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Modelling the direct socioeconomic impacts of the New Energy Taxation Directive (ETD) and the extension of the ETS on transport and building sectors

ABSTRACT

This document describes the modelling work developed by BC3 with IEEP and other partners of the Think Sustainable Europe network, for analysing the distributional impact that the new Energy Taxation Directive and the extension of the Emission Trading System on building and transport sector may have on the European households.

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This paper is based on data from Eurostat, Household Budget Survey (HBS) 2010 and 2015. The responsibility for all conclusions drawn from the data lies entirely with the authors.

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1. Introduction

The European Green Deal sets out a detailed vision for making Europe a climate-neutral economy by 2050, safeguarding biodiversity, establishing a circular economy and eliminating pollution, while boosting the competitiveness of European industry and ensuring a just transition for the regions and workers concerned (EC, 2019). The European Commission (EC) is committed to achieving a net reduction in emissions of at least 55% by 2030 compared to 1990 levels and to becoming a climate-neutral economy by 2050 (EC, 2020a and EC, 2018).

To achieve such ambitious climate goals, the EC also presented the first set of files adopted under the "Fit for 55" package. This package contains legislative proposals to revise the entire EU climate and energy framework to 2030, including the Energy Taxation Directive (ETD). The current Energy Taxation Directive (ETD) 2003/96/EC is clearly outdated and does not reflect the EU's climate and energy commitment. Therefore, the European Commission has revised the ETD and proposed updating the energy tax rates (EC, 2021). The proposal introduces a new structure of tax rates based on the energy content and environmental performance of the fuels and electricity. It also broadens the taxable base by including more products in the scope and by removing some of the current exemptions and reductions. In this way, the new system will ensure that the most polluting fuels are taxed the highest.

In the "Fit for 55" package, the EC also proposes to strengthen the Emissions Trading Scheme (ETS). Under the proposal, emissions from fuels used in road transport and building will be covered by a new separate emissions trading system. Therefore, it is expected that the new ETD and the extension of the ETS on transport and building will have a direct impact on the energy products that are consumed by the European households. Aware of this risk, and to address the social impacts arising from the fact that the energy suppliers are likely to pass on some of their carbon costs to consumers buying road transport and heating fuels, the EC also proposed to complement these measures with a new Social Climate Fund with a financial envelope of 72.2 billion euros.

However, until the moment there is very low evidence on the direct distributional and social impacts of these new measures, and if regressive impacts will remain a major barrier for implement ambitious climate policies.

Overcoming this barrier therefore requires an improved evidence base related to the distributional consequences of energy tax reforms in the consumption. If climate policies increase the gap between rich and poor households or reduce the affordability of energy services, then these policies might be rejected by the public and, as a result, attempts to decarbonize the economy will be less efficient. Therefore, the main goal of the present document is to described and present the modelling work developed by BC3 for analysing the distributional impact that the new ETD and the extension of the ETS may have on the households, as well as exploring whether the Social Climate Fund and the additional revenues from the new ETD are a sufficient tool to compensate low-income groups and ensure a just energy transition. This analysis covers the direct distributional impacts of the new ETD and the extension of the ETS brought about by higher energy prices expected from new carbon prices on fuels and heating and the higher energy taxation.

To this end, in this paper we first present and describe the methodology and modelling developed to analyze the social impact of the direct incidence of these policies on European households (section 2). While section 3 describes the price implications that the new ETD and the extension of the EU ETS may have on energy products consumed by European households, assuming that producers pass-through 100% of the new cost to final consumers. Finally, section 4 shows some of the distributional results that can be explored from the modelling exercise presented, using Spain as an example.

2. Methodology

To analyze the direct socioeconomic impacts of the new European Energy Taxation Directive (ETD) and the extension of European Emission Trading System (ETS) to transport and building emissions, we have developed a micro-model that allows us to simulate the distributional and social impact at a household level. The microsimulation model has been developed using the large amount of microhousehold data available from the Household Budget Survey (HBS) of each member state. The rich representation of household allows us to developed vertical distributional analysis, analysing the impact according to the different income levels, as well horizontal distributional analysis, i.e. including different socioeconomic characteristics of the European households.

This main micro-data source is the latest harmonised data wave of Eurostat's HBS. This survey collects data on household consumption expenditure on goods and services in monetary units (for all items) and in physical units (only for food categories in some countries) following the classification of individual consumption by purpose (COICOP) and includes different socio-demographic variables of households and individuals. The most recent information available covers all EU countries for 2015[1], except Malta, Portugal and Slovenia, for which data of 2010 HBS will be used. Although the data are not fully comparable across countries due to differences in data collection approaches, Eurostat's joint framework enhances comparability and allows us to utilise harmonised and consistent data[2].

2.1. Microsimulation

The microsimulation model is built up with the microdata from the HBS (Household Budget Survey) for 2015[3] provided by EUROSTAT for each country. The HBS provides information about household final consumption expenditure on goods and services and information on some demographic and

[1] Whereas most countries conducted their HBS in 2010 (first wave) and 2015 (second wave), others carried it out in different years. For the first wave, DE (Germany), LT (Lithuania) and MT (Malta) in 2008, CY (Cyprus) and SE (Sweden) in 2009 and FI (Finland) in 2012; and, for the second wave, SE (Sweden) in 2012, DE (Germany) in 2013, BE (Belgium) and HR (Croatia) in 2014, FI (Finland) and LT (Lithuania) in 2016 and FR (France) in 2017. In these cases, Eurostat adjusted the monetary data to 2010 and 2015 respectively using price coefficients.

[2] https://ec.europa.eu/eurostat/documents/54431/1966394/HBS_EU_QualityReport_2015.pdf/72d7e310-c415-7806-93cc-e3bc7a49b596

[3] For some countries such as Malta, Portugal and Slovenia, the 2015 surveys were not available and the 2010 surveys were used instead. The Austrian survey was not available for any of the years so the country is excluded from the study.

socioeconomic characteristics. Despite being country-level surveys whose classification and coding system of the essential variables have already been harmonized, several adjustments have been made to have an adequate database for the simulation.

The HBS provides two data files for each country: one related to the household and its expenditures and the other containing data on the members of the household. In order to create a single database, we have selected, created and/or renamed the variables of interest from both files for each MS and joined them all in a single file[4] (see scenarios.

Table 1). During this process, it has been necessary to do some assumptions due the lack of information on some categories or differences between countries. For example, in the case of Malta, the labels of some socioeconomic variables do not coincide with those reported in the User Manual provided by EUROSTAT. These differences have been detected in the variables of age and birth country. In the case of age, the code was modified to consider elder people over 60 in Malta, while in the rest of the countries the threshold is 65 years. In birth country, Malta does not have disaggregated people born in the rest of the EU countries and the rest of the world, so a specific label is created for this category called "Non-national".

Other adjustment has been done on the energy expenditure categories used in our microsimulation model. Table 2 offers an overview of the different energy products that we have included in our micro model and also provides the COICOP categories of each of them. As said, was also necessary to introduce some adjustment on the energy categories for some MS. I) Some countries (such as Germany and Sweden) have added the entire 045 COICOP group corresponding to household energy expenditures. To correct this data gap, the consumption structure of group 045 by ventiles has been calculated in the 2010 HBS and applied to the 2015 survey, and therefore we disaggregate electricity and heat energy in this MS. II) Other MS (such as Germany, Denmark, France and Spain) have fuel expenditure added. i.e. the data collected do not differentiate between diesel and petrol. In this case there is no possible direct solution, since the 2010 surveys did not make a disaggregation between diesel

[4] One database per year has been created, since in R it is not possible to join both dataframes due to some differences in the available variables.

and gasoline. Therefore, for Spain, the 2017 survey provided by the INE (National Institute of Statistics of Spain) has been used[5]. For the other MS that present this issue, it has not been possible to disaggregate fuel expenditure. However, this aggregation bias should not have a deep impact on results since the price shocks on gasoline and diesel are very similar in our scenarios.

Table 1. Joint database variables

Variables that come from the household file	Socioeconomic variables: Sample weight Country Decile Decile EU Quintile Quintile EU Ventile Ventile EU Density[6] Household type Income source[7] Household size Property[8] Expense variables: Total[9] Total energy[10] Electricity Natural gas LPGas Liquid fuels Solid fuels[11] Coal Other solid fuels Heat energy Diesel Petrol
Variables that come from the member file	Variables related to the household reference person[12]: Age Gender Birth country Studies Work hours

[5] The necessary adjustments have been subsequently applied to harmonize it with the data from the rest of the countries.
[6] Population density-level
[7] Main source of income
[8] To construct this variable, we made the following assumptions: i) The household is considered as "Renter" if it has an expense in HE041 and if it does not have an expense in HE042, ii) The household is considered as "Owner-occupier" if it has an expense in HE042 and if there is no expense in HE041, iii) In the case that the household has expenses in both categories, if the expense in HE041 is greater than in HE042 it is considered "Renter" and if the expense in HE042 is greater than in HE041 it is considered "Owner-occupier" and iv) If the household does not have expenses in any of the categories, the variable does not apply (NA). The category HE041 refers to expenses in actual rentals for housing paid by tenants and the HE0412 category to expenses in imputed rentals for housing of owner-occupiers.
[9] Total consumption expenditure
[10] Sum of electricity, natural gas, lpgas, liquid fuels, solid fuels and heat energy
[11] Sum of coal and other solid fuels
[12] For households in which the reference person was not defined in the microdata, the reference person has been considered the one who contributes the most to the household income.

Table 2. Energy product used in the micro model by COICOP category

Variable	HBS COICOP Code(s)	Description
Total	**HE00**	**Total consumption expenditure**
Total energy	HE045	Electricity, gas and other fuels expenses Sum of Electricity, Natural Gas, LPGas, Liquid fuels, Solid fuels, Heat energy.
Electricity	HE0451	Expenditure on electricity from all sources
Heating	**HE04521 + HE04522 + HE0453 + HE0454**	**Expenditure on gas and other fuels for heating** **Sum of Natural gas, LPGas, Liquid fuels and Solid Fuels**
Natural gas	HE04521	Expenditure on natural gas and town gas
LPGas	HE04522	Expenditure on lliquefied petroleum gas
Liquid fuels	HE0453	Expenditure on liquid fuels for domestic heating
Solid fuels Coal Other solid fuels	**HE0454 = HE04541 + HE04549** HE04541 HE04549	**Expenditure on solid fuels for domestic heating** **Sum of Coal and Other solid fuels** Expenditure on coal Expenditure on other solid fuels that are not coal
Heat energy	HE0455	Expenditure on hot water and steam purchased from district heating plants and ice used for cooling and refrigeration purposes.
Fuels Diesel Petrol	**HE0722 = HE07221 + HE07222** HE07221 HE07222	**Fuels for personal transport equipment** **Sum of Diesel and Petrol** Diesel fuel for transport Petrol/gasoline for transport

Finally, two other adjustments have been made to the expenditure variables[13]. First, since the survey data dates back to 2015, it has been necessary to carry out a temporary adjustment, scaling prices from 2015 to 2020 by applying the change in the Harmonized Index of Consumer Prices to each of the COICOP categories by country. Then, a micro-macro adjustment is also made because, although the use of the HBS allows a very detailed analysis of the impact of the proposed scenarios on the different types of European households, the consumption data provided by the survey does not match the data provided by the National Accounts (NA). So to adjust the database developed to the macro-aggregates, the consumption data by type of good from the HBS has been scaled to the consumption levels reported in the NA.

Once the database is ready, we have simulated the distributional impacts of different scenarios based on the ETD reform and the extension of the ETS. The welfare impact of each household has been calculated based on the total household expenditure, since it is considered a better proxy for the permanent

[13] The same adjustments are made in the 2010 database.

income of families as it undergoes a lower fluctuation than income both in the medium and long term (Goodman y Oldfield, 2004). To analyze the distributional incidence of the different scenarios in each European country, the change in expenditure level has been calculated by deciles (vertical inequality) and based on certain sociodemographic characteristics (horizontal inequality).

2.2. Modelling Limitations

Some limitations have been identified when calculating the changes in prices of energy goods for the different scenarios and when developing the microsimulation for the different European countries. These limitations can be valuable in identifying future areas for improvement for further studies.

2.2.1. Data availability

Despite being harmonized by EUROSTAT, the HBSs are property of the national statistical institutes of the European countries and therefore their authorization is necessary for the use of the data. That is why the study was unable to analyze the impacts of the new ETD in the case of Austria. Furthermore, as already mentioned, there are some data gaps in the HBSs of some countries, mainly due to the lack of disaggregation of some categories of consumption. Several of these data gaps have been corrected in the study but there are still some goods for which data are not available in those countries, either because they are not included in the survey, or because they are aggregated in other goods, or because they are not consumed in the country. (see Table 3). In the HBS of some countries, anomalies have also been detected with regard to socioeconomic variables: there are countries in which some of these variables are not collected and/or variables that have missing labels (see Table 4).

Table 3. Missing values by country in expenditure variables

Natural gas	LPGas	Liquid fuels for Heating	Coal	Other solid fuels	Heat district energy	Petrol
Sweden	Germany Sweden	Czechia Hungary Lithuania Romania	Finland Greece Italy Latvia Netherlands Sweden	France Germany Latvia Luxembourg Spain Sweden	Belgium Cyprus Ireland Luxembourg Netherlands Spain Portugal	France Germany Sweden

Table 4. Anomalies in socioeconomic variables

Density	Lack of “Sparsely populated” label: Malta
Income source	Not collected: Italy Luxembourg
Birth Country	Not collected: Germany Lithuania
Studies	Not collected: Netherlands Malta Slovenia

2.2.2. Microsimulation Limitations

Our microsimulation model does not capture the "behaviour" of households, i.e., it does not reflect the reaction of different types of households to expected changes in prices. In this sense, the results on energy bills only reflect the change in relative prices applied to household consumption structures before the reform. A "behavioural" impact study would require the use of a more sophisticated tool that would capture direct consumer reactions (through price elasticities of demand for energy goods) and also induced reactions (through cross-elasticities and also income elasticities, in the event that the reform, as expected, generates higher employment and higher household income). However, these effects are known to be small in the short and medium term, as households do not easily change their energy consumption behaviour. Therefore, the scientific literature shows that the price elasticities of energy consumption are usually very low (see Labandeira et al, 2017).

3. Price impacts of the new ETD and the extension of the ETS

This section presents the price impacts that the new Energy Taxation Directive as well the extension of the ETS would have on the energy products consumed by the European households if these policies would be implemented in 2020. For this exercise we are assuming that in the case of the extension of the ETS, the transport and building sector will pass-through 100% of the carbon prices to the final consumers. Therefore, this exercise reflects the highest impact price that the energy products consumed by the final consumers may experiment.

3.1. Data used for exploring the price impact of the reforms

As we have described before, to analyse the social and distributional impact of new ETD proposal and the extension of the ETS, we have selected the main energy products consumed by European households: Petrol and Diesel for transportation; Natural Gas, Gas Oil and Coal for heating; and Electricity. Energy consumption covered by these products accounts for almost the totality of energy products affected by new ETD proposal. The data used to simulate the price impacts has been obtained from Eurostat, from the Physical energy flow account for the year 2018 (last data available) (Eurostat, 2021a).

In the scenarios of the new ETD, liquid biofuels are considered as a part of petrol and diesel for transportation and gasoil for heating proportionally to the consumption of each energy product. In ETS scenarios liquid biofuels are not taken into account for estimating CO2 emissions.

There is no energy consumption information for the following products and countries: Diesel for transportation: Greece; Gas Oil for heating: Bulgaria, Czech Republic, Hungary, Latvia, Netherlands, Romania, Slovakia; Natural Gas: Cyprus, Malta; Coal: Cyprus, Denmark, Finland, Greece, Croatia, Italy, Luxembourg, Malta, Portugal, Romania, Sweden, Slovenia. This could be because there is no energy consumption of these products in these countries or because the information does not exist.

We have used different sources in order to obtain information about energy prices. Information about Petrol and Diesel for transportation and Gas Oil for heating come from European Commission, Weekly Oil Bulletin (EC, 2021f). Information about natural gas for heating and electricity come from Eurostat

(Eurostat, 2021b and 2021c). Information about Coal come from partners and DG TAXUD (2021g). All prices are for 2020 year. Ideally, we should have final prices by energy product divided by components with effective tax rates. In this way we could consider exemptions that may exist for some products and households (for example coal is exempted from taxation in some countries for households when used for heating). Nevertheless, as we do not have final prices with effective tax rates for all energy products we have built the prices.

In some cases, we use effective or nominal tax rates depending on the sources used:

- In the case of electricity and natural gas, Eurostat reports final prices divided by different components: 1) energy and supply and network costs; 2) indirect taxes (renewable taxes, capacity taxes, nuclear taxes in the case of electricity, environmental taxes and 'other taxes') and 3) VAT. Environmental taxes correspond to effective tax rates. However, final prices that we have used do not matches exactly with Eurostat prices. Due to the coronavirus crisis some countries reduced temporally the VAT and other tax rates on some energy products so in these scenarios we adjust the final prices considering that there are no such temporally reductions.
- In the case of oil products, we obtain prices from Oil Weekly Bulletin. These prices are divided by different components: 1) prices before taxes; 2) indirect taxes, that are also divided into duties and 'other taxes' and 3) VAT. Duties part correspond with nominal tax rates but when combined with 'other taxes' we obtain the effective tax rates.
- In the case of coal, as we couldn't find consistent data for every country, some partners provided their national data directly (Germany, Poland and Czechia) divided by different components: 1) coal price; 2) solid fuel tax and 3) VAT. Nevertheless, for the rest of the countries we have built coal prices using nominal tax rates from DG TAXUD and the average of coal prices components for Poland and Czechia. Thus, no exemptions for coal have been considered in the scenarios for any country. However, the impact of using nominal or effective rates would be very marginal specially for countries where coal is a very small share of household energy consumption, and even for a country like Poland (with a

significant consumption) it makes not a huge difference (current taxes on coal are already very low).

There is no information about prices for the following products and countries: Gasoil for heating: there is no information for 2020 prices for Slovakia so we take 2011 prices (last data available); Natural Gas for heating: Cyprus, Malta and Finland.

3.2. New Energy Taxation Directive Scenarios.

Following ambitious climate goals and being aware that the current Energy Taxation Directive (ETD) 2003/96/EC is clearly outdated and does not reflect the EU's climate and energy commitment, the European Commission has revised the ETD and proposed updating its tax rates (EC,2021a). The proposal introduces a new tax rates structure based on the energy content and environmental performance of the fossil fuels and electricity. It also broadens the taxable base by including more products in the scope and by removing some of the current exemptions and reductions. In this way, the new system will ensure that the most polluting energy products are taxed the highest. Table 5 offers a comparative between the ETD 2003 tax rates and the new proposal from the European Commission by energy product.

Table 5. Minimum nominal tax rates of main energy products

Energy Product	End use	ETD 2003/96/EC	New ETD proposal*
		€/1000 litres	€/GJ
Petrol	Transport	359	10.75
Diesel	Transport	330	10.75
Gas oil	Heating	21	0.9
		€/GJ	€/GJ
Natural Gas	Heating	0.3	0.6
		€/MWh	€/GJ
Electricity	Lighting/Heating	1	0.15
		€/GJ	€/GJ
Coal	Heating	0.3	0.9

*During transitional period[14]

[14] We use transitional tax rates because as mentioned in the ETD revision proposal, there are some fuels fossil based but less harmful and still have some potential to contribute to decarbonisation in the short medium term. This is the case of natural gas and means that we use 0,6 €/GJ as nominal tax rate instead of 0,9 €/GJ. After the transitional period this rate will increase to the full reference rate.

The current proposal not only increases tax rates on products derived from fossil fuels, but also establishes other measures that penalize polluting consumption and promoting the electrification of the economy as a tool to achieve ambitious climate goals. The EC has therefore proposed that electricity should be the least taxed energy product in each Member State. Several Member States currently tax electricity well above the current minimum ETD rates, so the new ETD could have a large impact on electricity prices. Lowering the electricity tax rate may also mean a large reduction in Member State revenues, which will introduce the debate of how to finance this cut in the government budget. Based on this debate and on the different policy implementations that the final ETD may have, we have developed three different pricing scenarios for the ETD according to different assumptions of the role of electricity:

- Scenario ETD 1: Increasing tax rates of fossil fuels and maintaining current taxation of electricity. In this scenario we assume that Member States will increase minimum tax rates of fossil fuels to new ETD proposal and they will maintain current tax rates in electricity.
- Scenario ETD 2: Increasing tax rates of fossil fuels and lowering taxation of electricity. Following the new ranking taxation criteria, electricity should be taxed as the lowest energy product. In this scenario we assume that Member States will increase minimum tax rates on fossil fuels while reducing tax rates in electricity to the lowest of the ranking. If electricity is currently below minimum it will not be affected. In this scenario we assume that, in case the revenues from the ETD reform are negative due to the reduction of the electricity tax rate, they will be financed through the State budget.
- Scenario ETD 3: Increasing tax rates of fossil fuels and lowering taxation of electricity to the minimum of the ranking with net impact in countries budget. In the countries with net negative revenues from the ETD reform (scenario 2), we assume that Member States will additionally increase the taxation of other fossil energy products in proportion to current energy consumption to compensate for the lower revenues from the cut in electricity tax rates.

The ETD reform also envisages the possibility of introducing exemptions on heating energy products for very low income and vulnerable households. Therefore, in each scenario we introduce a sensitivity analysis in which each Member State introduces this exemption on the increase of tax rates in heating energy products. In our scenarios with exemptions, we define vulnerable households as those whose income (we used expenditure as a proxy for living income) is below the poverty threshold. The poverty threshold is defined as 60% of the median income in each country. Finally, the core scenarios are complemented with scenarios in which the new revenues are recycling through lump-sum transfer to compensate households. In each scenario, two revenue recycling scenarios are considered: i) an equal lump sum for all households, whereby all households will receive the same transfer; and ii) an equal lump sum for the poorest 50% of households in each country, this second income recycling scenario attempts to explore whether income support for low-income household can ensure a fair and more progressive reform.

3.2.1. Price impacts of the new ETD proposal

The application of minimum tax rates on energy products under the new ETD proposal will lead to an increase in the final prices of fossil energy products. Here we analyse the price impact on private transport fuels, heating products and electricity prices under the different scenarios we have presented above.

Scenario ETD_1: Increasing tax rates of fossil fuels according to new ETD proposal and maintaining current taxation of electricity.

In this scenario the main changes are due to the application of new minimum tax rates to fossil fuels. With limited impact in almost all countries, there are some Member States that will be clearly affected in this scenario. For example, Hungary would have to increase final prices in petrol, diesel, natural gas and coal in 3.9%, 11.8%, 8.8% and 14.5% respectively. Poland would have to increase final prices in diesel, natural gas and coal in 10%, 6.3% and 12.5% respectively. The highest price increases would result for coal. In this scenario, Germany would have to increase the price of coal by 33.9% and Luxembourg by 21.6%. However, the distributional impact of higher coal prices would be very marginal, as coal consumption is very low in most Member States.

Analysing the effect by energy product we observe that six countries are currently taxing above minimum tax rates of the new ETD proposal so there

will be no price changes in these countries: Austria, Denmark, Finland, France, Ireland and Sweden. In Hungary, the increase in petrol taxes will increase final gasoline prices by 3.9%. Eleven countries will have to increase taxes in diesel to meet the new ETD: Bulgaria, Czechia, Estonia, Spain, Hungary, Lithuania, Poland, Portugal, Romania, Slovenia and Slovakia. Whereas, four countries would have to increase taxes in Gas Oil for heating: Belgium, Lithuania, Luxembourg and Slovakia.

Table 6. Change in final prices by energy products and country in ETD_1

	Petrol %	Diesel %	Gas oil %	Electricity %	Natural gas %	Coal %
Austria	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	0.0	0.0	3.8	0.0	2.9	11.6
Bulgaria	0.0	8.8	0.0	0.0	7.0	13.2
Cyprus	0.0	0.0	0.0	0.0	0.0	13.2
Czechia	0.0	1.1	0.0	0.0	4.7	14.6
Germany	0.0	0.0	0.0	0.0	0.0	33.9
Denmark	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.0	2.7	0.0	0.0	0.0	0.0
Spain	0.0	2.0	0.0	0.0	0.0	5.2
Finland	0.0	0.0	0.0	0.0	0.0	0.0
France	0.0	0.0	0.0	0.0	0.0	0.0
Greece	0.0	0.0	0.0	0.0	2.3	13.4
Croatia	0.0	0.0	0.0	0.0	7.0	13.3
Hungary	3.9	11.8	0.0	0.0	8.8	14.5
Ireland	0.0	0.0	0.0	0.0	0.0	0.0
Italy	0.0	0.0	0.0	0.0	0.0	9.2
Lithuania	0.0	3.0	3.3	0.0	8.1	13.4
Luxembourg	0.0	0.0	6.2	0.0	3.0	21.6
Latvia	0.0	0.0	0.0	0.0	2.1	2.8
Malta	0.0	0.0	0.0	0.0	0.0	13.4
Netherlands	0.0	0.0	0.0	0.0	0.0	9.0
Poland	0.0	10.0	0.0	0.0	6.3	12.5
Portugal	0.0	6.3	0.0	0.0	0.0	0.0
Romania	0.0	7.2	0.0	0.0	8.0	12.9
Sweden	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	0.0	1.1	0.0	0.0	0.0	0.0
Slovakia	0.0	3.3	4.0	0.0	5.6	13.2

Source: Own Elaboration

Scenario ETD_2: Increasing tax rates of fossil fuels according to new ETD proposal and lowering taxation of electricity to the minimum of the ranking.

Compared to the previous scenario, the main difference is that we assume that in this scenario Member States will follow the EC recommendation that electricity is the least taxed energy product. Member States that are currently taxing electricity above minimum levels would experiment the biggest impacts. For example, Denmark would have to reduce electricity tax rates to a third part in order to set the same taxation as the lowest energy product (in this case natural gas). This cut would reduce final prices of electricity in 40% in Denmark.

There are also important cuts in electricity prices in Austria, (-5.1%), Cyprus (-8.2%), Germany (-5.8%), Spain (-3.6%), France (-14.3%), Poland (-11.8%) and Sweden (-4.9%) (see Table 7).

Seventeen Member States are currently taxing electricity as the lowest energy product so there would be no changes in electricity in these countries: Belgium, Bulgaria, Czechia, Estonia, Greece, Croatia, Hungary, Ireland, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Portugal, Romania, Slovenia, Slovakia. For these Member States, Scenario ETD_1 and ETD_2 will therefore have similar price impact.

Table 7. Change in final prices by energy products and country in ETD_2

	Petrol %	Diesel %	Gas oil %	Electricity %	Natural gas %	Coal %
Austria	0.0	0.0	0.0	-5.1	0.0	0.0
Belgium	0.0	0.0	3.8	0.0	2.9	11.6
Bulgaria	0.0	8.8	0.0	0.0	7.0	13.2
Cyprus	0.0	0.0	0.0	-8.2	0.0	13.2
Czechia	0.0	1.1	0.0	0.0	4.7	14.6
Germany	0.0	0.0	0.0	-5.8	0.0	33.9
Denmark	0.0	0.0	0.0	-39.9	0.0	0.0
Estonia	0.0	2.7	0.0	0.0	0.0	0.0
Spain	0.0	2.0	0.0	-3.6	0.0	5.2
Finland	0.0	0.0	0.0	-0.9	0.0	0.0
France	0.0	0.0	0.0	-14.3	0.0	0.0
Greece	0.0	0.0	0.0	0.0	2.3	13.4
Croatia	0.0	0.0	0.0	0.0	7.0	13.3
Hungary	3.9	11.8	0.0	0.0	8.8	14.5
Ireland	0.0	0.0	0.0	0.0	0.0	0.0
Italy	0.0	0.0	0.0	-0.5	0.0	9.2
Lithuania	0.0	3.0	3.3	0.0	8.1	13.4
Luxembourg	0.0	0.0	6.2	0.0	3.0	21.6
Latvia	0.0	0.0	0.0	0.0	2.1	2.8
Malta	0.0	0.0	0.0	0.0	0.0	13.4
Netherlands	0.0	0.0	0.0	0.0	0.0	9.0
Poland	0.0	10.0	0.0	-11.8	6.3	12.5
Portugal	0.0	6.3	0.0	0.0	0.0	0.0
Romania	0.0	7.2	0.0	0.0	8.0	12.9
Sweden	0.0	0.0	0.0	-4.9	0.0	0.0
Slovenia	0.0	1.1	0.0	0.0	0.0	0.0
Slovakia	0.0	3.3	4.0	0.0	5.6	13.2

Source: Own Elaboration

Scenario ETD_3: Increasing tax rates of fossil fuels according to new ETD proposal and lowering taxation of electricity to the minimum of the ranking with net impact in countries accounts.

In this scenario the changes in the electricity price remain the same as in the previous scenario. However, if the net revenue is negative due to the reduction in electricity tax rates, in this case the tax rates on fossil fuels will increase to compensate for the negative revenue from the reduction in electricity tax rates,

which will have a zero net impact on the budget of the Member States[15]. For example, Denmark would have to increase additionally tax rates in Petrol, Diesel, Gas Oil for heating and Natural gas, in order to compensate the negative revenues from the reduction of 40% in electricity prices (Table 8).

Nine countries will experience higher final prices on remaining fossil fuels to compensate for the electricity rate cut: Austria, Cyprus, Germany, Denmark, Spain, Finland, France, Italy and Sweden. In the case of Poland, the revenue effect of lower electricity tax rates is lower than the new revenues from the increase in fossil fuel tax rates, so its impact would already be positive in net terms, and therefore no adjustment is necessary.

Table 8. Change in final prices by energy products and country in ETD_3

	Petrol %	Diesel %	Gas oil %	Electricity %	Natural gas %	Coal %
Austria	2.8	3.2	5.6	-5.1	5.1	13.1
Belgium	0.0	0.0	3.8	0.0	2.9	11.6
Bulgaria	0.0	8.8	0.0	0.0	7.0	13.2
Cyprus	4.2	4.6	7.5	-8.2	0.0	13.2
Czechia	0.0	1.1	0.0	0.0	4.7	14.6
Germany	2.1	2.7	5.8	-5.8	4.8	74.9
Denmark	22.1	29.3	30.2	-39.9	46.3	0.0
Estonia	0.0	2.7	0.0	0.0	0.0	0.0
Spain	1.0	3.3	2.4	-3.6	1.7	11.5
Finland	1.0	1.3	2.1	-0.9	0.0	0.0
France	6.9	8.3	13.7	-14.3	13.4	28.6
Greece	0.0	0.0	0.0	0.0	2.3	13.4
Croatia	0.0	0.0	0.0	0.0	7.0	13.3
Hungary	3.9	11.8	0.0	0.0	8.8	14.5
Ireland	0.0	0.0	0.0	0.0	0.0	0.0
Italy	0.1	0.1	0.1	-0.5	0.2	9.2
Lithuania	0.0	3.0	3.3	0.0	8.1	13.4
Luxembourg	0.0	0.0	6.2	0.0	3.0	21.6
Latvia	0.0	0.0	0.0	0.0	2.1	2.8
Malta	0.0	0.0	0.0	0.0	0.0	13.4
Netherlands	0.0	0.0	0.0	0.0	0.0	9.0
Poland	0.0	10.0	0.0	-11.8	6.3	12.5
Portugal	0.0	6.3	0.0	0.0	0.0	0.0
Romania	0.0	7.2	0.0	0.0	8.0	12.9
Sweden	9.8	10.7	15.6	-4.9	11.2	0.0
Slovenia	0.0	1.1	0.0	0.0	0.0	0.0
Slovakia	0.0	3.3	4.0	0.0	5.6	13.2

Source: Own Elaboration

[15] Prices on fossil fuels are increased proportionally to consumption.

3.2.2. Revenues from the new ETD reform

The new revenues of the different Member States are obtained on the basis of the change in tax rates to comply with the new ETD and the current national consumption of each energy product. In the scenarios with exemptions, it has been necessary to adjust the revenues, considering only the consumption of non-exempt households.

In the ETD_1 scenario total revenues account for 1.971 billion€. As can be expected from the price impact analyzed, Poland will be the country with the highest revenue (EUR 814 million) followed by Hungary (EUR 302 million), as these are the Member States that have to increase energy tax rates the most in order to comply with the ETD reform. Other countries, such as Spain, will also have higher revenues because the new tax rates affect energy products with high domestic consumption.

In the ETD_2 scenario, there is an overall reduction in total revenues due to the reduction in the electricity tax rate in several MSs (-7.866 billion€). Germany, Denmark and France will have significant negative revenues [16] (-2.26 billion€, -1.105 billion€ and -4.482 billion€ respectively). Although Poland also decreases its electricity tax rates, its revenues remain positive due to higher revenues from increased taxation of fossil energy products.

In the ETD_3 scenario total revenues account for 1.163 billion€. Several Member States will have a net zero impact on their national accounts due to the offsetting of lower electricity tax rates with the increase in all other energy tax rates. The remaining countries would have the same revenues as in scenario ETD_2.

Finally, as expected, in all scenarios when exemptions for low-income households are considered, revenues are lower. However, this impact is marginal due to the low consumption of low-income classes.

[16] In the case that Member states have negative revenues due to the electricity cut. In this scenario we assume that these countries will compensate this effect in their national budgets.

Table 9. Total revenues by country and ETD scenario.

	ETD_1 M€	ETD_1_WE M€	ETD_2 M€	ETD_2_WE M€	ETD_3 M€	ETD_3_WE M€
Austria	0	0	-195	-195	0	0
Belgium	110	99	110	99	110	99
Bulgaria	30	30	30	30	30	30
Cyprus	0	0	-27	-27	0	0
Czechia	78	76	78	76	78	76
Germany	2	2	-2,260	-2,260	0	0
Denmark	0	0	-1,105	-1,105	0	0
Estonia	4	4	4	4	4	4
Spain	289	289	-325	-325	0	0
Finland	0	0	-38	-38	0	0
France	0	0	-4,482	-4,482	0	0
Greece	4	4	4	4	4	4
Croatia	15	14	15	14	15	14
Hungary	302	296	302	296	302	296
Ireland	0	0	0	0	0	0
Italy	0	0	-68	-68	0	0
Lithuania	38	38	38	38	38	38
Luxembourg	8	7	8	7	8	7
Latvia	1	1	1	1	1	1
Malta	0	0	0	0	0	0
Netherlands	0	0	0	0	0	0
Poland	814	807	298	290	298	290
Portugal	110	110	110	110	110	110
Romania	94	93	94	93	94	93
Sweden	0	0	-529	-529	0	0
Slovenia	13	13	13	13	13	13
Slovakia	59	57	59	57	59	57
Total	1,971	1,939	-7,866	-7,897	1,163	1,131

Source: Own Elaboration

3.3. Extension of the ETS Scenarios.

The sectors currently covered by the current EU ETS (power and heat generation, energy-intensive industrial sectors and aviation within Europe) account for around 40% of the EU's total emissions (EC, 2021b). The EC is proposing that emissions from the EU ETS sectors be reduced by 61% by 2030, compared to 2005 levels (EC, 2021c). This new target cannot be reached without significant emissions reductions in buildings and road transport. For this reason, the European Commission has proposed to extend the EU ETS to these sectors (EC, 2021d). In order to analyse the effect of the Commission proposal in European households, we have modelled a scenario introducing 45 €/tonCO2 to the main energy products consumed by households that are not currently covered by the current Emission Trading System. We have used 45€/tonCO2 as this is the average for the period 2021-2025 considered in the ETS revision impact assessment (EC, 2021e). These products are: Petrol and diesel for transportation; Gas oil, Natural gas and Coal for heating. There are

some countries that in 2020 already had a carbon tax in some of these products (marked with "x" in Table 10). In Member States that already have a national carbon price above €45/tonne CO2, we do not apply any additional carbon price, so they will not be affected by the extension of the ETS to transport and building. For those Member States that already have a carbon price on the energy products analyzed, but are below €45/tonne CO2, we apply the difference between the proposed carbon tax and their current situation[17]. Nevertheless, all countries contribute with their revenues from carbon taxes to the Social Climate Fund. As before with the reform of the ETD, the core ETS scenario is complemented with two analyses in which the new revenues (from the SCF or 25% of the national revenues from the ETS extension) are recycling through lump-sum transfer to compensate households. Two revenue recycling scenarios are considered: i) an equal lump sum for all households, whereby all households will receive the same transfer; and ii) an equal lump sum for the poorest 50% of households in each country, this second income recycling scenario attempts to explore whether income support for low-income household can ensure a fair and more progressive reform.

Table 10. Carbon taxes in different countries by energy product in 2020

		Transport uses		Heating uses		
Country	Price	Petrol	Diesel	Gas Oil	Natural Gas	Coal
Denmark	23.77 €	X	X	X	X	X
Finland	62.18 €			X	X	X
France	44.18 €	X	X	X	X	X
Ireland	25.06 €	X	X	X	X	X
Portugal	23.77 €	X	X	X	X	X
Slovenia	17.37 €	X	X	X	X	X
Sweden	108.88	X	X	X	X	X

Source: Own elaboration

The increase in the fossil fuels prices will have significant social and distributional impacts that may disproportionally affect households and regions. To address the social impacts arising from the fact that the fuel suppliers are likely to pass on some of their carbon costs to consumers buying road transport and heating fuels, the EC has also proposed the creation of

[17] Additionally, we have modelled a sensibility analysis with a 100€/ton carbon price in order to see the effect in prices in those countries with an existing carbon price.

a Social Climate Fund. The new Social Climate Fund will support EU citizens most affected or at risk of energy or mobility poverty. It will help to mitigate the costs for those most exposed to changes, to ensure that the transition is fair and leaves no one behind. The Social Climate Fund would be financed by the EU budget, using an amount equivalent to 25% of the expected revenues of emissions trading for building and road transport fuels[18]. Following the SCF proposal, we have introduced a revenue recycling scenario through a lump sum to households using the maximum allocation shares per Member State (Table 11) set out in the proposal. In addition, to explore and compare the impact of the SCF, we have introduced an additional revenue recycling scenario, in which we assume that the SCF will not be created and that each Member State will use its contribution to the SCF (25% of its national revenue from the ETS extension) to compensate households.

Table 11. Maximum financial allocation by member state

Austria	0,89	Ireland	1,02
Belgium	2,56	Italy	10,81
Bulgaria	3,85	Lithuania	1,02
Cyprus	0,2	Luxembourg	0,1
Czechia	2,4	Latvia	0,71
Germany	8,19	Malta	0,01
Denmark	0,5	Netherlands	1,11
Estonia	0,29	Poland	17,61
Spain	10,53	Portugal	1,88
Finland	0,54	Romania	9,26
France	11,2	Sweden	0,62
Greece	5,52	Slovenia	0,55
Croatia	1,94	Slovakia	2,36
Hungary	4,33		

Source: COM (2021) 568 final

3.3.1. Price impacts of the extension of the ETS proposal

In this scenario we introduce a carbon price (45 €/tonCO2) on energy products consumed by households that are not currently under the ETS (petrol and

[18] It is important to mention that in this scenario countries still have 75% of total revenues available to use in order to compensate vulnerable households.

diesel for transport, gas oil, natural gas and coal for heating). Thus, the fossil fuels that emit the most are those that would be taxed most heavily (see emission factors in Table 12). There are also some countries that there are currently applying a carbon tax to some energy products (see Table 13). In these cases, only additional carbon tax up to 45 is applied (if a country is taxing above 45 €/tonCO2, there are no change in prices).

Table 12. Emission factor by energy product

	Petrol	Diesel	Gas Oil	Natural Gas	Coal
tCO2/TJ	69	74	74	56	98
kgCO2/litre	2.3	2.7	2.7	-	-
kgCO2/kg	-	-	-	-	2.53

Source: IPCC/OECD/IEA

Table 13. Carbon Tax applied by member state in 2020

	Petrol	Diesel	Gas Oil	Natural Gas	Coal
Denmark	23.77	23.77	23.77	23.77	23.77
Finland	-	-	62.18	62.18	62.18
France	44.18	44.18	44.18	44.18	44.18
Ireland	25.06	25.06	25.06	25.06	25.06
Portugal	23.77	23.77	23.77	23.77	23.77
Slovenia	13.37	13.37	13.37	13.37	13.37
Sweden	108.81	108.81	108.81	108.81	108.81

Source: Own Elaboration

The results of this scenario show that the main changes in prices would be in heating fuels. In particular, Eastern European countries will be the most affected by the introduction of this carbon price. Prices changes in petrol and diesel will be between 10% and 15% in almost all countries. In Hungary and Latvia natural gas prices will increase 37%, in Romania and Lithuania 34% and in Bulgaria and in Croatia 30% (Table 14). As mentioned before, although Germany would have the highest effect on prices, it would be the Eastern European Countries that would have the greatest impact on households due to their higher energy consumption.

Table 14. Change in final prices by energy products and country in ETS

	Petrol %	Diesel %	Gas oil %	Electricity %	Natural gas %	Coal %
Austria	11.4	14.1	24.2	0.0	16.7	62.6
Belgium	9.8	11.5	32.1	0.0	21.9	86.7
Bulgaria	13.3	16.0	18.3	0.0	29.2	82.1
Cyprus	11.4	13.1	21.5	0.0	0.0	82.7
Czechia	11.7	14.0	26.7	0.0	19.7	91.1
Germany	9.5	13.2	28.1	0.0	17.6	220.5
Denmark	4.2	6.0	6.2	0.0	7.1	23.7
Estonia	9.9	13.5	20.5	0.0	25.5	72.1
Spain	10.6	13.9	26.2	0.0	14.3	75.6
Finland	9.1	12.2	0.0	0.0	0.0	31.9
France	0.2	0.2	0.4	0.0	0.3	44.7
Greece	8.9	12.8	16.7	0.0	19.8	79.6
Croatia	10.7	13.3	30.7	0.0	29.6	78.8
Hungary	12.8	14.8	14.8	0.0	36.9	78.4
Ireland	4.4	5.6	12.2	0.0	6.6	52.9
Italy	8.8	11.4	13.1	0.0	13.9	77.8
Lithuania	11.4	14.9	33.8	0.0	33.9	81.5
Luxembourg	11.2	14.8	32.6	0.0	25.0	92.8
Latvia	10.9	14.2	25.2	0.0	36.6	73.9
Malta	8.9	11.7	14.5	0.0	0.0	83.6
Netherlands	8.0	12.0	15.1	0.0	11.0	78.3
Poland	12.7	15.0	24.2	0.0	26.6	72.6
Portugal	4.3	5.7	6.8	0.0	6.7	59.6
Romania	12.9	15.2	18.4	0.0	33.6	82.5
Sweden	0.0	0.0	0.0	0.0	0.0	23.1
Slovenia	8.3	9.9	12.7	0.0	13.6	55.5
Slovakia	10.5	13.9	14.9	0.0	23.3	82.0

Source: Own Elaboration

3.3.2. Revenues from the ETS reform

In this scenario total revenues account for 30.460 billion€, but only 25% of revenues are considered into account in order to compensate households (7.6 bn€)[19]. In this context we have modelled two different scenarios of recycling revenues following different criteria in order to analyse the effect of the Social Climate Found (SCF). In the first scenario, we assume that member states will receive the maximum allocation from the SCF, which is financed by 25% of the total revenue from the EU ETS extension. In contrast, in the other scenarios we assume that MS will directly use their contribution (25% of their revenues from

[19] This amount does not exactly match with amount estimated by European Commission in the Impact Assessment of the Social Climate Fund proposal (7.9 bn€). These differences are due to the different data sources and the assumptions made in our analysis. However, as can be seen, the order of magnitude is similar to that expected from the EC. As a result, our estimated revenues do not exactly match those from the EC proposal. However, with regard to the SCF allocation, our estimate is very close to that proposed by the EC in the first years of the scheme, and so can be seen as a good representation of the welfare impacts associated with revenue recycling via the SCF. Our estimates of remaining national revenues are slightly lower than the levels that can be expected by MSs when including emissions from commercial operators also.

the extension of the ETS) to compensate households, thus assuming that the SCF will not be created. In this way, we can compare the impact of the SCF and inter-MS transfers considered in this package.

Table 15. Revenues by different energy products by country in scenario ETS

	TOTAL M€	SCF M€	25% M€
Austria	631	68	158
Belgium	1,063	195	266
Bulgaria	100	293	25
Cyprus	61	15	15
Czechia	492	183	123
Germany	8,027	624	2,007
Denmark	339	38	85
Estonia	52	22	13
Spain	2,689	802	672
Finland	259	41	65
France	4,595	853	1,149
Greece	459	420	115
Croatia	194	148	48
Hungary	622	330	155
Ireland	439	78	110
Italy	4,375	823	1,094
Lithuania	168	78	42
Luxembourg	74	8	18
Latvia	83	54	21
Malta	18	1	5
Netherlands	1,515	85	379
Poland	2,638	1,341	659
Portugal	303	143	76
Romania	427	705	107
Sweden	370	47	92
Slovenia	198	42	50
Slovakia	271	180	68
Total	30,460	7,615	7,615

Source: Own Elaboration

3.4. Combined Scenarios. New ETD + ETS extension.

Finally, we explore the price impact of the combination of both policies, i.e., the ETD reform and the extension of the ETS to the road transport and building sectors. Emissions trading will address CO2 emissions, while ETD will ensure that fuel taxation incentivizes efficient energy use and consumption of more sustainable energy products, without including a specific CO2 tax component. In this context, each of the ETD scenarios, with and without exemptions, has been combined together with the ETS scenario in which member states receive the maximum allocation from the SCF:

- Scenario ETD 1 + ETS: Increasing tax rates on fossil fuels and maintaining current taxation of electricity while introducing a carbon tax to the main

energy products consumed by households that are not covered by the current Emission Trading System.

- Scenario ETD 2 + ETS: Increasing tax rates of fossil fuels and lowering electricity tax rates according to ETD ranking while introducing a carbon tax to the main energy products consumed by households that are not covered by the current Emission Trading System.
- Scenario ETD 3 + ETS: Increasing tax rates of fossil fuels and lowering taxation of electricity to the minimum of the ranking with net impact in countries accounts while introducing a carbon tax to the main energy products consumed by households that are not covered by the current Emission Trading System.

Finally, and following the previous scenarios structure. The ETD+ETS scenarios are complemented with different revenue recycling scenarios. In these scenarios, the new revenues, from the SCF and the extra revenues from the reform of the ETD, are recycling through lump-sum transfer to compensate households. Two revenue recycling scenarios are considered: i) an equal lump sum for all households, whereby all households will receive the same transfer; and ii) an equal lump sum for the poorest 50% of households in each country, this second income recycling scenario attempts to explore whether income support for low-income household can ensure a fair and more progressive reform.

3.4.1. Price impacts of combined ETS and all ETD scenarios

Tables 16, 17 and 18 show the price impact of each of the ETD scenarios combined with the ETS scenario. As can be seen, the ETS effect dominates the price impacts. This reflects the larger impact of the ETS extension, as well as showing that the ETD reform is cautious and will have a relatively low impact on energy prices.

Table 16. Change in prices due to combination of ETD_1 and ETS scenarios

	Petrol %	Diesel %	Gas oil %	Electricity %	Natural gas %	Coal %
Austria	11.4	14.1	24.2	0.0	16.7	62.6
Belgium	9.8	11.5	35.9	0.0	24.9	98.3
Bulgaria	13.3	24.8	18.3	0.0	36.2	95.3
Cyprus	11.4	13.1	21.5	0.0	0.0	95.9
Czechia	11.7	15.1	26.7	0.0	24.3	105.6
Germany	9.5	13.2	28.1	0.0	17.6	254.4
Denmark	4.2	6.0	6.2	0.0	7.1	23.7
Estonia	9.9	16.2	20.5	0.0	25.5	72.1
Spain	10.6	15.9	26.2	0.0	14.3	80.8
Finland	9.1	12.2	0.0	0.0	0.0	31.9
France	0.2	0.2	0.4	0.0	0.3	44.7
Greece	8.9	12.8	16.7	0.0	22.1	93.0
Croatia	10.7	13.3	30.7	0.0	36.6	92.2
Hungary	16.7	26.6	14.8	0.0	45.7	92.9
Ireland	4.4	5.6	12.2	0.0	6.6	52.9
Italy	8.8	11.4	13.1	0.0	13.9	87.0
Lithuania	11.4	18.0	37.2	0.0	42.0	95.0
Luxembourg	11.2	14.8	38.7	0.0	28.0	114.3
Latvia	10.9	14.2	25.2	0.0	38.7	76.8
Malta	8.9	11.7	14.5	0.0	0.0	97.0
Netherlands	8.0	12.0	15.1	0.0	11.0	87.3
Poland	12.7	25.0	24.2	0.0	32.9	85.1
Portugal	4.3	12.1	6.8	0.0	6.7	59.6
Romania	12.9	22.4	18.4	0.0	41.7	95.4
Sweden	0.0	0.0	0.0	0.0	0.0	23.1
Slovenia	8.3	11.0	12.7	0.0	13.6	55.5
Slovakia	10.5	17.1	18.9	0.0	28.9	95.2

Table 17. Change in prices due to combination of ETD_2 and ETS scenarios

	Petrol %	*Diesel %*	*Gas oil %*	*Electricity %*	*Natural gas %*	*Coal %*
Austria	11.4	14.1	24.2	-5.1	16.7	62.6
Belgium	9.8	11.5	35.9	0.0	24.9	98.3
Bulgaria	13.3	24.8	18.3	0.0	36.2	95.3
Cyprus	11.4	13.1	21.5	-8.2	0.0	95.9
Czechia	11.7	15.1	26.7	0.0	24.3	105.6
Germany	9.5	13.2	28.1	-5.8	17.6	254.4
Denmark	4.2	6.0	6.2	-39.9	7.1	23.7
Estonia	9.9	16.2	20.5	0.0	25.5	72.1
Spain	10.6	15.9	26.2	-3.6	14.3	80.8
Finland	9.1	12.2	0.0	-0.9	0.0	31.9
France	0.2	0.2	0.4	-14.3	0.3	44.7
Greece	8.9	12.8	16.7	0.0	22.1	93.0
Croatia	10.7	13.3	30.7	0.0	36.6	92.2
Hungary	16.7	26.6	14.8	0.0	45.7	92.9
Ireland	4.4	5.6	12.2	0.0	6.6	52.9
Italy	8.8	11.4	13.1	-0.5	13.9	87.0
Lithuania	11.4	18.0	37.2	0.0	42.0	95.0
Luxembourg	11.2	14.8	38.7	0.0	28.0	114.3
Latvia	10.9	14.2	25.2	0.0	38.7	76.8
Malta	8.9	11.7	14.5	0.0	0.0	97.0
Netherlands	8.0	12.0	15.1	0.0	11.0	87.3
Poland	12.7	25.0	24.2	-11.8	32.9	85.1
Portugal	4.3	12.1	6.8	0.0	6.7	59.6
Romania	12.9	22.4	18.4	0.0	41.7	95.4
Sweden	0.0	0.0	0.0	-4.9	0.0	23.1
Slovenia	8.3	11.0	12.7	0.0	13.6	55.5
Slovakia	10.5	17.1	18.9	0.0	28.9	95.2

Table 18. Change in prices due to combination of ETD_3 and ETS scenarios

	Petrol %	*Diesel %*	*Gas oil %*	*Electricity %*	*Natural gas %*	*Coal %*
Austria	14.3	17.3	29.8	-5.1	21.8	75.7
Belgium	9.8	11.5	35.9	0.0	24.9	98.3
Bulgaria	13.3	24.8	18.3	0.0	36.2	95.3
Cyprus	15.6	17.7	28.9	-8.2	0.0	95.9
Czechia	11.7	15.1	26.7	0.0	24.3	105.6
Germany	11.6	15.9	33.9	-5.8	22.4	295.4
Denmark	26.3	35.2	36.3	-39.9	53.4	23.7
Estonia	9.9	16.2	20.5	0.0	25.5	72.1
Spain	11.6	17.2	28.6	-3.6	16.0	87.1
Finland	10.1	13.5	2.1	-0.9	0.0	31.9
France	7.1	8.5	14.0	-14.3	13.7	73.3
Greece	8.9	12.8	16.7	0.0	22.1	93.0
Croatia	10.7	13.3	30.7	0.0	36.6	92.2
Hungary	16.7	26.6	14.8	0.0	45.7	92.9
Ireland	4.4	5.6	12.2	0.0	6.6	52.9
Italy	8.9	11.5	13.3	-0.5	14.1	87.0
Lithuania	11.4	18.0	37.2	0.0	42.0	95.0
Luxembourg	11.2	14.8	38.7	0.0	28.0	114.3
Latvia	10.9	14.2	25.2	0.0	38.7	76.8
Malta	8.9	11.7	14.5	0.0	0.0	97.0
Netherlands	8.0	12.0	15.1	0.0	11.0	87.3
Poland	12.7	25.0	24.2	-11.8	32.9	85.1
Portugal	4.3	12.1	6.8	0.0	6.7	59.6
Romania	12.9	22.4	18.4	0.0	41.7	95.4
Sweden	9.8	10.7	15.6	-4.9	11.2	23.1
Slovenia	8.3	11.0	12.7	0.0	13.6	55.5
Slovakia	10.5	17.1	18.9	0.0	28.9	95.2

Source: Own Elaboration

3.4.2. Revenues from combining the ETS and all ETD scenarios

The revenues from these scenarios are those from the combination of both group of scenarios. However, only the positive revenues from the ETD scenarios are taken into account. We assume that the reduction in revenues due to lower electricity will be compensated by other sources from the national budget each MS. The following table shows total revenues that countries will have and can used to compensate households. The total revenues considered in the revenue recycling scenarios come from the maximum allocation of the Social Climate Fund and the positive revenues from the ETD scenarios.

Table 19. Revenues by energy products and country in scenario ETS

	ETS+ETD_1 M€	ETS+ETD_1_WE M€	ETS+ETD_2 M€	ETS+ETD_2_WE M€	ETS+ETD_3 M€	ETS+ETD_3_WE M€
Austria	68	68	68	68	68	68
Belgium	305	294	305	294	305	294
Bulgaria	323	323	323	323	323	323
Cyprus	15	15	15	15	15	15
Czechia	260	259	260	259	260	259
Germany	626	626	624	624	624	624
Denmark	38	38	38	38	38	38
Estonia	26	26	26	26	26	26
Spain	1.091	1.091	802	802	802	802
Finland	41	41	41	41	41	41
France	853	853	853	853	853	853
Greece	425	425	425	425	425	425
Croatia	162	162	162	162	162	162
Hungary	632	626	632	626	632	626
Ireland	78	78	78	78	78	78
Italy	823	823	823	823	823	823
Lithuania	116	115	116	115	116	115
Luxembourg	16	14	16	14	16	14
Latvia	55	55	55	55	55	55
Malta	1	1	1	1	1	1
Netherlands	85	85	85	85	85	85
Poland	2.155	2.148	1.639	1.631	1.639	1.631
Portugal	253	253	253	253	253	253
Romania	799	798	799	798	799	798
Sweden	47	47	47	47	47	47
Slovenia	55	55	55	55	55	55
Slovakia	238	237	238	237	238	237
	9.586	9.554	8.778	8.746	8.778	8.746

Source: Own Elaboration

4. Overview of the distributional analysis of the modelling: the case of the ETD in Spain

This section shows some of the distributional and social impacts that can be explored from the modelling exercise presented, using Spain as an example. For this purpose, only the socioeconomic impact of the ETD reform in Spain is explored, including as an example some vertical analyses (by income groups) but also horizontal ones (considering different socioeconomic characteristics). Therefore, this section aims to provide a brief overview of the type of results that can be exploited from the modelling exercise. In particular, we explore the distributional impact of the scenario ETD_3. In ETD_3, we consider that Spain will increase tax rates on fossil fuels to meet the ETD reform and lower electricity taxation to the minimum of the ranking. In addition, lower revenues from lower electricity tax rates are offset by higher energy taxes on fossil fuel products. Therefore, in this scenario we assume that the Spanish government's budget remains the same.

Figure 1 shows the distributional welfare impact of the ETD 3 scenario, in its two variants, with and without exemptions (labelled "WE") by expenditure deciles[20]. These results show, firstly, the low relative impact that the ETD reform will have in Spain, showing also that the ETD reform is prudent since most Member States already have higher energy tax rates than the proposed in the ETD reform. Also in this scenario for Spain, the possible negative welfare impacts from the higher prices of the fossil energy products are offset by the lower electricity prices.

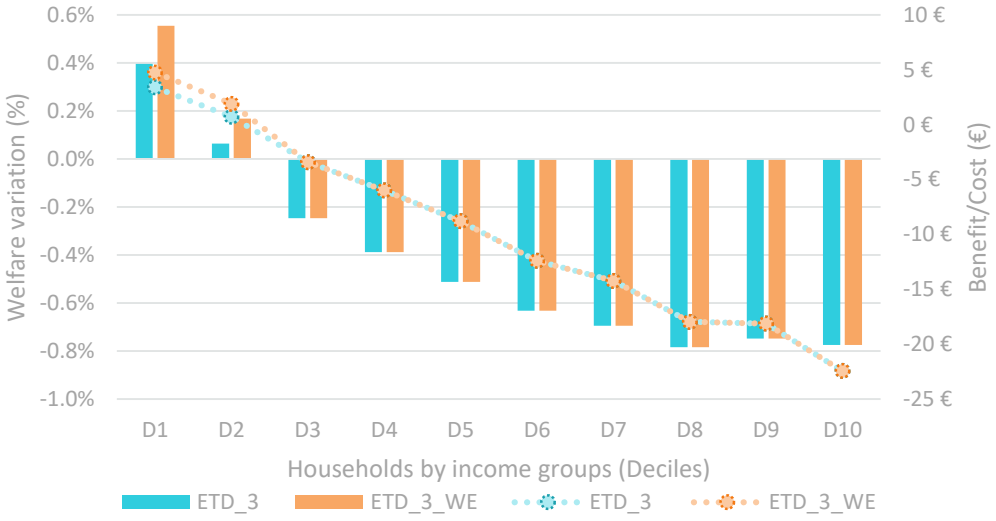
In term of the distributional impacts, Figure 1 shows that welfare will be asymmetric across the income distribution[21]. Thus, households belonging to the first two deciles (i.e., households with lower income) would slightly improve their welfare. As expected, a more pronounced welfare gain is observed when considering the exemptions for vulnerable households from the new tax rates on heating (ETD_3_WE). However, from decile 3 to 10, the results show welfare

[20] Expenditure is used since it is considered a better approximation of permanent household income (Goodman and Oldfield, 2004). Equivalent expenditure deciles are calculated from household expenditure relativized by the modified OECD equivalence scale. The modified OECD scale values the reference person in the household at 1, all other persons aged 14 and over at 0.5, and all other persons under 14 at 0.3.

[21] For shake of simplicity, the concept income is used to refer to the equivalent household expenditure. Negative changes in income as a result of changes in the prices of energy goods imply a loss of household welfare, while positive changes imply an increase in welfare.

losses, which are higher in middle income groups. This impact shows that the middle classes will be more affected by the ETD reform in Spain.

Figure 1. Welfare impacts by income groups



Note: D1 is lowest income Group whereas 10 is the wealthiest.

The previous distributional impacts can be explained by the consumption pattern of Spanish households (see Figure 2). Thus, low-income households benefit the most as they dedicate a greater proportion of their income on electricity, whose prices is lower in this scenario. Also, these households expend a smaller proportion of their income on fuel for private transportation. It must be considered that many very low-income households do not have a private vehicle and therefore will not be affected by the increase in fuel prices for private transport. On the other hand, the middle income groups are the ones that expend a higher proportion of their income on transport fuel, which explains why they perform worse in this scenario.

Figure 2. Energy consumption patter in Spain by Deciles

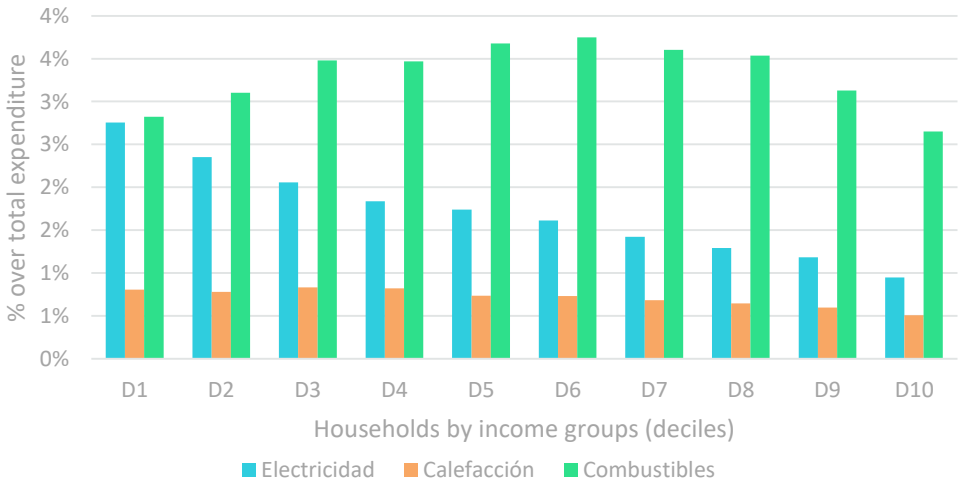
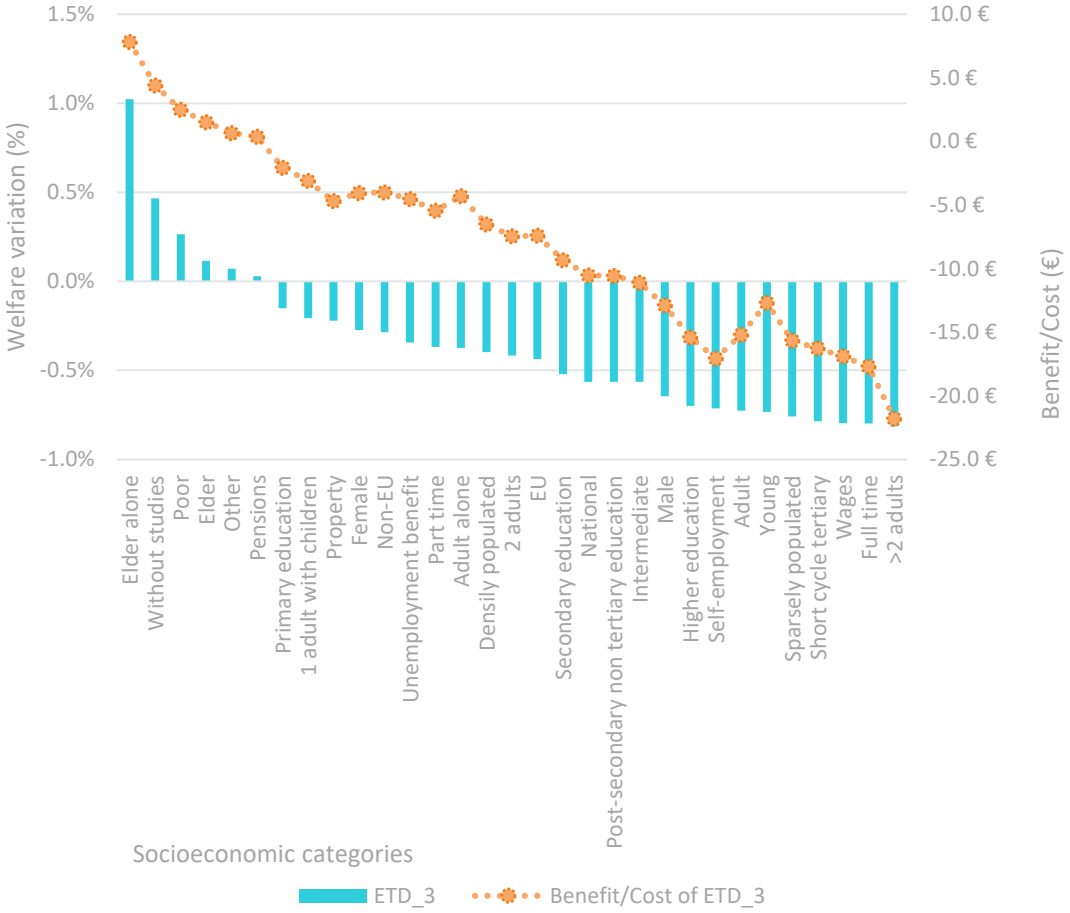


Figure 3. Welfare impact according different socioeconomic characteristics



The different socioeconomic characteristics included in the HBS, which is the main source of data in our modelling work, allow us to develop horizontal and granular analyses, exploring impacts according to different household socioeconomic characteristics. Figure 3 shows the average welfare impact according to different household characteristics. Thus, in the ETD_3 scenario households composed of a single elderly person, vulnerable households and households whose reference person is not educated would benefit the most from the ETD reform. These households are related to the lowest income brackets and dedicate a higher proportion of their income on electricity and a very low proportion on transportation fuel, which explains their potential welfare gains. On the other hand, households that expend a higher proportion of their income on fossil fuel products will be the most negatively affected by the policy. This is the case for households consisting of two or more adults with or without children and households in which the reference person is young or educated.

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Annex I. Emission Factors

Carbon conversion factors for fuels are shown in the table A1. Electricity emission factor correspond to 2019 Greenhouse gas emission intensity of electricity generation by country (source 2).

Source 1: https://www.sciencedirect.com/topics/engineering/specific-emission-factor

Source 2: https://www.eea.europa.eu/data-and-maps/daviz/co2-emission-intensity-8/#tab-googlechartid_googlechartid_chart_111_filters=%7B%22rowFilters%22%3A%7B%7D%3B%22columnFilters%22%3A%7B%22pre_config_date%22%3A%5B2019%5D%7D%7D

Table A1: Carbon conversion factors for fuels and electricity

tCO2/TJ	Petrol	Gas oil	Heating Oil	Electricity	Natural Gas	Coal
Austria	69	74	74	26	56	98
Belgium	69	74	74	48	56	98
Bulgaria	69	74	74	118	56	98
Cyprus	69	74	74	178	56	98
Czechia	69	74	74	120	56	98
Germany	69	74	74	97	56	98
Denmark	69	74	74	31	56	98
Estonia	69	74	74	207	56	98
Spain	69	74	74	58	56	98
Finland	69	74	74	25	56	98
France	69	74	74	16	56	98
Greece	69	74	74	168	56	98
Croatia	69	74	74	46	56	98
Hungary	69	74	74	63	56	98
Ireland	69	74	74	88	56	98
Italy	69	74	74	65	56	98
Lithuania	69	74	74	23	56	98
Luxembourg	69	74	74	24	56	98
Latvia	69	74	74	42	56	98
Malta	69	74	74	99	56	98
Netherlands	69	74	74	108	56	98
Poland	69	74	74	209	56	98
Portugal	69	74	74	71	56	98
Romania	69	74	74	80	56	98
Sweden	69	74	74	3	56	98
Slovenia	69	74	74	67	56	98
Slovakia	69	74	74	33	56	98