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## Analysis of EU ETS reforms from Poland's power sector perspective

**Abstract.** The main objective of this article is to present ongoing reform of the EU Emission Trading Scheme (EU ETS) from Poland's power sector perspective. Focus has been put on the one proposed by the European Commission (EC) (2014). The evolution of the methods of allocation of the European Emission Allowances and the impact of different factors on their price formation has been discussed. Oversupplies of allowances and the following price fluctuations have been recognized as main but not sufficiently clearly explained reasons of the allowance market instability. Some weaknesses of the EC recently proposed purely administrative reform of the allocation rules and the market functioning have been pointed out. Additionally the proposal of EU ETS reform elaborated by the Euro-CASE (2015) has been discussed as an alternative. In the Euro-CASE proposal the "price-collar" has been proposed as the market based mechanism for better price stabilisation. These two proposals have been discussed from the perspective of COP21's conclusions. Some implications and potential advantages for Poland have been presented. The estimated increase of costs in the current Poland's power sector has been presented to illustrate the potential risk due to the expected allowance price rise till 2020. It has been suggested to start public discussion on how Poland can in the most cost effective way exploit the recently EU ETS reform enabled options.

**Streszczenie.** Głównym celem artykułu jest przedstawienie reformy systemu handlu emisjami UE (EU ETS) zaproponowanego przez Komisję Europejską (KE) (2014) z punktu widzenia polskiego sektora elektroenergetycznego. Opisano zmiany w sposobie przydzielania pozwoleń na emisję w EU ETS i wpływ różnych czynników na cenę pozwoleń. Nadpodaż pozwoleń i następujące zmiany ich cen zostały uznane za główne, ale niewystarczająco dokładnie wyjaśnione przyczyny niestabilności rynku pozwoleń. Zostały omówione słabe strony reformy KE opartej całkowicie na rozwiązaniach administracyjnych. Jako alternatywę do reformy KE opisano rozwiązania zaproponowane przez Euro-CASE (2015) proponujące wykorzystanie mechanizmu rynkowego „price collar” do stabilizacji cen uprawnień. Obie propozycje zostały przedyskutowane z perspektywy zobowiązań podjętych na COP21. Pokazano oszacowanie przewidywanego wpływu wzrostu cen uprawnień na koszty funkcjonowania obecnego polskiego sektora elektroenergetycznego do roku 2020. Zaproponowano rozpoczęcie dyskusji na temat sposobów wykorzystania w sposób jak najbardziej efektywny możliwości, jakie powstały w wyniku reformy EU ETS. **Analiza reform EU ETS z punktu widzenia polskiego sektora elektroenergetycznego**

**Keywords.** EU ETS reform, Poland's energy policy, back-loading, MSR

**Słowa kluczowe.** reforma EU ETS, polityka energetyczna Polski, back-loading, stabilizacyjna rezerwa rynkowa (MSR)

### 1. Introduction

The European Union (EU) has plans to reduce its greenhouse gases (GHG) emissions by 20% in 2020, by 40% in 2030 and then even further by 80–95% by 2050, against 1990 levels. Over years the EU has built a strong legal, regulatory, monitoring and verification framework to establish and control legal binding obligations and rules of its climate policy. The EU ETS related legislation started with Directive 2003/87/EC (EU ETS Directive) [6]. Nowadays the main policy instruments used by the EU in its efforts to reduce GHG emission are the EU Emission Trading Scheme (EU ETS) and the Effort Sharing Decision (ESD) [1, 9, 10, 13].

The main objective of this article is to present ongoing reform of the EU Emission Trading Scheme (EU ETS) from Poland's power sector perspective. Focus has been put on the one proposed by the European Commission (EC) (2014). Additionally the proposal elaborated by the Euro-CASE (December 2015) has been discussed as an alternative. These two are discussed in light of COP21's<sup>1</sup> conclusions. The evolution of the methods of allocation of the European Emission Allowances (allowances) within the EU ETS and the impact of different factors on allowance price formation are briefed. Some implications and potential advantages for Poland are also presented. It is discussed how Poland can exploit the recently EU ETS - reform enabled options in its unavoidable energy sector transformation to a more sustainable model. The indirect objective is also to initiate discussion on energy policy of Poland in the context of the post-Paris EU climate policy. This objective is getting even more important after the publication of the critical report of Poland's preparation to meet climate-energy policy [7].

### 2. Allowance allocation rules in EU ETS

#### 2.1 Historical overview

The EU ETS Directive as amended by few directive, namely Directive 2004/101/EC (Linkage Directive), Directive 2008/101/EC (Aviation Directive) and Directive 2009/29/EC, now precisely defines the mechanisms of allocation of the allowances. These are two: free allocation and auctioning.

The rules of allocation have changed during the EU ETS periods (fig. 1) [1, 9, 10, 13, 17]:

- 1st trading period 2005–2007 (pilot phase): the emission cap was set to 2058 million tCO<sub>2</sub>; the number of granted allowances was too high resulting in a wide fluctuation of the price of allowances between €7/tonne and €31/tonne, finally falling to almost zero (€0.06/tonne) in 2007.

Looking for reasons of such dramatic plunge of the prices one can list: (a) the emission reduction goals were wrongly set being not demanding enough; (b) aggregate emission data were known after the mid of the phase when it turned out that realised aggregate emissions were lower than allowance supply; (c) possibility of allowances banking e.g. moving allowances from this period to the second one was not permitted; (d) progress in renewable energy sources (RES) and energy efficiency induced by the EU climate policy contributed more than expected to lowering the demand for allowances; (e) the low credibility of international commitment.

2nd trading period 2008–2012 (coincided with the first Kyoto compliance period): the cap was 1859 million tCO<sub>2</sub>; though the number of allowances was reduced by 6.5%, the economic crisis and the failure of the COP in Copenhagen were the main reasons for the price fluctuation. Again the surplus allowances impacted their market price as the average annual allowance prices varied between €22/tonne (2008) and €8.12/tonne (2012).

<sup>1</sup> Conference of the Parties to the UNFCCC

3rd trading period 2013-2020: major reform took effect (1.1.2013). Biggest changes were the introduction of the dynamic cap of 2084 million tCO<sub>2</sub> in 2013, decreasing linearly by 38 million tCO<sub>2</sub> per year and a progress towards auctioning of allowances in place of cost-free allocation.

The prices were relatively stable in this period – ranging from approximately €4/tonne to €8/tonne.

4th trading period 2021-2028: it will be governed by the follow-up of the Paris Agreement.

The EU limit of 1 816 Mt CO<sub>2</sub> imposed on stationary installations to be achieved by 2020, was already reached in 2014 [17]. Combustion-related emissions accounted for 68% of total EU ETS emissions in 2015. In 2008-2014, industry's revenues from the EU ETS are estimated at €24 billion while calling for even more free allowances worth about €160 billion for the period after 2020.

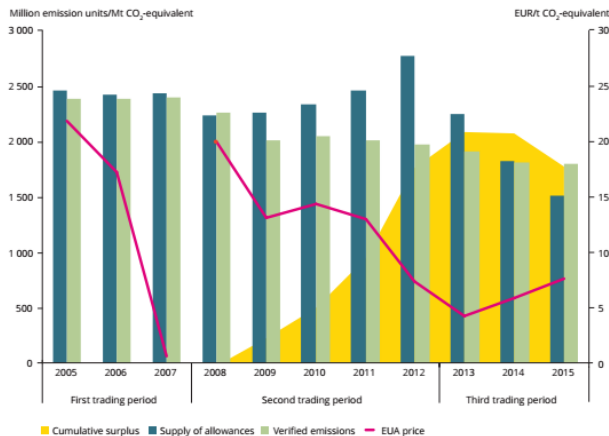


Fig. 1 Emissions, allowances, surplus and carbon price in the EU ETS, 2005–2015 [17]

## 2.2 Current rules

Since 2013 the main way of allocating allowances is the auctioning sales considered the most transparent and equitable method of allocating allowances as it implements the principle „polluter pays“.

Free allocation is based on ex ante benchmarks<sup>2</sup>, developed by the EC in consultation with industry sector for products not for sector or output. Free allocation is not foreseen for the electricity production. Provisions of art. 10(c) (article numbers are referred to the EU ETS Directive) specific for electricity sector are discussed in section 6.

Free allocation is conditional - at least 50% of the revenues generated from the auctioning of allowances should be used for the following purposes: reduction of GHG emissions; development of renewable energy sources (RES), and other technologies contributing to the transition to a low-carbon economy; measures to avoid deforestation and increase afforestation and reforestation; forestry sequestration; capture and geological storage; a shift to low-emission and public forms of transport; research in energy efficiency and clean technologies; improvements in energy efficiency and insulation; covering of administrative expenses of the management of the European scheme. Member States of the European Union (MS) are required to inform the EC about how they use these proceeds.

Allowances granted free of charge to the manufacturing industry are passed on to companies on the basis of harmonized rules to ensure equal treatment for this type of installation in the EU.

<sup>2</sup> Benchmarks are performance indicators for a certain sector or product and can be used to determine the performance of one installation against that of others.

Installations in sectors and sub-sectors, which are considered to be exposed to a high risk of carbon leakage<sup>3</sup>, are subject to special rules in order to support their competitiveness. Those meeting the requirements of the benchmarks, as a rule, receive free of charge all the needed allowances, depending on their historical emissions, for the whole period 2013-2020. Installations failing the benchmarks, receive proportionately lower allocation of free allowances in relation to their emissions so they are forced to reduce emissions or buy more allowances.

In sectors, which are not considered to be exposed to a significant risk of carbon leakage, other than energy, transformation for the fully auction system takes place progressively. The best 10% of the GHG installations for a given product in 2007-2008 are granted with more allowances than the others. Units, placed in the top band of benchmark as a general rule received free of charge 80% of allowances, which they needed in 2013. This percentage is reduced each year and in 2020 is to be 30% with the intention to be totally ceased by 2027 (art. 10(a)). Installations which do not achieve the level set by benchmarks receive proportionately lower quantity of allowances. This system rewarding the best installations is designed as an additional incentive for companies to reduce emissions. In aviation throughout the all period 2013-2020 only 15% of allowances will be sold at auctions.

This mechanism of free allocation was designed to grant 80% of free allowance to industry in 2013 (up to their relevant benchmark) with diminishing trend to 30% in 2020, no free allocation for power sector, and 100% allocation for industry sectors deemed exposed to carbon leakage. The benchmark based system, not applicable to aircraft operators or power sector, has the so called “flat rate” reductions rule built in. However there is a risk that default flat rate of 1% may penalise the sectors where available emission potential has been already consumed in the previous EU ETS phases. That in turn will increase the risk of carbon leakage. Allowances not allocated free of charge will be sold at auctions.

After 2020 free allocation will be continued.

## 3. Current problems of EU ETS

The EU ETS has been for some recent years unable to operate effectively and deliver more ambitious results than those envisaged for 2020 [10]. According to the prognosis, in the long term the EU ETS in its current form may have a negative impact on the ability of cost-effective meeting of more demanding emission reduction targets.

The main problems the system encountered are: (a) threat of carbon leakage in some energy intensive industries; (b) unsatisfactory operation of the New Entrant Reserve (5% of the EU-wide allowances for the period 2013-2020 shall be reserved for the so called new entrants (art. 10(7));

(c) low prices of the GHG allowances unable to invigorate the investments in low-carbon technologies. Only the last issue is a subject of extensive study in this paper.

As late as in 2012, the EC reported a significant oversupply of emission allowances [11]. Concerns were voiced about the low price of allowances and the high level of their volatility. The allowances were cheap, because a demand on it decreased while supply remains at the same level. Before 2013, at the market there was a surplus of 2 billion allowances in relation to the actual demand. By 2020,

<sup>3</sup> The term “carbon leakage” refers to a situation that may occur if, for reasons related to the costs of climate policies the company shifted production to other countries with fewer restrictions on GHG emissions. This can lead to an increase of total emissions.

the surplus can reach 2.6 billion. Such an imbalance reduces incentives for low-carbon investments investment and reduces the efficiency of the system as a climate combat tool.

The EU ETS was then standing in front of a challenge of increasing surplus emission allowances, principally as a result of higher than expected reduction of emissions since 2008, which was mainly caused by the prevailing economic crisis. At the time it was the commonly accepted explanation. Later it turned out not to be fully acceptable.

In depth research revealed that the impact of different factors on allowance price formation from the beginning up to the first year of the 3rd phase of the EU ETS is hardly to be explained by this reason only – there must be other reasons that led to such deep fall of the market (fig. 1) [14].

Only 10% of price fluctuations can be explained by fundamental market developments (e.g. more extensive introduction of RES than expected, financial crisis, international credits from Clean Development Mechanism (CDM)). It therefore means that 90% of the collapse of the price are difficult to explain. When the politically driven changes (e.g. back-loading) are taken into account statistically explained level increases from 10% to 44% but still remains not fully clear (fig. 2).

Thus it can be concluded that the EC has started the reform being not fully aware of the reasons of the EU ETS unsatisfactory functioning. Moreover, the observed fluctuations of the allowance price suggest future necessity for setting upper and lower bounds to limit the price volatility (see section 5).

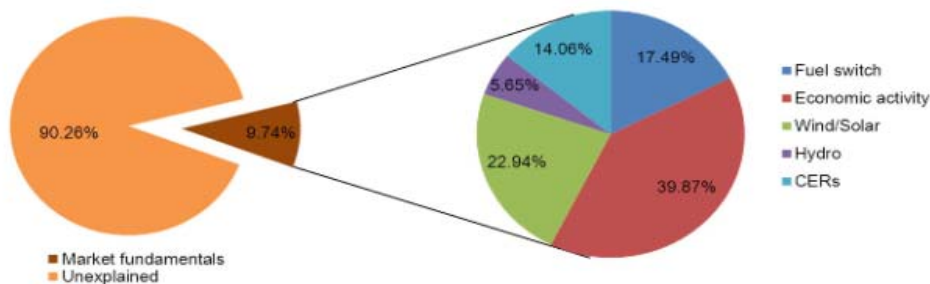


Fig. 2. Impact of different factors on allowance price in the EU ETS [14]

#### 4. EU ETS reforms

##### 4.1 EC early proposals

The EC was aware that deep structural reform of the EU ETS is required. To rectify the situation in the long-term, six options of structural reform of the European carbon market were proposed by the EC in the Carbon Market Report (November 2012) [16]. These can be grouped into three categories:

##### A. Reduce allowance surplus

- Increasing the EU's GHG reduction target to 30% in 2020.
- Retiring a number of allowances in the 3<sup>rd</sup> phase.
- Early revision of the annual linear reduction factor.

##### B. Adjust scope

- Extension of the scope of the EU ETS to other sectors to cover by the EU ETS these sectors which are less prone to economic cycles.

- Limit access to international credits. The openness of the EU ETS to internationally generated credits is considered one of the reasons of the excessive market. To invigorate market for low-carbon technologies in the EU influx closing or substantial reduction of international credits was proposed.

##### C. Reduce price uncertainty

- Discretionary price management mechanisms such as price floor for auctions or price management reserve. These two were alternative options

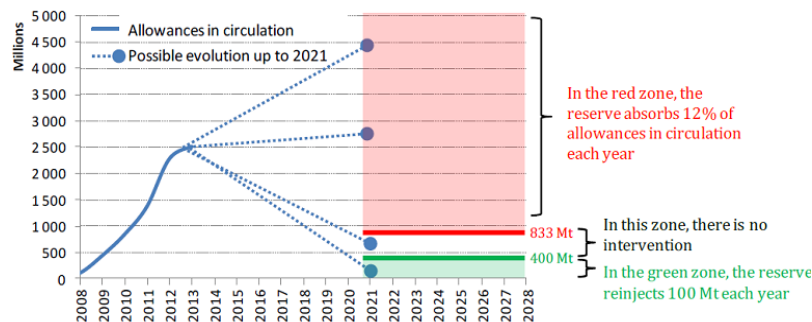


Fig. 3. The MSR triggering mechanism [18]

##### 4.1.1 Back loading

To instantly counteract this negative phenomenon the EC proposed rather temporary solution - the so-called "back-loading" (November 2012). It is merely administrative intervention in the GHG market consisting in the postponing of a certain fraction of the auctioned allowances. This intervention would make the EU ETS more insensitive to

the imbalance between supply and demand of the allowances. In December 2013 the European Parliament supported use of the back-loading, which started its operation in March 2014. The European Parliament agreed to shift some allowances due to be auctioned in 2014-2016 to be sold later in 2019-2020.

This would, however, not affect the total amount of the allowances, which are structurally in surplus, and as only shifted in time they remain looming over the market.

Despite the step it was commonly agreed that in the long-term this surplus continues to threaten, and undermines the right functioning market of the allowance.

#### 4.1.2 Market stability reserve

Exploring further the long-term options, after public debate on the EU ETS, the EC limited the number of the options and proposed (January 2014) the so called Market Stability Reserve (MSR) to operate in the 4th phase. Effect of the MSR, is based on the assumption, that if the total number of allowances on the market exceeds a certain limit, the allowances will be shifted from the market to the stability reserve. If necessary, allowances would be restored on the market.

At the time, when the number will exceed 833 million units in the year, from September of the following year by another 12 months oversupply in the amount of 1% per month will be phased out. In the opposite situation, part of the allowances will return on the market. It is now accepted rule that if a surplus on the market falls below 400 million, the powers of the reserve will be placed back on the market. The current surplus is more than 2 billion pieces (in 2013, this surplus was 2.1 billion; in 2014 it was reduced to some 2.07 billion; with no back-loading the surplus in 2014 would almost reach 2.5 billion allowances).<sup>4</sup> However allowances withdrawn so far in the framework of back-loading in quantity of 900 million will now be transferred to the MSR. It is believed this step will contribute to the rise of allowance prices.

Higher rate of the allowances will necessitate restructuring of budgets in the EU ETS covered companies. They will be compelled to increase energy efficiency and invest in RES, to reduce the costs of purchase of the allowances. It is envisaged that energy-intensive industries remain to a large extent relieved from these higher costs to stay globally competitive since they are able to receive 6.3 billion free allowances worth up to €160 billion. It is envisaged that unallocated 550...700 million allowances will be shifted to the MSR in 2020. 250 million of the unallocated allowances from 2013-2020 will support a reserve for new and developing installations. The European Parliament and the Council approved the MSR in October 2015. It is worth noting that this decision coincided with adoption of the Communication on a 2030 Climate and Energy Policy Framework setting higher reduction limit (i.e. 40% in 2030). It was also agreed that the total number of allowances will be reduced at the rate of 2.2% every year starting from 2021. The EC proposed a plan on auctioning till 2020 which takes into account all currently envisaged instruments to rectify the present situation in the allowance market, namely free allocation, New Entrants' Reserve (NER) and back-loading and then reintroduction of back-loading after 2019.

Under the auctioning system companies are forced to buy a steadily increasing proportion of their allowances at auctions. According to the EU plans, full auction will become effective by 2027. However, eight MS which joined the EU in 2004 or later, namely Bulgaria, the Czech Republic, Estonia, Cyprus, Lithuania, Hungary, Poland and Romania will remain the opportunity to use limited number of free allowances for power plants until 2019. In return, these countries are obliged to invest at least the equivalent

of the free allowances in the modernization of the energy sector. Because of the lion share of the energy sector in the EU ETS emissions, it can be assumed, that from 2013 on, more than 40% of the total quantity of allowances will be sold at auction system. This amount takes into account the free transfer of entitlements in the eight MS. From 2013 onwards, 88% of allowances to be auctioned are distributed among MS in according to their shares, which were calculated on the basis of verified emissions from installations covered by the ETS in 2005. 10% will be distributed among the least affluent MS (19 MS including Poland) as an additional source of allowances, in order to support from these revenues investments in these countries to reduce GHG emission and for adaptation of their economies to climate change policy. The remaining 2% of the allowances will be distributed as bonus, to those MS which, succeeded until 2005 in reducing GHG emissions by at least 20% in relation to their commitment in the Kyoto Protocol (Kyoto bonus). These are Bulgaria, Czech Republic, Estonia, Lithuania, Latvia, Hungary, Poland, Romania and Slovakia. It is assumed that the allowances issued starting 2013 shall be valid for the entire 3rd trade period (2013-2020). These general rules are subject to some exceptions laid down in art. 10 (a), (b) and (c) of the EU ETS Directive which allows free allocations to specific sectors when certain conditions are met.

The MSR triggering mechanism is explained in fig. 3 that shows a schematic representation of projected allowances in circulation (size of the cumulative allowance surplus) that serves as the basis for intervention conditional on two quantity-based triggers (red and green line).

The legal framework around the reserve gives no discretion to the EC making the system fully transparent.

The MSR is supposed to be established in 2018 and start operation at the beginning of 2019 (the EC proposed 2021). Allowances, which by 2020 were suspended as part of back-loading or have not been used, will be in reserve instead hit the carbon market. The MSR has been expected to contribute to a stable operation of the EU ETS to send proper signal to the investors. In time its operation should be limited to minimum to return to entirely market based operation.

#### 4.2 EC recently proposed EU ETS reform

In July 2015 the European Parliament agreed to reform the EU ETS operation in the 4th phase. The EC announced 15 July 2015 a proposal to revise the EU ETS based on the previously agreed MSR.

The proposal aims at:

- Revision of the EU ETS Directive in a manner to ensure emissions in the EU ETS are reduced by 43% below 2005 levels by 2030.
- Promotion of low-carbon innovation and establish, for industrial sectors, appropriate provisions to address the potential risk of carbon leakage in the absence of comparable climate policy measures in other major economies.
- Implementation of further EU ETS-related aspects of the 2030 climate and energy policy framework.

##### 4.2.1 Change of decline factor

The main changes embrace change of the annual rate at which the overall number of emission allowances will decline, revision of procedures on free allocation to carbon leakage endangered industry based on predictable, robust and fair rules, the establishment of a modernization and an innovation funds, and optional free allocation of allowances to modernise electricity generation in some MS.

<sup>4</sup> According to the European Environmental Agency, the massive surplus of carbon permits in the system is declining as in 2015 it was 0.7% lower in comparison to 2014 [17].

The linear factor by which total amount of allowances decrease is set to 1.74% annually (2008-2012). It aims at 70% reduction in the EU ETS by 2050, which is not in line with the EU's agreed long term objective of 80...95% reduction by 2050 as compared to 1990. To meet the overall EU 40% target for 2030 (it demands 43% GHG reduction target in the EU ETS in 2030) the limit of GHG emissions will have to be lowered by 2.2% per year from 2021 onwards. This change will give an additional reduction of around 556 million tonnes of GHG in the period 2021-2030 compared to the current annual decline of 1.74%.

#### 4.2.2 Allocation of free allowances

The allocation of free allowances will be kept although to better management of the system it is proposed to introduce (a) a more frequent alignment of the free allocation to production data; (b) updating the benchmarks used to calculate the free allocation; (c) list of sectors receiving the highest share of free allocation will be more targeted to those most exposed to the potential risk of carbon leakage.

Submission of the proposal had been preceded by a public consultation on revision of the EU ETS Directive for the period after 2020 launched by the EC in 2014. The conclusions of this consultation are publicly available.

The new rules are intended to solve the problem of imbalance between supply and demand in the market allowances, which inhibits the incentives for low-carbon investments in the EU.

This is the first step towards achieving the EU's target for reducing GHG emissions by at least 40% on the domestic market as its contribution to a new global climate agreement. The change has to rectify the current inefficiencies of the EU ETS and prove that it still remains the most effective system to limit GHG emissions in the post-Paris coming decade. The reformed EU ETS should inspire other international partners to use GHG prices as the driver for gradual but continual decarbonisation process of economies. The revised system should provide stronger incentives for innovation and restore the European industry competitiveness on global markets. Funding for low-carbon technologies are foreseen as support to countries with lower income. This will help to further stimulate the exploitation of RES and other low-carbon technologies, and energy efficiency which next to decarbonisation are key objectives of the EU. Implemented change of the EU ETS based on the MSR will strengthen the functioning of the electricity market in Europe, what will ensure, that energy will be delivered to customers in the most economical way.

Looking at the planned changes and whereas recently adopted solutions designed to bring about changes in the prices of GHG emission allowances, one can certainly predict that allowance prices will rise. Assessing the market of GHG emission allowances in the long-term perspective, and assuming that, in accordance with the plans every year the EU will reduce emissions by roughly 1.1%, it is to be found that at the end of 2030 there will be surplus of allowances of nearly 400 million. Currently, surplus of GHG emission allowances amounts to more than 2 billion ones, with the price of more than 8 €/tonne. So if we assume that in 2030 the surplus will be 400 million, what means that the surplus will be relatively small and one can estimate the future price. This could be considered as an optimal state. However, we must remember that in the MSR is at the same time about 3 billion weaned from carbon market.

There is a real chance that the return to standard volumes auction will develop supply pressure and come to a stop the observed allowance price increases.

The mechanism of national implementing measures provides for the possibility of applying for allocation of free emission allowances for production other than electricity generation. To calculate the amount of allowances specific formulae is used which indicates that over the 3rd phase, some 43% of the total phase allowances of the 3rd phase (6.6 billion pieces) are to be allocated for free to industrial installations.

The EU aims to integrate the EU ETS with similar systems operating in other countries. The principles of the merger, for example with Australian system have been already agreed. The EU ETS can afford to collect €80 billion for the combat with climate change. The EC expects, that part of the proceeds from emissions trading of the GHG, will be spent on financing climate projects in developing countries.

#### 4.2.3 Modernization fund

Being aware of the high investment needs relating to energy efficiency and the modernization of energy systems in lower income MS, the Modernization Fund will be set up.

Between 2021 and 2030, 2% of the allowances, approximately 310 million, will be lay by to establish the fund with contribution from all MS. The criterion for the fund eligibility was limited to MS with a gross domestic product (GDP) per capita of less than 60% of the EU average (in 2013), all in total 10 MS including Poland.

#### 4.2.4 Innovation fund

To support investments in energy efficiency, RES, carbon capture and storage (CCS) and other low-carbon innovation in energy intensive industry, the Innovation Fund will be established after 2021.

It will be supported with 400 million allowances of estimated market value of €10 billion. In order to enable the investments earlier. i.e. before 2021, a further €50 million of the unallocated allowances from 2013-2020 will be reserved to support breakthrough technologies in industry.

#### 4.2.5 Further steps

Despite of all this efforts the EC is aware of the need for further possible reforms of the system based on experience which should be considered post-2020. These can embrace [4]:

- the validity of allowances across EU ETS phases;
- the possibility for MS to exclude certain small installations from the EU ETS and subjecting them to equivalent measures;
- the sustainable funding of the EU-wide single registry for the EU ETS.

These efforts illustrate the wish of the EC to reduce GHG emission whereas support technological shift to low-carbon path.

### 5. ETS reform proposed by EURO-CASE<sup>5</sup>

Proposal to reform the EU ETS has been a subject of research of many scientific groups and scholars [2].

They can be roughly divided into two categories – addressing the price and quantity of the allowances. They differ in price/quantity certainty and degree of delegation given, e.g. rule based or discretion of the system governing body.

Recently, in 2014, the subject was taken by Euro-CASE which is the very unique voice from European academies in

<sup>5</sup> The paragraph is heavily based on the work of the Euro-CASE in which one of the authors took part.

the climate change discussion and provides a platform of scientific consideration free of political influence.

According to the document produced „Euro-CASE policy brief reform options for the European Emissions Trading System”<sup>6</sup> the proposed and adopted by the European Parliament optimization methods for emission allowances prices are not sufficient, since they tackle the problem very narrowly and the reform really needed shall be structural and comprehensive [11]. As presented the EC has claimed to resolve the existing problem by introducing reform aiming at reduction of the supply of allowances, namely by establishing the MSR. However, according to Euro-CASE, the EC did not properly address the problem of low prices and the phenomenon of price uncertainty. These two seem the most uncertain elements of the EU ETS hindering low-carbon investments. The EC addresses in its proposals only to the existing large surplus market of allowances. Their impact is difficult to precisely evaluation of this phenomenon, because the justification mechanism is not transparent. The Euro-CASE points out, that the EU proposed reforms do not take into account the problem of dynamic cost-effectiveness. It states that “the reason is the relationship between the amount of allowances surplus and formation of their prices, which appears to be incomprehensible from the perspective of intertemporal periods.”

The problem of lack of dynamic cost effectiveness is considered crucial in the future reform and therefore should be properly addressed. Too low cost of allowances can cause weakening of dynamic cost changes, and disturb right investment and research and development (R&D) decisions.

Moreover, the number of the allowances neither on the demand nor on the supply side can be enough precisely estimated. This can lead not only to preserving the current low prices, but may also have a negative impact on future investment decisions and preserve market uncertainty even at periods with relatively high price of allowances.

The third concern is that continued low allowance prices would inspire most ambitious MS to put into operation national reduction schemes what in turn will disintegrate the EU ETS essentially based on MS co-operation and commonly accepted rules.

Euro-CASE postulates that instead of narrow the reform of the EU ETS, which as proposed by the EC concentrating on surplus of the allowances there is a need to carry out the necessary comprehensive reform, which will embrace the following set of issues having impact on price of the allowance.

### 5.1.1 Allowance price formation

To understand the proposals of EU ETS reforms presented by the EU, which are currently under discussion, it is important, to understand, how allowance prices are formed. The EU ETS fundamental reviews associated with reducing emissions they affect the price through the demand side, and the political decisions have an impact on changes of prices through the supply side.

As stated in section 3 latest researches clearly show, that these factors, which are associated with the reduction of GHG operating through the demand side are not fully able to explain the drop of the allowance price in the EU ETS. It could be that, the uncertainty related to both supply and demand are strong enough to make the private investors recourse to discounting long-term balance of

<sup>6</sup> The document was convened in Brussels on 24-25 September 2014 in order to inform about policy paper on options for reform of the EU ETS and present them to the appropriate decision makers.

supply and demand and place greater importance to the current allowances oversupply in the market, which makes the price below the threshold enabling market transformation.

Another explanation is also likely - market players have no trust in the climate policy and its new instruments, announced and planned, and therefore they rather await more mild supply, being not ready to undertaken more active innovative and investment steps.

The cumulated demand and supply uncertainties together with the lack of market trust in effective politically inspired ways of coming out from the current EU ETS crisis are very much likely to continue keeping the allowance price low causing the whole system unable to perform effectively, i.e. meeting the GHG reduction goals in most economical way.

Commonly adopted is the view that the accumulated surplus of allowances in the EU ETS poses a big problem, with which we must necessarily cope with. Therefore the introduction of the MSR. However, there are many doubts whether the MSR is able to solve the price stabilisation problem and properly address the problem of lack of dynamic cost effectiveness.

Instead, Euro-CASE proposes to introduce a price collar introducing borders of the upper and lower of allowance price level, what would be the ideal policy instrument in the evaluation criteria of cost effectiveness (fig. 4).

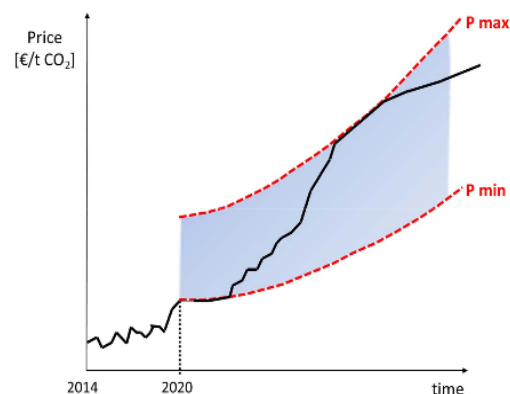


Fig. 4. Operation of the price collar proposed by the Euro-CASE for the EU ETS reform [12]

The price level (starting price of the auction) will address national preferences, for example, more ambitious national targets for mitigation, without undermining the environmental effectiveness of additional national policies. Price caps are result from the fact that prices may increase significantly as a result of market shocks. In determining the ceiling, the risk decreases symmetrically, what would be important for investors. This will help to reduce uncertainty about supply and demand now and in the future, and thus will stabilize the situation and satisfy market expectations. This may affect the abnormalities in functioning of market, in this sense, that on political market, such as UE ETS prognosis is much more exposed to the risk of uncertainty and the change in the law with potentially huge impacts than it take place on other markets. Important is the construction of the price collar. Kind of its design will decide about opportunities to achieve environmental efficiency of the EU ETS.

The price collar proposed should establish reliable framework for investment decisions as collar pricing will stabilize expectations. Dynamic profitability should also be ensured.

However, it is important to be aware, that the price collar will not be implemented without any problems. At first, the

political criteria related to feasibility, based on quantitative reform are seen as more politically infeasible. The price collar is perceived as a type of tax, and therefore it may cause resistance and adaptation problems. Secondly, there are also some challenges in the implementation of the collar price: modelling seems to be the easiest way to determine a suitable price range, however there is a large uncertainty between models, even if their assumptions are harmonized. Results of simulations of allowance prices at two sessions – with no collar and with collar are presented in fig. 5.

Careful implementation will require taking this into account and finding ways to solidly determine the price range spread across the results for entire model. In addition, unforeseen events can change the conditions under which the price collar was modelled, so it must be flexible enough that it can be adapted in such circumstances without losing credibility. Arbitrary corrections should be excluded, and any changes should be transparent and carried out on the basis of pre-defined rules.

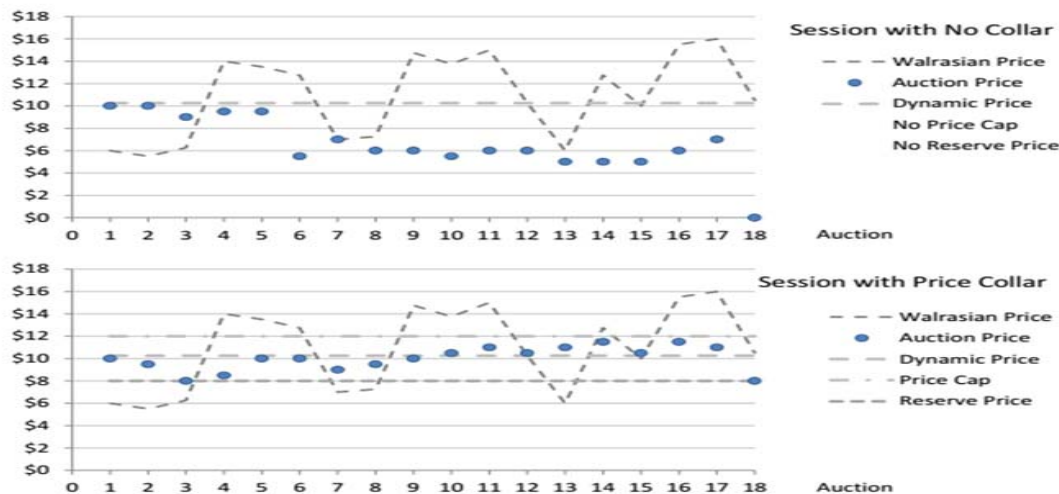


Fig. 5. Auction prices (dark spots) and static prediction (gray dashed line) without a collar price in the upper panel and flange price in the lower panel [18]

### 5.1.2 Market enlargement

There are a number of political problems related to EU ETS driven economy. The best visible to society is carbon leakage, fortunately observed only in few EU energy intensive industrial sectors. No doubts that one of the many reasons for that phenomenon can be attribute to climate change policy, namely, the ambitious GHG reduction target set by the EU that is not globally accepted, and followed by the majority of countries of the world. This substantially reduces the environmental effectiveness of the EU ETS. It also constantly sparks off intensive political debates on its negative impact on competitiveness of the EU economy.

The other issue often raised is that currently the EU ETS includes 45% of all GHG which are emitted in the EU embracing only those sectors, in which emissions can be accurately measured, reported or verified. Thus, in order to achieve the increasing long-term emission reduction targets other sectors will inevitably have to be covered by the EU ETS. Complete sectoral coverage will enable to reap the options of least costs that can in some MS lay in other sectors than energy. Therefore the Euro-CASE additionally proposes expanding the EU ETS to other sectors, e.g. transport, buildings.

Similarly, another of the most effective counter measures is to expand the number of countries that accept comparable prices of GHG emissions. It can be controlled by the extension of the group of countries that participate to EU ETS or attach new regions. In fact the Paris Agreement creates conditions for level playing field creating in the long term competitive conditions equal for all energy intensive industries globally, as it covers almost 96% of global emissions (compared with 14% under the Kyoto Protocol nowadays and none global emission growth).

The next measure proposed should be involvement of extra market failures caused by other policy instruments besides GHG prices. This approach is in line with art. 6 of the Paris Agreement which provides for “international policy linkage”. It is thereby exceptionally important for the successful exploitation of the foundation provided by the agreement. Achieving this not only international carbon markets, but international linkage of other national policy instruments is included. In this way compliance costs can be substantially reduced enabling, more ambitious commitments in future.

Therefore the most effective way to solve the problem of carbon leakage and the most effective way to reduce emissions on a global scale will increase the number of sectors and countries which are covered by emissions trading systems of GHG.

### 5.1.3 Discussion

It is commonly agreed that the allowance prices exert impact on R&DD policy and therefore can substantially contribute to low-carbon transformation e.g. by adopting new technologies. Changes should relate primarily the establishment of the collar prices, which reflects lower and upper limits of prices, whereby both of them are growing at time, and they are directly addressed the dynamic uncertainty of cost effectiveness. It is believed that the price collar can determine a stable and sufficiently high price of the allowances. It is also a useful tool to manage the prices in future. Trustworthy range of prices should stimulate the market and invigorate investments in innovation, which are irreplaceable and absolutely necessary in the long term for effective decarbonisation process.

From the analysis it is clear, that besides of fixing of the price collar, comprehensive reform proposal is needed. The sectoral expansion is an important milestone of the reform

as a policy instrument in addition to the price of GHG for the purpose of stimulating innovation. Latest, but not the least important, it is addressing the issue of carbon leakage, which can be solved by expanding the group of countries, that participate in the EU ETS or by combining with other regions.

The EU proposed reforms could be implemented, in principle, already before 2020, but given the long-time of realization, this does not seem to be politically feasible. Linear reduction factor is independent of specific reform and it should be adapted and compatible with the goal of Europe-wide GHG for 2030, when it will be agreed. It can be concluded, that establishment of a price collar, however politically difficult, may be the best way to solve various problems. There is a risk that the MSR being politically feasible and viable will happen to be a costly modification of back-loading requiring withdrawal from the market of about 900 millions of allowances in order to increase the allowance price to investment-sufficient level.

The chances of the reform package for political acceptance at the EU level are low at the moment when the EC tabled its own proposal. However there have been concerns that the EU ETS in its present form will bring not expected effects or even collapse which in long-term would reduce the current EU climate policy to separated national policies which will significantly increase cost of climate policy in the EU. The advantage of the price collar is that it will allow MS to implement their national energy and climate policy while taking into account their technological preferences and emission reduction objectives. There would be no threat that diversification of national policies will decrease prices below the minimum value set in the EU ETS and thus allow for a minimum coordination between the MS.

## 6. Implications for Poland

Phase 3 of the EU ETS introduced penalty for non-compliance, participant who fail to meet the EU ETS obligation is fined €100 per tCO<sub>2</sub>.

To elevate the possible financial burden, supporting lower income MS is explicitly written in the EU ETS reformed objectives by providing funding to modernise their energy systems. These benefits offered are not properly estimated in Poland.

The economic impact of this free allocation on the electric energy sector in Poland has been a subject of simplified study [19]. More in-depth study covering the whole energy sector is to be found elsewhere, e.g. in [15]. In order to determine the costs of allowances to be borne in future by conventional power plants in Poland, under the current EU ETS rules, three scenarios of allowance price increase till 2020 were created. These were based on the prices predicted by a number of leading agencies projecting the future allowance costs for the period 2015-2020 [19].

The base scenario is an average of the published results. The minimum scenario has been created as an average of the two lowest scores in a given year, while the maximum scenario as the average of the two highest predictions in a given year (fig. 6). This approach seems to be realistic and the price scenarios are likely to happen.

The whole Poland's capacity was aggregated into four groups: combined heat and power plants (CHP) fuelled with gas (EC GZ); CHP plants fuelled with hard coal (EC WK); power plants fuelled with hard coal (EL WK); power plants fuelled with lignite (EL WB).

Projected costs due to the need of purchasing allowances were counted by multiplying the yearly estimated shortage of allowances for a certain groups of power stations and the shortage of allowances that the units

will endure. They are presented in fig. 7 for the three optional scenarios based on the previously projected prices (fig. 6).

To determine the possible impact of the rising allowances costs, the previously obtained values were compared with the average historical profit, understood as total revenues minus total costs with exclusion of the cost of participation in the EU ETS (in 2008-2014).

Impact on the future revenues of other factors such as fuel price, GDP, annual temperature change, technological progress were not considered. Possible increase of the installed capacity till 2020 was neither taken into account. Important thing is that at some point it is possible that the EU ETS costs itself could reach the balance and thus make the conventional power plants not profitable.

It is seen in fig. 8, that while gas CHP are the least impacted by the rising allowance costs, the situation of hard coal fuelled power plants might change significantly beginning 2017. For the other two groups, namely EC WK and EL WB base scenario costs will exceed the average balance in 2019.

Poland is likely to receive approximately 630 million allowances to be sold at auction in the period 2013-2020. In 2015 Poland was to sell approximately 17 million of allowances. Funds from auctions are the state budget revenues. Half of the revenues from the sale shall be spent on adaptation to the EU climate policy. The law also implies two exceptions to the auction system – repeal (i.e. derogations) for the power and the national implementing measures. Repeals make it possible to obtain specified number of free allowances under the condition that a number of certain conditions are fulfilled.

In retrospect, Poland's energy sector has already benefited from the provisions set in art. 10c. It provides an option for a transitional free allocation to installations for electricity production in operation by 31 December 2008 or to installations for electricity production for which the investment process was physically initiated by the same date, provided that some specific conditions are met.



Fig. 6. Price scenarios based on forecast European Union Allowances (EUA) price in 2015-2020 [19]

For 2013-2019, pursuant to art. 10c the EC plans to allocate to the eight MS approximately 680 million allowances with an estimated market value of up to €12 billion. The number of free allowances to be given Poland amounts to almost 404 million (€7 406 million). However, it is raised that their allocation is in contrast with EU ETS objectives, for example the Carbon Market Watch widely presents as a bad practice "In the current EU ETS phase, 82% of the Polish investments through art. 10c focus on fossil fuel capacity modernisation, including investments in Bełchatów, the second largest fossil fuel power station in the world" [1]. The Polish power plants account for 17% of total emissions on the 30 top list of



biggest power plant emitters in 2015 with Belchatów on the first place with a total emission of 37.1 mln tonne CO<sub>2</sub> (the

emissions intensity is 1 069 g CO<sub>2</sub>/kWh) [1].

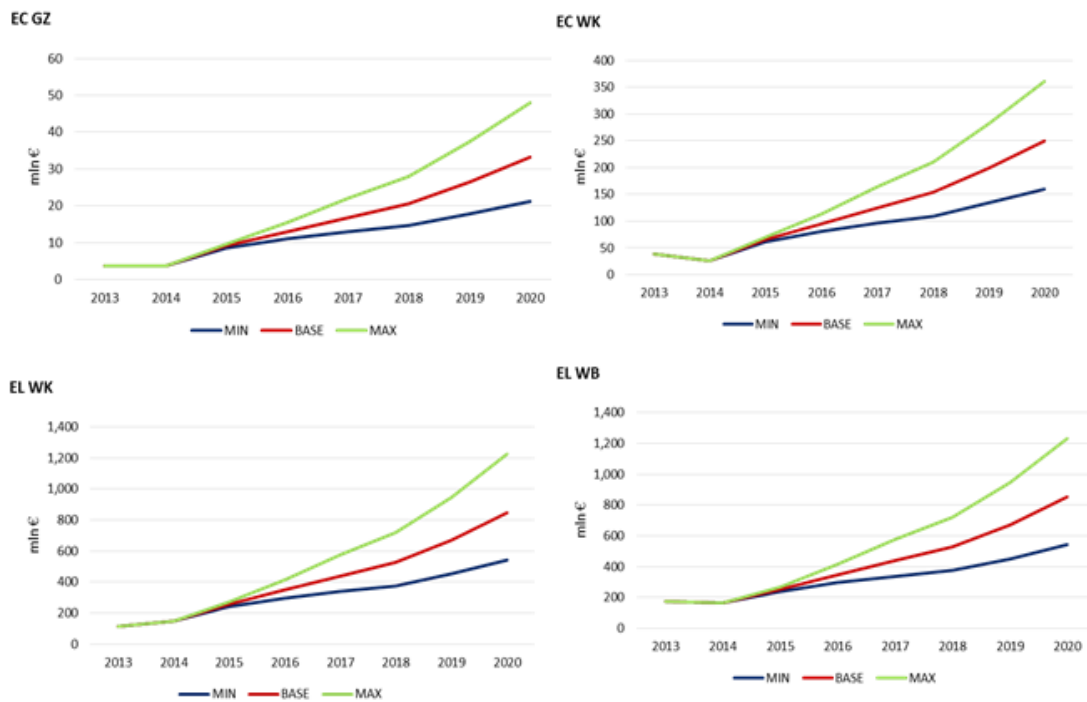


Fig. 7. Projected future EU ETS costs in the predefined groups in 2013-2020 [19]

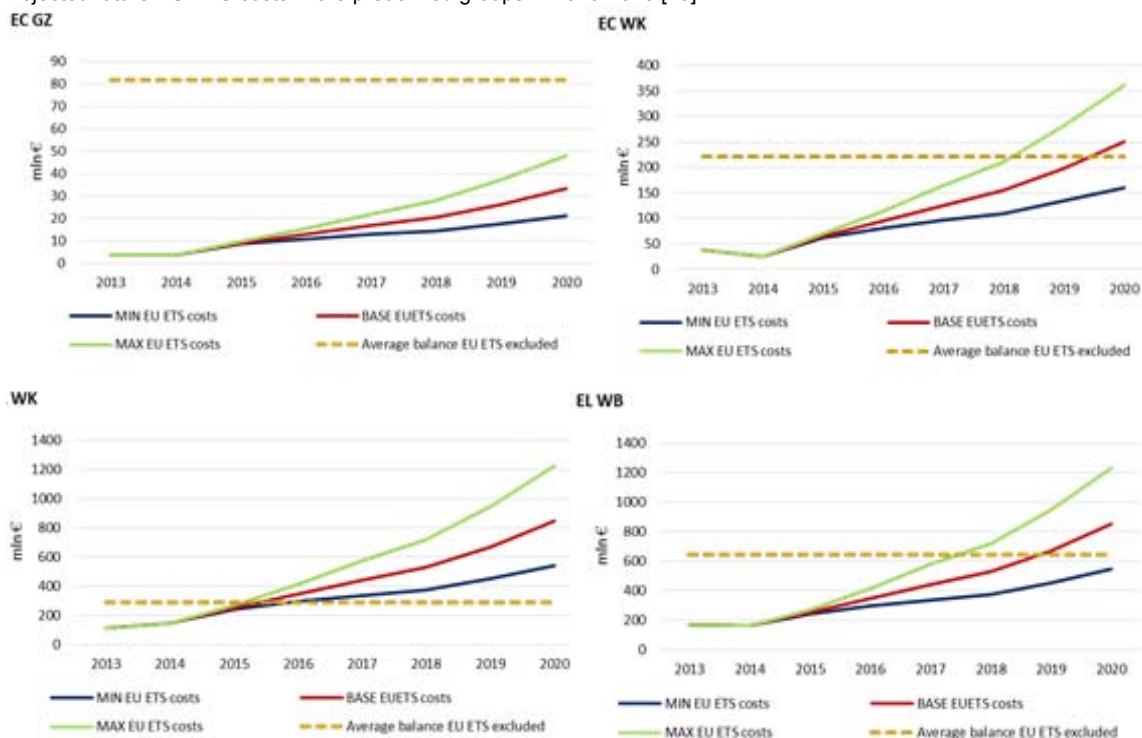


Fig. 8. Barrier of plants profitability based on historical economic balance and forecasted EU ETS costs [19]

Free allocation shall not exceed 70% of the annual verified emission in 2005-2007 from the electric energy sector and being gradually diminished shall extinct by the end of 2019. The free allowances are granted under the condition that modernization in electricity generation takes place, e.g. upgrading or introduction of clean technologies.

A list of eligible installations, the so called National Implementation Measures, is a subject of EC approval.

The following technologies fall into the category [4]:

- End-use energy efficiency (thermal integrity of buildings, lighting, electric appliances, motor drives, heat pumps, etc.).

- Renewable energy in centralized and decentralized power generation, indirect heating and cooling applications, as well as for blending with petrol or diesel oil.
- Supercritical coal plants, advanced gas combined cycle plants and combine heat and power production (CHP).
- CCS.
- Nuclear energy including 3<sup>rd</sup> and 4<sup>th</sup> generation of reactor technology.
- Advanced transmission and distribution grids and smart metering.
- Plug-in hybrid and battery/full electric vehicles, both for passenger and freight road transportation (light commercial vehicles).
- Improvements in conventional engines in transport.

In addition, there is a list of other technologies that requires further R&D phase before entering the market, e.g. solar photovoltaics (PVs), remote offshore wind, demand side technologies.

This list together with the most promising new technologies should serve as a reference list when setting the priorities of the energy policy of Poland till 2050 (PEP'2050) – the opportunity to receive EU funding will mostly be confined to the technologies listed.

Therefore Poland has vital interests in such further development and amendment of the EU ETS that produce fair level ground for different energy technologies, including clean coal technologies, e.g. CCS. It makes a challenge for all stakeholders, but especially for the relevant ministers, to prepare climate and energy strategies that would maximise the transformation of the energy sector into more sustainable in the perspective of 2030 and further.

The proposed EU ETS reform gives several options that deserve careful consideration in Poland. Firstly it shall be politically recognised that climate change policy is the main drive for technology change in the pursuit to low-carbon economy. There are multiple options for lowering GHG emissions from the energy system while still satisfying the global demand for energy services. Some of these possible options, such as energy efficiency, RES, fossil fuel switching, nuclear and CCS are the realistic choices for Poland.

They should have clearly been taken into account in PEP'2050 [8] what did not happen in its draft of 2015. One of the most attractive, and politically accepted by the EC, is energy efficiency which further remains untapped energy resource in Poland.

Additional potential danger for Poland's energy policy arises from the fact that steadily growing number of international banks and financial institutions have been withdrawing from financing energy investments not complying with the climate policy objectives. Financial opportunities stemming from different financial schemes made available by the EU climate policy, current in place and those planned, can only partly compensate for this looming lack of financing. In the proposal for revision of EU ETS Directive it is stated "The amount of climate finance to be mobilised will also depend on the ambition and quality of the proposed Intended Nationally Determined Contributions (INDCs) of Parties, subsequent investment plans and national adaptation planning processes." There is still 15 GtCO<sub>2</sub> hole between emissions reduction declared in INDCs by nations and the needed reduction to keep global temperatures not to rise over 2°C. Therefore the contribution of emissions reductions of 1 GtCO<sub>2</sub> GHG by 2020 offered by more than 720 local and regional governments, embracing 10% of the global population, have been welcomed at the COP22 [3]. While the national

contributions are set for 2025 and 2030, local and regional plans reach up to 2050.

This policy is accompanied by a growing list of financial opportunities which can indirectly be used to accomplish the transformation at national level, e.g. the European Fund for Strategic Investments, European Structural and Investment Funds (EFSI), the European Social Fund or the Horizon 2020 programme. Meeting only the Europe 2020 Strategy for smart, sustainable and inclusive growth will require €1.5...2 trillion in green investments.

From the social point of view, it is to be noted that any measures against GHG emission, like the EU ETS or a carbon tax, can be cost-effective in climate combat, but the resulting increases in energy prices may diminish the purchasing power of households' budgets. Well-designed carbon-low legislation should generate enough revenue to fully compensate financial burden imposed on the most vulnerable households due to higher energy prices.

Social issues due to the low-carbon transition are also addressed in the EU ETS Directive reform proposal as it allows that the proceeds from the EU ETS are used to solve relevant social problem what should be done in close coordination with social partners. This gives attractive option to start public dialogue on coal sector reform.

Very first commentaries after the Paris Agreement point out that climate policy is very much likely to raise the costs of energy that rely on fossil fuels and then energy related products. The impact will come largely from policy actions taken by governments domestically in their efforts to comply with the agreement provisions. A preliminary inventory of such actions was compiled in the form of the INDC submitted by 186 countries before the Paris's COP.

Also the increase in GHG allowance price is inevitable. The EC creating MSR announced that in the period 2021-2030 it is to achieve the allowance price of approximately €30, and after 2030 it wants to receive an increase of up to €100.

## 7. Summary

Hardly any other area of the EC policy evokes such discussion and controversy as the climate policy, especially when it comes to binding emission reduction targets and instrument to accomplish them. It especially applies to Poland where in general climate policy is questionable and commonly seen as being against national interest.

EU climate policy related aspects, especially after the Paris Agreement, seem to be a steady and long-lasting component of the future economic development – "overarching priority for the Commission over the coming years". The often raised, also in Poland, argument that the world biggest emitters have not reduction commitments is not valid any longer.

In the opinion of the EC "The first two years of the phase 3 indicated that the system architecture is robust and that the EU ETS has created a functioning market infrastructure and a liquid market." Although the words are a bit too overoptimistic, it can in general be concluded that the EU ETS played its role in the past and now, from the perspective of the global efforts to combat climate change (the Paris Agreement follow up), it gives the MS advantageous position of the front runner as compared with the new comers.

The political feasibility of any EU ETS reform is very much likely to encounter considerably resistance from different MS and lobbies, but without a thorough reform of the EU ETS, EU climate policy as a whole may be at risk.

The objectives of the EU climate policy cannot be effectively met with the MS acting unilaterally as this prevents synergy and market scale advantages. Anyway,

there has been a danger that MS will individually implement national measures to meet climate objectives, e.g. carbon taxes or carbon prices unless effective operation of the EU ETS is restored. It may have negative results for those MS lagging the leaders – opposing climate compelled transformation of economy followed by inappropriate use of EU funds allocated for such transformation will inevitably lead to economic, social and technological sluggishness.

Now it is to be expected that the Paris Agreement will entail further development of the EU climate policy, to strengthen political support and then a financial and regulatory framework that would boost investment in the low-carbon economy.

The EU policy allows meeting national reduction targets in ways which are most appropriate to national circumstances, if only they remain consistent with the internal market. The EU ETS reform proposal continues to give MS a lot of freedom to meet their commitment objectives. The EU regulation has been limited and it is up to the MS how to implement the measures into their law systems. This approach gives the opportunity to choose the most appropriate means of implementing the EU ETS Directive as it allows MS to introduce the amended rules that are consistent with their national existing substantive and procedural legal framework implementing the EU ETS, in particular on issuing permits for installations as well as enforcement measures and penalties.

The back-loading can be considered as an ad-hock measure only applicable within the 3rd phase of the EU ETS. It is not likely that in long-term it can restore the balance between supply and demand in the allowance market.

Therefore the EC came up with the proposal of establishing the MSR to be put into action beginning the 4<sup>th</sup> phase of the EU ETS. Under the proposal, energy intensive industries will continue to receive free carbon emissions allowances, as compensation for the EU's stricter climate rules, but fewer will be granted and fewer industries will qualify for them. The annual rate at which it reduces allowances, compared to the current EU ETS trading period, will also be speeded up.

The Euro-CASE proposal, however difficult to be politically accepted at this stage, remains attractive solution due to its firm market bases. It provides the price-collar which in fact will set bottom and upper boundaries for the allowance price. This in turn should contribute to more stable prices giving the right signals to the market investors. Removing some market failures it should better contribute to development and diffusion of low-carbon technologies. The proposal requires further research and promotion.

The EU shall in December 2016 to decide on the allocation of free allowances to the industry after 2020, and how many are auctioned to invest in the low carbon technologies.

The EC in its "Winter Package, unveiled on 30 November 2016, put forward new energy related proposals which should be carefully studied in Poland. One of them, namely article 23 of the new electricity market regulation, proposes introduction of capacity mechanisms that is considered by many as veiled subsidies for fossil fuels.

Not disregarding the real threats Poland may face, it is advantageous to consider the policy as a vehicle to transform Poland's energy system since the current coal-dependent sector does not seem to be able to be conserved in the long perspective.

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## REFERENCES

- [1] A Guide to European Climate Policy Vol. 1 – EU's Emissions Trading System, Carbon Market Watch, 2016 <http://carbonmarketwatch.org/european-climate-policy-guide-vol-1-eu-ets/>
- [2] Borghesi S., Montini M., "The allocation of carbon emission permits: theoretical aspects and practical problems in the EU ETS", FESSUD, Working Paper Series No 75.
- [3] Carbon Climate Registry <http://carbons.org/>
- [4] COMMISSION STAFF WORKING DOCUMENT EXECUTIVE SUMMARY OF THE IMPACT ASSESSMENT Accompanying the document "Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC to enhance cost-effective emission reductions and low carbon investments". SWD(2015) 136 final. [http://ec.europa.eu/clima/policies/effort/documentation\\_en.htm](http://ec.europa.eu/clima/policies/effort/documentation_en.htm)
- [5] Controlling costs while controlling emissions – a price collar approach to cap-and-trade <<https://www.brookings.edu/opinions/time-for-a-price-collar-on-carbon/>>
- [6] Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.
- [7] Dostosowanie polskiego przemysłu do wymogów Pakietu energetyczno-klimatycznego, Nr ewid. 164/2016/P/15/021/KGP, NIK, 2016.
- [8] Polityka Energetyczna Polski do 2050 roku (projekt 2015) <http://bjp.me.gov.pl/node/24670>
- [9] ETS reform: everything you need to know in a nutshell <http://www.europarl.europa.eu/news/en/news-room/20150225STO26902/ETS-reform-everything-you-need-to-know-in-a-nutshell>
- [10] EU ENERGY, TRANSPORT AND GHG EMISSIONS TRENDS TO 2050, EU, 2013.
- [11] Euro-CASE policy brief on reform options for the European Emissions Trading System (EU ETS), 2015, Euro-CASE.
- [12] Holt Ch.A., Shobe W., Price and Quantity "Collars" for Stabilizing Emissions Allowance Prices: An Experimental Analysis of the EU ETS Market Stability Reserve. <http://www.rff.org/research/publications/price-and-quantity-collars-stabilizing-emissions-allowance-prices-experimental>
- [13] [http://ec.europa.eu/clima/policies/effort/documentation\\_en.htm](http://ec.europa.eu/clima/policies/effort/documentation_en.htm)
- [14] Koch, N., Fuss, S., Grosjean, G., Edenhofer, O., Causes of the EU ETS price drop: Recession, CDM, renewable policies or a bit of everything?—New evidence, Energy Policy, Vol. 73, October 2014, Pages 676–685.
- [15] Prognoza zapotrzebowania gospodarki polskiej na węgiel kamienny i brunatny jako surowca dla energetyki w perspektywie 2050 roku. Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, 2013.
- [16] Report from the Commission to the European Parliament and the Council – The state of the European carbon market, 14/11/2012.
- [17] Trends and projections in the EU ETS in 2016, EEA Report No 24/2016 <http://www.eea.europa.eu/publications/trends-and-projections-EU-ETS-2016>
- [18] Trotignon, R., Gonand, F., de Perthuis, C., 2014. EU ETS reform in the Climate-Energy Package 2030: First lessons from the ZEPHYR model (Policy brief No. 2014-01). Climate Economics Chair, Paris.
- [19] Włodarczyk M.: An assessment of the impact of EU ETS on the Polish conventional power sector over the period 2008-2020, M.Sc. Thesis, Warsaw University of Technology, 2016.