Centre for Climate and Energy Analyses

THE EFFECTS OF THE IMPLEMENTATION OF THE BORDER TAX ADJUSTMENT IN THE CONTEXT OF MORE STRINGENT EU CLIMATE POLICY UNTIL 2030

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List of abbreviations

BTA	Border tax adjustment
CAKE	Centre for Climate and Energy Analyses
CAP in the EU ETS	Total annual pool of allowances in the EU Emissions Trading Scheme (EU ETS)
CarbonPIE	Simulation model for the EU Emissions Trading Scheme (EU ETS)
CBAM	Carbon border adjustment mechanism
CGE	Computable general equilibrium model
CREAM	Carbon Regulation Emission Assessment Model – the CGE model for analyses of EU policies in the EU ETS and non-ETS areas
CO_2 eq.	Carbon dioxide equivalent
EC	European Commission
EU	European Union
EU ETS	EU Emissions Trading Scheme
EU Green Deal	Communication from the European Union: The European Green Deal of 11 December 2019
EUA	European Union Allowances allocated to the operators of stationary installations and used to account for emissions in the EU Emissions Trading Scheme (EU ETS). 1 EUA = 1 t CO_2 eq.
GECO	Global Energy and Climate Outlook
GHG	Greenhouse gas
GHG55	The scenario assuming a 55% greenhouse gas emission reduction in 2030 in the European Union compared with the 1990 emission level
GDP	Gross domestic product
IO	Input – Output table
JRC EC	Joint Research Centre of the European Community
KOBiZE	National Centre for Emissions Management
MSR	Market Stability Reserve
NDC	Nationally Determined Contribution
NER	New Entrants Reserve
Non-ETS	Sectors which are not covered by the EU Emissions Trading Scheme (EU ETS)
WTO	World Trade Organisation

Main conclusions

- **An increase in the prices of imports into the EU** – according to the projection, the prices of imported goods to the EU in the sectors covered by the border tax adjustment will be higher by about **1.6%** on average in 2030.
- **A change in the value of imports** – an increase in the prices of imported goods to the EU will cause a change in the value of imports by about **-3.4%** in the sectors covered by the border tax adjustment. The changes in imports to the EU will be the largest in the sector of **ferrous metals, by -11.6%.** Although imports will grow in some of the sectors which are not covered by the border tax adjustment (e.g. manufacturing); however, in overall terms, **the total change in imports into the EU from the other regions of the world** will be about **– 0.5%** and it will be fairly differentiated among EU Member States (about -1.2% for Poland).
- **An increase in the prices of products exported from the EU and a decline in the value of exports** – as the result of an increase in the prices of goods manufactured in the EU, the prices of goods exported from the EU to the other regions of the world will grow. The prices of export goods in the sectors covered by the border tax adjustment will grow by about **0.2%.** The increase will be the largest in the sector of ferrous metals, by 0.4%. The value of exports from the EU in the sectors covered by the border tax adjustment will be -1.1%. **When taking all the sectors into account, the average change in exports to the regions outside the EU** will be about **-0.7%** and it will be the largest in Bulgaria, -1.3%, and the Baltic States, -1.2% bout -1% for Poland).
- **An increase in the value of the output in the EU** – the introduction of the border tax adjustment will cause an increase in the output in the sectors covered by that adjustment by **0.4%.** An exception will be sector of ferrous metals in Bulgaria and the Baltic States, where the output will noticeably change by about -2%.
- **A slight impact of the border tax adjustment on the value of the GDP** – in EU Member States (with changes close to 0%), since the increase in the value of the output will be offset by the decline in the output in the other sectors. **The household consumption in the EU** will slightly grow by about 0.1% in relation to the improved terms of international trade.
- **A reduction in the global GHG emissions** – the introduction of the border tax adjustment in the EU will cause a reduction in the global GHG emissions by about **24 Mt CO_2 eq.** The largest percentage change will occur in the region of Ukraine, Belarus and Moldova (by about -1%), due to the proximity of these states to the EU. Moreover, according to the projection, the additional effort to be taken in 2030 in the EU by all the sectors covered by the EU ETS (after the GHG emission reduction target has been raised to 55%) will amount to about 200 Mt CO_2 eq.
- **The revenues to the budget** – the implementation of the border tax adjustment within the EU will bring in 2030 additional revenues estimated at about **EUR 7.61 billion (USD 10.6 billion)** in constant 2011 prices. These resources can be used, among others, to mitigate the effects of the transition in the states which are affected to the greatest extent by EU climate policy.
- **The border tax adjustment** – it is a form of the protection of industry within the EU and in the longer term it may lead to less effective use of resources (capital and labour). Taking this into account, the thesis can be put forth that another form of the prevention of carbon leakage, e.g. based on the promotion and development of other ETS schemes outside the EU, can bring better effects.

Summary

1. In relation to the plan to raise the EU GHG emission reduction targets by 2030 to 50-55% compared with the 1990 level and also to attain climate neutrality by 2050, consideration should be given to the implementation of new measures to protect sectors against loss of competitiveness and carbon leakage. The continued differences in the levels of reduction measures poses the risk of dislocation of emission-intensive production to the states without restrictions on GHG emission levels. Thus, the European industry faces significant competition. One of the protection measures proposed by the European Commission is the mechanism for adjusting prices at borders to account for CO_2 emissions (Carbon Border Adjustment Mechanism – CBAM), which aims at preventing carbon leakage. This study analyses the impact of the introduction of the CBAM mechanism on the economies of EU Member States, including, among others, on price levels, changes in the values of production, exports and imports, as well as macroeconomic indicators, such as GDP and household consumption.
2. The analysis used the GHG55 scenario assuming that the GHG emission reduction target will increase to 55% in 2030 compared with the 1990 level and the BTA (*border tax adjustment*) scenario assuming the implementation of a GHG emissions-related border tax adjustment for products imported into the EU. The border tax adjustment covers the imports into the EU from the EU ETS sectors. The base for selecting the sectors which potentially might be covered by the border tax adjustment was the list of sectors exposed to carbon leakage in the EU ETS scheme in the period from 2021 to 2030. They include: oil, ferrous metals, non-ferrous metals, chemical products, paper products and non-metallic minerals. According to the projection (the GHG55 scenario), these sectors can account for about 48% of emissions in the EU ETS scheme in 2030.
3. The analysis carried out indicates that the implementation of the border tax adjustment could cause an increase in the prices of products imported from the countries outside the EU in the sectors covered by the adjustment and, at the same time, a decline in the value of imports. The largest drops in the value of imports come in the sectors affected by the highest increases in the prices of imported products. With quite high drops in the value of imports from the sectors covered by the adjustment, the other sectors of the economy see its increase (on average by 0.3%), among others, as a result of substitution[1] for products covered by the adjustment.

[1] Substitution is the mutual replaceability of foods with similar properties – for more see point 74 of the analysis.

Table 1. Prices, imports, exports and production volumes for EU-27; deviations from the GHG55 scenario in 2030.

Sectors		Imports from outside the EU		Exports outside the EU		Production
		Prices	Value	Prices	Value	Value
Covered by border tax adjustment	Ferrous metals	3.1%	-11.56%	0.37%	-1.96%	1.59%
	Non-metallic minerals	2.69%	-4.59%	0.3%	-1.13%	1.1%
	Oil	2.15%	-4.82%	0.04%	-0.57%	0.76%
	Chemical products	0.68%	-2.29%	0.17%	-0.95%	0.27%
	Non-ferrous metals	0.6%	-2.29%	0.21%	-1.55%	0%
	Paper products	0.58%	-2.46%	0.08%	-0.47%	0.09%
Not covered by border tax adjustment	Manufacturing	-0.02%	0.37%	0.1%	-0.69%	-0.34%
	Services	-0.03%	0.19%	0.06%	-0.29%	0%
	Agriculture	-0.04%	0.1%	0%	-0.15%	-0.04%
	Energy	-0.12%	0.72%	0.13%	-1.14%	0.07%

Source: Own elaboration by CAKE/KOBiZE

4. The implementation of the border tax adjustment also causes a decrease in the value of exports from EU Member States to the other regions of the world. This decrease in the value of exports to non-EU regions is caused by:
   - an increase in the production prices and, at the same time, prices of exported goods in the EU, as a consequence of higher import prices,
   - an increase in the output for EU internal markets and a high intensity of trade among EU Member States, with simultaneously falling imports from the regions outside the EU.
5. The analysis shows higher output levels in EU Member States in the sectors of the economy covered by the border tax adjustment (except for non-ferrous metals). The highest increases come in the sectors of: ferrous metals (the manufacture of iron and steel), by about 1.6%, and non-metallic minerals (e.g. the manufacture of glass), by 1.1%. However, the higher production in the sectors covered by the adjustment is offset by the output drops in the other sectors, primarily in the manufacturing sector (with a decline of about 6%). Therefore, the implementation of the border tax adjustment in the analysed form has a slight impact on the GDP value in EU Member States. This impact varies among the states, but for the EU as a whole the change in the GDP value relative to the scenario without the adjustment (GHG55) is close to zero.
6. The value of household consumption (well-being) grows as a result of better terms of trade and the appreciation of currencies in EU Member States (for a detailed explanation see section 6.4). The average increase in the value of household consumption in the EU states is 0.04%; it is the highest in Ireland (0.14%) and Belgium (0.12%).
7. The results demonstrate that the change of the location of production and the intensity of trade between the EU and the other regions caused by the implementation of the border tax

adjustment contribute to reducing the global emissions by about 24 Mt CO_2 eq. This change is not large when compared with the total global emissions. However, a comparison of this value with the projected emission reductions in the EU ETS, which will take place, according to the projection, after the EU emission reduction target has changed demonstrates that 24 Mt CO_2 eq. represents about 10% of the reduction in the EU ETS and about 30% of the reduction to come in the industrial sectors covered by the adjustment relative to the scenario assuming the implementation of the existing climate policy (Baseline GECO 11/2018).

8. It should be borne in mind that the analysis does not consider in detail the legal and political conditions related to the implementation and functioning of the border tax adjustment. The barriers mentioned above can pose the main obstacle to the implementation of border tax adjustment.
9. The border tax adjustment is a form of protection of industry in the EU area and in the longer term it may lead to less effective use of resources (capital and labour). Taking this into account, a thesis can be put forth that a different form of action to prevent carbon leakage, e.g. one based on the promotion and development of other ETS schemes outside the EU could bring better effects in the long run.
10. According to the projection, in 2030 the total revenues from the border tax adjustment will be about EUR 7.61 billion (USD 10.6 billion) in constant 2011 prices (with Poland's share of about 5%).

1. Description of the issues

11. The European Union (EU) is committed to achieving climate neutrality in 2050. The EU target now in effect, assuming a greenhouse gas (GHG) emission reduction in 2030 by at least 40% compared with the 1990 level, was proposed as a contribution under the Paris Agreement[2]. Moreover, a constantly problematic issue relating to global GHG emissions is the continued difference in levels of ambitions regarding reduction measures among the States – Parties to the Agreement, which thus poses the risk of dislocation of emission-intensive production to states without restrictions related to the implementation of climate policy or those with much weaker restrictions. This problem can become even more conspicuous as a result of the expected strengthening of the EU emission reduction target by 2030 and the achievement of the climate neutrality target by 2050. In order to reach the newly set targets in an effective manner, the European Commission (EC) adopted the Communication *The European Green Deal* on 11 December 2019. This document laid down the long-term objective of the EU achieving climate neutrality by 2050, including by increasing the EU reduction ambitions so as to reduce by 2030 its greenhouse gas emissions by 50-55% compared with their 1990 level.

12. Given that disproportions persist among the reduction ambitions of the largest world economies, in 2019 the EU addressed again the issue of the adoption of the border tax adjustment referred to the Communication *The European Green Deal* which provided that 'the Commission will propose a carbon border adjustment mechanism, for selected sectors, to reduce the risk of carbon leakage.' The introduction of the carbon border adjustment mechanism is expected to provide an additional instrument to protect the industrial sectors in the EU Member States. In accordance with *The European Green Deal*, such a mechanism will be proposed for selected sectors to reduce the risk of carbon leakage if differences in levels of reduction ambition worldwide persist (European Commission, 2019). After initial consultations the proposal for the carbon border adjustment mechanism is to be subjected to more detailed consultations in the third quarter of 2020, while the proposal for a directive is expected in mid-2021. In addition to general public consultations, the European Union intends to hold consultations with technical experts in order to ensure that the proposal complies with the rules of the World Trade Organization (WTO).

13. The main purpose of the introduction of the carbon border adjustment mechanism (which encompasses essentially different forms of border tax adjustment) is to prevent the effect of carbon leakage in the EU emissions trading scheme (EU ETS). Carbon leakage occurs when production or investment are transferred from the EU to other countries with lower ambitions to reduce emissions or when EU products are replaced by more carbon-intensive imports (*Pyrka M, Lizak S, 2009*).

[2] https://ec.europa.eu/clima/policies/international/negotiations/paris_en

14. However, there is a risk that the implementation of the border tax adjustment within the EU may have an adverse effect on the competitiveness of companies in EU Member States. The border tax adjustment will cause changes in the prices of imports and this may have an adverse impact on the competitiveness of goods manufactured in the EU on the world markets. A certain solution is the introduction of the additional protection of exporters; however, this may lead to protests by the trade partners of the EU. In order to optimally fit the carbon border adjustment mechanism, different forms of border tax adjustment for selected products are considered; specifically, a special import duty, the obligation to purchase emission allowances for products imported into EU Member States or consumer taxes. There is no doubt that the introduction of one of the proposed forms of the border tax adjustment is a measure to reduce global GHG emissions and this can make a positive contribution to the fulfillment of the Paris Agreement. However, to date the EU has not worked out a form of such a border tax adjustment which would be acceptable to the States-Parties to the Paris Agreement and, therefore, difficult negotiations will be needed in the nearest future to reach consensus in this matter.

15. Taking into account the discussions underway at the EU level on the possible implementation of the the carbon border adjustment mechanism, using the computable general equilibrium (CGE) model called CREAM, the analysis analyses the effects of the implementation of such a mechanism on the economies of the EU Member States. In addition, an attempt is made to assess whether the operation of the adjustment mechanism can have a positive effect on the reduction in global GHG emissions. The analysis covers heavy and energy-intensive industries, such as the sectors of oil, including the manufacture of coke, chemical products, non-metallic minerals (e.g. cement, lime, gypsum and glass), paper products, the manufacture of iron and steel, and aluminium, which, according to the literature, can be the key sectors exposed to carbon leakage (*Gąska J, Pyrka M, 2019*).

2. The border tax adjustment and other carbon border adjustment mechanisms

2.1. Definitions

16. The carbon border adjustment mechanism (CBAM) is a set of instruments including all the measures designed to offset the climate policy costs among trade partners.

17. The CBAM mechanisms involve two general approaches to the calculation of burdens or possible compensations based on (*Rocchi et al. 2018*):

- the origin or place of production of imported goods – based on the carbon content of the imported goods,

- the destination or place of consumption of imported goods – based on the carbon content of the goods, while the carbon costs incurred by national companies are lowered since the goods are exported to countries with different (lower) import duty rates (carbon costs).

18. One of the CBAM mechanisms which has been most widely discussed is the border tax adjustment (BTA) to be imposed on imported products. The border tax adjustment can be designed in such a manner as to offset the carbon costs incurred by producers in different regions of the world. It can also take the form of a border tax the rates of which do not depend on the carbon costs incurred by producers at the location of the production plant. The latter form of the tax is the least complicated one but it will offset to the least extent the carbon costs among trade partners.

2.2. Examples of implementation modes

19. The introduction of the carbon border adjustment mechanism as an instrument of EU climate policy will affect trade in goods by differentiating them on the basis of their carbon footprint. Therefore, the carbon border adjustment mechanism should be designed so that it complies with the WTO rules.

20. Consideration is now given to different CBAM mechanisms which should be taken into account in respect of their implementation at the EU level, including e.g. the inclusion of importers into the EU ETS scheme (or equivalent trading schemes). One of the possible options to be applied is the idea presented by France in its non-paper of February 2016. It is based on the inclusion of importers into the EU ETS scheme and it is defined on the basis of the import volume. Due to the EU benchmarks, the proposed mechanism would take into account the free allocation of allowances to sectors within the EU ETS.

21. Another CBAM option is a consumption charge[3]. Such a mechanism consists in the determination of the carbon intensity at the particular stages of production to determine the carbon footprint, which is then used to calculate the border tax adjustment rate for the finished product. More information on this and other CBAM options can be found on the website of the European Roundtable on Climate Change and Sustainable Transition (ERCST), via the link: https://ercst.org/event/border-carbon-adjustments-conceptual-stakeholders-meeting-on-alternatives/.

22. Another, the most widely discussed option of the introduction of the carbon border adjustment mechanism which in this study focuses on is the implementation of the border tax adjustment for importers to be collected in the sectors which are exposed to the greatest

[3] Alternatives to Border Carbon Adjustments – Conceptual Stakeholders Meeting, ERCST Roundtable on Climate Change and Sustainable Transition, webinar on 9 June 2020

extent to carbon leakage. In this case, the basis for the calculation of the carbon tax can be the difference between the cost related to the functioning of the EU ETS scheme and the carbon cost incurred in the producer's country. This means that importers would incur the carbon depending on the value of allowances in the EU ETS, optionally taking into account the adjustment for the existence of the free allocation of allowances and compensations for the indirect carbon costs.

23. It should be pointed out that the introduction within the EU of any of the proposed carbon border adjustment mechanisms does not need to be regarded as an alternative to the existing instruments to protect sectors against carbon leakage, such as the free allocation of emission allowances and the compensations for the indirect carbon costs, since these instruments do not respond to the problem of the carbon footprint caused by the imports of goods to the EU[4].

3. The objectives of introducing the border tax adjustment in the EU

24. The fundamental objective of introducing both the border tax adjustment and the other carbon border adjustment mechanisms is to:

- prevent carbon leakage,
- maintain the competitiveness of the EU industry in the context of the increasing costs of climate policy,
- exert pressure on the states which do not adopt climate commitments (environmental objectives),
- work towards the more uniform taxation of consumption in the EU.

25. From the point of view of the implementation of EU climate policy, the prevention of carbon leakage in the EU emissions trading scheme (EU ETS) should be treated as a priority task, since carbon leakage weakens the reduction efforts taken by the EU. The highest risk of carbon leakage will occur, among others, in those sectors that are characterized by the highest carbon intensity (taking into account direct and direct emissions). The sectors and subsectors deemed to be exposed to significant carbon leakage are laid down in the official list of the European Commission. Just as the free allocation of allowances, the implementation of the concept of border tax adjustment is intended to prevent carbon leakage by halting the deterioration of the competitiveness of companies within the EU which is caused by the growing costs of climate policy.

[4] Moghaddam R, Moghaddam F, Cheriet M, A modified GHG intensity indicator: Toward a sustainable global economy based on a carbon border tax and emissions trading

26. A significant effect of the introduction of the border tax adjustment for imported products which we expect to achieve is an increase in the national output induced by higher prices of goods imported into the EU. The greater output in EU Member States will mean higher emissions in the industrial sectors within the EU. However, the total emissions in the EU ETS may not exceed the emission limits in place (the cap in the EU ETS), which results from the operating rules of the EU ETS scheme. Moreover, the total global emissions can decrease as a result of the implementation of the border tax adjustment provided that less carbon-intensive technologies than those in the other regions are used within the EU[5].

27. The introduction of charges for GHG emissions through the EU ETS causes a difference between the prices of goods manufactured abroad and those produced in the EU. European companies are in an unfavourable situation compared with their foreign competitors, since the difference in the prices of products becomes larger than the present EU import tariffs (specifically, when the average exceeds 2.8%)[6]. The introduction of the border tax adjustment would enable manufacturers to offset their carbon costs and improve the competitiveness of European companies; this, in turn, can encourage other regions to adopt similar regulatory measures. As an effect, this can expand the range where the border tax adjustment applies beyond the EU and trigger decarbonisation of industry on a global scale.

4. Scenarios

4.1. GHG55

28. The scenarios used in the analysis are based on the policies and measures included in the baseline scenario presented in the Global Energy and Climate Outlook 2018 (Baseline GECO 11/2018), prepared by the Joint Research Centre of the European Commission in 2018[7]. As a result of an increased share of renewal energy sources and improved energy efficiency, the GHG emission reduction in the EU Member States in Baseline GECO 11/2018 Baseline scenario in 2030 slightly exceeds 40% compared with the 1990 level. In addition, Baseline GECO 11/2018 assumes GHG reduction targets resulting from the NDCs for the other regions of the world outside the EU.

29. Compared with the policies and measures included in Baseline GECO 11/2018 adopted in this analysis the GHG55 scenario includes additional GHG emission reductions in the EU Member States in 2030, without a change in energy policy which would require e.g. higher energy efficiency or reduced consumption of fossil fuels. In the GHG55 scenario, all the changes in fuel consumption are caused by the introduction of a more stringent emission reduction target in the EU.

[5] Khourdajie A, Finus M, Measures to enhance the effectiveness of international climate agreements: the case of border carbon adjustments (second revised version),
[6] EU carbon border tax: Unnecessary for now but still a good idea, ING, 14 April 2020
[7] https://ec.europa.eu/jrc/en/publication/baseline-global-energy-and-climate-outlook

30. **The GHG55 scenario assumes that the GHG emission reduction target will be increased to 55% in 2030 compared with the 1990 level.** In this scenario, both the reduction target in the EU ETS and the emission limits for non-ETS sectors were adopted in accordance with the publication '*The European Green Deal impact on the GHG's emission reduction target for 2030 and on the EUA prices*' (CAKE/KOBiZE, March 2020).

31. If the new EU target were adopted its effect would be a higher emission reduction in the EU ETS scheme to the level of about 57% compared with 2005. In the non-ETS area, it was assumed that the Member States should achieve together the reduction target of about 48% in 2030 relative to the 2005 level.

32. In order to better reflect the present climate policy, the **GHG55 scenario also includes the free allocation of emission allowances in the EU ETS.** In the sectors exposed to the risk of carbon leakage, a part of allowances is allocated free of charge to installations. In the CREAM model, this is reflected through a grant to the sectors which is calculated on the basis of historical information on the level of the free allocation in the EU ETS (an exogenous, historical variable), the current emission levels in the sectors (an exogenous variable calculated in the model) and the allowance prices (an exogenous variable calculated in the model).

    In the CREAM model, the following industrial sectors are entitled to free allocation (a detailed list of the sectors in given in Table 2 in Annex I):

    - air transport (atr),
    - oil (oil),
    - ferrous metals (fem),
    - non-ferrous metals (nem),
    - chemical products (che),
    - paper products (pap),
    - non-metallic minerals (nmm).

4.2. BTA

33. Compared with the GHG55 scenario, the BTA scenario provides for the implementation of the border tax adjustment, to be levied on products imported into the EU. One of the most important issues related to the introduction of the border tax adjustment is the manner of its calculation. The BTA scenario proposes that the border tax adjustment should represent the product of the border tax adjustment rate and the volume of the import (the border tax adjustment base) from a given region of the world to EU Member States.

    The border tax adjustment is determined from the formula:

$$BTA_{g,r} = Tax\_rate_{g,r} \cdot Imp_{g,r}$$

where: $BTA_{g,r}$ – the amount of the border tax adjustment in the sector g for the region *r*, $Tax\_rate_{g,r}$ – the border tax adjustment rate in the sector g for the region r, $Imp_{g,r}$ – the value of the import (the border tax adjustment base) inthe sector g from the region *r*.

34. The border tax adjustment rate depends on the carbon intensity of the production of imported goods and the difference between the market allowance price in the EU ETS and the possible carbon cost incurred in the exporter's country. The cost in the exporter's country results from the need to fulfil the NDC submitted under the Paris Agreement. The carbon price outside the EU should reflect the marginal cost of emission reduction (i.e. the cost of reducing emissions by an additional tonne) in the sectors covered by the EU ETS. However, this cost does not have to be expressed by an explicit emission charge or tax, as other policies designed to reduce emissions (e.g. to develop renewable energy sources or to improve energy efficiency) certainly generate costs. In the latter case, the valuation of emissions is estimation-based.

    The border tax adjustment tax rate ($Tax\ rate_{g,r}$) is determined from the formula:

$$Tax\ rate_{g,r} = \frac{GHG_{g,r}}{Prod_{g,r}} \cdot (PGHG_{EU\ ETS} - PGHG_{g,r})$$

    where: $GHG_{g,r}$ – the GHG emission level in the sector g and the region, $Prod_{g,r}$ – the output in the sector g and the region *r*, $PGHG_{EU\ ETS}$ – the market-based emission allowance price in the EU ETS, $PGHG_{g,r}$ – the carbon price incurred by manufacturers in the sector g and the region *r*.

35. The unit carbon intensity of output represents both direct and indirect emissions. Direct emissions are related to fuel combustion and process emissions in a given sector. Indirect emissions are related to the electricity consumption level and the carbon intensity of electricity generation.

$$GHG_{g,r} = GHG\_dir_{g,r} + GHG\_ind_{g,r}$$

    where: $GHG\_dir_{g,r}$ – the direct GHG emission level in the sector g and the region r, $GHG\_ind_{g,r}$ – the indirect GHG emission level (related to electricity consumption) in the sector g and the region *r*.

$$GHG_{ind\ g,r} = Ele_{g,r} \cdot \frac{GHG\_ele_r}{Ele\_tot_r}$$

    where: $Ele_{g,r}$ – the electricity consumption level in the sector g and the region *r*, $GHG_{g,r}$ – the emission level in the sectors producing electricity in region *r*, Ele_tot_r – the total electricity production in the region *r*.

36. The value of the unit carbon intensity is determined as an external parameter (an exogenous quantity) on the basis of the output and direct and indirect emissions, in accordance with

Baseline GECO 11/2018. Similarly, the values of the carbon prices for the regions outside the EU correspond with Baseline GECO 11/2018. In accordance with the assumption adopted, the prices in the regions outside the EU do not change in the GHG55 scenario. The other variables used to determine the border tax adjustment, i.e. the prices in the EU ETS and the value of imports to EU Member States, are exogenous quantities and they are calculated using the model in the BTA scenario.

37. The differences in carbon prices between the EU ETS and the particular regions which occur in the BTA scenario are shown in Fig. 1. The prices in the regions outside the EE correspond to the marginal cost of the emission reduction in accordance with the NDCs submitted under the Paris Agreement. In fact, the carbon costs in different regions can result from the use of different measures to reduce emissions, e.g. from the functioning of the ETS scheme, the implementation of the carbon tax and the other policies to reduce emissions. The level of the BTA rate depends on the difference between the projected marginal costs of emission reductions in the EU Member States and other regions. As shown in Fig. 1, the greatest differences with respect to the EU occur in Russia, India, North and Central Africa, Japan and Brazil. In turn, the carbon prices are very similar in the EU and Canada.

Fig. 1. The difference in carbon prices between the regions outside the EU and the UE, in accordance with the BTA scenario [USD'11/ Mg CO2 eq.].

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Source: Own elaboration by CAKE/KOBiZE

5. Sectors covered by the border tax adjustment

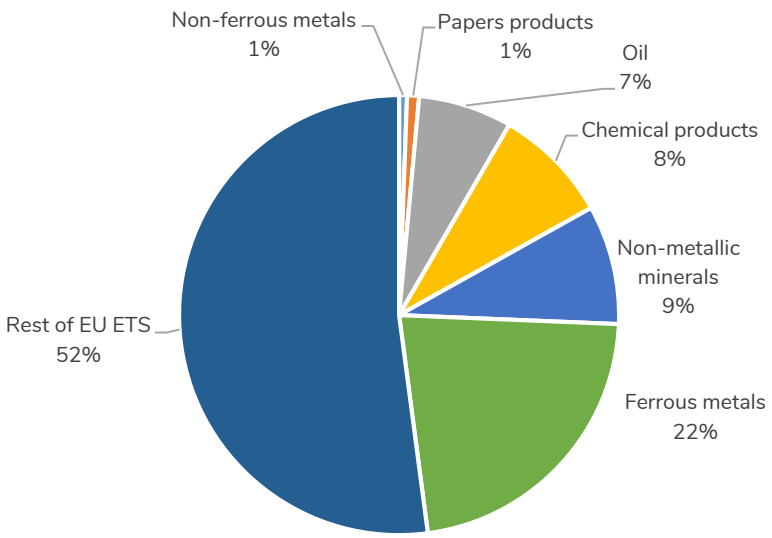
38. The border tax adjustment was applied to imports into the EU from the industrial sectors covered by the EU ETS, except for the electricity production sector. The six sectors selected for the analysis include:

- oil (oil),
- ferrous metals (fem),
- non-ferrous metals (nem),
- chemical products (che),
- paper products (pap),
- non-metallic minerals (nmm).

39. It was assumed that the border tax adjustment should apply to imports from sectors with high energy and carbon intensity of their output. In order to designate the sectors for the pilot phase of the implementation of the border tax adjustment in the BTA scenario, use was made of the list of sectors exposed to carbon leakage in the period from 2021 to 2030. On the basis of an analysis of the activities included in the list of those exposed to carbon leakage, the sectors (listed in the previous point) entailing these activities were indicated in the model. All the sectors subjected to the border tax adjustment in the analysis are energy-intensive and highly carbon-intensive and in disaggregated form they were included in the list of sectors exposed to carbon leakage (they also covered by the EU ETS). Given the differences in the aggregation level between the CGE model and the list of sectors exposed to carbon leakage, the sectors selected for analysis in the model included the activities directly exposed to carbon leakage and the other ones unaffected by carbon leakage. A detailed list of activities in the sectors is presented in Table 2 in Annex I.

40. Fig. 2 shows the shares of industrial sectors in the GHG emissions in the EU ETS in the GHG55 scenario. The data presented in Fig. 2 contain information on direct emissions for which installations account as part of their participation in the EU ETS. In EU Members States, the sectors covered by the border tax adjustment are responsible for almost 50% of emissions in the EU ETS. The sector of ferrous metals is of the greatest importance in terms of the emission levels of industrial sectors, as its share is as much as 22%. According to the projections for 2030, the emissions from the other industrial sectors represent slightly smaller shares; specifically, the sector of non-metallic minerals is responsible for about 9% of emissions in the EU ETS, the sector of chemical products for 8% and the oil sector for 7%. The sectors of paper products and non-ferrous metals have the smallest share in emissions, about 1% each. Despite their small share, the sectors of paper products and non-ferrous metals are exposed to international competition and they belong to the group of energy-intensive sectors; in light of this, the analysis determined that they possibly qualified to be covered by the border tax adjustment.

Fig. 2. The shares of the sectors covered by the border tax adjustment in the GHG emissions in the EU ETS in EU Member States in the GHG55 scenario in 2030.

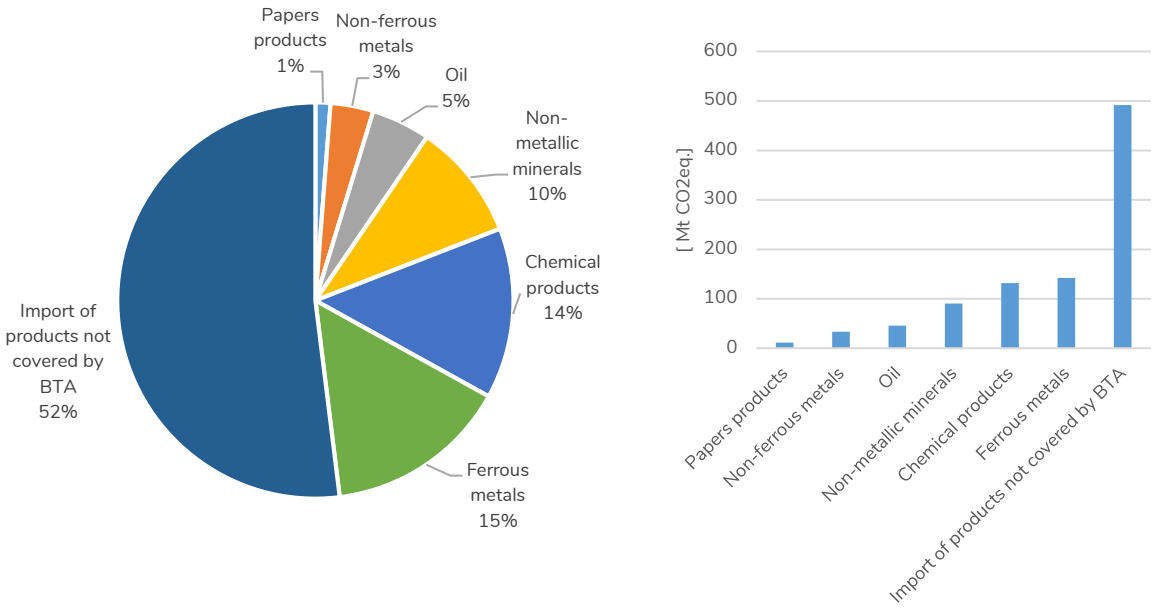


Source: Own elaboration by CAKE/KOBiZE

41. The import-related direct and indirect emissions in the GHG55 scenario indicate that the sectors covered by the border tax adjustment are responsible for half the emissions generated in the manufacture of goods which are imported to EU Member States. The total global emissions generated as a result of this manufacture (in the GHG55 scenario) are about 950 Mt CO_2 eq., including 455 Mt CO_2 eq. of emissions (both direct and indirect[8]) from the sectors for which the border tax adjustment has been proposed. This means that most of industrial emissions arise in a relatively few sectors. It would be much easier to apply the border tax adjustment only to the products which make a large contribution to emissions than to extend the border tax adjustment to the entire imports (this would cause additional administrative burdens).

[8] Indirect emissions are related to the electricity consumption in a given sector.

Fig. 3. Direct and indirect GHG emissions inherent in the imports to the EU from the sectors covered by the border tax adjustment, according to the GHG55 scenario, in 2030.

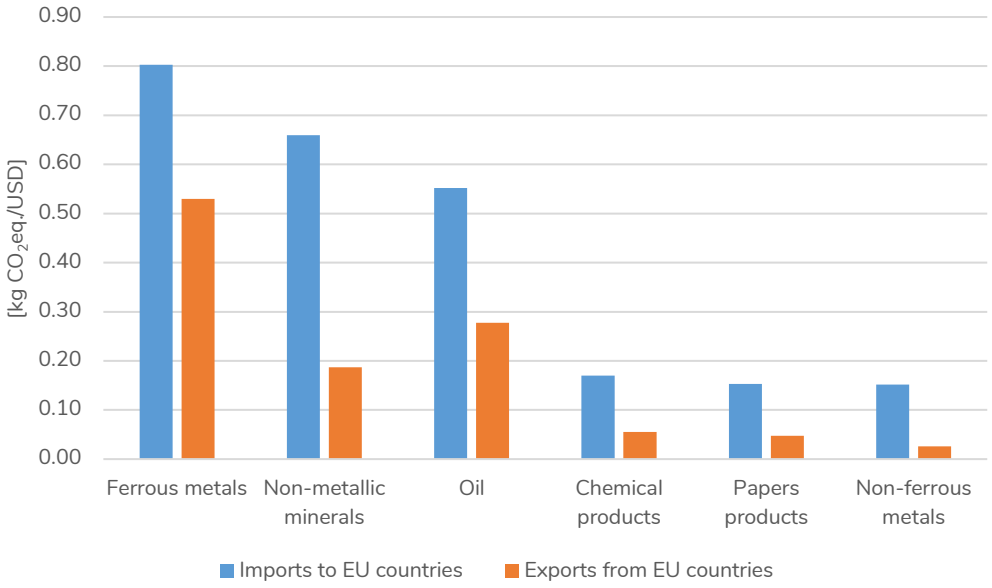


Source: Own elaboration by CAKE/KOBiZE

42. On the basis of the results of the GHG55 scenario, data were elaborated on the projected carbon intensity of imports and exports (i.e. the emissions per unit of imports or exports) in the particular sectors in 2030. The estimated carbon intensity shown in Fig. 4 accounts for both projected direct and indirect emissions. The footprint of the products imported to the EU (relative to their value in USD) is much greater than the footprint of the products manufactured and exported from the EU. Primarily, this is an effect of the lower carbon intensity of the manufacture in EU Member States compared with that of the rest of the world (on average about three times as low for the sectors analysed). An additional factor which contributes to the low carbon intensity of exports compared with that of imports is the structure of the trade of EU Member States. Some goods imported to EU Member States are intermediate products used as inputs to further production processes. The further production processes do not involve so high GHG emissions and have a higher added value. The role of the former factor is well illustrated by the difference between the carbon intensities of imports and exports for the sector of ferrous metals. Given the level of aggregation, the sector of ferrous metals does not include parts of finished products, e.g. tools made of steel (the manufacture of finished metal products), the production of which would involve lower carbon intensity. The difference which can be seen in the sector of ferrous metals between the carbon intensities of imports and exports thus results from the production processes and – using the example of steel – from the advantage gained by the use of electrical processes in the EU over integrated processes which are more carbon-intensive.

43. As part of general conclusions, it should also be added that in the sectors analysed there are also significant differences in carbon intensity among the exports from the particular EU Member States. Unfortunately, a comparison of the projected carbon intensity of the exports for Poland demonstrates that our economy still continuous to be more carbon-intensive than the EU average.

Fig. 4. The carbon intensity of the imports and exports of EU Member States from/to the other regions of the world in the sectors covered by the border tax adjustment in 2030, according to the GHG55 scenario [kg CO2eq./USD].



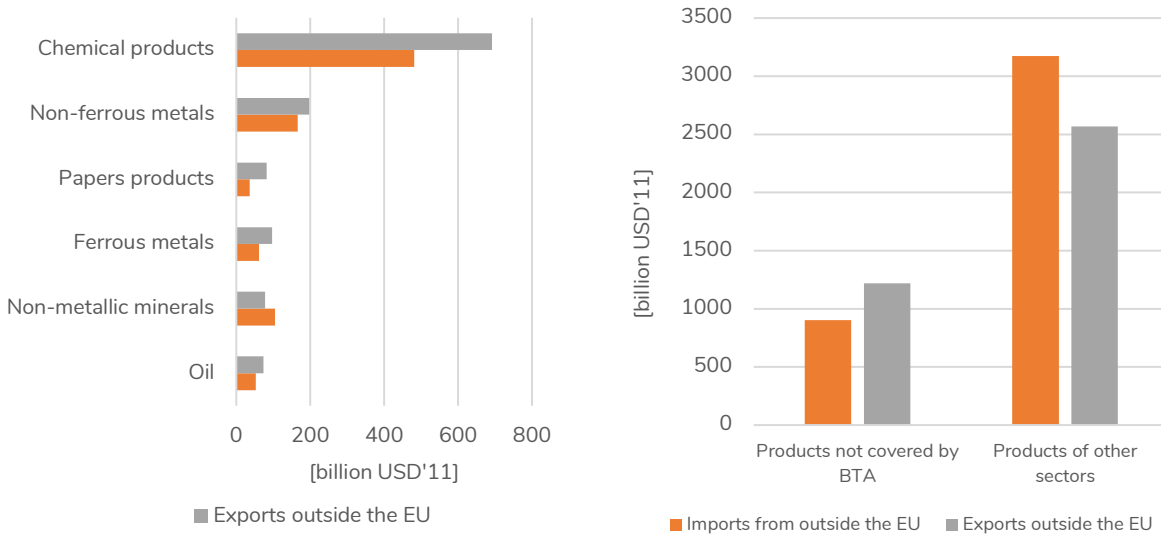
Source: Own elaboration by CAKE/KOBiZE

44. The difference in the carbon intensity of production between the EU and the regions outside the EU can be an important factor affecting the scale of carbon leakage related to the replacement (decrease of the output) of the national production by imports. There are two main forms of such a replacement of production – the former consists in the stoppage or cessation of the national production and the imports of goods from foreign manufacturers. In turn, the latter consists in the transfer of production plants and new investment projects from the EU to other regions. In terms of change in global emissions, this is of key significance, since the transfer of plants can involve the continued use of less carbon-intensive technologies which have until then been applied in EU Member States. This will lead to a lesser increase in global GHG emissions (*Hille E, Lewandowski P, Śniegocki A, 2012*). With reference to the problem of the transfer of production and the related carbon leakage, the question arises as to whether in the future the newly opened factories in China will be less

carbon-intensive than the plants closed in the EU. If so, the global emissions would be reduced as a result of relocating production plants.

45. The sectors regarded as those that potentially may be covered by the border tax adjustment in the EU have a significant share in the emissions in the EU ETS (about 48%) and in trade, accounting, respectively, for 22% of imports and 32% of exports from/to the regions outside the EU (Fig. 5). Among others, given the level of trade, the introduction of the border tax adjustment can cause consequences for the EU economy as a whole. For this reason, there is a need for an analysis of the impact of the border tax adjustment on the EU economy and the particular Member States. It should be emphasised that in economic terms the main problem related to the levying of the border tax adjustment even on a small part of the economy can be an adverse effect on its competiveness. The levying of the border tax adjustment on specific products characterised by high carbon intensity (such as steel) may disturb trade in the other parts of the value chain. If the transfer of production to the regions outside the EU may become a problem the selective border tax adjustment at the EU borders can lead to the situation where instead of importing steel we will import products situated at a further stage of the steel processing chain, such as finished steel product

Fig. 5. The values of imports and exports into/from EU Member States in the sectors covered by the border tax adjustment in 2030, according to the GHG55 scenario [bln USD'11].



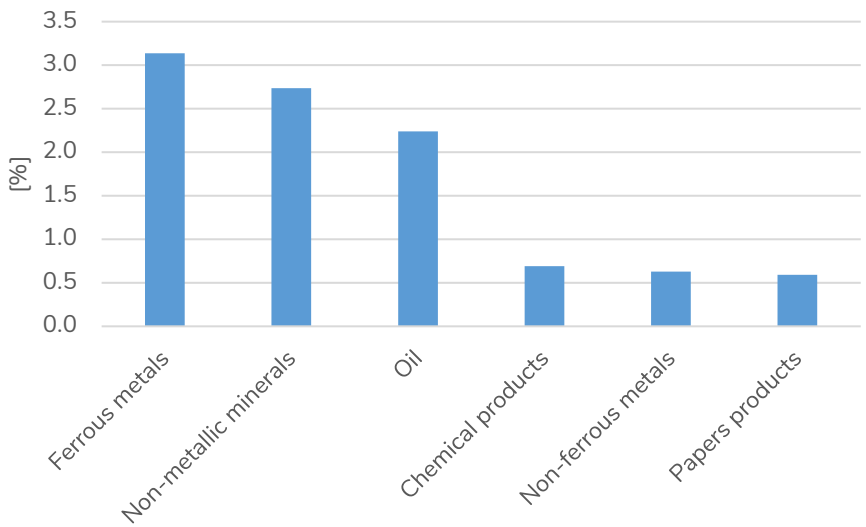
Source: Own elaboration by CAKE/KOBiZE

6. An assessment of the effects of the introduction of the border tax adjustment in the EU in 2030

6.1. The impact on the prices and volume of imports from outside the EU

46. **In relation to the (net) value of imports, the border tax adjustment is 2-3% for ferrous metals, non-metallic minerals and oil, while it is 0.6-0.7% for non-ferrous metals and chemical and paper products.** This relatively low level of the average border tax adjustment rates partly results from the adopted assumption providing that the valuation of the emissions taken into account for imports only uses the *difference* between the emission allowance price in the EU ETS ad the estimated marginal cost of emission reduction outside the EU. Moreover, in the model the product groups on which the border tax adjustment is levied are aggregates of strictly energy-intensive production and other than energy-intensive production (e.g. the sector of non-ferrous metals includes not only the manufacture of aluminium but also the manufacture of metal products; the sector of paper products includes not only the manufacture of paper but also the printing activity etc.). For single, strictly energy-intensive products (e.g. iron and paper), these rates would be higher than the average rate applicable to a broader product base. Similarly, the changes in import prices presented below refer to the broader product groups, in line with the sectoral aggregation applied in the model (depending, among others, on the availability of the projections of output, energy consumption etc. for 2030).

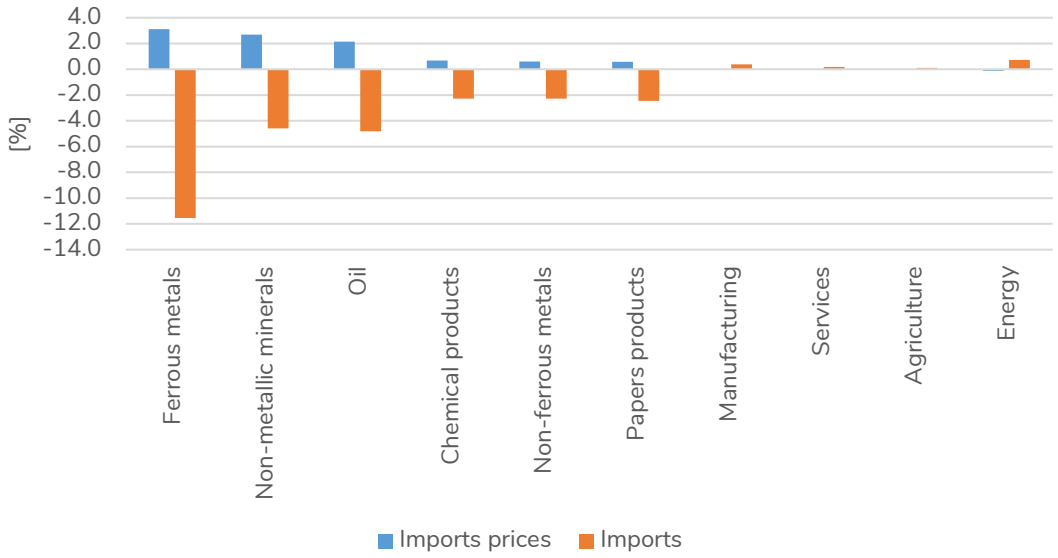
Fig. 6. Average border tax adjustment rates as percent of the value of imports for EU-27 [%].



Source: Own elaboration by CAKE/KOBiZE

47. The levying of the border tax adjustment on goods imported into EU Member States will cause their prices to grow and this, in turn, will lead to a decrease in the volume of imports. The greatest import drops will occur in the sectors affected by higher price increases. At the same time, these sectors will see the highest increases in the national output. As shown in Fig. 7, the greatest import drops will occur in the sectors of: ferrous metals (the manufacture of iron and steel), by 11.6%; oil (refined petroleum products), by 4.8%; and non-metallic minerals (e.g. the manufacture of glass), by 4.6%. The imports in the sector of paper products will fall to a lesser extent, by about 2.5%, while in the sectors of chemical products and non-ferrous metals it will drop by 2.3%.

Fig. 7. The prices and values of imports from outside the EU in EU-27; deviations from the GHG55 scenario [%].

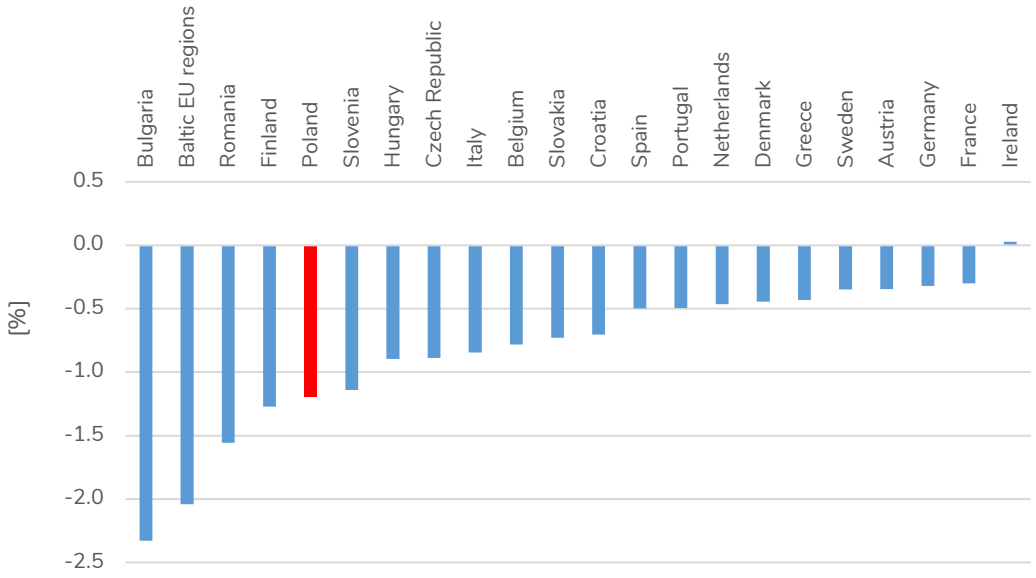


Source: Own elaboration by CAKE/KOBiZE

48. With quite a large decline in the imports from the sectors covered by the border tax adjustment, their value tends to grow in the other sectors of the economy (on average by about 0.3%), as a result of a slight deterioration of competitiveness of goods manufactured in the EU and situated further in the value chain than the products covered by the border tax adjustment. This is caused by an increase in the prices of energy-intensive products which are used as inputs to the manufacture of other goods – this is the case with the production in the EU rather than outside the EU. Despite the fact that in percentage terms the increase in the imports of the products which are not covered by the border tax adjustment is slight (see Fig. 7), in terms of volume, it is about EUR 7.9 billion (USD 11 billion) in constant 2011 prices (see Fig. 11) and represents about one third of the total decrease in the imports of energy-intensive goods from outside the EU. This effect should be explained by the overwhelming share of goods from the manufacturing sector other than energy-intensive ones in imports.

49. Since the imports in the sectors covered by the border tax adjustment are not of decisive importance in the total structure and volume of imports into EU Member States, there is not a large decrease in the total volume of products imported from outside the EU. The total decrease in the imports into the EU is about 0.5% and it is fairly differentiated among EU Member States (Fig. 8). The largest decrease in imports occurs in Bulgaria (2.3%) and the Baltic States (2%). This decrease is the larger the greater the share of goods covered by the border tax adjustment is in the total imports (from outside the EU) of a given country. The decrease in imports also depends on which countries the goods are imported from and the extent to which they are affected by the border tax adjustment.

Fig. 8. The total change in the volume of imports into the EU from the other regions of the world after the introduction of the border tax adjustment, according to the BTA scenario; deviations from the GHG55 scenario [%].



Source: Own elaboration by CAKE/KOBiZE

6.2. The impact on prices and the volume of EU exports

50. The introduction of the border tax adjustment causes a slight increase in the production and export prices of EU Member States. The increase in the production prices is mainly caused by higher prices of products imported into the EU and covered by the border tax adjustment which are inputs to the manufacture of domestic goods. In most EU Member States, this is also enhanced by the real appreciation[9] of prices, which is manifested by a slight increase of wages and costs of capital (see section 7.6). The increase in prices leads to a decrease in

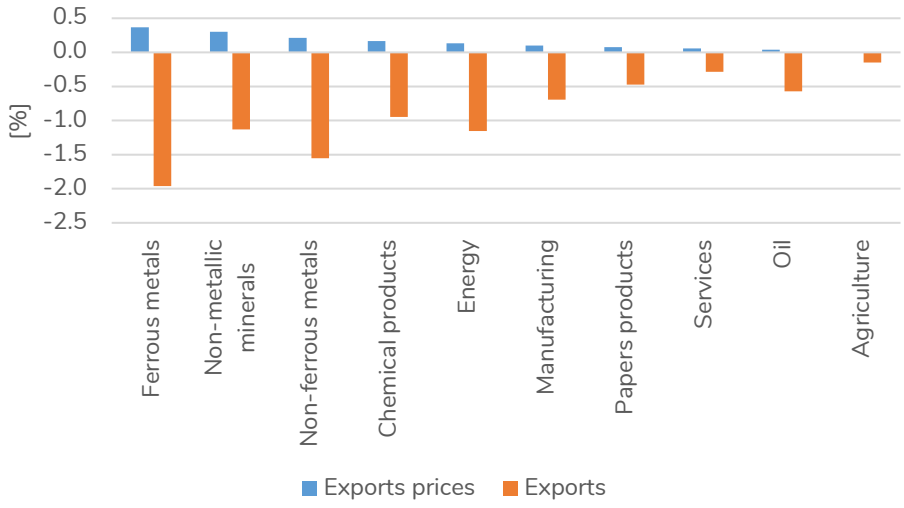
[9] Appreciation is the strengthening of the price of a given currency relative to another currency – see more in section 5.9 of the analysis.

exports to the countries outside the EU (see Fig. 9). As a rule, the greatest decreases in exports occur in the sectors which experience the largest price increases. At the same time, certain deviations from this rule can be seen, e.g. for the sector of non-ferrous metals. Among others, these deviations result from the fact that in certain cases it is more difficult to replace imports from the EU; therefore, the purchasers outside the EU region can pay relatively more.

51. In the sectors covered by the border tax adjustment, the increases in export prices do not exceed 0.4% (Fig. 9). The introduction of the border tax adjustment causes a slight increase in prices in the sectors which are not covered by the border tax adjustment, too. E.g. for the sectors of energy and manufacturing the prices increase by about 0.1%.

52. A decrease in exports to the countries outside the UE and imports from these countries is accompanied by **an increase in the output for the internal EU markets and greater intensity of trade among EU Member States.** Under the conditions of scarce resources, given that imports decrease in the sectors covered by the border tax adjustment, exports to the regions outside the EU must also fall so that the production can be used to meet the needs of the internal EU markets. The mechanism which ensures such a shift of production is that of carbon border adjustment. The greatest decrease in EU exports, by about 2%, occurs in the sector of ferrous metals, followed by the sector of non-ferrous metals (1.5%). The decreases in exports from the sectors of non-metallic minerals and chemical products are about 1%. The smallest decreases among the sectors covered by the border tax adjustment can be seen in the sectors of oil and paper products (about 0.5%).

Fig. 9. The prices and value of exports to the regions outside the EU in EU-27; deviations from the GHG55 scenario [%].



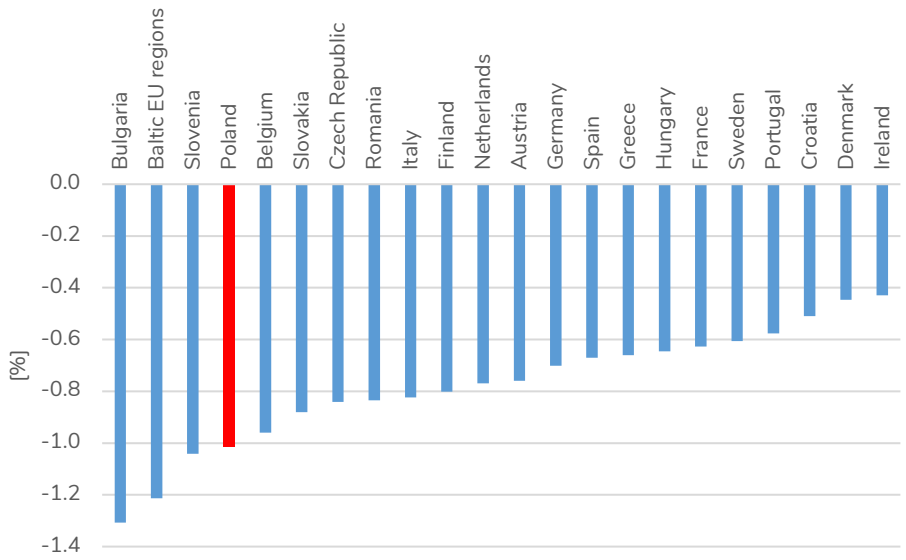
Source: Own elaboration by CAKE/KOBiZE

53. It follows from Fig. 9 that exports also fall in the sectors which are not covered by the border tax adjustment. It should be noted that the decline in the exports of goods in the manufacturing represents 40% of the total decrease in EU exports to the countries outside the EU (see Fig. 11). The improvement in the EU balance of trade with the rest of the world in the scope of the goods covered by the border tax adjustment is accompanied by a roughly equivalent deterioration of the balance of trade in the scope of the other goods and services.

54. Fig. 10 shows the total change in the value of exports from all the sectors of the economy relative to the scenario without the border tax adjustment (GHG55) broken down into Member States. The average decrease in exports to the regions outside the EU is about 0.7%, while it is the greatest in Bulgaria (1.3%) and the Baltic States, i.e. Lithuania, Latvia and Estonia (1.2%). There are also decreases (of about 1%) in Sweden, Poland and Belgium. The decrease is the larger:

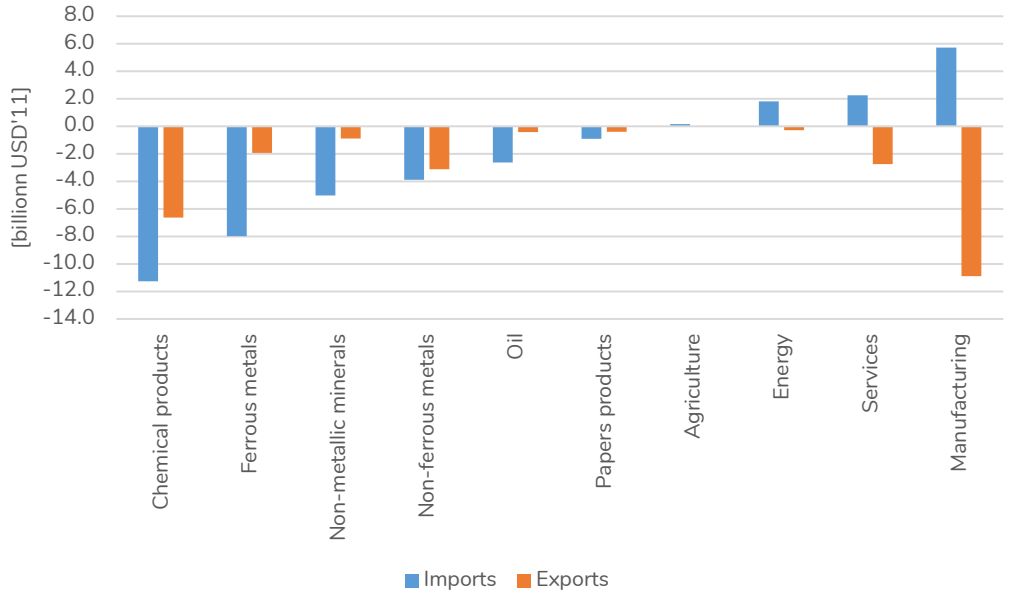
- the more a given country depends on the imports of products covered by the border tax adjustment from outside the EU (a decrease in imports from outside the EU with a simultaneous increase of trade within the UE and higher national demand causes a decrease in exports to the regions outside the EU),
- the greater part energy-intensive products represent (directly and indirectly) in the exports of a given country,
- the greater part of its exports a given country sends to the regions outside the EU.

Fig. 10. The total change in the volume of exports in 2030 from EU Member States to the other regions of the world after the introduction of the border tax adjustment; deviations from the GHG55 scenario [%].



Source: Own elaboration by CAKE/KOBiZE

Fig. 11. Exports to the regions outside the EU and imports from the regions outside the EU in EU-27; deviations from the GHG55 scenario [bln USD'11].



Source: Own elaboration by CAKE/KOBiZE

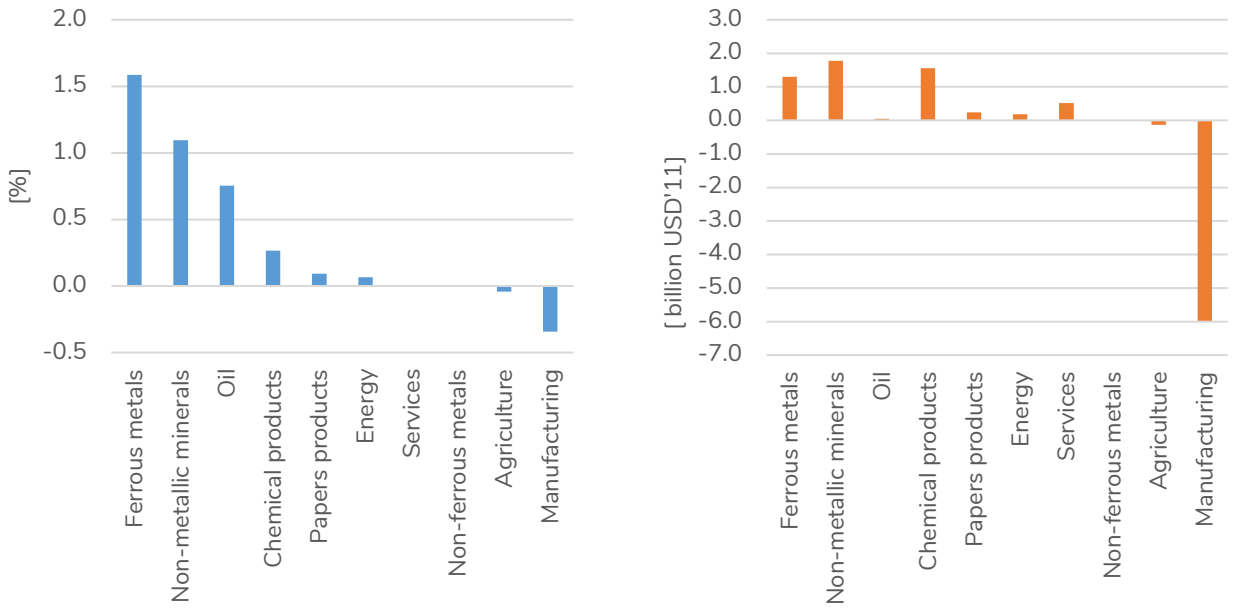
6.3. The impact of the output by sector in EU Member States

55. The impact of the introduction of the border tax adjustment on the output in the EU results, to a large extent, from the changes unfolding in its trade with the rest of the world. The results indicate an output increase in the EU in the sectors of the economy covered by the border tax adjustment (except for non-ferrous metals). Fig. 12 shows the projected output change (measured by the value added, at constant prices) in the EU caused by the introduction of the border tax adjustment in the BTA scenario. The largest increases occur in the sectors of ferrous metals (1.6%) and non-metallic minerals (1.1%). The output increases in such sectors as oil (0.7%) and chemical products (0.3%) can also be considered substantial, and so can, to a lesser extent, those in the sector of paper products (0.1%). The output increases in these sectors are primarily an outcome of the replacement of imports by national production.

56. An exception among energy-intensive sectors is the sector of non-ferrous metals, which also includes the manufacture of metal products. When all the Member States are considered as a whole, the total output in this sector practically does not change. This can be explained by taking into account two issues, firstly, that in this case the average import tax rate is relatively low, just as for chemical and paper products; hence, the effect of substitution for imports by the national production is relatively weak. Secondly, an increase in the prices of imported energy-intensive products affect to a slightly greater extent the production costs in the sector of ferrous metals in the EU than in the case of the sectors of chemical and paper products,

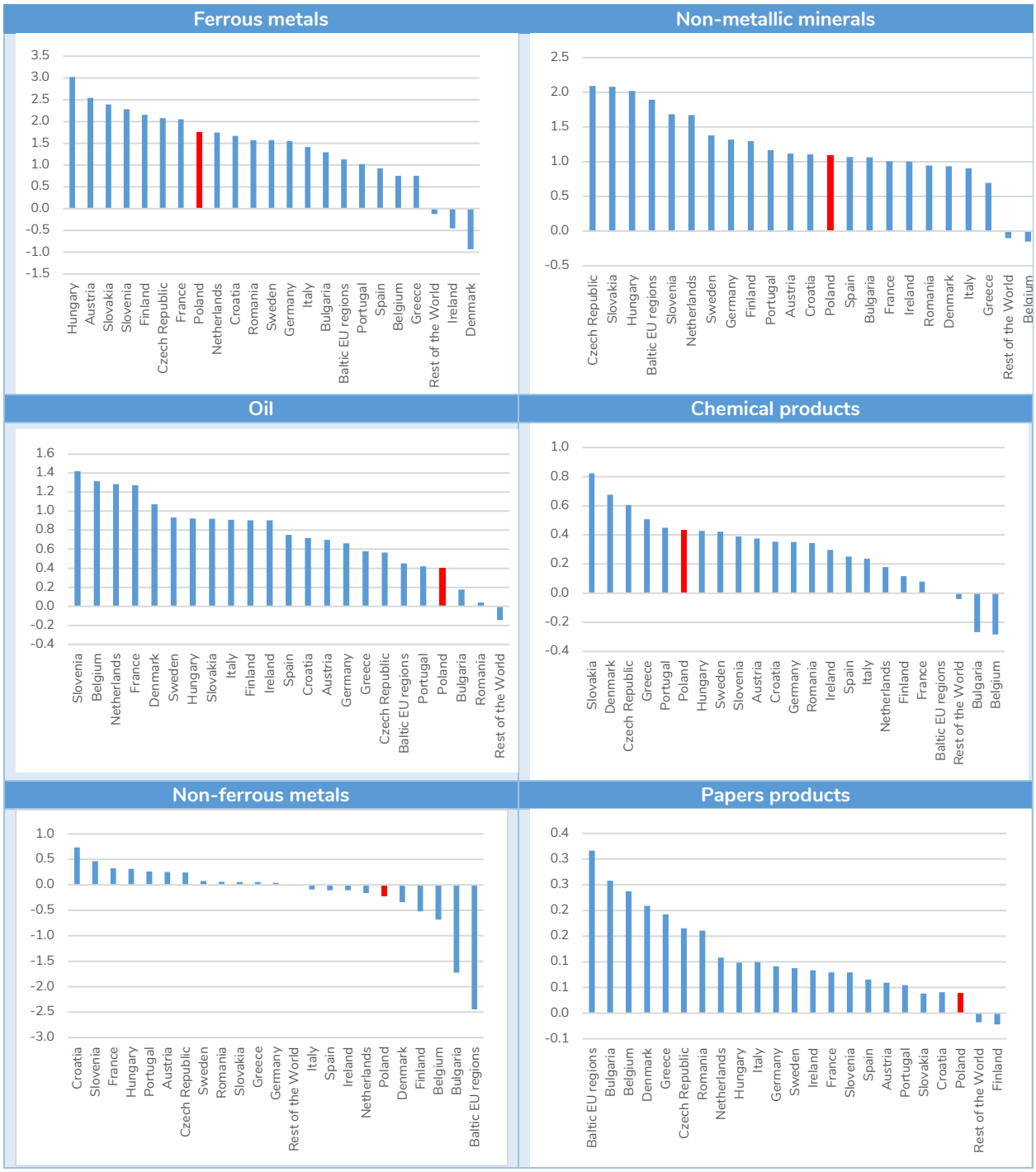
and this explains a slightly larger decrease, too, in this sector compared with the other sectors mentioned above. As a result, in the sector of non-ferrous metals a decrease in imports is accompanied by a similar fall in exports to the regions outside the EU and, in consequence of this, the output in the EU as a whole does not change significantly. However, there are differentiated effects in the particular Member States, e.g. in Bulgaria and the Baltic States (i.e. Lithuania, Latvia and Estonia) the output noticeably falls, by about 2%. In the other EU Member States, both increases and decreases of the output in this sector are already much smaller. Detailed data on this issue are shown in Fig. 13. The relatively large decreases in Bulgaria and the Baltic States can be explained by an increase in the production prices in the sector of non-ferrous metals which is greater in them than in other countries (albeit it is still a slight one in absolute terms), which worsens their competitiveness in the international trade within the EU. In turn, this greater increase in prices mostly results from a larger share than in other countries of carbon-intensive goods imported from outside the EU in the production costs in the sector of non-ferrous metals.

Fig. 12. The output (the real value added) in EU-27; deviations from the GHG55 scenario [%].



Source: Own elaboration by CAKE/KOBiZE

Fig. 13. The global output in the sectors covered by the border tax adjustment; deviations from the GHG55 scenario [%].



Source: Own elaboration by CAKE/KOBiZE

57. A slight increase can be seen in the energy output in the EU, which is related to an output increase in the sectors covered by the border tax adjustment. On the other hand, the output in the manufacturing sector diminishes, among others, as a result of more costly imports and higher prices within the EU. It should be pointed out that the decrease in the value added in

manufacturing, which is about EUR 4.3 billion (USD 6 billion) annually (in constant 2011 prices), completely offsets the slight output increase in energy-intensive sectors.

6.4. The impact on the GDP and consumption

58. It follows from Fig. 14 that the introduction of the border tax adjustment causes a slight increase in the household consumption in EU Member States. The average increase in the household consumption in the EU is 0.04%; moreover, it is the largest in Ireland (0.14%) and Belgium (0.12%). The main factor which contributes to the positive change in the household consumption is the improvement in the so-called terms of trade.

59. The simulation of the introduction of the border tax adjustment assumes that the trade balances of the particular countries are constant (in a nominal approach, excluding the border tax adjustment). Due to this assumption, the assessment of the effects of the policy considered here is not affected in such a manner that e.g. an increase in the consumption level in a given country is partly financed by a higher foreign debt. A decrease in the total imports from outside the EU caused by the introduction of the border tax adjustment and the related increase in the prices of imported goods initially improves (*as the first-round effect*) the balance of the EU trade with the rest of the world. In such a situation, the initial trade balance can be preserved at a lower level of exports to the regions outside the EU. Lowered exports make it possible to allocate additional resources (of labour and capital) to meet the consumption needs within the EU.

60. A mechanism which ensures such an adjustment of the trade balance is an increase in export prices relative to import prices (excluding the border tax adjustment), which by definition is tantamount to an improvement in the terms of the EU trade with the rest of the world. An increase in export prices partly results from higher prices of raw materials and energy-intensive production inputs. Moreover, in most EU Member States, this is enhanced by the real appreciation of national currencies, as a result of which the purchasing power of wages in the EU grows relative to the rest of the world (the real appreciation can take the form of higher exchange rates of the EU currencies or higher wages and capital gains incomes than those in the rest of the world). Improved terms of trade are the main source of an increase in the household consumption level (identified here with improved well-being) in EU-27. The differentiated well-being in the particular EU Member States can almost fully be explained by the differentiation of the terms of the trade of these countries with the rest of the world caused by the introduction of the border tax adjustment.

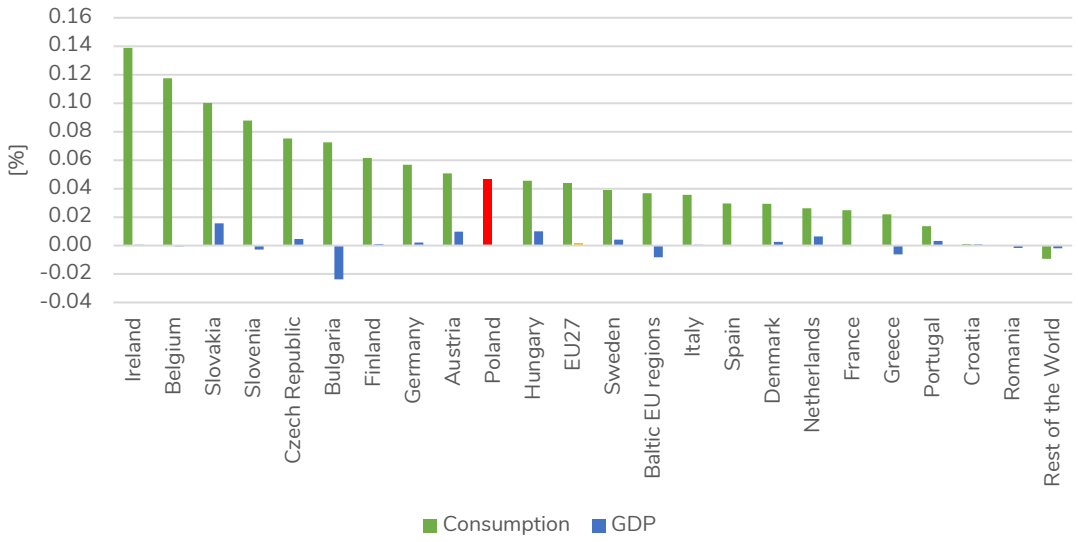
61. In addition to the positive impact on the terms of trade, the border tax adjustment – just as other types of taxes – brings about some limitation of the total economic activity in all the regions. Indeed, on the global scale, the results show a certain decrease in the GDP and consumption – a slight one, given the small scale of border tax adjustment. However, the dominant effect from the EU perspective turns out to be the improved terms of trade, causing

an increase of consumption at the expense of its fall outside the EU. In the EU, this effect prevails over the loses brought about by the border tax adjustment. This result is consistent with the conclusions of the study by Dixon and Rimmer (2008), who demonstrate in their analysis of unilaterally imposed tariffs that the prevalence of the effects of improved terms of trade is typical in the situation of low initial tariffs. However, in the case of high initial tariff levels, the negative effects of the imposition of an additional import duty prevail over the effects of improved terms of trade.

62. At the same time, improved terms of trade entail a deterioration of price competitiveness on the global markets. E.g. this can be seen in the exports of goods from the manufacturing sector (excluding energy-intensive products) which declines by more than EUR 7.18 billion (USD 10 billion) in constant 2011 prices.

63. An increase in the EU output of the sectors manufacturing goods covered by the border tax adjustment is partly or almost wholly offset by a decrease in the output in the manufacturing sector and, to a lesser extent, by the output in the other industrial sectors. This means that the implementation of the border tax adjustment has a minimal impact on the value of the GDP in EU Member States. This impact differs among the states, but changes in the value of the GDP vary about zero relative to the scenario without the border tax adjustment (GHG55). The greatest fall in the GDP in consequence of the implementation of the border tax adjustment can be seen in Bulgaria. However, even in this case, the GDP loss is barely 0.06% and it is mainly caused by a fall in the output in the sector of non-ferrous metals.

Fig. 14. Household consumption and the GDP; deviations from the GHG55 scenario [%].

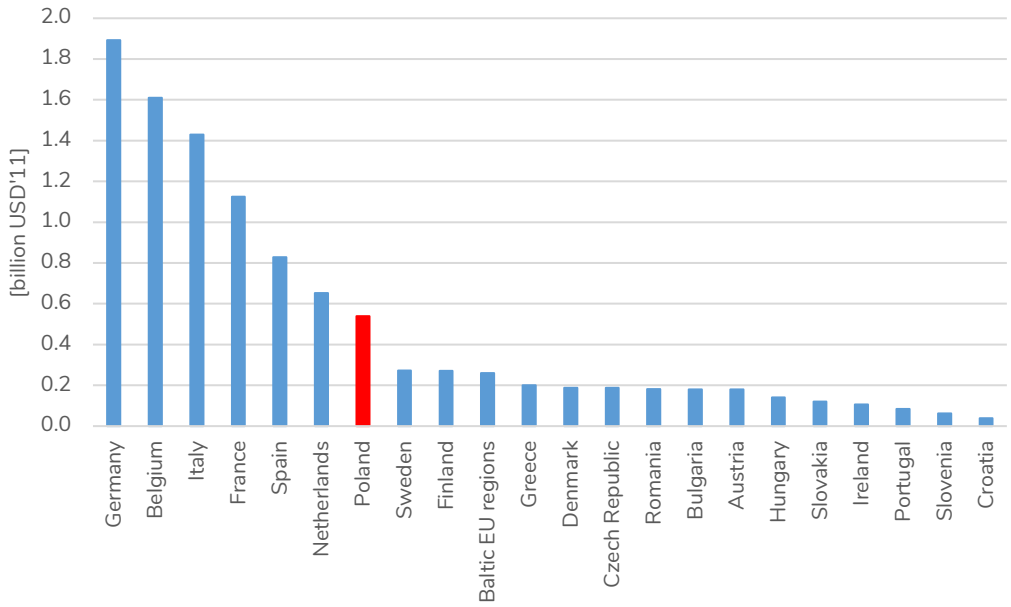


Source: Own elaboration by CAKE/KOBiZE

6.5. Budget revenues from the border tax adjustment

64. It follows from Fig. 15 that the introduction of the border tax adjustment generates additional revenues for the budgets of EU Member States. The largest revenues from the border tax adjustment are gained by Germany, i.e. USD 1.9 billion (EUR 1.36 billion[10]) in constant 2011 prices, followed by Belgium with its USD 1.6 billion (EUR 1.15 billion) in constant 2011 prices. The estimated proceeds from the border tax adjustment in Poland are USD 0.5 billion (EUR 0.36 billion) in constant 2011 prices. The lowest revenues from the border tax adjustment are gained by Slovenia and Croatia, respectively, USD 0.06 and 0.04 billion (EUR 0.04 and 0.03 billion) in constant 2011 prices. The main factor affecting the value of revenues from the border tax adjustment is the value of imports from outside the EU. Moreover, these revenues depend on the sources of origin of imported goods, given the differences in carbon intensity between the different regions of the world and EU-27. The total proceeds from the border tax adjustment in 2030 within the EU are estimated at about USD 10.6 billion (EUR 7.61 billion) in constant 2011 prices. If it proves possible to decide through negotiations that part of the resources from the border tax adjustment is allocated to specific objectives, they could be used e.g. to mitigate the effects of the transition in those EU Member States that are affected to the greatest extent by climate policy.

Fig. 15. The proceeds from the border tax adjustment [bln USD'11].



Source: Own elaboration by CAKE/KOBiZE

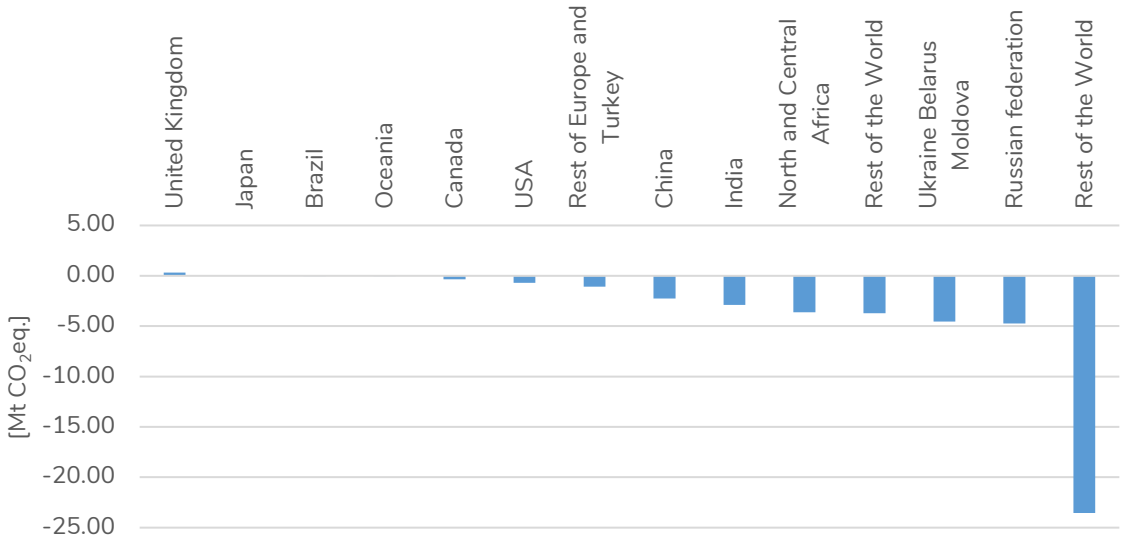
[10] The EUR/USD exchange rate = 1.392, according to Eurostat data (updated on 24.02.2020).

6.6. The impact of the border tax adjustment on global emission levels

65. The dislocation of production and a change in the intensity of the trade between the EU and the other regions resulting from the implementation of the border tax adjustment contribute to a decrease in global GHG emissions. According to the projection, even after the submitted NCDS have been fulfilled (as accounted for in the GHG55 scenario), the carbon intensity of production outside the EU remains higher in the overwhelming part of the regions of the world than in EU Member States. In light of this, it can be demonstrated that the border tax adjustment will be an effective tool to limit carbon leakage.

66. From the point of view of climate protection, apart from limiting carbon leakage in the EU, there are also other arguments for implementing the border tax adjustment – once it is in place, the carbon intensity of production in the other regions of the world becomes a factor which plays a role in the selection of the sources of imports into the EU. This should encourage manufacturers outside the EU to implement less carbon-intensive technologies and this can lead to the achievement of higher GHG reduction targets in the countries which are not EU Member States and, hence, globally.

Fig. 16. The impact of the border tax adjustment on a change in emissions in the regions outside the EU; deviations from the GHG55 scenario [Mt CO_2 eq.].



Source: Own elaboration by CAKE/KOBiZE

67. The changes in emission levels which can be seen are not large, as the total emissions in all the regions of the world (globally) fall by about 24 Mt CO_2 eq. in 2030. Although this value of the total change in GHG emissions is practically negligible when compared with the total global emissions (or even the total emissions in EU Member States), still it represents about 10% of an additional reduction effort which the EU ETS sectors will have to take after the reduction target is changed from 40% to 55% in 2030. It follows from Fig. 16 that the

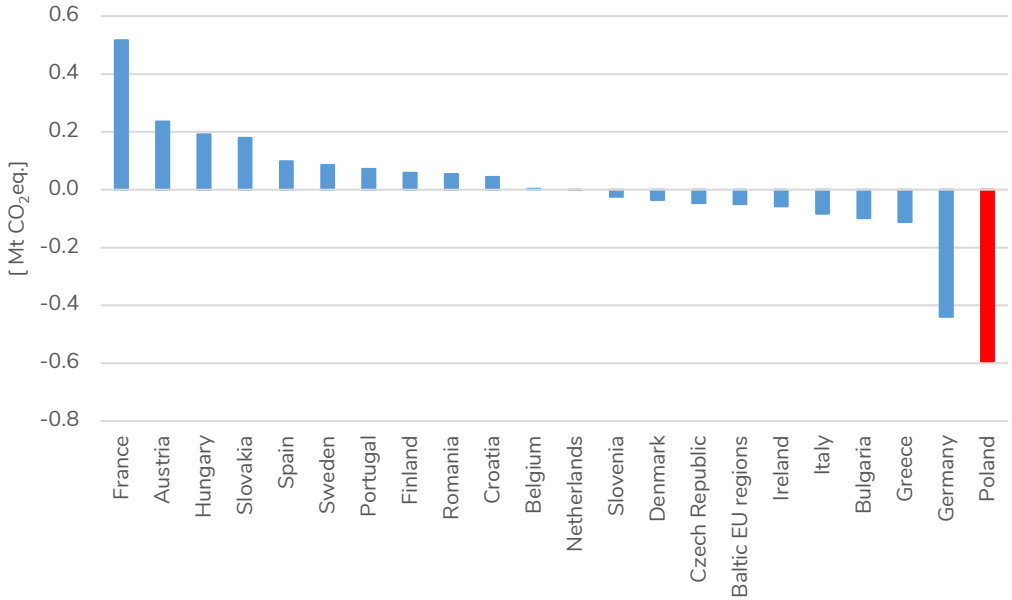
introduction of the border tax adjustment has the greatest impact on the emissions in the region of Russia and the region of Ukraine, Belarus and Moldova (UBM) because of their proximity to the EU. In percentage terms, GHG emissions fall to the greatest extent in the region of Ukraine, Belarus and Moldova (by about 1%). The slight scale of the change which can be seen w global emissions results from a small limitation of the total imports into the EU. Although the imports from the sectors covered by the border tax adjustment decrease by several percent, in contrast, in the other sectors their value can be seen to grow (e.g. in the manufacturing sector).

68. The slight change in global emissions also results from the account taken in the analysis of the carbon prices in the regions outside the EU (as an effect of NDCs) and the existing EU protection of the sectors exposed to carbon leakage in the form of free allocation of emission allowances. The above assumptions are of key importance, since under them already in the GHG55 scenario the transfer of part of production to the regions outside the EU is prevented.

69. A noticeable increase in the emissions in the United Kingdom, by about 0.1%, is an effect of the exit of this country from the EU ETS. Given the uncertain situation regarding the future trade agreements, imports from United Kingdom were not covered by the border tax adjustment in simulations. Such an action causes an increase in exports to EU Member States and, in consequence, an increase in output and GHG emissions in this region. The adoption of the assumption on the absence of the border tax adjustment in the trade between United Kingdom and the EU has no large impact on the other results of the analysis.

70. The total GHG emissions do not change after the introduction of the border tax adjustment, which results from the absence of a change in the emission limits in the GHG55 and BTA scenarios. However, the GHG emissions in the particular EU Member States slightly change as a result of: (1) changes in the structure and output of the national production and (2) the differences in the reduction potential in the sector of electricity and heat production. The greater output in the EU industrial sectors causes higher emissions and needs to be offset in the sector of electricity and heat production; among others, this causes a slight decline in emissions in Poland and Germany.

Fig. 17. GHG emissions in EU-27; deviations from the GHG55 scenario [Mt CO2 eq.].



Source: Own elaboration by CAKE/KOBiZE

7. The impact of the assumptions on the results of the analysis

71. The conclusions from the simulation analysis depend on the assumptions of the model used and the adopted (external) projections of the development of the world economy until 2030. The general economic assumptions of the CGE model used in the present study are not different from the assumptions of other CGE models applied in analyses of climate and energy policy (GEM-E3 Model Documentation). The areas for a possible extension of the analysis by considering alternative assumptions on the design of the border tax adjustment or the functioning of economies are indicated below. At the same time, these the potential directions of further studies.

72. In the present study, it is assumed that the size of the border tax adjustment is based on the difference between the (projected) emission allowance price in the EU ETS and the estimated marginal costs of emission reductions in the particular regions outside the EU. Firstly, the estimated costs of emission reductions entail significant uncertainty. Therefore, a potential direction of studies is a review of research on this issue intended to determine the intervals of carbon prices which would provide a reference point for setting the border tax adjustment rate. Secondly, the estimated marginal costs of emission reductions outside the EU apply to all the sectors of the economy as a whole rather than solely energy-intensive sectors. This produces a certain asymmetry in the design of the border tax adjustment (since the emission allowance price in the EU ETS mostly applies to energy-intensive sectors). Thirdly, the border tax adjustment covers only direct emissions and emissions caused by the electricity consumption in production. An alternative solution is for the border tax adjustment to be

based on total carbon intensity, including the entire production chain (although this produces additional difficulties related to the estimation of total carbon intensity).

73. The analysis assumes constant labour and capital resources in the particular countries. This means that labour and capital do not flow among countries under the impact of the policies considered here. At the same time, it assumes full mobility of capital and labour among the sectors of the economy (and, therefore, the economic effects are considered in the long term, e.g. without analysing the impact on unemployment). This assumption also explains the insignificant impact of the border tax adjustment on the GDP, which – on the supply side – is determined by the available resources of capital and labour (slight changes in the GDP result from changes in the effectiveness of the allocation of these factors). If the global mobility of capital and labour were allowed, this would primarily limit the benefits from enhanced consumption in the EU caused by improved terms of trade. In the extreme case of full mobility of capital and labour, these benefits would be completely gone.

74. A possible effect of the introduction of a tariff or another import duty is the poorer productivity of national manufacturers which results from the reduced competitive pressure from foreign manufacturers. Therefore, the border tax adjustment could cause part of less productive manufacturers to stay on the market; in macroeconomic terms, this would lead to some loss of well-being. However, this effect is not included either in the CREAM model or most CGE models used in similar analyses, which are based the assumption of perfect competition and the absence of economies of scale in production and/or on the Armington model, which describes international trade. Alternative solutions include, among others, the use of the Melitz model to describe trade, which provides for the impact of import duties on productivity (*Dixon et al. 2016, 2019*). CGE models of this type, proposed in recent years in the literature, have not yet entered the mainstream of simulation analyses in use, due to the higher degree of their complexity and the need for information on the parameters of the model. On this basis (also taking into account the comments in the previous paragraph), it can be concluded that indeed the simulation results on higher consumption (improved well-being) in EU Member States should not be treated as the main or decisive grounds for possibly introducing the border tax adjustment.

75. The parameters of the CGE model of key importance for the assessment of the effects of the introduction of the border tax adjustment are the substitution elasticities which describe: (1) the degree to which the national production can substitute for imported goods, and (2) the degree to which the products imported from different sources (countries) can be substituted for. The higher elasticities of the substitution of imports by the national production are, the larger import decreases are caused in the EU by the levying of the border tax adjustment. In turn, the lower the substitution elasticities are in respect of the sources of imports, the greater increases in export prices in the EU arise as a result of improved terms of trade in the EU compared with the rest of the world. Thus, the higher elasticities of the substitution of imported goods by the national production are and the lower elasticities of the substitution

of import sources (with respect to the goods covered by the border tax adjustment) are, the more the consumption grows in EU Member States as shown by simulations. In the CREAM model, the elasticities were adopted after the GEM-E3 model (*Capros et al. 2013*). Nevertheless, the estimation of these elasticities involves significant uncertainty; moreover, there are no empirical studies which would, among others, make it possible to take into account the differentiation of these elasticities among countries. A comprehensive approach to the uncertainty related to the parameters mentioned above would require the use of a systematic sensitivity analysis (*Zachłod-Jelec, Boratyński 2016*), which can be explored in a separate study.

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Annex I

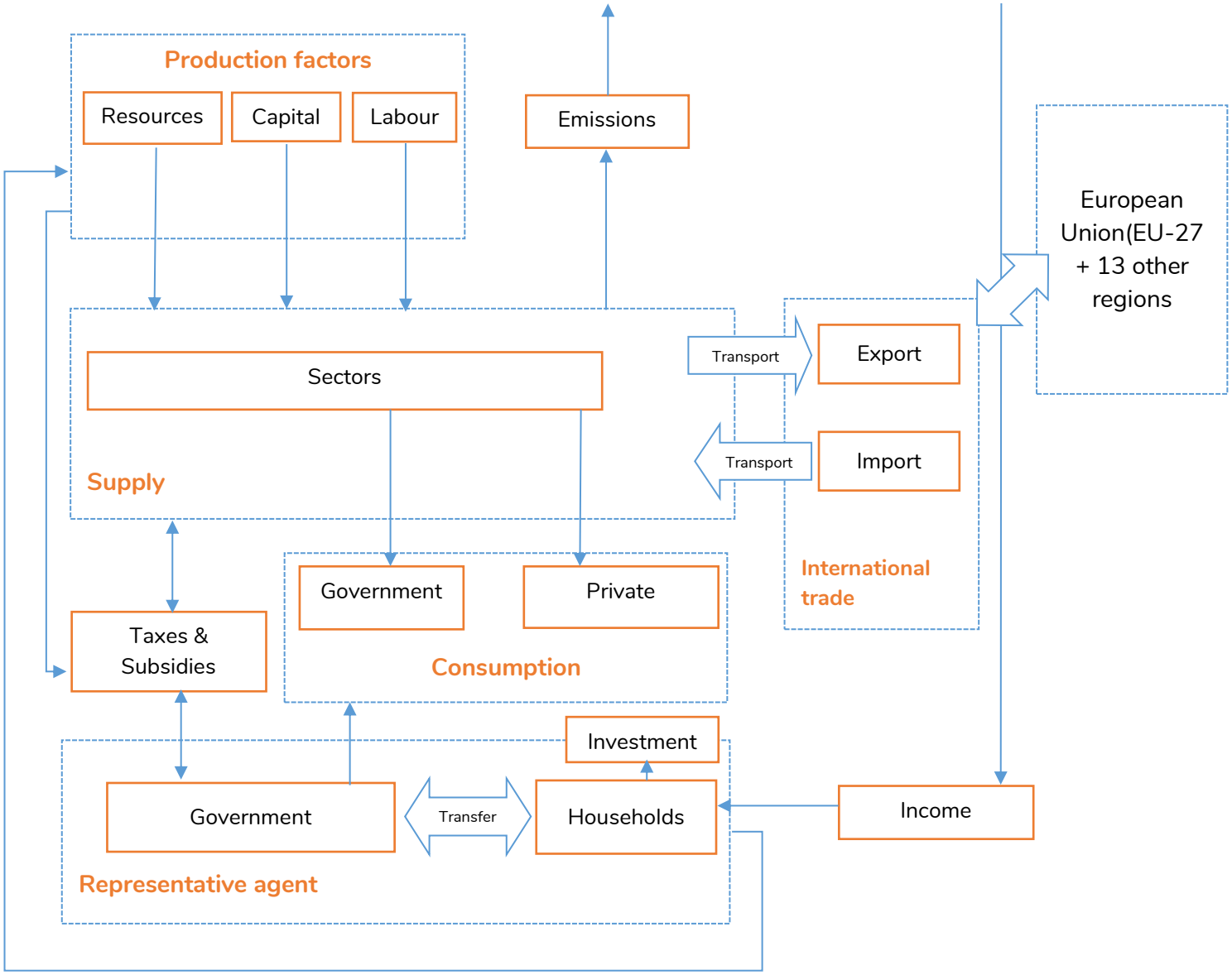
Characteristics of the CREAM computable general equilibrium model

The computable general equilibrium (CGE) model called CREAM[11] in its static version was used to analyse the effects of the introduction of the border tax adjustment. This model is a global, multi-sectoral tool. Its flow chart is shown in Fig. 18. The timeframe of the analysis extends until 2030. In the first step the GHG emission reduction target was raised to 55% and in the next step the border tax adjustment was introduced for products imported into EU Member States.

The CREAM model uses a database built on the basis of input-output (IO) tables published by the Joint Research Centre (JRC) of the EC in 2018. They contain data on production processes at the level of sectors, input-output linkages (via indirect outlays) and final demand, including investments as well as household and government consumption. Moreover, the database contains data on bilateral international trade, including the data on transport costs and information on different types of taxes. In addition, it includes data on fuel consumption and greenhouse gas (GHG) emissions in the particular sectors and regions. The model distinguishes 35 regions (including 21 Member States and the region of the Baltic States), 31 sectors (including energy-intensive sectors), 10 of which are sectors covered by the EU ETS scheme, such as the sectors of: oil (oil), ferrous metals (fem), non-ferrous metals (nem), chemical products (che), paper products (pap), non-metallic minerals (nmm), air transport (air), electricity supply (separately by fuel: coal fired (cof), oil fired (oif) and gas fired (gaf)). The other sectors belong to the non-ETS area. The sectoral division strictly depends on the classification applied in the database. The model also distinguishes 8 electricity production technologies, including 4 technologies using renewable energy sources and nuclear fuel-based generation, as well as 3 electricity production technologies based on fossil fuels (which are covered by the EU ETS and listed above). In addition, it contains detailed data on GHG emissions in different sectors. The model distinguishes CO_2 emissions from combustion broken down into fuel types: coal, refined petroleum products and gas, as well as process emissions, including, apart from CO_2, N_2O (nitrous oxide), CH_4 (methane) and F-gases (fluorinated gases).

[11] CREAM - Carbon Regulation Emission Assessment Model

Fig. 18. The flow chart of the CREAM model.



Source: Own elaboration by CAKE/KOBiZE

Table 2. The list of regions in the CREAM model.

List of regions in the CREAM model				
No.	Abbreviation	State	EU Member States	Aggregated states
1.	AUT	Austria	+	
2.	BEL	Belgium	+	Belgium, Luxembourg
3.	BGR	Bulgaria	+	
4.	CRO	Croatia	+	
5.	CZE	Czech Republic	+	
6.	DEU	Germany	+	
7.	DNK	Denmark	+	
8.	ESP	Spain	+	
9.	FIN	Finland	+	
10.	FRA	France	+	
11.	GRC	Greece	+	Greece, Cyprus
12.	HUN	Hungary	+	
13.	IRL	Ireland	+	
14.	ITA	Italy	+	Malta, Italy
15.	NLD	Netherland	+	
16.	POL	Poland	+	
17.	PRT	Portugal	+	
18.	ROU	Romania	+	
19.	SVK	Slovakia	+	
20.	SVN	Slovenia	+	
21.	SWE	Sweden	+	
22.	BLT	Baltic States	+	Estonia, Lithuania, Latvia
23.	GBR	Great Britain		
24.	USA	United States		
25.	JPN	Japan		
26.	CAN	Canada		
27.	AUZ	Oceania		Australia, New Zealand
28.	RUS	Russian Federation		
29.	BRA	Brazil		
30.	CHN	China		China, Hong Kong
31.	IND	India		
32.	RET	Rest of Europe and Turkey		Norway, Switzerland and the other EFTA states, Turkey
33.	UBM	Ukraine, Belarus and Moldova		Belarus, Ukraine and the other Eastern European states
34.	NAM	North and Central Africa		Bahrain, Iran, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, UAE, Morocco, Tunisia, Rest of the states of North Africa and West Asia
35.	ROW	Rest of the world		Other

Table 3. The list of sectors in the CREAM model.

The list of sectors in CREAM model				
Abbrevation	**Sector**	**Sectors covered by the EU ETS**	**Class**	**Statistical classification of economic activities in the European Community NACE Rev. 2)**
cro	Crops		0111	Wheat
			0112	Maize (corn)
			0113	Rice
			0114	Sorghum
			0115	Barley
			0116	Rye
			0119	Other cereals
			012	Vegetables
			013	Fruit and nuts
			015	Edible roots and tubers with high starch or inulin content
			017	Pulses (dried leguminous vegetables)
coa	Coal		05	Mining of coal and lignitedobywanie węgla kamiennego i węgla brunatnego (lignitu)
cru	Crude oil		061	Extraction of crude petroleum
			091(part)	Support activities for petroleum and natural gas extraction (petroleum part)
oil	Oil	+	19	Manufacture of coke and refined petroleum products
gas	Gas		062	Extraction of natural gas
			091(part)	Support activities for petroleum and natural gas extraction (natural gas part)
			352	Manufacture of gas; distribution of gaseous fuels through mains
ele	Electricity supply		351	Production, collection and distribution of electricity
			353	Steam and hot water supply
fem	Ferrous metals	+	241	Manufacture of basic iron and steel and of ferro-alloys
			2431	Casting of iron and steel
nem	Non-ferrous metals	+	242	Manufacture of basic precious and other non-ferrous metals
			2432	Casting of other non-ferrous metals
			25	Manufacture of fabricated metal products, except machinery and equipment
che	Chemical products	+	20	Manufacture of chemicals and chemical products
pap	Paper products	+	17	Manufacture of paper and paper products
			18	Printing and reproduction of recorded media
nmm	Non-metallic minerals	+	099	Support activities for other mining and quarrying
			23	Manufacture of other non-metallic mineral products
elg	Electric goods		26	Manufacture of computer, electronic and optical products
tra	Transport equipment		29	Manufacture of motor vehicles, trailers and semi-trailers
			30	Manufacture of other transport equipment

oth	Other equipment goods		28	Manufacture of machinery and equipment n.e.c.
			31	Manufacture of furniture
			32	Other manufacturing
			33	Repair and installation of machinery and equipment
cgi	Consumer goods industries		101	Processing and preserving of meat and production of meat products
			102	Processing and preserving of fish, crustaceans and molluscs
			103	Processing and preserving of fruit and vegetables
			104	Manufacture of vegetable and animal oils and fats
			105	Dairy products
			106	Rice, semi- or wholly milled, or husked
			107	Manufacture of bakery and farinaceous products
			108	Manufacture of other food products
			109	Manufacture of prepared animal feeds
			11	Beverages products
			12	Tobacco products
			13	Manufacture of textiles
			14	Manufacture of wearing apparel
			15	Manufacture of leather and related products
			16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
con	Construction		41	Construction of buildings
			42	Civil engineering
			43	Specialized construction activities
atr	Transport (Air)	+	51	Air transport
ltr	Transport (Land)		49	Land transport and transport via pipelines
wtr	Transport (Water)		50	Water transport
mse	Market services		36	Collection, purification and distribution of water, water collection, treatment and supply
			37	Sewerage
			38	Waste collection, treatment and disposal activities; materials recovery
			39	Remediation activities and other waste management services
			45	Wholesale and retail trade and repair of motor vehicles and motorcycles
			46	Wholesale trade, except of motor vehicles and motorcycles
			47	Retail trade, except of motor vehicles and motorcycles
			53	Postal and courier activities
			58	Publishing activities
			59	Motion picture, video and television program production, sound recording and music publishing activities
			60	Programming and broadcasting activities
			61	Telecommunications
			62	Computer programming, consultancy and related activities
			63	Information service activities

			64	Financial service activities, except insurance and pension funding
			661	Activities auxiliary to financial service activities, except insurance and pension funding
			663	Fund management activities
			65	Insurance, reinsurance and pension funding, except compulsory social security
			662	Activities auxiliary to insurance and pension funding
			M, N	Professional, scientific and technical activities and Administrative and support service activities
nms	Non-market services		R, S, T	Arts, entertainment and recreation; Other service activities; Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
			84	Public administration and defense; compulsory social security
			99	Activities of extraterritorial organizations and bodies
cof	Coal fired	+		
oif	Oil fired	+		
gaf	Gas fired	+		
nuc	Nuclear			
bio	Biomass			
hyd	Hydro electric			
win	Wind			
pv	PV			
ani	Livestock		014	Animal production
			03	Fishing
			017	Hunting, trapping and related service activities
fos	Forestry		02	Forestry

Annex II

Characteristics of the CarbonPIE simulation model

The changes in emission levels in the EU ETS in the GHG55 and BTA scenarios were determined on the basis of the projection of the supply of allowances and the reduction of emissions in the EU ETS. The projection was performed using the CarbonPIE (*Carbon Policy Implementation Evaluation Tool*) simulation tool. Table 4 shows the emission levels projected under the GHG55 and BTA scenarios in the EU ETS in 2030, including their deviations from the baseline emissions under Baseline GECO 11/2018.

Table 4. The change in GHG emissions in the sectors covered by the EU ETS, including emissions from aviation [Mt CO_2eq.]

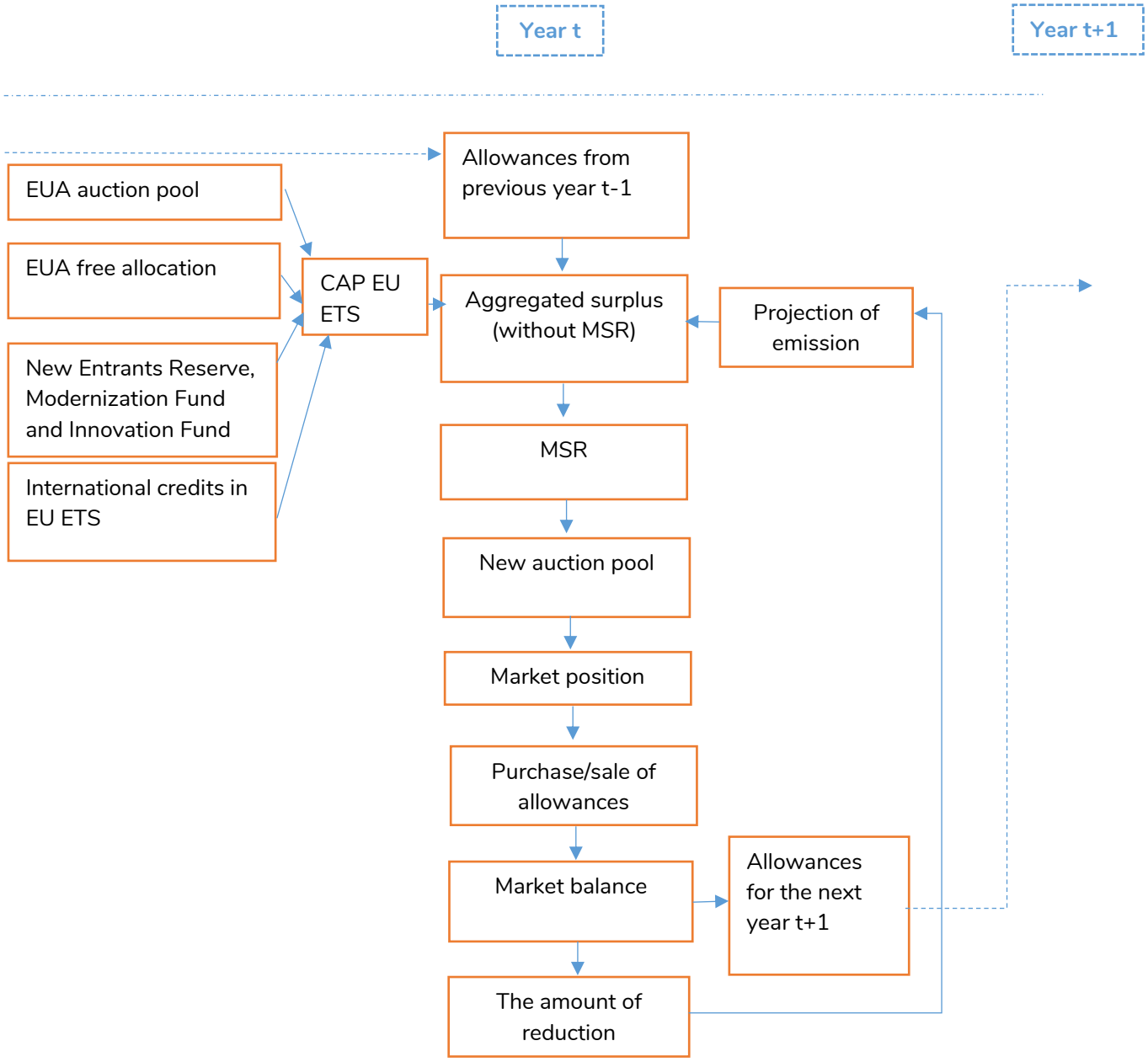
Year	2030
Baseline GECO 11/2018	1260
GHG55 and BTA scenarios	1056
Decline in emissions in the GHG55 scenario (relative to Baseline GECO 11/2018)	16%

Source: Own elaboration by CAKE/KOBiZE

CarbonPIE is a simulation model. Its task is to map the supply of emission allowances, while keeping the details related to the functioning of the EU ETS scheme. In addition, it reflects the behaviour of market actors who receive part of allocation free of charge and can also buy, sell or bank emission allowances, depending on their market position and needs. The part of the model which reflects the behaviour of the actors on the EU ETS market has been elaborated on the basis of equations and assumption adopted for the *Zephyr* model[12]. In order to illustrate the successive computation stages, Fig. 19 shows the flow chart of the model. Initially, the *CarbonPIE* model maps the pathways for the allocation of allowances in the EU ETS: free allocation of allowances, the auction volume, the New Entrants Reserve (NER), the Modernisation Fund and the Innovation Fund. In the next step, for pre-determined emission levels and supply of allowances, the operation of the Market Stability Reserve (MSR) is simulated to determine the auction volume. The computations are carried out separately for each year until a balance is reached between supply and demand in a pre-set period.

[12] The publication *Lessons on the Impact of a Market Stability Reserve using the Zephyr Model*, WP no. 2015-11, October 2015, authors: Raphaël Trotignon, Pierre-André Jouvet, Boris Solier, Simon Quemin i Jérémy Elbeze, Chaire Economie du Climat, Universitte Paris-Dauphine CDC Climat.

Fig. 19. The flow chart of the CarbonPIE model.



Source: Own elaboration by CAKE/KOBiZE