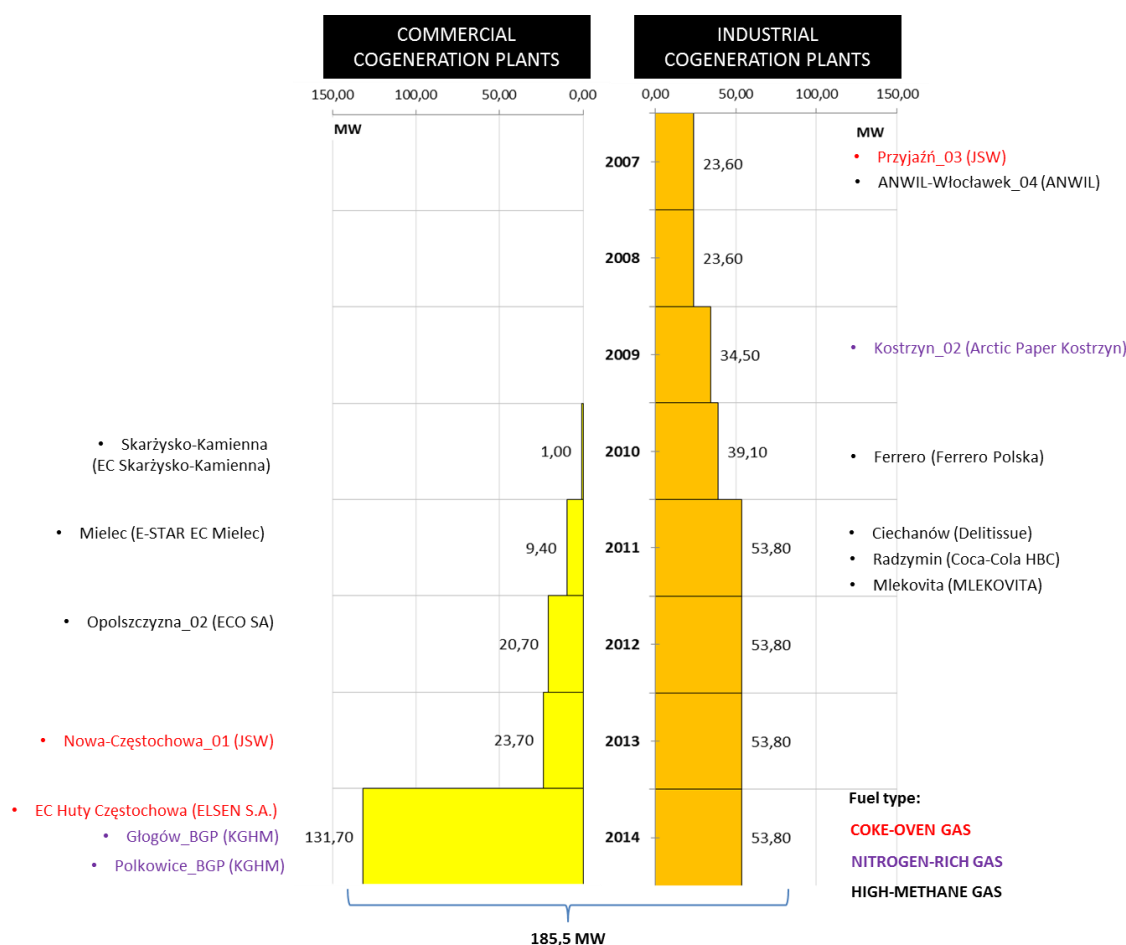


Fig. 3. List of new capacities commissioned in the years 2007–2014. Own work of the basis [3, 4]

Another key modification was connected to the property rights issued before the amended Energy Law Act came into force, and assumed that these property rights would not be considered in the settlement of the obligation's performance. The support mechanism modified in this way began to operate in April 2014, and the first property rights found their way to the registers in July 2014.

At this point it should be noted that the demand for property rights was additionally determined by the provisions of the Regulation [7] which state that if an energy company in the year previous to the year in which the tariff was prepared performed its obligation by paying the equivalent fee to the amount matching the amount of electrical energy higher than 10% of

the sales portfolio, this company could take into consideration only 80% of the costs of the equivalent fee incurred as justified costs in the tariff.

The inability to take into consideration the full costs incurred would noticeably translate into an increased demand and, consequently, a higher value of the property rights.

### 2.3. Effectiveness assessment of the mechanism

According to the assumptions, the support mechanism was to tap into the technical and economic potential of cogeneration and facilitate modernisation and construction of new generation capacities, minimizing, at the same time, all costs incurred. In the years 2007–2012, combined heat and

power generation led to the issuance of approx. 18.7 TWh PMGM, whose market value related to equivalent fees amounting approx. PLN 2.3 billion. Tab. 1 presents the above data in detail. By referring the value of support to the quantity of energy sold to end users it could be concluded that the social cost of this system was on average approx. 3.3 PLN/MWh in the analysed period.

At this point it seems justified to present the results which were obtained thanks to supplying the support mechanism with 2.3 billion PLN. As outlined in the publications [3, 4], there were new investments introduced to the Polish electrical power system, both in the field of commercial and industrial power generation. In total, in the years 2007–2014, nearly 186 MW of capacity allocated in sources based on coke-oven, nitrogen-rich and high-methane gas were commissioned, as illustrated in detail in Fig. 3. It should be emphasized that because of the length of the investment cycle, only some decisions on the construction were made on the basis of the financial support provided by the property rights' market. Assuming the value of 3.7 million PLN/MW [5] as the unit cost for the construction of a gas source and the cycle of duration of the preparatory and construction phase to be approx. 5 years [5], it could be stated that the collected financial resources should be sufficient for the construction of approx. 620 MW within the next several years.

### 3. Overview

In accordance with the results of the calculations conducted in 2007, i.e. at the time when the support mechanism was being introduced, the cogeneration systems in Poland produced approx. 280 PJ of heat, which referred to only 64% of the economic potential (approx. 430 PJ). This situation could have been altered by the implementation of the support mechanism and setting its height at the level of 120 PLN/MWh for gas technologies. This would have encouraged the growth of the economic potential by approx. 23%, i.e. to the level of 530 PJ in 2020 [6]. The algorithm for the calculation of the equivalent fee and the mechanism for cancellation of property rights resulted in the permanent calculation of property rights below the threshold value forming the investment reference point. During the period of nearly six years of the support mechanism's functioning, only about 186 MW were commissioned from new cogeneration gas sources, with the value of the entire market amounting to 2.3 billion PLN. The introduction of a new mechanism in 2014, which allowed for temporary validity of the property rights

and negated the possibility of the entirety of the costs related to the payment of equivalent fees being transposed to the tariff, will strengthen the market value of the property rights. Nonetheless, in the opinion of the authors, this will not constitute a sufficient stimulus for investment as the value of the equivalent fee for 2015 is lower by approx. 17% than the nominal threshold value which guarantees the financial viability of an investment. In addition, the global reduction of the dynamics in the demand for heat, which also has an effect on the scheduled investments in generation capacities, can be of great concern to the analysts. In accordance with [5], in the years 2014–2050, only an increase of approx. 12% and 7%, respectively in the demand for heat will take place in the urban and industrial sector.

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