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How to finance the climate transition: analysis of the transition costs in the EU and suggestions to effectively further (international) cooperation

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Synthesis/Abstract

In 2023 many climate-related records have been broken. According to a recent report by the United Nations "national climate action plans remain insufficient to limit global temperature rise to 1.5 degrees Celsius and meet the goals of the Paris Agreement", and with current national plans the global temperature will rise by 2.5 to 3.0 degrees Celsius above pre-industrial levels by 2100[1]. Among other things, a hotter world will lead to an increase in climate migrants. National governments will need to develop more stringent rules and regulations, implement existing rules, and work more closely together globally to reduce emissions that are causing this climate change.[2] Furthering global cooperation, curbing all GHG emissions and ensuring a fair transition are the key topics that should be agreed upon at the COP28 in Dubai.

To halt climate change in December 2019 the European Commission presented an ambitious plan to be the first continent to become climate neutral in 2050: "the Green Deal". To meet this ambition, the Commission proposed to reduce net CO_2-equivalent emissions by at least 55% relative to 1990 and it is expected that in 2024 the target for 2040 will be set at a net reduction of about 90%. A 55% and subsequently 90% reduction requires a step up from the EU-average reduction of 30% realised by 2021.

The price difference between grey fossil fuels (and other greenhouse gasses) and available greener alternatives (incl. low carbon) is still significant; technological innovation has not (yet) covered this price gap. Policy interventions that bridge the so-called 'unprofitable top margin' (or UTM) are required in order to deliver on agreed upon climate targets. In order to give policy makers (and the general public) an impression of the (current) difference between green and grey, we calculated the EU climate transition cost for 2040.

In our approach we considered the proposed reduction targets for the years 2030, 2035 and 2040, respectively 58%, 75% and 90% (EU Scientific Advisory Board on Climate Change, 2023). The UTM is calculated by multiplying the amount of GHGs to be reduced between 2021-2030/35/40 by the difference between 'green' and 'grey' production methods.

An average value of the difference between 'green' and 'grey' production methods of €155 per ton is used. Since this is an average value, an uncertainty range from €99 per ton to €224 per ton is considered. This approach allows us to calculate the UTM bandwidth for each of the three carbon reduction targets. Associated costs of (required) infrastructure investments and costs of stranded assets are also relevant: according to the EU Impact Assessment (2018) they increase total cost by approximately 37%. Technological development and UTM differences per member state are not taken into account. The transition cost bandwidth per member state can in practice be slightly higher or lower if local conditions are fully taken into account.

Tables 1 and 2 show that the annual EU27 cost is 1.2%-2.8% of GDP to reduce CO_{2eq} emissions by 58% in 2030. The annual EU27 cost increases to 2.6%-5.8% of GDP to achieve a 90% reduction target in 2040. This increase reflects the steep increase in annual GHG reduction that needs to occur beyond 2030. Results differ per country and range from 12% (Poland) to 0.1% (Sweden) of annual GDP in 2040. We find that the transition cost to reduce carbon emissions is very likely to be lower than the societal cost of the adverse impacts of climate change that we see increasing at an alarming pace. Green alternatives also tend to improve energy self-sufficiency and lead to a diversification of suppliers likely reducing cost in the long run.

In short, European citizens could avoid having to spend billions on mitigating the adverse impacts of climate change if collectively roughly 4% of annual GDP is spent on climate measures (obviously others would also need to make efforts). A proposal to do so by European Climate Commissioner Hoekstra to the international community during COP28 might be just what is needed to end the current stalemate and make equitable steps towards global net zero.

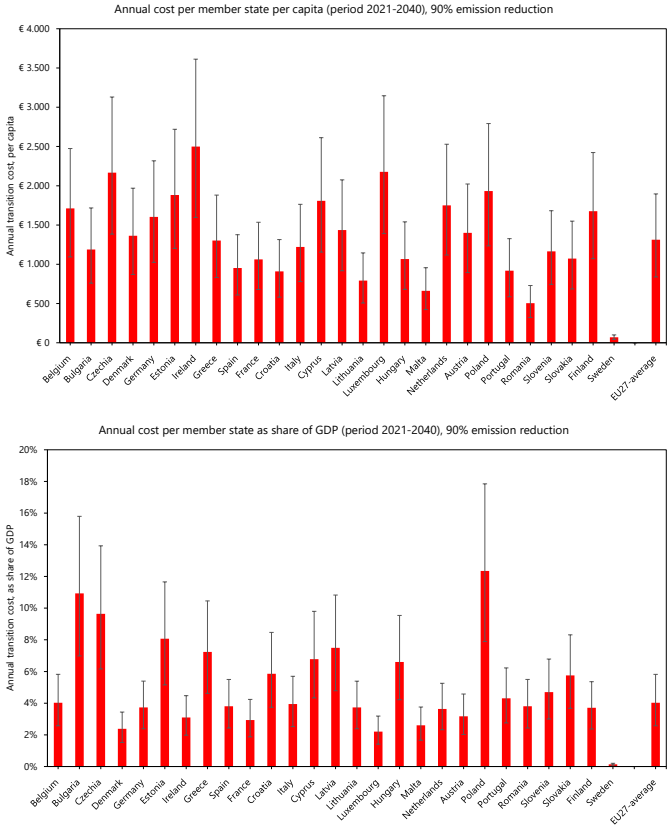
We encourage countries to find an equitable solution that bridges the 'price gap between green and grey' during next week's COP28. This could be by expanding globally on initiatives such as: carbon credit trading (such as the EU-ETS), the CBAM initiative (soon to encompass more sectors), cross-border investing (optimise €/ton CO_{2eq} emission reduction), land use change to ensure negative emissions (forest preservation and reforestation), certification of net-zero energy carriers (such as green and low-carbon ammonia) and/or commit to spending for instance 4% of annual GDP on the transition (as this takes into account welfare differences).

1 Nationally determined contributions under the Paris Agreement. Synthesis report by the secretariat. (p.28), 14-11-2023.
2 See the following short film by The Economist for a better understanding of what a 3.0 degrees warmer world will look like.

Table 1. **Key findings: cost of the climate transition in Europe, 2030, 2035 and 2040 proposed targets (quick-scan).**

Total transition cost EU27: UTM, stranded assets and infrastructure cost	2030: 58%			2035: 75%			2040: 90%		
	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Total cost (bln euro)	€ 1,616	€ 2,529	€ 3,655	€ 3,945	€ 6,177	€ 8,926	€ 7,154	€ 11,201	€ 16,188
Annual cost per capita	€ 399	€ 625	€ 903	€ 627	€ 982	€ 1,418	€ 838	€ 1,312	€ 1,896
Annual cost as share of GDP	1.2%	1.9%	2.8%	1.9%	3.0%	4.4%	2.6%	4.0%	5.8%
Annual cost (bln euro)	€ 180	€ 281	€ 406	€ 282	€ 441	€ 638	€ 377	€ 590	€ 852

Table 2. **Key results: cost of the climate transition, per member state per capita (left) and as share of GDP (right).**



Introduction

In 2023 many climate-related records have been broken. According to a recent report by the United Nations "national climate action plans remain insufficient to limit global temperature rise to 1.5 degrees Celsius and meet the goals of the Paris Agreement", and t with current national plans the global temperature will rise by 2.5 to 3.0 degrees Celsius above pre-industrial levels by 2100[3]. National governments will need to develop more stringent rules and regulations, implement existing rules, and work more closely together globally to reduce the adverse impact of climate change. Furthering global cooperation and how to ensure the transition to be fair are the key topics that should be agreed upon during the COP28 in Dubai.

Across Europe citizens are increasingly concerned about the environment, as shown by EU Parliament election results (May 2019) and various civil-society led protests (e.g. XR in the Netherlands). In response European Commission President Ursula von der Leyen and Executive Vice President Frans Timmermans informed the public in December 2019 how their 'Green Deal' will "reconcile the economy with our planet". In practice, this means that the European Commission aims to make Europe the first carbon neutral continent by 2050. In addition, the recently installed EU Commissioner for Climate Action Wopke Hoekstra promised the EU Parliament that he will propose a climate reduction target for 2040 (which is likely to be 90%) in the first quarter of 2024, A 90% reduction is a significant step up from the current 2030 target that aims to cut GHG emissions by 55% in 2030.

Since 1990 the EU27 output of greenhouse gasses decreased from 4.7 Gt CO_{2eq} in 1990 to 3.2 Gt CO_{2eq} in 2021 (30%)[4]. This reduction has been partly achieved through financial incentives (such as subsidizing wind and solar projects), international agreements (such as the Kyoto and Montreal Protocols to curb methane and CFK/PFK emissions), and the EU-ETS. To reach the ambitions set out in the Green Deal an additional reduction of 1.3 Gt CO_{2eq} should be achieved[5], while a 90% target in 2040 would mean a reduction of 2.8 Gt CO_{2eq}. Additional European and national efforts will play a significant role in achieving this reduction.

According to an Impact Assessment prepared by the Commission, the total cost of reducing GHG emissions by 55% is approximately €420 billion annually in the period 2021-2030[6], or 2.5% of GDP (2018) at market prices.

3 Nationally determined contributions under the Paris Agreement. Synthesis report by the secretariat. (p.28), 14-11-2023.

4 In the period 1990 – 2018 the economy grew by 61 percent. Ref: COM (2020) 80 final.

5 According to the EEA [env_air_gge] in 2021 the EU emitted 3.2 Gt CO_{2eq} (excluding memo items).

6 These numbers reflect the total additional energy system investment cost (including the cost of stranded assets and infrastructure), the energy purchase cost, and direct efficiency investment cost. These numbers exclude additional investment costs stemming from the transport sector. Costs in the transport sector, estimated at 620 billion euro annually, cover the additional capital cost for energy purposes (i.e. energy efficiency and use of alternative fuels). Total cost of the energy system in 2015 were €13.4 billion, or 10.6% of GDP. Ref: SWD(2020) 176 final, part 2/2, p.105-109.

Although this is a considerable investment in the energy system, the estimated cost is significantly less than the expected climate impact-induced bill, which is conservatively estimated at 4% of EU GDP by the end of this century[7].

The required annual investment in the energy system of about €420 billion mentioned in the Impact Assessment consists of three components:

- First, the difference between green and grey energy sources needs to be overcome and/or efficiency needs to be improved.
- Second, new infrastructure needs to be developed to connect the supply and demand of (new) energy sources.
- Third, owners of stranded assets will need to be compensated.

The EU Impact Assessment makes no differentiation between these three components or between member states. In this paper we will focus on the first component and give an indication of the total cost to society of doing things 'green' instead of 'grey'. This difference is also known as the Unprofitable Top Margin, or UTM. We expand on findings of the Impact Assessment by investigating the UTM up to 2040 (component 1), and we scale findings to include transition cost related to infrastructure investments and stranded assets (components 2 and 3)[8]. Findings will provide an indication (per MS) of the total cost (annual, per capita and as share of GDP) to achieve the 2040 target. Furthermore, we provide suggestions for (global) policy makers on how to best close the 'price gap' between green and grey. These suggestions can be used during negotiations held in Dubai during COP28.

Approach

In this paper we consider the three intermediate reduction targets as suggested by the European Scientific Advisory Board on Climate Change to reach climate neutrality in Europa by 2050: a short-term 58% CO_{2eq} emissions[9] reduction target for 2030, a 75% target for 2035, and a 90% target for 2040[10]. These targets encompass all greenhouse gas emissions.

To determine the UTM, an average value of €155 per ton CO_{2eq} is used. This value is based on the SDE++ average subsidy limit in 2023 for all options in the category renewable energy[11]. Naturally, this value is an approximation of the actual average value of the UTM, which in practice differs between member states, depending on geopolitical factors and on the mix of green alternatives/opportunities that each country has. Therefore, we also take an uncertainty range into account. The uncertainty range is also based on the average subsidy limit of selected SDE++ categories. The lower limit is based on the category CCS/CCU and is €99 per ton CO_{2eq}. The upper limit is based on the category 'other options' (including hydrogen, residual heat, biofuels, etc.) and is €224 per ton CO_{2eq}. The resulting uncertainty range provides the upper- and lower boundaries; actual cost per member state will most likely fall within this bandwidth[12].

UTM: By unprofitable top margin (UTM) we mean the difference between the cost price of green and grey technologies. In this paper the UTM is used as a proxy for the subsidy/regulations/taxes needed to allow greener production methods to compete with current (fossil-fuel based) production methods (for instance, to generate electricity).

Predicting the future is impossible, but nonetheless required as policy decisions to achieve certain goals need to be made today. In the discussion section we reflect on how some of the most relevant factors could influence the findings. The applied methodology can be expanded upon and applied to other years/targets and to other countries in the world. It should be considered as a quick-scan; at country level more thorough analysis should be performed.

7 According to the ClimateCost project, the cost of sea and river flooding will be particularly high for Central and Eastern European member states due to the extensive river system that flows through them. Ref: Horizon (2014). Please be aware that this is a dated study and likely the calculated impacts of climate change (as share of GDP) are a significant underestimation.

8 The EU IA stated that total cost amounted to 2.5% of GDP in 2018. Our analysis finds that the UTM in 2018 equalled 1.57%. The difference (37%) is hence related to the transition cost of investing in infrastructure and financial losses from stranded assets.

9 Former EU Vice-President Frans Timmermans has stated that the EU can increase its target to 57% in 2022, an increase of 2%.

10 The EUSAB-CC report from 15 June 2023 provided a range for 2030 (56%-60%), for 2035 (71%-80%), 2040 (88%-95%) and 2050 (99%-105%) in table 8 page 43. Achieving these targets will keep Europe within an acceptable level of environmental risk.

11 https://www.pbl.nl/sites/default/files/downloads/pbl-2023-ot-model-update-sde-plus-plus-2023-4815.xlsx, only positive values have been selected to determine the average. The 'afgetopt' (capped) criteria are used, as they better reflect willingness-to-pay.

12 Data and calculation steps can be downloaded through the following link: Excel-analysis-climate-transition-cost. The model allows for adjusting UTM values and reduction target objectives by making changes to the yellow-coloured cells. A 100% reduction was not assessed in this study as we expect that the last 10% reduction has a very different transition cost compared to 50%-90%.

Results

The annual costs (UTM only) for the EU27 to achieve a CO_{2eq}. reduction of 58% range between €130 (0.9% of GDP) and €295 billion (2.0% of GDP) annually[13]. To achieve a CO_{2eq}. reduction of 90% in 2040 these values increase to between €275 (1.9% of GDP) and €620 billion (4.2% of GDP) annually. The figures in the Appendix show that there is a difference between member states[14]. Generally speaking, larger member states have a higher UTM compared to smaller member states. To better compare the UTM between member states, the costs as a share of GDP per year per member state are presented in Figure 2. This Figure shows that most of the EU member states need to annually invest between 1.0%-2.5% of their GDP in order to achieve 58% reduction and between 3.0%-5.0% of their GDP in order to achieve 90% reduction.

The cost related to required infrastructure investment and stranded assets is about one-third of the UTM and should also be taken into account. For the EU27 this means an additional cost of between €50 (0.3% of GDP) and €110 billion (0.8% of GDP) annually[15] to reach the 2030 target and between €100 (0.7% of GDP) and €230 billion (1.6% of GDP) annually to reach the 2040 target.

The cost of the transition are relatively low for Scandinavian and Eastern Balkan members. On the other side of the spectrum the cost for Cyprus, Greece and Poland is relatively high. The combined effect of subsidies, taxation and standards will need to drive the cost of grey production/consumption up more compared to other countries. However these member states also benefit more from an expected reduction in the production cost of green alternatives. The differences are caused by many factors, key among them are: investments made in the past, geological differences (such as (lack of) access to hydropower), type and size of certain industries, and local climate.

The size of the UTM is strongly dependent on the type of technologies that are installed. For example, in the Netherlands, €23 billion is the difference between grey and green alternatives looking at the 2040 target. However, this value ranges from €15 billion to almost €34 billion respectively if the low category limit and high category limit are fully considered.

Although both scenarios are extreme values, these values demonstrate that the mix of technologies has a significant influence on the total cost of the transition.

Furthermore, results shows that the total cost (as share of annual GDP) to reduce CO_{2eq} emissions significantly differs between member states. Poland needs to spend annually 12% of its GDP to meet the 90% target, whereas Sweden meets this goal by spending only 0.1% of its GDP.

If the EU wants to halt climate change and reduce adverse effects, it is important to work together. The differences found in total transition cost need to be taken into account when developing new subsidy schemes, regulations and/or taxes. The EU Parliament's choice for a steeper EU-ETS reduction path and its ambition to expand the CBAM in coming years to encompass more sectors are good steps in this direction, especially since they also have an effect on emissions of non-EU countries that want to export goods, such as the US and China.

13 GDP 2021, price level constant. Ref: Eurostat, nama_10
14 All EU member states are presented on the y-axis. The average value of €155 per ton is shown in the main bar for every country, where the uncertainty range from €99 per ton to €224 per ton is represented by the error bars.
15 GDP 2021, price level constant. Ref: Eurostat, nama_10

Discussion

The results of this paper show that the total cost of the transition towards a climate neutral continent is significant. However, the annual cost of this transition (most likely) outweighs the adverse impacts of climate change, which will have (hard to quantify) disastrous impacts on our way of life and on nature and will result in much larger (climate) migrant flows than we see today.

As mentioned, a number of simplifications were made to stay within the scope of this paper. As a result, our findings could be both an overestimation or an underestimation of the total transition cost per member state. Below we list the likely impact (positive or negative) of the most important simplifications to our results:

- **(-) Differences per member state:** The costs of reducing CO_{2eq} emissions are based on the UTM 'category limits' as developed in the Netherlands. However, there are big differences between European member states. The cost of reducing CO_{2eq} emissions in the Netherlands is relatively high, due among other things to the relative higher price of land and share of natural gas in the energy mix. In comparison, countries that have a high dependency on coal plants are likely to have lower costs, since replacing existing coal plants by natural gas combined cycle plants would lead to a comparably cost-effective reduction in CO_{2eq} emissions[16].

- **(+) Infrastructure and stranded assets:** A significant share of the required investments to expand and/or replace infrastructure will be covered by the national and regional grid operators and lead to an increase in the total cost of the transition. The cost of infrastructure and stranded assets is included in this analysis, but only as a rough estimation, and actual cost will depend strongly on local conditions and technological advancement in flexible energy storage and production facilities.

- **(-) Technological advancement:** For many renewable energy technologies a cost reduction is assumed or observed (for solar and wind this is the case). Technological advancement and economies of scale make current costly technologies cheaper over time. As it is very difficult to predict the level of technological advancement, this is not taken into account, UTM values can hence be overestimated.

- **(+/-) Other external factors:** Energy price fluctuations, inflation, geopolitical stress, and other indirect and external effects are not considered.

Part of the required subsidies, taxation and regulations to realise the transition have already been implemented by the EU – and its member states (e.g. the German € 9 billion National Hydrogen Fund). Although these measures are a good start, as UN and IPCC reports show, forecast emission reduction is not yet in line with emission targets. The price gap between green and grey is hence not yet fully bridged and more action is needed.

16 Note that investing in natural gas plants to replace coal plants can lead to significant (and cost-effective) reductions in CO_2 emissions in the short term. Towards 2050 carbon capture and storage technologies or biogas should be adopted to ensure that the risk of a 'fossil fuel lock-in' (as new gas plants have a lifespan over 20 years) is mitigated.

Suggestions for policymakers to close the 'price gap'

Looking at the investment effort required, one might conclude that reducing CO_2 emissions is too expensive. However, when the implications of not tackling climate change are taken into account (annual mitigation costs of up to 4% of EU GDP around 2100, hundreds of thousands of premature deaths every year[17], a significant increase in climate-induced migration and impacts on biodiversity), closing the gap between green and grey becomes the obvious choice. To ensure that society is 'nudged' towards adopting greener technologies and shifts to greener consumption patterns, national governments have a number of tools at their disposal:

- **Net-zero certification:** The EU recently set targets to reduce emissions in various sectors by demanding a certain share of energy/fuel to be net-zero or renewable (for instance, a 42% target for renewable hydrogen in industry in 2030). Delivering on these targets at home requires alignment of certification of what is 'green' or 'low-carbon' on a global scale. Additional efforts to strengthen (and expand) on this approach are likely to play a significant role in achieving not only EU, but also global emission reduction targets.

- **Cross-border (global) cooperation:** There are significant differences between the cost to reduce a ton of CO_{2eq} per member state/in countries outside the EU. As such, there is room for optimisation, not only between sectors but also across borders. If countries address the EU climate target as an objective that can also be achieved by achieving CO_{2eq} reduction abroad, the total cost of the reducing emissions at home will likely be lower.

- **Negative emissions:** The level of greenhouse gasses in our atmosphere have been both higher and lower than current levels. Higher because of deforestation/volcanic eruptions and lower because of more vegetation and/or ice. This shows that it is possible to affect our climate by changing the way we use our land. Additionally, geo-engineering solutions such as Direct Air Capture could also play a role, although are not yet very cost effective.

- **Subsidies:** The UTM can be covered by providing subsidies. These can be granted to private individuals (to install solar panels on homes) and to companies (to invest in greener technologies). 'Green' subsidies are generally well received, especially if subsidies are spent on technologies that are expected to reduce in cost over time. However, it should be noted that subsidies are not always available for all classes in society and not all member states may have the financial means to provide subsidies equal to their UTM.

- **Taxes:** Governments can impose taxes. For example, by setting a pricing mechanism on each ton CO_{2eq} emitted over the benchmark of a specific sector. The main goal of such a tax is to penalize the conventional technology in order to make renewable alternatives more attractive. However, taxing tends to work best in sectors that operate on a national scale, since sectors that operate on a European or international scale will face unfair competition and might be forced to relocate part of their production process. This practice is known as carbon leakage. Taxing at the EU level, or at EU borders (CBAM), is the better option for sectors that face EU- and/or international competition.

- **Regulation:** Governments can set certain quality standards (or labels) with which home owners, products, etc. must comply. Like taxes this type of regulation should only be introduced in markets that have a national scale. New regulation introduction has similar drawbacks to those mentioned under 'taxes' and a new European or international regulation is likely to be better received.

- **Commitment to spend 4% of GDP on transition:** As estimated in this paper, the average annual cost of the transition (2040 target) is limited compared to the expected impact of climate change. The EU can take the lead with a strong spending commitment and implement a combination of the above options to bridge the gap between green and grey. Other countries in the world can join this spending commitment. Committing to spending as share of GDP could make the cost of the transition more equal between countries.

To achieve the European and global greenhouse gas reduction targets, policy makers should (continue to) implement a combination of the above tools. In our view, bridging the current gap between green and grey should be seen as a priority objective, both at the European and at the international level, since achieving this will provide benefits to all. Hopefully, the outcomes of the COP28 discussions will constitute steps in the right direction and will be reflected in national policy efforts.

17 Ref: European Environmental Agency (2019)

Energy Expertise & EU Consultancy Services Berenschot

In order to accelerate the energy transition, Berenschot supports EU institutions, national governments, NGOs and semi-public and private organizations. In our work we make use of the best practices from our (Dutch) experiences and expertise. Our approach integrates extensive and in-depth expertise of energy markets, knowledge on sustainability with deep technical insight and functioning of the public sector and political discourse.

In addition to our energy services, the Berenschot EU team offers a range of consultancy services towards the European Union and Dutch clients who wish to spread their wings in Europe. Our aim is to live up to our excellent reputation in the Netherlands, for example in the field of participative governance and communication, and to help clients tackle major social challenges. Would you like to learn more about our expertise?

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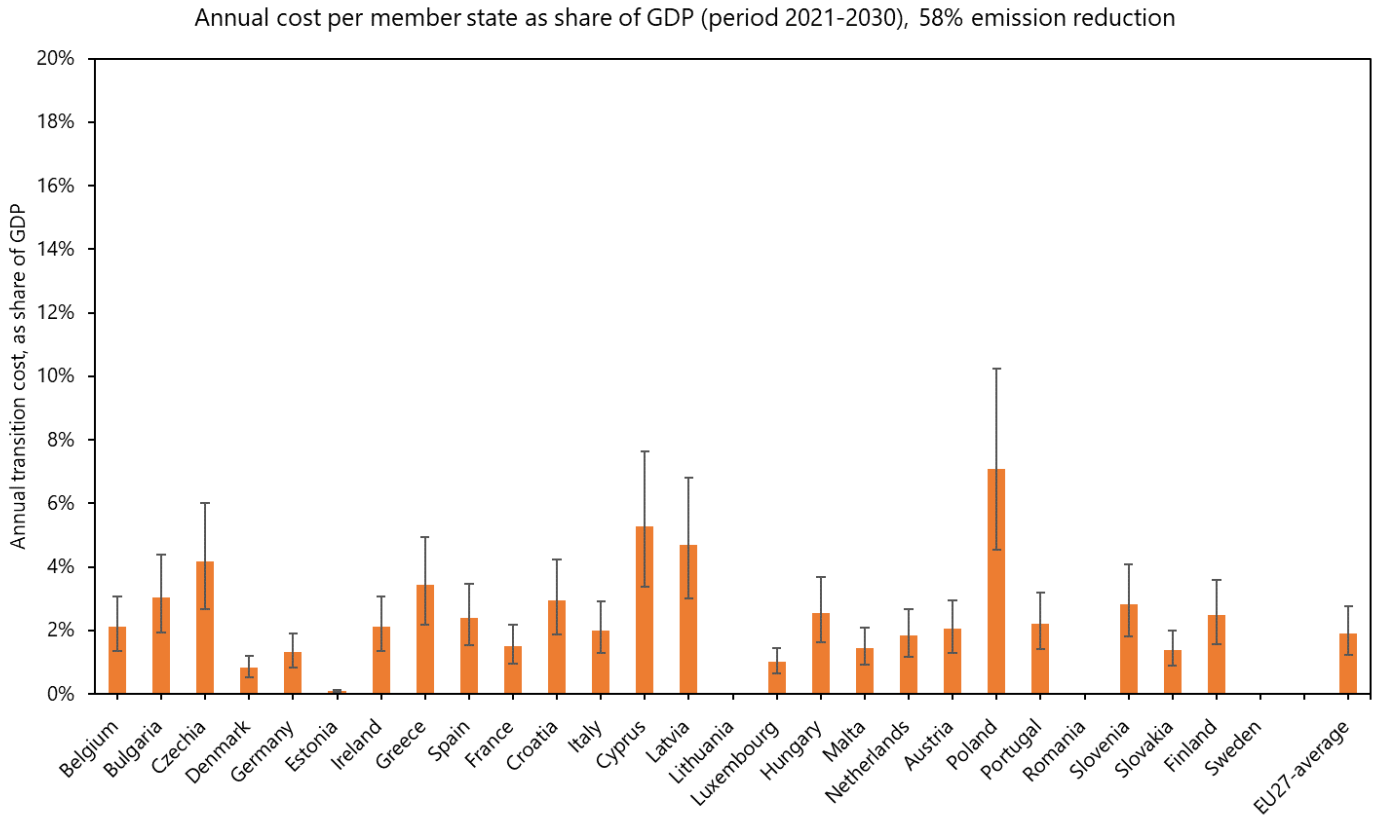
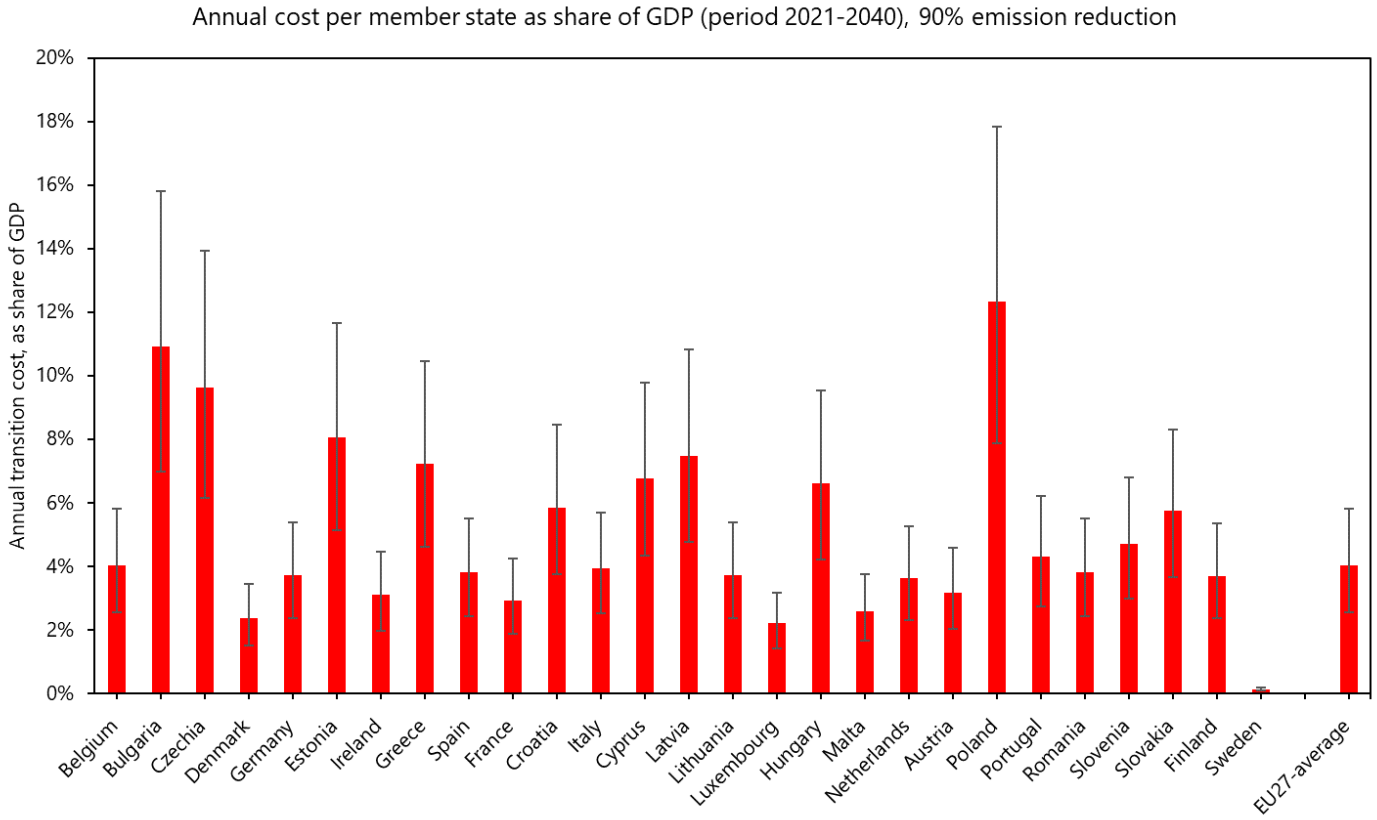
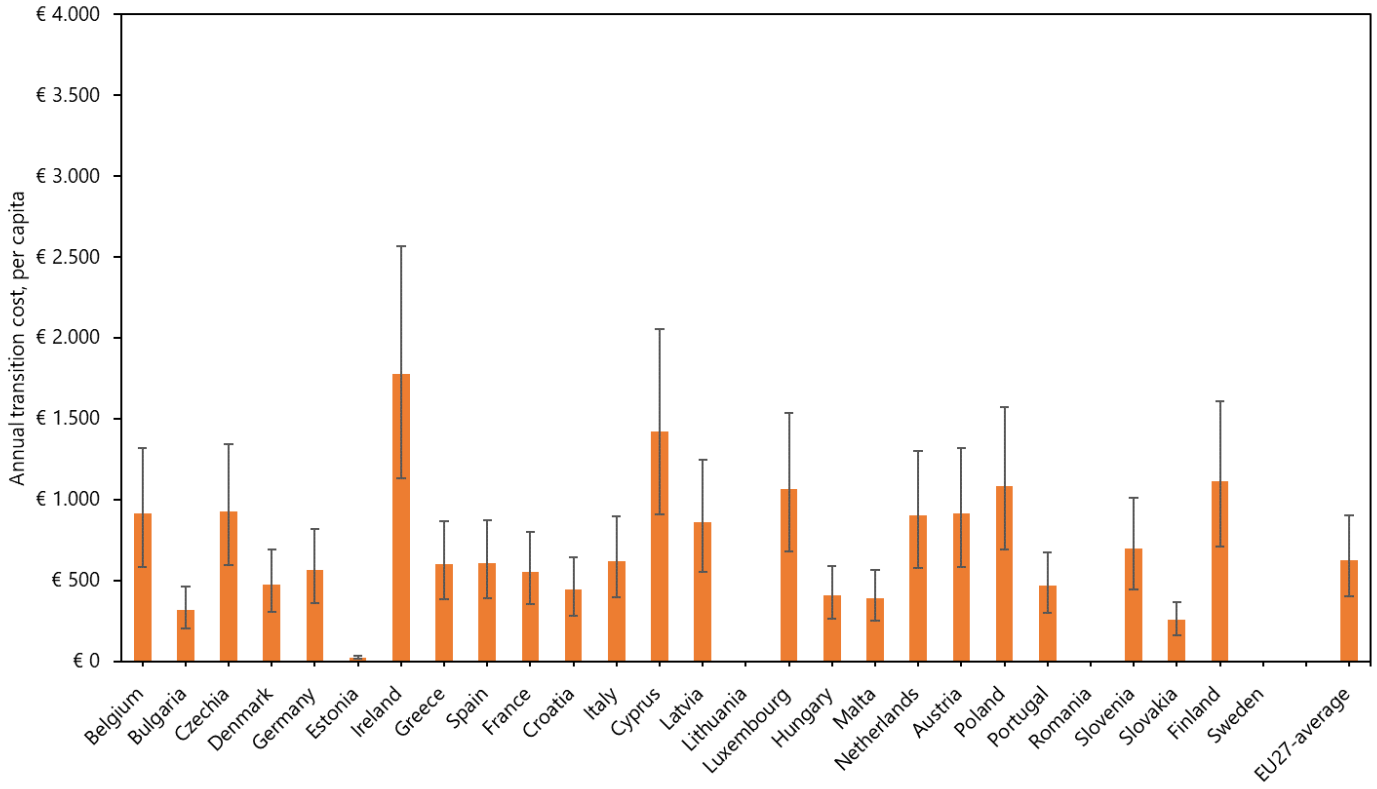
Appendix: Cost per MS as share of GDP and per capita, 2021-X

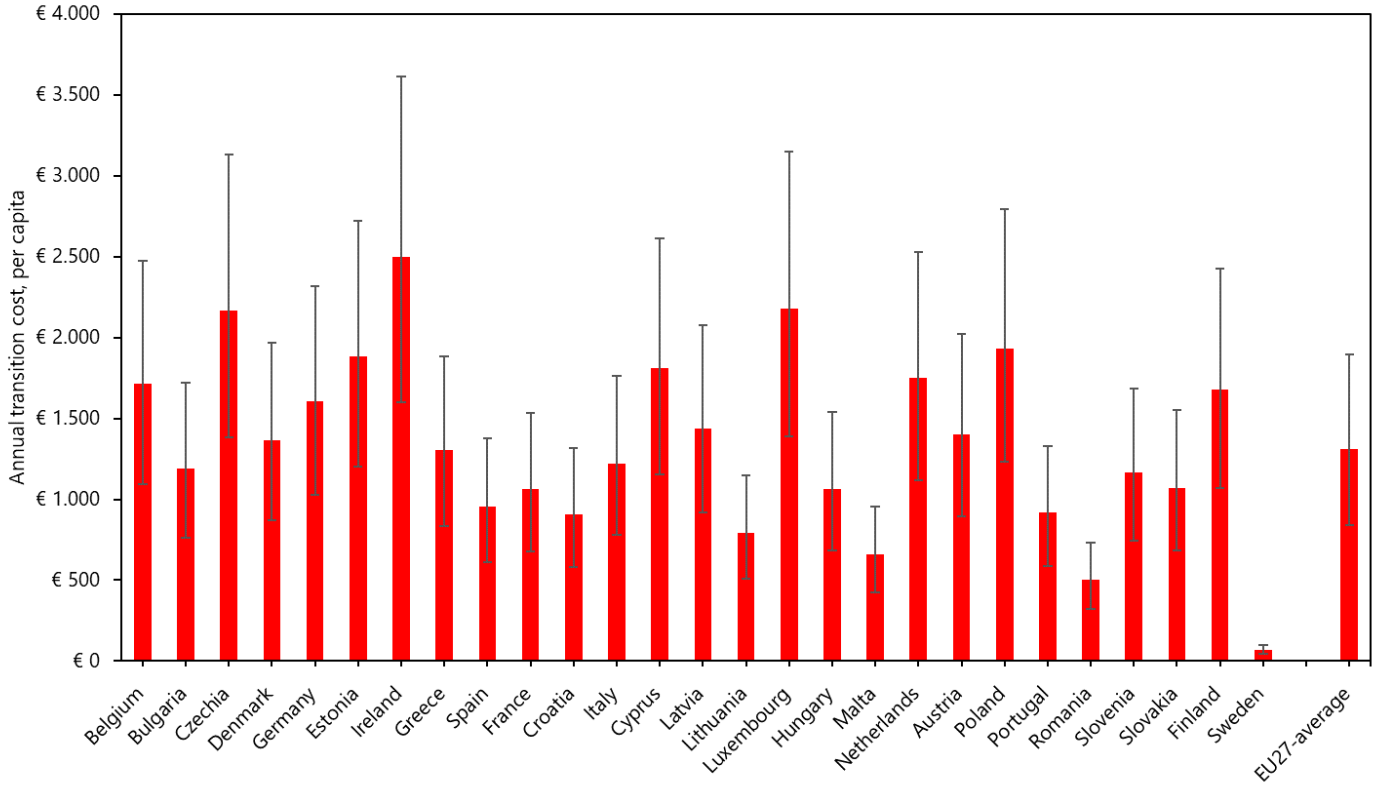




Annual cost per member state per capita (period 2021-2030), 58% emission reduction



Annual cost per member state per capita (period 2021-2040), 90% emission reduction



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Everything we do is carefully researched, substantiated and examined from many different angles. That is the foundation for solid recommendations and smart solutions, which may not always be what people were expecting. It is this capacity to surprise and look beyond the obvious that makes us unique. We are not in the business of simply tackling symptoms. We don’t stop until the issue is solved.

Berenschot Groep B.V.

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