Carbon leakage and competitiveness in the EU until 2050

Policy Brief

August 2018

About this report

This Policy Brief constitutes the Deliverable 3.3a of the REEEM Project, which analyses economic, social and environmental impacts of pathways towards a low-carbon EU energy system. The deliverable provides insights based on a detailed economic analysis considering over 20 scenarios utilized for deliverable 3.2, a case study on carbon leakage and competitiveness. The case study assessed impacts of alternative policy measures to reduce CO_2 emissions in the EU-28, also considering different levels of emissions reduction in the remaining regions of the World. Due to the numerical tool utilized for this analysis, a global dynamic-recursive CGE model, the interconnections between different economy sectors and between regions could be simulated to, ultimately, produce results for sectoral production and competitiveness, GDP variation between different scenarios and CO2 emissions. This report summarizes the main findings of the case study and highlights the main implications of different emission cuts.

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About REEEM

REEEM aims to gain a clear and comprehensive understanding of the system-wide implications of energy strategies in support of transitions to a competitive low-carbon EU energy society. This project is developed to address four main objectives: (1) to develop an integrated assessment framework (2) to define pathways towards a low-carbon society and assess their potential implications (3) to bridge the science-policy gap through a clear communication using decision support tools and (4) to ensure transparency in the process.

The REEEM project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691739. This publication reflects only the views of its authors, and the European Commission cannot be held responsible for its content.

Introduction

To deal with the rising concerns of climate change, the world leaders gathered in Paris in 2015 to sign what has become known as "The Paris Agreement". The agreement represents a global scale effort to mitigate the climate change, with the goal of limiting the increase in global temperature rise this century to a maximum of 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1,5 degrees Celsius, recognizing that this would significantly reduce the risks and impacts of climate change [1].

To achieve this goal, the Agreement signatories need to use various environmental policies, e.g. the EU-ETS. The purpose of this policy brief is to report on the implications of such policies on the EU economy.

Definition of the problem and why it matters

Emission of greenhouse gases (GHG) is inherent to economic activities. Limiting the amount of GHG a company can emit has a negative impact on its costs, i.e., the costs of providing goods and services increase as companies must either invest in costly abatement technologies or purchase ETS allowances. When faced with higher production costs due to environmental policies, companies can transfer their production or future investments to countries not being covered by similar policies, a phenomenon known as **carbon leakage**. Industries that are not subject to carbon leakage (e.g. those providing non-tradable goods, or those that find it difficult to reallocate) become less **competitive**. Carbon leakage and competitiveness are believed to have negative impact on GDP growth and employment levels. Therefore, in this brief we present our findings regarding the impact of environmental policies in the EU on the carbon leakage and competitiveness of EU industries in order to support future policy decisions.

Modelling framework

To assess the impact of climate policies on carbon leakage and competitiveness we use a macroeconomic recursive dynamic general equilibrium model NEWAGE (National European Worldwide Applied General Equilibrium). The model considers interdependencies among different sectors of an economy as well as interdependencies among different economies and, thus, is able to describe the behaviour of individual firms and households. It covers the world economy, though most countries are aggregated to regions. Therefore, there are 18 regions, 9 within Europe, 9 outside of Europe. Similarly, production sectors are also aggregated. There are 5 energy production sectors, 5 energy-intensive industry sectors, 3 sectors representing the rest of the industry and 4 sectors representing the rest of the economy. Within the electricity sector 18 generation technologies are included. Production possibilities are represented through constant elasticity of substitution (CES) production functions.

Like any other model, NEWAGE relies on a set of assumptions needed to simplify real world complexities. These assumptions include:

Substitution elasticities representing how easy or difficult it is to substitute between different production factors or technologies. For example, how can a firm substitute between capital and labour, or between wind and solar to produce electricity.

Technological change is captured through efficiency improvements using an autonomous energy efficiency index (AEEI), calibrated according to the EU Reference Scenario 2016 [2]. The assumed AEEI index declines over the years implying that production of goods or services will require less input in the future in terms of energy used [3].

Other assumptions including **decommissioning curves** for the different electricity production technologies, as well as assumptions on **population growth** and the **unemployment rate**.

The CO_2 emission trajectory depends upon the analysed scenario. The trajectory also differs for EU 28 countries and non-EU countries to reflect different policy objectives pursued in the EU and the rest of the world.

Finally, as a base year 2011 was selected, and simulations were run up to year 2050 in five-year steps.

Definition of scenarios analysed

To evaluate the impact of environmental policy measures in an uncertain world, different environmental scenarios have been developed that address the interdependencies between environmental policies in the EU and the rest of the world.

The EU level of cooperation towards environmental issues was captured through three different scenarios based on the White Paper on the future of Europe [4], which is a report created by the EU Commission that maps out the drivers of change in the next decade and presents a range of scenarios for how Europe could evolve by 2025. The least ambitious scenario **"Business as usual" (E1)** assumes that Europe follows the rationale of Scenario 1: "Carrying on" from the White Paper on the future of Europe [4], implying that there are no major changes to European environmental policies and they follow the actual tendencies, meaning that the EU-ETS and ESD continue as the main policies in this area. In the second scenario analysed, **"Cluster Union" (E2)**, Europe follows the rationale of Scenario 3: "Those who want do more" from the White paper [4], meaning that selected countries have more ambitious targets. While targets for ETS sectors remain identical for members of the Cluster Union and other EU countries, compared the E1 scenario, the non-ETS targets in 2050 for the members of the Cluster Union are of 80% GHG reduction, compared to 2005 levels, and between 50 and 60% for the remaining countries. Membership in the Cluster Union depends mostly on the GDP per capita and geographical location of the EU Members. Finally, the most ambitious scenario for Europe analysed is **"Stronger Union" (E3)** in which Europe follows the rationale of Scenario 5: "Doing much more together" from the White paper [4], meaning that all member states increase their cooperation across all policy areas.

For the rest of the world, a **"No ambition" (W0)** scenario in which the rest of the World has no ambition in terms of climate mitigation policy was assumed. A second World scenario analysed assumes **"Business as usual" (W1)** scenario in which the rest of the World emissions follow the Reference Technology Scenario from the Energy Technology Perspectives (ETP) [5], which W1 scenario takes into account existing energy and climate related commitments by countries, including those under the NDCs submitted under the UNFCCC process, which are currently not compatible with the 2°C target. The third world scenario analysed, **"Regional push" (W2)** implies a selected group of regions target 2°C compliant ambition while remaining regions follow the Business as Usual scenario. Finally, the fourth and the most ambitious World scenario **"2 °C target" (W3)** implies that the world emissions follow the 2DS Scenario from the ETP 2017 [5]. This last scenario lays out an energy system pathway and a CO_2 emissions trajectory consistent with at least a 50% chance of limiting the average global temperature increase to 2°C by 2100.

Finally, we also examined different policy measures to reduce emissions, including the EU-ETS and the Effort Sharing Decision (ESD), which sets national emission targets for the non-ETS sectors. Four variations of emission targets for the ETS sectors were considered in 2050, including the business as usual scenario, 80%, 90% and 95% CO2 emissions cut compared to 1990. For the ESD sectors, two cases were considered: business as usual and new targets, which are more ambitious than the original. Additionally, we also considered three cases where all sectors of the economy are covered by the EU-ETS, with emission cuts of 80%, 90% and 95% in 2050 compared to 1990. For both policies, EU-ETS and ESD, the business-as-usual targets were adopted from the EU Reference scenario [2], which considers a reduction of respectively 61 and 28% for 2050 compared to 2005 levels.

For the policy package formed by a target of 80% emission cut in the ETS sectors and new targets for the ESD sectors, two extra variations were analysed with the application of a Price Collar. This extra mechanism consists of setting a maximum allowance price for the ETS sectors, which were considered to be as 90 and 80% of the original price, for the years after 2020.

Results

As a general result, the simulations show there is a **negative link between CO_2 reduction** in 2050 relative to 1990 **and GDP growth** between 2050 and 2011 for all scenarios analysed, as shown in Figure 1. It is important to note that NEWAGE does not consider positive externalities arising from reducing GHG emissions, which are not included in the GDP value. By reducing the GHG emissions, air and water pollution as well as the risk for natural disasters decrease and, thus, positive impacts on the environment and on health and thereby positive effects on the economy in the long term can be expected but are not accounted for in the model.

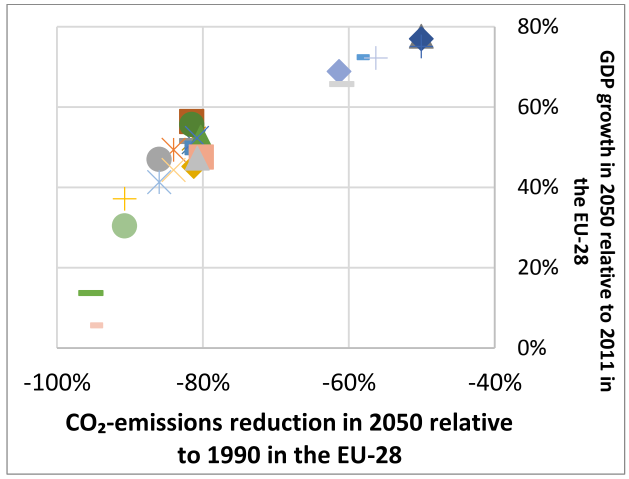

Figure 1 : GDP growth versus CO_2 emissions reduction. Both values are for the EU-28. Each marker is a different scenario

In terms of **carbon leakage** our results show that if we assume the rest of the world implements rather no environmental measures (scenario W0) we notice that the CO_2 cut in the EU-28 tends to leak to other OECD countries, in particular the USA, in the form of industrial production moving to these regions, as they tend to compete in the same high-value sectors.

To measure the impact of environmental policies on **competitiveness**, we analyse the change in gross valued added (GVA) across different industries for different policies. In Figure 2, considering W2 for all scenarios and Cluster Union, with 80% reduction target for the ETS sectors and new targets for the ESD sectors, as the reference, we find that the most affected sectors are the chemical industry, iron and steel, nonferrous metals and non-metallic minerals. All these industries are characterised as very energy intensive and find it difficult to substitute fossil fuels with cleaner energy sources due to prohibitive costs. Depending on the scenarios analysed, these sectors lose up to 50% of GVA compared to the reference.

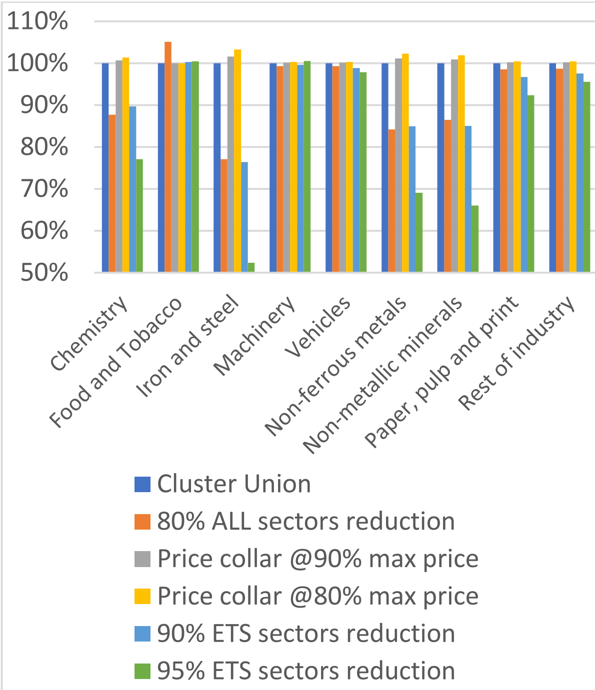

Figure 2 Gross Value Added in 2050 in the EU-28 for different sectors and EU ambition levels and policies. (Cluster Union = 100%)

We also analyse the impact of the level of world's environmental policies on EU competitiveness, as shown on Figure 3. We find that higher climate ambition in the rest of the world has positive effects on the international competitiveness of European energy intensive sectors due to increased CO_2 emission costs outside of Europe while the resulting decrease in world economic growth leads to production declines in more export-oriented sectors.

Finally, results indicated that electrification can play an important role in alleviating the impact of environmental policies. They suggest that as Europe opts for more ambitious environmental targets, electrification can help in mitigating the negative effects. What we find is that increasing the ease with which fossil fuel technologies can be substituted by electrification has significant positive impact on the GDP growth. Thus, when increasing the elasticity of substitution from a rather conservative value of 0,1 (original assumption) to a value of 1, the GDP increases by 5%, and to a more optimistic value of 10, GDP growth increases by 20%. Therefore, fostering and facilitating electrification contribute significantly to alleviating the negative impacts of transforming the energy system.

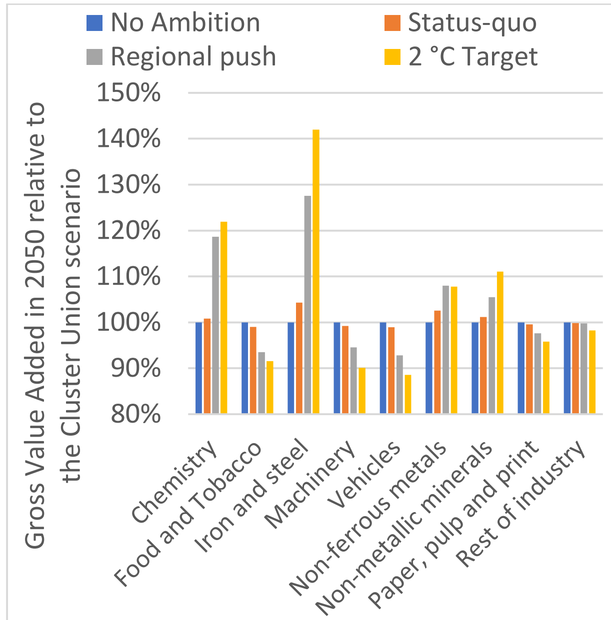

Figure 3: Gross Value Added in 2050 in the EU-28 for different sectors and world ambition levels. (No Ambition = 100%)

Conclusions and Recommendations

In this policy brief we presented the simulation results that can be a guide to future environmental policy decision in the context of the Paris agreement. We attempted to determine the potential impact of interdependencies between environmental policies in the EU and the rest of the world on the EU economy.

The model simulations showed that higher CO_2 reductions result in lower GDP growth in 2050 compared to 2011, regardless of the scenario analysed. This result should be caveated, as NEWAGE does not monetize positive environmental effects of GHG reductions, such as improvement in air quality, reduction of pollution related health problems, as well as future consequences of lower ambition and resulting climate impacts. Furthermore, even though the model assumes exogenous development of existing technologies, it ignores the fact that strict environmental measures will probably induce research and development and development of new technologies which could contribute to GDP growth, as observed in the past.

In terms of competitiveness, environmental ambition impacts primarily chemistry industry, iron and steel, nonferrous metals and non-metallic minerals. Depending on the scenarios analysed, these sectors lose up to 50% of GVA compared to the reference.

Another issue that we analyse was the impact of level of environmental ambition of the rest of the world on EU economy. Contrary to the initial expectation, the impact is not uniform. High environmental ambition of the rest of the World, positively impacts the energy intensive industries, increasing their GVA. On the other hand, high environmental standards in the rest of the world negatively impacts GDP growth in those countries, hence negatively affecting EU export-oriented industries, and decreasing the GDP growth of EU members.

Furthermore, what we find is that electrification can mitigate the negative effects of environmental policies. For this to occur, it must be easy for the industry to substitute fossil fuel technologies with electrification. This result should be understood as a signal to actively support innovation, as it is the only way to provide the industrial sectors with efficient flexibility.

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