

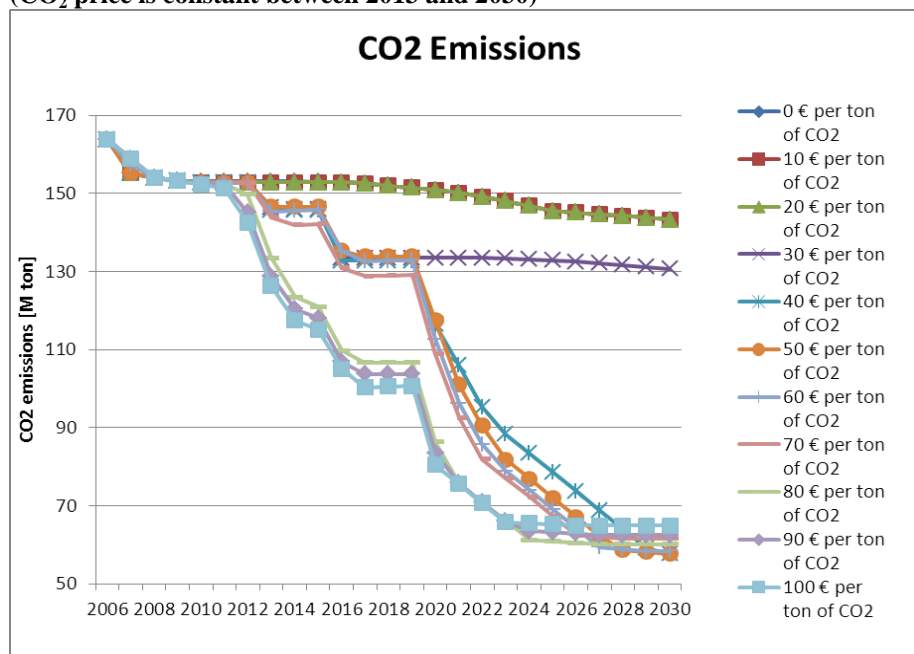
Impacts of the implementation of CO₂ price on Polish CO₂ emissions

The implementation of the European Union energy policy Emission Trading System (ETS) is about to institute non free allowances for CO₂ emissions in order to cut them. This tax is on the verge of changing deeply Polish power sector, essentially based on coal, because of the substantial increase of electricity production cost it is going to lead to. ETS proceeds in three stages: firstly, until 2013, CO₂ allowances will be granted for free; secondly, between 2013 and 2020, CO₂ price will be implemented and finally, after 2020, CO₂ price will be higher.

The aim of this study is to analyze the consequences of ETS implementation on CO₂ emissions of Polish energy sector.

In order to understand general evolution of CO₂ emissions a first analysis was run, keeping constant CO₂ price between 2013 and 2020.

Figure 1: Evolution of CO₂ emissions depending on CO₂ price
(CO₂ price is constant between 2013 and 2030)



This first analysis enables to highlight global behavior of CO₂ emissions.

The first observation which can be done is that cutting substantially CO₂ emissions requires a minimal price for CO₂ allowances. A price lower than 20 € per ton of CO₂ emissions only enables to decrease emissions by 0.04% whereas with a 30 € CO₂ price, decrease hardly reaches 6.6%. On the contrary, as soon as CO₂ price exceeds 40 € per ton, emission decrease can reach 31% with the lowest emissions in 2030, since in this scenario coal plants are replaced by emission cutting technologies (green and nuclear).

In addition, three periods of emission evolution can be identified. During the first period, between 2006 and 2013, CO₂ emissions slightly decrease thanks to the implementation of quotas about electricity generation from renewable sources.

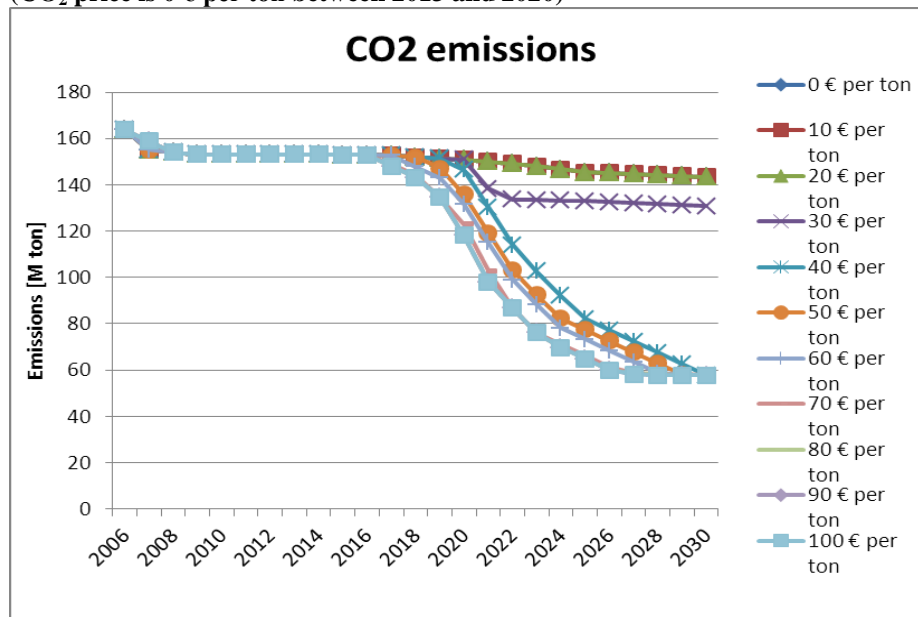
The second period, from 2013 to 2020 (implementation of CO₂ price), shows a cut of CO₂ emissions by stages. The first important decrease appears between 2013 and 2016 and

can be explained by the implementation of CO₂ allowances cost. The second decrease step occurs in 2016. This is due to an important increase of wind potential which is multiplied by a 2 factor. Consequently, this potential is made the most to replace emitting coal plants.

Finally, the third period occurs between 2020 and 2030. During this time, emissions seem to decrease exponentially. This is due to the implementation of high potential of nuclear technology, which can be used only from 2020 according to current Polish power sector.

Nevertheless, ETS will implement different prices for CO₂ for the second and the third period. In order to study the influence of each period on CO₂ emissions, analyses were run keeping constant CO₂ price for one period.

Figure 2: Evolution of CO₂ emissions
(CO₂ price is 0 € per ton between 2013 and 2020)



This analysis confirms the need of a minimal price for CO₂ allowances to cut emissions efficiently. With lower price than 40 €, emission improvement is not satisfying. On the other hand, beyond 40 € per ton, results are quite similar. Paying 100 € per ton of CO₂ only enables to decrease emissions by 6% comparing to 40 € per ton scenario.

Moreover, the analysis of CO₂ price aftermaths during the 2013-2020 period is interesting, as emissions vary very differently according to the fixed price of CO₂ for the third period.

Figure 3: Evolution of CO₂ emissions
(CO₂ price is 0 € per ton between 2020 and 2030)

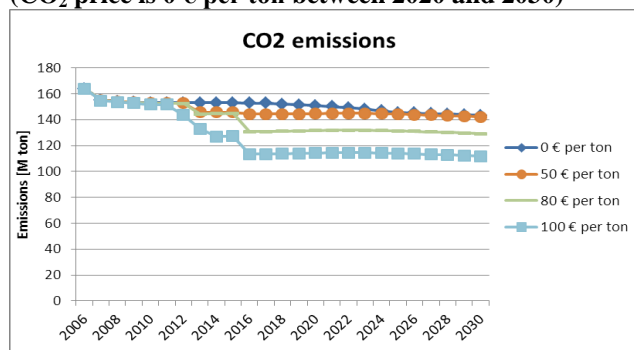


Figure 4: Evolution of CO₂ emissions
(CO₂ price is 25 € per ton between 2020 and 2030)

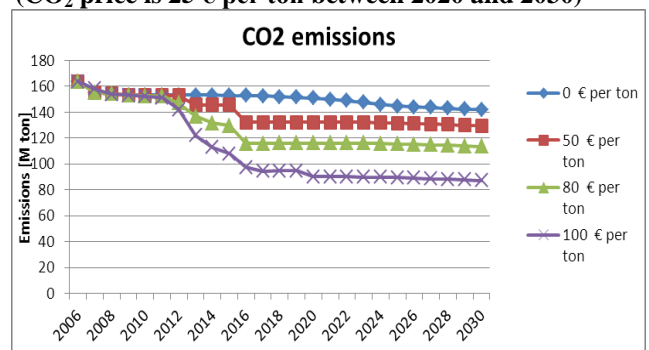
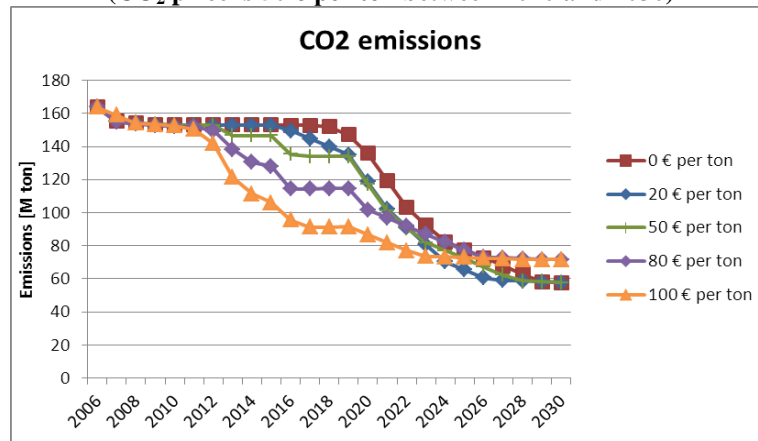


Figure 5: Evolution of CO₂ emissions
(CO₂ price is 50 € per ton between 2020 and 2030)



Once again, it is visible that in order to reduce emissions after 2020 but also between 2013 and 2020, 40 or 50 € per ton at least are necessary after 2020.

In addition, with high CO₂ price, two scenarios can appear (it is visible in [Figure 6](#)). For CO₂ prices higher than 60 € between 2013 and 2020, biomass and gas technologies are implemented. With such high price, the cheapest scenario seem to close all coal plants as quickly as possible, developing green technology at the top of its potential (wind, hydro and biomass). In order to meet the demand before 2020, gas technology is used too, reducing by this way the final share of nuclear electricity generation. Even if this type of scenario can reduce global CO₂ emissions, emission standards in 2030 are higher than cheaper scenario. Indeed, gas plants are more efficient about CO₂ emissions than coal plants, but they still emit more than nuclear plants. Consequently, the development of nuclear power after 2020 is closely linked to CO₂ policy implemented between 2013 and 2020.

Besides, gas is a source of CO₂, but also SO₂ and NO_x emissions. The global emission decrease this scenario seems to generate can be interesting in short-term, but it may not be the optimal scenario regarding a longer period.

Furthermore, it is important to keep in mind that 90 or 100 € per ton of CO₂ would be huge costs for companies who could then be tempted to relocate their plants out of the European Union in order to evade CO₂ taxes.

In order to sum up these observations, cutting CO₂ emissions efficiently requires at least a price of 40 € per ton of CO₂ emissions after 2020 (which is the most efficient period to decrease CO₂ emissions), and lower than 60 € per ton between 2013 and 2020 to prevent carbon leakage. In addition, nuclear power is developed provided a CO₂ price higher than 40 € per ton after 2020, but its share of electricity production is above all determined by CO₂ price between 2013 and 2020, as shown in [Table 1](#).

Table 2: Evolution of nuclear share according to CO₂ price

CO2 price 2013-2020	CO2 price after 2020	Share of nuclear electricity in 2030 [%]
100	50	15
80	50	32
60	50	54
50	50	56
0	50	56
20	30	0
20	40	56
20	50	56
20	80	56

Finally, the best CO₂ scenario would implement CO₂ price about 50 € per ton after 2020 according to [Figure 7](#). According to this, [Figure 5](#) shows that an optimal scenario would use CO₂ price between 20 and 40 € for the 2013-2020 period. However, a scenario 20-50 € per ton would cut emissions by 22% whereas 40-50 € would only reach an emission decrease of 23%, increasing costs by 55%.

As a consequence, the best CO₂ policy efficiency-price ratio would implement a tax of 20 € per ton of CO₂ between 2013 and 2020, and 50 € then. This would lead to an important development of nuclear power enabling to cut CO₂ emissions until 65% in 2030 considering emissions in 2006 as a reference, and decreasing global CO₂ emissions between 2006 and 2030 by 22%.