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PART 1/3

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Council Directive

restructuring the Union framework for the taxation of energy products and electricity (recast)

{COM(2021) 563 final} - {SWD(2021) 640 final} - {SWD(2021) 642 final} -
{SEC(2021) 663 final}

Table of contents

Glossary

Term or acronym	Meaning or definition
CHP	Combined heat and power generation
CJEU	Court of Justice of the European Union
CN	Combined Nomenclature
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DG TAXUD	Directorate-General for Taxation and the Customs Union
eAD	Electronic Administrative Document for excise goods which are moved under duty-suspension
EEA	European Economic Area
EGD	European Green Deal
EMCS	Excise Movement Control System
Energy Taxation Directive	Council Directive 2003/96/EC
ETD	Energy Taxation Directive
EU ETS	European Union Emissions Trading System
EUA	European Union Allowance
GHG	Greenhouse Gas (CO_2, N_2O, perfluorinated chemicals (PFCs))
Horizontal Excise Directive	Council Directive 2008/118/EC
JRC	Joint Research Centre
LPG	Liquefied Petroleum Gas
Mineral Oils Directives	Directives 92/81/EEC and 92/82/EEC
NACE	European Classification of Economic Activities
NOx	Nitrogen oxides
PM 2.5	Tiny particles or droplets in the air that are two and one half microns or less in width.
RED / RED II	Renewable Energy Directive / Recast Renewable Energy Directive
REF	EU Reference Scenario
REFIT	The Commission's regulatory fitness and performance programme

SAAD	Simplified Administrative Document
SAF	Sustainable Aviation Fuels
SO2	Sulphur dioxide
TFEU	Treaty on the Functioning of the EU
UCC	Union Customs Code

1. INTRODUCTION: POLITICAL AND LEGAL CONTEXT

The world is facing a profound climate crisis and the challenges of this crisis requires a global response. To meet the objective of a climate-neutral European Union (EU) by 2050 in line with the Paris Agreement[1], the EU needs to increase its ambition for the coming decade and update its climate and energy policy framework. As laid down in the European Green Deal[2] (EGD), the Commission proposed a new EU target for 2030 of reducing greenhouse gas (GHG) emissions by at least 55% compared to levels in 1990 and the first proposal of a European Climate Law [3]. This new target is based on a comprehensive impact assessment[4] and has been endorsed by the European Council[5]. To deliver on these GHG emissions reductions, the Commission will review and propose to revise where necessary all relevant policy instruments by June 2021.

In the Commission work programme for 2021, the revisions and initiatives linked to the EGD climate actions and in particular the 55 % net emissions reduction target are presented under the 'Fit for 55 Package'. This package will cover in particular the review of sectorial legislation in the fields of climate, energy, transport, and taxation[6].

The initiative for a revision of Directive 2003/96/EC (Energy Taxation Directive or ETD), which is the subject of this impact assessment, is part of that package to be adopted in June 2021. The other initiatives are subject to dedicated and in-depth impact assessments led by the Commission services, and are beyond the scope of this impact assessment. These other initiatives include new proposals and the review of existing acquis in the area of climate and energy policy:

- the EU Emissions Trading System (ETS)[7] to potentially include the building, maritime and road transport sectors as well as to change the treatment of the aviation sector, which is already included in its scope;
- the Effort Sharing Regulation (ESR)[8]
- the Renewable Energy Directive (REDII)[9];
- the 'ReFuelEU Aviation' initiative aimed at boosting the production and uptake of sustainable aviation fuels in the air transport sector;
- the 'FuelEU Maritime' initiative aimed at increasing the demand of renewable and low-carbon fuels in the maritime transport sector.
- the Energy Efficiency Directive to implement the ambition of the new 2030 climate target (EED)
- A new Carbon Border Adjustment Mechanism
- Reducing methane emissions in the energy sector

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[1] https://unfccc.int/sites/default/files/english_paris_agreement.pdf

[2] COM(2019) 640 final, p.4

[3] The Commission adopted the proposal COM (2020) 563 final, amending the initial Commission proposal (COM(2020) 80 final) on the European climate law to revise the EU emission reduction target to at least 55% by 2030.

[4] COM(2020) 562 final

[5] European Council Conclusions of December 2020, EUCO 22/20 CO EUR 17 CONCL 8

[6] European Commission. (2020). Commission Work Programme 2021: Annex I outlines all the instruments to be proposed which includes among others the review of energy taxation.

[7] Directive 2003/87/EC

[8] Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement

[9] Directive (EU) 2018/2001– This directive establishes an obligation on fuel suppliers to ensure a minimum mandatory share of renewable energy within the final consumption of energy in the transport sector by 2030.

- the Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry (LULUCF)[10]
- the Directive on deployment of alternative fuels infrastructure[11]
- the Regulation setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles[12]

The EGD sets out a detailed vision to make Europe the first climate-neutral continent by 2050, safeguard biodiversity, establish a circular economy and eliminate pollution, while maintaining the competitiveness of industry and ensuring a just transition for the regions and workers affected. Delivering on the revised target with a coherent policy framework to support implementation across sectors will make industry and businesses 'trailblazers'. This is expected to modernise the economy, and deliver innovation while ensuring security and resilience of energy supply and health benefits.

In this context, effective carbon pricing and the removal of incentives for fossil fuel consumption throughout the EU are very much needed to deliver the GHG emission reductions together with other regulatory measures. The review of the Energy Taxation Directive, as an integral part of the EGD, should focus on environmental and climate issues in order to support the transformation of the EU's economy for a sustainable future. One major aspect is that all instruments of the EGD need to support and enhance the EU vision of achieving climate neutrality by 2050 in a coherent way. This means it is essential to ensure that taxation is aligned with climate and environmental objectives. In fact, taxation can enhance other key EU policies and help achieve these objectives by creating proper incentives to change behaviour, and to create the right environment for green innovation. The inclusion of enhanced taxation elements in the EGD supporting other policy instruments acknowledges the importance of the "polluter pays" principle, the internalisation of externalities and the role that taxation can play by providing the incentives to further steer behaviour of producers and consumers.

While the ETD is historically an instrument for Member States to collect tax revenues, the environmental objective of taxation has gained relevance in the present context. The European Green Deal has underlined that it is essential to ensure that taxation is aligned with climate objectives and that the review of the ETD focuses on environmental issues by putting, in particular, an end to fossil fuel incentives. Therefore, this review is designed to deliver a contribution to meeting the greenhouse gas reduction targets of the Climate Law and to be consistent with the other 'Fit for 55' initiatives. The review acknowledges that the main role in the decarbonisation of the EU economy corresponds in any case to the ETS and to the Effort Sharing Decision.

The Climate Law targets could theoretically be achieved without the contribution delivered by the proposed ETD revision. However, as it is considered that the ETD would have to be revised to address a number of shortcomings of the current Directive (e.g. related to the proper functioning of the internal market) and to be focused on environmental issues, it makes sense to consider revising the ETD in such a way as to make it consistent with other 'Fit for 55' proposals and deliver a meaningful contribution to the targets of the Climate Law. Without the contribution of the ETD, other initiatives would have to contribute more. This, for example, could result in a higher ETS price. The coordination of the two initiatives (ETD and ETS) can help to achieve the targets in 2030 and beyond in a more cost-efficient way.

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[10] Regulation (EU) 2018/841 of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework

[11] Directive 2014/94/EU of 22 October 2014 on the deployment of alternative fuels infrastructure

[12] Regulation (EU) 2019/631 of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles

The ETD can support and complement the initiatives in the 'Fit for 55 Package' in contributing to the increased ambition of at least 55% reduction in GHG emissions by 2030 by ensuring that the taxation of motor and heating fuels reflects better the impact they have on the environment and on health. This can be achieved by removing disadvantages for clean technologies and introducing higher levels of taxation for inefficient and polluting fuels. The proposed policy measures in this impact assessment will contribute to the objectives of EU's climate, environmental and energy policies by providing secure, affordable and clean energy for EU citizens and businesses. Furthermore, it will facilitate the transition away from fossil fuels towards cleaner energy to deliver on the EU's Paris Agreement commitments for reducing GHG emissions.

Box 1: Overview of Directive 2003/96/EC and its rationale compared to the ETS

Fuel taxation has been part of the existing national taxation measures well before the existence of the EU Directive of 2003. At present, energy taxes, which in most Member States do not pursue an explicit and well defined CO2 reduction objective, range from 3.5% to 9% of total national revenues.

Directive 2003/96/EC lays down the EU rules for the taxation of energy products used as motor or heating fuels and of electricity. Prior to its entry into force in 2003, the Union framework for energy taxation mainly covered mineral oils by means of Directives 92/81/EEC and 92/82/EEC (the so-called "Mineral Oils Directives"). The ETD replaced those Directives retaining their structure based on minimum levels of taxation expressed in terms of volume but widening the scope to avoid distortions between competing sources of energy (such as electricity). It set new minimum rates for the new products under the widened scope and increased the rates for the mineral oils previously covered.

The objective of this harmonisation of energy taxation was to avoid the harmful effects of energy tax competition between Member States. This harmonisation ultimately aimed at strengthening the internal market by tackling possible distortions of competition stemming from the relocation of consumers of energy (i.e. businesses) to Member States with more beneficial tax regimes.

The ETD also intended to allow Member States to use taxation policy in support of other policies. These include the environmental protection and the achievement of international climate related commitments (at the time of the adoption of the ETD, specifically the Kyoto Protocol), energy efficiency, consideration of transport policies and redirection of fiscal policy to combat unemployment.

Since its adoption in 2003, energy markets and technologies in the EU have experienced significant developments, and the EU's international commitments, including the Paris Agreement, as well as the EU's regulatory framework in the area of energy and climate change have evolved considerably.

In view of energy efficiency and environmental objectives, in 2011 the European Commission made a proposal[13] aiming at restructuring the energy taxation to reflect both energy content and CO_2 emissions, as well as at rationalising the structure of possible exemptions and reductions. Following four years of unsuccessful negotiations in the Council in which Member States were unable to reach a unanimous agreement on the way forward, the European Commission decided to withdraw the proposal in 2015[14].

The Commission services published an evaluation report of the ETD[15] on 12 September 2019. In the light of this evaluation, the EU Finance Ministers adopted Council Conclusions at the ECOFIN meeting on 5 December 2019[16]. These conclusions underline that energy taxation can be an important part of the economic incentives that steer successful energy transition, driving low greenhouse gas emissions and energy savings investments while contributing to sustainable growth. Considering the importance of an updated energy taxation framework, the Council Conclusions invited the Commission to analyse and evaluate possible options with a view to publishing in due course a proposal for the revision of the Directive.

In particular, the conclusions support an update of the legal framework for energy taxation contributing to the wider economic and environmental EU policy objectives. They invite the Commission to give particular consideration to i) the scope of the directive, ii) the minimum rates and iii) the specific tax reductions and exemptions.

The Council also highlighted the importance of fully assessing the proposals in terms of their economic, social and environmental costs and benefits. The implications for competitiveness, connectivity, employment and sustainable economic growth, particularly for sectors most exposed to international competition should also be assessed.

The ETD sets minimum levels of fuel taxation according to the different products and uses for energy products used as motor or heating fuel- and electricity, including the sectors in the ETS and/or subject to other standard regulations (such as blending obligations or emission standards for vehicles).

While the ETD is a tax on output fuels, the ETS applies a charge to CO2 emissions in some installations. Therefore, the coverage of the two Directives are independent and the two instruments are considered to be complementary. The economic sectors/energy uses can be subject to ETD and ETS at the same time. A certain overlap in the coverage of the two instruments would arise in case the ETD rate is increased to include a CO2 component. In that case, for the sectors simultaneously covered by ETD and ETS, it could be considered that there is a double carbon price. As long as a sector/energy use is taxed with ETD for fuel consumption and charged by ETS for CO2 emissions, no overlap or double taxation would occur between the two instruments.

Both instruments cover some uses of energy, such as power and heat generation and energy-intensive industries. Other areas are excluded by either one or both of them. Such, for example, include process emissions, which are covered by EU ETS and not by the ETD.

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[13] COM(2011)169

[14] Withdrawal of Commission proposals (OJ C 80, 7.3.2015, p. 17–23)

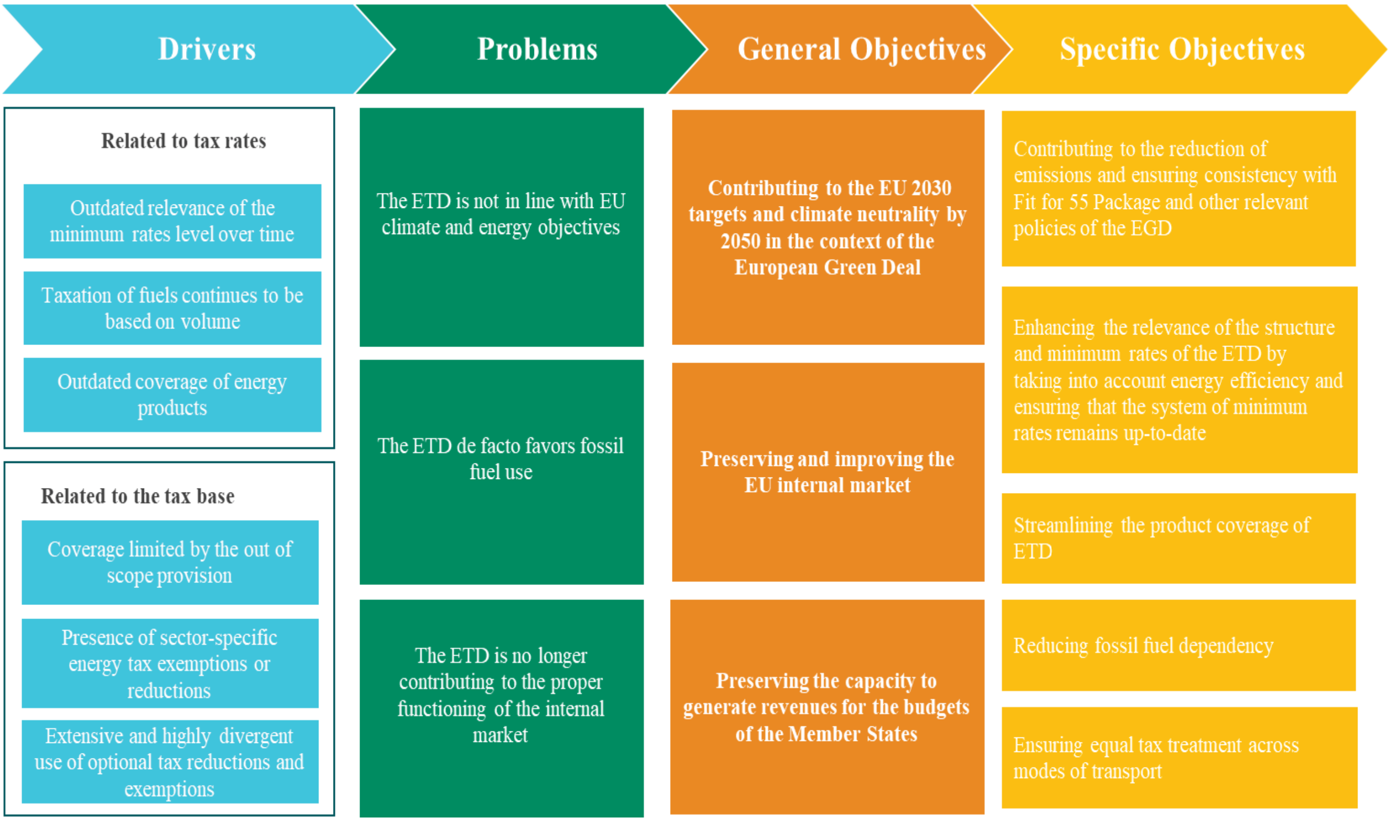
[15] Commission report: evaluation of the Energy Taxation Directive, SWD(2019) 329 final.

[16] Energy taxation: Council calls for an updated framework contributing to a climate neutral EU.

2. PROBLEM DEFINITION

This section will define and analyse the problems and their drivers and it will assess the expected evolution of these problems in the absence of any EU policy intervention. The section will also present the need for the review of the directive in line with the "Logic for Intervention" below. Figure 1 below presents a snapshot of the main problems, their drivers, and the objectives of the proposed initiative.

Figure 1: Logic for Intervention



2.1 What are the problems?

At the time of its adoption, the ETD represented a positive contribution to the EU legislative framework by establishing harmonised common rules at the EU level for the taxation of electricity and basically, all motor fuels and heating fuels in 2003. However, the ETD has remained unchanged despite the fact that technologies, energy markets and other EU legislation have evolved considerably over the past 15 years. Consequently, significant misalignment exists between the ETD and all these areas today. The overall conclusion of the evaluation report is therefore that the ETD does not ensure the equal tax treatment of energy sources based on their negative externalities. Such externalities include, for example, the emission of greenhouse gases and other air pollutants.

The ETD is not in line with EU climate and energy objectives: The Directive does not adequately promote greenhouse gas emission reductions, energy efficiency and the take-up of electricity and alternative fuels (hydrogen, synthetic fuels, e-fuels, advanced biofuels, etc.).

As a result, the ETD does not provide sufficient incentives for investments in clean technologies. There is a lack of alignment between the ETD and, among others, the Renewables Directive and the Energy Efficiency Directive.

The treatment of the business sector, in particular energy intensive business and manufacturing sectors, varies considerably under the ETD. Furthermore, the exemptions for the aviation and maritime sectors are incoherent with the push for climate change. For these reasons, the ETD is not in line with the objectives of the EGD, and hence, it cannot ensure at present consistency with the 'Fit for 55 Package'.

The ETD de facto favours fossil fuel use: Highly divergent national rates are applied in combination with a wide range of tax exemptions and reductions in order to pursue national industrial and economic policies. The wide range of exemptions and reductions are de facto forms of fossil fuel incentives, which are not in line with the objectives of the EGD. Furthermore, renewable fuels and energy products produced from biomass (see Box 2) are treated less favourable due to their lower energy content. Yet the same minimum tax rate is applied. All these differences increase the fragmentation of the internal market, provide an unequal fiscal treatment of the different fuels and distort the level playing field across the relevant sectors of the economy.

Box 2: What are biofuels, bioliquids and biogas?

These products are produced from biomass (such as plant or animal material) and definitions of these products in the REDII differentiate between biofuels as liquid fuels for transport, bioliquids as liquid fuel for energy purposes other transport, such as heating and biogas as gaseous fuels*. In the EU most biofuels today are blended with fossil transport fuels. Typically, ethanol is mixed with gasoline and biodiesel is mixed with gas oil. There are three main types of biofuels:

i) Non-Sustainable: These biofuels do not achieve significant reductions in greenhouse gases compared to fossil fuel alternatives and/or the cultivation of their feedstock results in land use conflict (food security, land with high biodiversity).

ii) Sustainable**: these biofuels achieve a certain reduction in greenhouse gases compared to fossil fuel alternatives and does not result in land use conflict.

iii) Advanced*** : Beyond complying with the sustainability and greenhouse gas saving criteria listed above, advanced fuels are produced from feedstock that ensure that they do not create additional demand for land while promoting the use of wastes and residues.

Bioliquids include e.g. vegetable oils and fats and are also subject to the above sustainability criteria. Biofuels and biogas for transport are also eligible to be treated as advanced.

* As defined by Article 2 (24), (28), (32) and (33) of Directive (EU) 2018/2001 of the European parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast; REDII)

**As defined by Article 29(2) to (7) of RED II excluding high indirect land-use change-risk biofuels as defined in Article 26(2) of that Directive.

*** As defined by Annex IX Part A of Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast)

The ETD is no longer contributing to the proper functioning of the internal market: The current ETD no longer achieves its primary objective in relation to the proper functioning of the internal market, as the minimum tax rates have lost their converging effect on national tax rates. In the absence of an indexation mechanism, their real value has eroded over time and they no longer have a converging effect on national rates as the vast majority of Member States tax most energy products and, in some cases electricity, considerably above the ETD minima. Highly divergent national rates are applied in combination with a wide range of tax exemptions and reductions in order to pursue national policies. The wide range of exemptions and reduction are de facto, forms support to fossil fuel consumption. These concern important sectors, such as aviation and maritime transport that are currently fully exempt from energy taxation, while land transport bears an important burden of energy taxation (except for leisure flights). All this increases the fragmentation of the internal market in particular distorts the level playing field across the involved sectors of the economy and creates unfair tax treatment.

In addition, there are some aspects of the ETD that lack clarity, relevance and coherence, which creates legal uncertainty. These include, among others, the definition of taxable products and uses that are out of the scope of the Directive and the interpretation of the exemption related to motor fuels used in air and water navigation.

The ETD has historically been an instrument for Member States to collect tax revenues. On average, ETD revenues represent around 5% of total tax revenues in the EU. From an economic perspective, indirect taxes can raise revenues in a less distortive way than direct taxation, because they have a less detrimental impact on growth. During the last decades the Commission has strongly encouraged Member States to make more use of indirect taxes as compared to direct taxes, especially labour taxation. Considering the projected evolution of the energy system under existing climate and energy policies, duly attention has to be given to the expected tax revenues evolution and their stability over time. In fact, a trade-off between environmental objectives and revenue stability may arise if the tax succeeds in internalising environmental costs thus contributing to reduce the taxable basis and namely fossil fuels use. While the aim of this review is not to increase revenues from the tax, it is one of the objectives to preserve the revenues raising potential for Member States (according to their policy choices in the area of taxation) at the same time that the tax ensures a reduction of negative externalities. The reduction of negative externalities and the preservation of revenues potential are not contradictory objectives. This can be achieved by means of the revision of the minimum rates and the broadening of the taxable base.

2.2 What are the problem drivers?

A) Related to the tax rates

A.1 Outdated relevance of the converging role of the minimum rates level over time

In the absence of an indexation mechanism, the real value of minimum rates has eroded over time. The 2019 Evaluation observes that the absence of an increase in minimum rates for more than a decade at EU level has eroded the tax-induced price signal that was supposed to encourage the convergence objective imbedded in the harmonisation and internal market logic of the Directive. As a result the national rates are generally well above the fixed minima and are very different at national level. As an example, the petrol real value of the minimum rate has decreased of around 2/3 since 2003 (CPI indexation).

As most Member States have increased their national level of taxation since then while others have not, there is risk of growing distortion of competition in the Single Market and an erosion of the tax base in high-taxing countries, notably for motor fuels that can be easily and legally transported across borders. This situation has eroded the convergence logic of the harmonisation Directive.

The minimum level of taxation for unleaded petrol already existed under the Mineral Oils Directives of 1992, with a rate fixed at EUR 287 per 1 000 litres. With the entry into force of the ETD, this minimum level of taxation was increased to EUR 359 per 1 000 litres. The ETD raised the minimum level of taxation of gas oil used as propellant from EUR 245 to EUR 302 per 1 000 litres in 2004, and to EUR 330 per 1 000 litres in 2010.

The implementation of the ETD had an initial one-off converging effect. The initial approximation of rates was strongest for the countries joining the EU after 2004. At the time of the ETD adoption, 14 out of the 15 EU Member States were already taxing unleaded petrol above the new minimum, while at the time of accession all but three of the 13 post-2004 Member States were below the minimum levels of taxation. For gas oil used as propellant, nine EU-15 Member States were taxing it above the new minimum against five of the post-2004 countries. Therefore, the minimum levels of taxation applicable to motor fuels under the ETD provided a safety net to avoid a “race to the bottom” in the taxation rates applied by the Member States.

The contribution of the current minimum levels applicable to petrol and gas oil, to the smooth functioning of the single market by approximating excise duty rates, is limited by the possibility of setting national rates above the minimum levels defined in the ETD, resulting in highly divergent national rates for transport fuels. Final prices across the EU ranged in 2018 from 1.10 EUR/litre to 1.68 EUR/litre. Most of the difference results from taxation as the variation of commodity prices remained between 0.53 to 0.66 EUR/litre in 2018[1]. The variation of the tax component was significantly higher, ranging from 0.36 to 0.78 EUR/litre. These differences induced a phenomenon of consumers crossing borders in order to refuel their vehicles at lower prices (tank tourism) in bordering regions. This indicates local distortion of competition.

The 2019 evaluation (annex 6) shows the per capita releases for consumption of petrol and gas oil in each Member State. Significantly higher values in certain Member States might indicate the practice of tank tourism

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[1] DG Energy – Weekly Oil Bulletin.

Figure 2: National Tax Rates and current ETD minimum rates in 2020)[17] [18]

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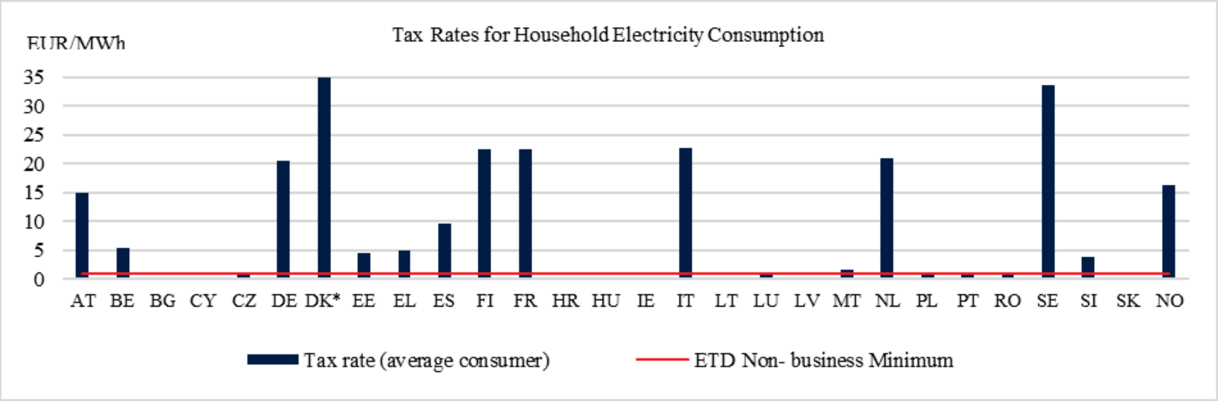
[17] Household tax rates: the ETD allows Member States to exempt the use of energy products and electricity used by households

[18] Heating fuels: The ETD allows Member States to restrict the scope of “business-use”. Some Member States apply to higher non- business rate to certain commercial uses, such as services. For further explanation, please consult Annex 5.



Source: TEDB

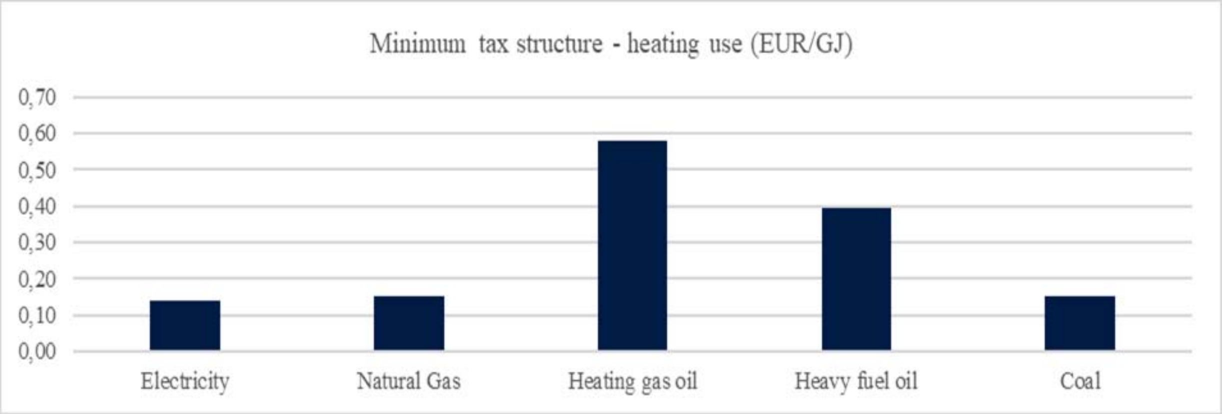
A.2 Taxation of fuels continues to be based on volume

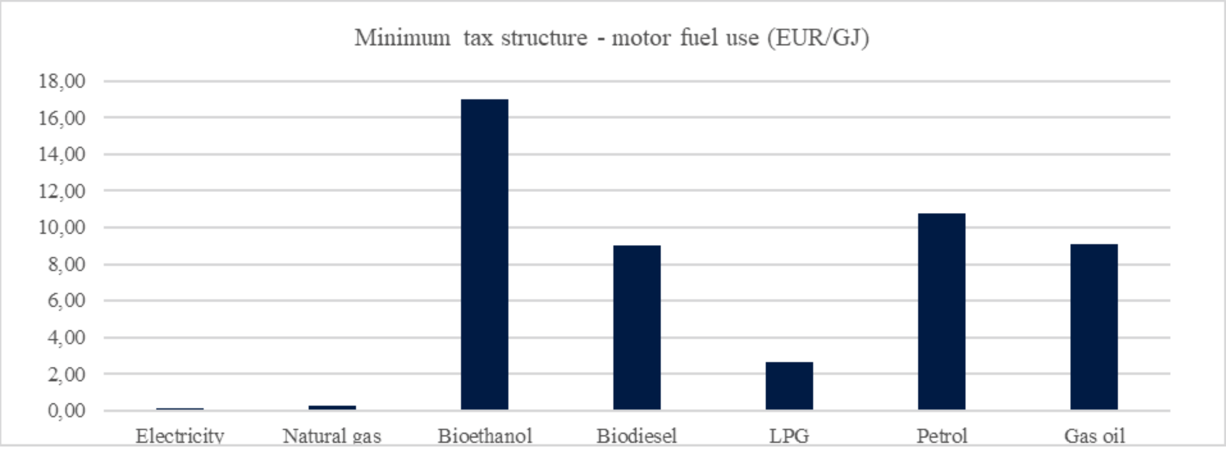
The **taxation of fuels according to volume** and not according to their energy content discriminates against renewable fuels in favour of conventional fossil fuels. The fiscal treatment of new energy products and technologies is unclear.

The lack of sustainability criteria and classification in the ETD to ensure that the use of biogas and liquid fuels produced from biomass in transport and such fuels used for heating is done in a way that guarantees real carbon savings and protects biodiversity, hampers the consistent tax treatment of these biomass fuels. The taxation of them under the ETD, like for almost all fuels, is based on volume and the applicable rate is the same as the rate applicable to the equivalent fossil fuel. The ETD, therefore, fails to take into account the lower energy content of the renewable fuels leading to a higher tax burden on the renewable fuel compared to the same volume of the competing fossil fuel. As a result, as biofuels used for transport is to be taxed at the national tax rate applicable to the equivalent fossil fuel – being fossil petrol or gas oil expressed in volume units – this means that the same distance travelled with biofuels is more heavily taxed.

Moreover, the taxation according to volume also results in unjustified differences of the taxation among different fossil fuels, such as petrol and diesel and among different products for heating use (see figures below).

Figure 3: Minimum tax structure - heating and motor fuel use (2003 minimum rates)



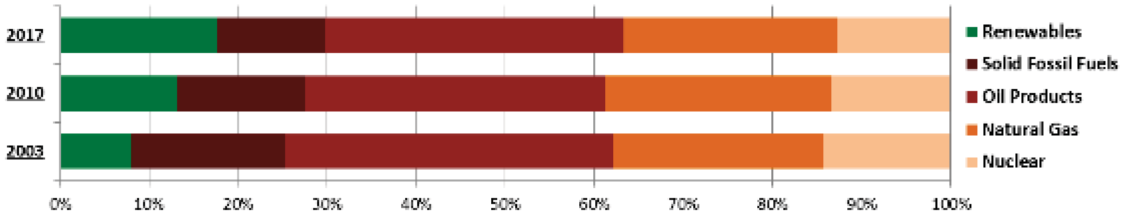


Source: Commission (JRC) calculations on Eurostat data

A.3 Outdated coverage of energy products

The ETD is outdated. The **EU's energy mix** is continuously evolving, as reflected also in the overall 'Fit for 55 Package', with the deployment of renewable energy and the decrease of the use of fossil fuels as a direct consequence of the policy choices made since the signature of the Kyoto protocol. The share of **renewable energy** in the EU's energy mix has increased almost three-fold since the ETD was adopted. Despite the growing market relevance of renewable fuels, their tax treatment under the ETD still relies on rules developed at a time when these fuels were niche alternatives without major market significance. It is a fact that the ETD does not provide clear provisions for a growing portion of the changing EU's energy mix. The relevance of the current ETD will further decrease as the ambition of climate policies increases. The 2030 climate and energy framework sets a target of at least 32% share for renewable energy[19].

Figure 4: EU27 energy mix by type of fuel



Source: Eurostat [nrg_ind_ren]

The ETD was adopted long before the emergence of new technologies and uses that are predicted to become important building blocks on the path to the EU's decarbonised future. At the time of the adoption of the ETD, biofuels in transport were immature products, limited in variety and significance. However, over the last one and a half decades, second[20] and third[21] generation biofuels emerged. The environmental performance of these successive generations of biofuels kept improving. Yet, the ETD does not differentiate between these types of biofuels.

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[19] 2030 Energy Strategy.

[20] For example, non- food biomass.

[21] For example, biofuels derived from algae.

Alternative fuels, such as hydrogen[22], e-fuels[23], synthetic fuels, bio-methane and renewable fuels of non-biological origin are gaining traction. However, the ETD does not ensure a tax treatment of these low-carbon alternatives, which is coherent with their potential to reduce GHG emissions, therefore constituting a disincentive for their higher penetration in the EU. The ETD does not even provide clear legal provisions for the taxation of some of these new products.

Because of all this, the current ETD is not properly suited to ensure the preferential treatment of these new energy products and their applications.

B) Related to the tax base

B.1 Coverage limited by the out of scope provision

Article 2 (4) (b) of the ETD lists certain energy products as well as uses of energy products and electricity for which the Directive itself shall not apply, apart from the application of the control and movement provisions laid down in Article 20. Such out of scope uses are as follows:

i) any uses other and as motor fuel or as heating fuels,
ii) the dual use of energy products (such as the use of energy products for chemical reduction, electrolytic, or metallurgical processes),
iii) the use of electricity when it accounts for more than 50% of the cost of a product, and
iv) mineralogical processes.

However, Member States remain free to subject these uses to non-harmonised taxation although in practice very few do so. The current ETD provides short definitions only for dual use and mineralogical processes, leaving sizeable room for interpretation and legal uncertainty.

According to a dedicated modelling exercise by DG Joint Research Centre of the European Commission (see Annex 10), 68% of the EU's industrial energy consumption falls under the out of scope provision and is therefore not subject to harmonised taxation. As most Member States opt not to apply non-harmonised taxation, most "Out of scope" energy use is untaxed.

The impact of the provision however varies significantly across industrial sectors and Member States. The estimated share of "Out of Scope" energy use is the highest in the following sectors:

i) "Non- metallic minerals", including the production of building materials clay, sand and limestone (almost all of the sector's energy consumption falls under the Out of Scope provision). .
ii) "Iron & Steel" (depending on a country's national definitions, over 90% of the sector's energy consumption can fall under the Out Of Scope provision)[24]

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[22] For use both in dedicated combustion engines and in fuel cells for electric vehicles.

[23] Drop-in fuels produced from power-to-gas, power-to-liquid, to be used in internal combustion engines.

[24] There is currently no harmonised definition of metallurgical processes in place in the ETD, leading to diverging national implementation as attested by discussions among Member States and interpretations given by the CJEU in rulings on individual cases. Underlying results are based on a wider interpretation of metallurgical processes. Some Member States apply a narrower definition by considering parts of the industrial processes as heating, and therefore subject them to harmonized taxation. Others consider such processes covered by Article 2 (42) (b) of the ETD ("Out of Scope" energy use), which in most cases means that they are not taxed. A uniform

iii) “Non-ferrous metals”, including the production of aluminium, zinc and copper (over 80% of the sector’s energy consumption falls under Out of Scope)

(Other industrial sectors, such as “Food and beverage” and “Textile and leather” benefit less from the provision, leaving about three quarters of the energy consumption in these sectors in the scope of the ETD. (see more detailed results in section 3 of Annex 10).

Although the ETD sets the same definitions for all, differences across Member States arise depending on the prevalence of production processes in each country’s value chain. Some Member States process raw materials, with these processes being the most energy intensive part of the production, and export the product to other Member States. Consequently, the share of untaxed Out of Scope uses will be higher in the exporting country. In the “Chemicals” sector for example, the share of Out of Scope energy use varies from 12% to 66% across Member States.

B.2 Presence of sector-specific energy tax exemptions or reductions

The presence of sector-specific energy tax exemptions or reductions, notably for the transport sector (aviation, maritime, inland shipping and road haulage), for the agricultural/ forestry/aquaculture sectors and for the energy-intensive industries and other business sectors, substantially weakens the incentives for investing in more energy-efficient and less polluting capital stock and production processes in these sectors. As a result alignment and consistency of the current ETD with the European Green Deal is weakened and does not allow to make these sector contribute to the decarbonisation effort.

At present, the ETD provides for an exemption of energy products supplied for **air navigation and navigation in Community waters**, other than for private pleasure purposes. Even if Member States may limit the scope of the exemptions to international and intra-Community transport by taxing these sectors domestically or after having entered into a bilateral agreement with another Member State to waive the exemption, the reality is that exemptions remain. These exemptions offer these sectors a favourable tax treatment in the transport sector as road transport is not exempted and the exemption of rail transport is optional. Moreover, the present situation substantially weakens the incentives for investing in more energy-efficient and less polluting crafts. The lack of proper differentiation between the different fuels in these sectors covered by the mandatory tax exemptions does not facilitate reducing the significant price difference between fossil fuels and sustainable fuels. Properly designed taxation measures could support the uptake of sustainable fuels and at the same time their production what could result in lower prices for these fuels.

Concerning, more particularly the aviation sector, it is worth considering that even after the drop caused by COVID-19 in 2020 and successive years, under the baseline scenario CO_2 emissions from aviation are still forecast to increase by 24% by 2030 and by a further 27% by 2050 compared to 2005 levels[25]. This highlights the fact that, together with the increase in demand, the current exemption / structure does not encourage the switch to less polluting aircraft or fuels.

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wider interpretation was applied to all Member States tailored to the uniform Eurostat data set, which provided the starting point of the modelling exercise.

[25] According to the October 2020 update of the European Commission EU Reference Scenario.

Existing market-based instruments, the EU ETS for intra-EEA aviation and since January 2021 the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) only partially internalise climate externalities**.** For intra-EEA flights, climate change impacts are currently not fully internalised through the EU ETS as a significant proportion (44% in 2019) of total verified emissions are allocated for free to aircraft operators. This, however, is reassessed in the revision of the EU ETS, where a reduction of the number of the free allocations is among the policy options considered. As for extra-EEA flights, the price signal provided by CORSIA clearly falls below the EU ETS carbon price and would only marginally reflect the climate external costs generated by extra-EEA flights. See Annex 7 for more details about the analysis for this sector.

While the problems of increasing GHG emissions and expensive decarbonisation supply measures equally apply to maritime and inland shipping, no market-based instruments are currently applied in this sector. Moreover, similarly to the case of the aviation sector, the exemption of the maritime and inland shipping gives a preferential energy tax treatment to the sector with respect to other modes of transport.

Lower minimum levels for products used as motor fuels are applicable in the **agriculture sector**[26] (which can moreover enjoy a level of taxation down to zero, for energy products as well as for electricity), and to **stationary motors and machinery for construction and public works.**

Energy intensive industries and other business sectors can, when in compliance with State aid regulations, also benefit from tax reductions potentially down to zero. This is possible under certain conditions, such as qualifying as an energy-intensive business (as defined by the ETD), and/or where agreements, tradable permit schemes or equivalent arrangements are implemented, as far as they lead to the achievement of environmental protection objectives or to improvements in energy efficiency. The national implementation of these provisions varies among Member States and across economic sectors.

B.3 Extensive and highly divergent use of optional tax differentiations, reductions and exemptions

The ETD leaves room for the Member States to implement total or partial exemptions or reductions in the level of taxation. The effective application of optional differentiations often reflects the individual interests of Member States. The extensive and highly divergent use of optional tax reductions and exemptions by Member States fragments the internal market and in particular distorts the level playing field across the respective sectors of the economy. There is a disconnection – and in some cases, a contradiction – between some optional tax exemptions and reductions allowed by the ETD and other EU instruments for energy and climate. The following list provides an overview of the main (possible) differentiations other than those already described in the previous section**:**

- possibility of differentiated rates of taxation above the minima (e.g. when linked to product quality, or depending on quantitative consumption levels for electricity and energy products used for heating purposes or between business and non-business use for heating fuels and electricity, etc.);
- possibility of lower rate for the commercial use, as opposed to non-commercial use, of gas oil used as propellant for the carriage of goods or of passengers;

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[26] In this Impact Assessment report references to the agricultural sector also refers to the agricultural, forestry and aquaculture sectors in line with Article 8 (2) (a) and Article 15 (3) of the current ETD.

- tax exemption for energy products and electricity used to produce electricity, with a possibility, within defined limits, to introduce a taxation for reasons of environmental policy; and optional total or partial tax exemption or reduction for electricity from certain sources (including, among others, electricity from solar, wind, wave, tidal or geothermal origin);
- possibility of total or partial exemption or reduction in the level of taxation for energy products and electricity used for producing heat in combined heat and power generation and for electricity produced from combined heat and power generation (provided that the combined generators are environmentally friendly); optional total or partial tax exemption or reduction for natural gas and LPG used as propellants (moreover, for LPG, as well as for kerosene, used as heating fuels, the minimum level of taxation applicable is zero);
- country specific minimum levels[27], as well as additional derogations for specific policy considerations, when requested by a Member State, which granted by means of a Council Implementing Decision. Such measures are of a diverse nature, and include among others: specific rates for specific geographical areas, the tax treatment of electricity directly supplied to vessels at berth in a port ("shore-side electricity") or to electricity supplied to electrical vehicles at charging stations and a tax exemption to operate machinery in humanitarian demining or for low-value solid fuel.

Beyond the discretionary application of tax differentiations, exemptions and reductions, the implementation of other provisions may also undermine the objective of harmonisation. Such include: legal uncertainty in the application of the control and movement provisions and the definition of the conditions establishing, in certain cases, chargeability and chargeable event. A divergent interpretation and implementation of these provisions may be an obstacle to the free movement of goods and investment capital.

As regards the control and movement provisions, an update of the list[28] of energy products to which those provisions apply may be needed. While several attempts to amend this list for various reasons including the fight against tax fraud have been made, this has not been successful to date and as a result national solutions have been implemented.

Concerning chargeability and chargeable event, particularly for storage of electricity, the current ETD was adopted long before several storage technologies (including chemical, electrical and mechanical solutions) emerged. Therefore, its provisions leave the possibility of divergent national implementation open. The ETD states that electricity is taxed at the time of supply but does not clearly define whether electricity is released for consumption when supplied to storage facilities. This could open the possibility of double taxation of electricity that is stored and re-sold. The lack of EU-wide harmonisation could create an insecure environment for business, and consequently might hinder investment in storage technologies.

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[27] Particularly Article 9(2) of the ETD.

[28] See Article 20 of the ETD.

2.3 Effective Energy Tax Rates

This section complements the definition of the problems by means of synthetic indicators, which summarise the main findings presented above in terms of problems arising from the present level of rates and definitions of the taxable base. As mentioned above, much of the EU's energy consumption is not taxed at the nominal levels listed in the national legislations.

Effective rates do not result from a single problem driver identified in this Impact assessment, nor do they reflect the shortcomings resulting from a single problem driver. Effective rates are a combined result of the national tax rates applied jointly with the use of sectoral and other tax exemptions and reductions, the highly divergent national criteria attached to benefiting from these tax reliefs and eroded minimum rates that allow for large differences across national effective rates. Effective tax rates are best suited to serve as the basis for policymaking. In fact, effective tax rates are synthetic indicators, which present nominal rates adjusted for tax reliefs and thereby allow for cross country comparisons. Effective rates also illustrate the prevalence of fossil fuel incentives, counterproductive to the goals of the Fit–for-55 package and source of possible distortions -in the internal market.

Consequently, effective rates cannot be derived from a single problem driver. As they represent shortcomings stemming from various features of the current ETD, they also represent the underlying reasons for a number of elements of the new tax design.

A wide range of energy consumers benefit from various tax reliefs, in the form of rebates, refunds, differentiation and exemptions. This Impact Assessment delivers a systematic overview of tax reliefs in the EU27, quantifies tax reliefs in the transport, agriculture, households, services and industry sectors and computes set of effective tax rates. In addition, the criteria attached to tax reliefs are inventoried. (See Annex 5)

. The difference between nominal and effective rates show that the tax burden eventually born by consumers- can vary significantly. The tax effectively paid can be modified in two ways. Firstly, by altering nominal tax rates. In other words, increasing or decreasing the rates applied to energy products and uses. Secondly, by altering the taxable base. This can be achieved by changing the list of beneficiaries or eligibility criteria attached to tax reliefs. Changes in effective rates measure the impact of policy intervention affecting the taxable base, the nominal rate or both. Therefore, it is important to use duly computed effective tax rates to measure the impact of proposed policy changes. Effective tax rates, unlike their nominal counterparts, also allow for cross-country and cross sector comparison.

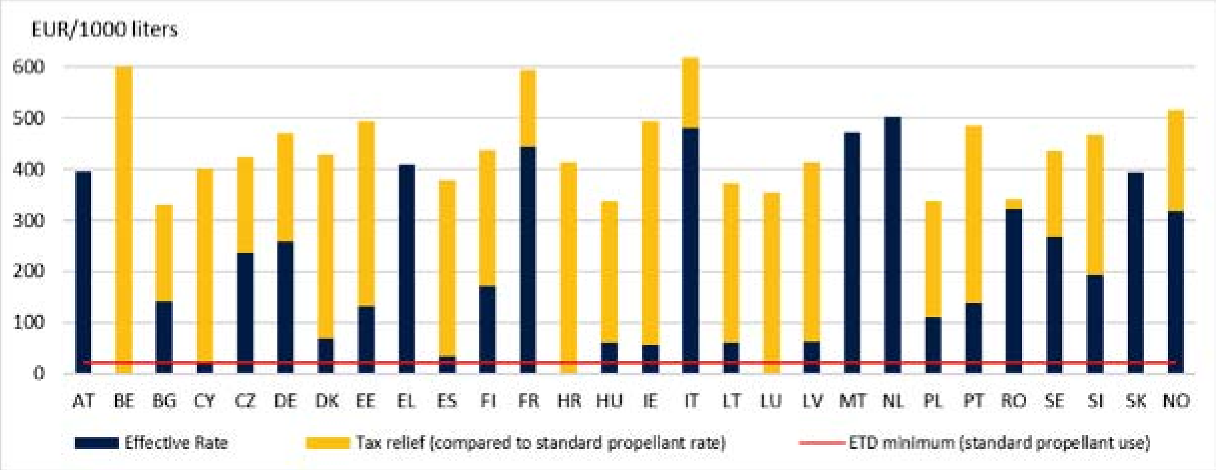
Therefore, the effective tax rates are also the best indicators to summarise the shortcomings of the current ETD and consequently the drivers for its revision. While nominal rates themselves provide no clear indication for the environment or internal market related problems of the EU's current energy tax design, effective rates can serve the purpose. They illustrate the ETD's shortfalls in terms of preserving the EU's internal market as well as contributing to the 2030 targets and climate neutrality by 2050 in the context of the European Green Deal. In fact, effective rates demonstrate harmful fossil fuel incentives in the form of sector and use specific tax reliefs and show the real differences in energy taxes paid by consumers across Member States. For example, only a combination of nominal rates and applicable tax reliefs provides an accurate picture of distortions of the internal market by illustrating the differences in taxes paid by industrial consumers in different Member States.

Findings presented in this Impact Assessment are based on answers given by 28 Finance Ministries to a dedicated survey conducted by the Commission in early 2020 (the 27 Member States and Norway). TAXUD Energy Metadata Survey (TEMS) allowed the collection of systematic information on tax reliefs and the national criteria attached to their application. TEMS also covered the taxation of various environmentally friendly technologies that are important drivers of the blocks energy transition. Amongst them, hydrogen, energy storage and renewables. In order to keep the reporting burden low for Member States, the survey was designed to be complemented by external data sources. Most notably, Taxes in Europe Data Base and Eurostat energy balances. CO2 taxes, in the Member States that apply such a tax, are accounted for in the computation of the effective tax rates[29].

As an example, the following graphs illustrate the effective tax rates for the most relevant energy product in agriculture, households and transport. They show the difference between nominal and effective tax rates, whereas tax reliefs are marked in yellow.

The ETD allows Member States to tax the use of gas oil in the **agriculture** sector[30] below the minimum, including full tax exemption. Some Member States make use of this provision (all yellow bars) while others apply the nominal rate (all blue bars). Yet others apply a refund or rebate (mixed bars) that decreases the effective rate compared to the nominal rate, while respecting the minimum. The result is a highly divergent taxation of gas oil, which accounts for over half of the sectors' energy consumption. Tax reliefs for the use of gas oil may increase fuel use and represent fossil fuel incentives, hindering the achievement of the EU's 2030 environmental goals as well as to reach climate neutrality by 2050.

Figure 5: Effective Rates for Gas Oil Use in Agriculture[31]. 2019/2020



Source: TEMS

The ETD also allows for the differentiation of **non-commercial and commercial use of gas oil in road transport,** with the latter covering the transport of goods and passengers. As of early 2020, ten Member States made use of this provision, mostly in the form of refunds that haulage operators can apply for. Tax reliefs for the use of commercial gas oil push the rates down towards the ETD minimum and therefore do not have a significant negative impact on

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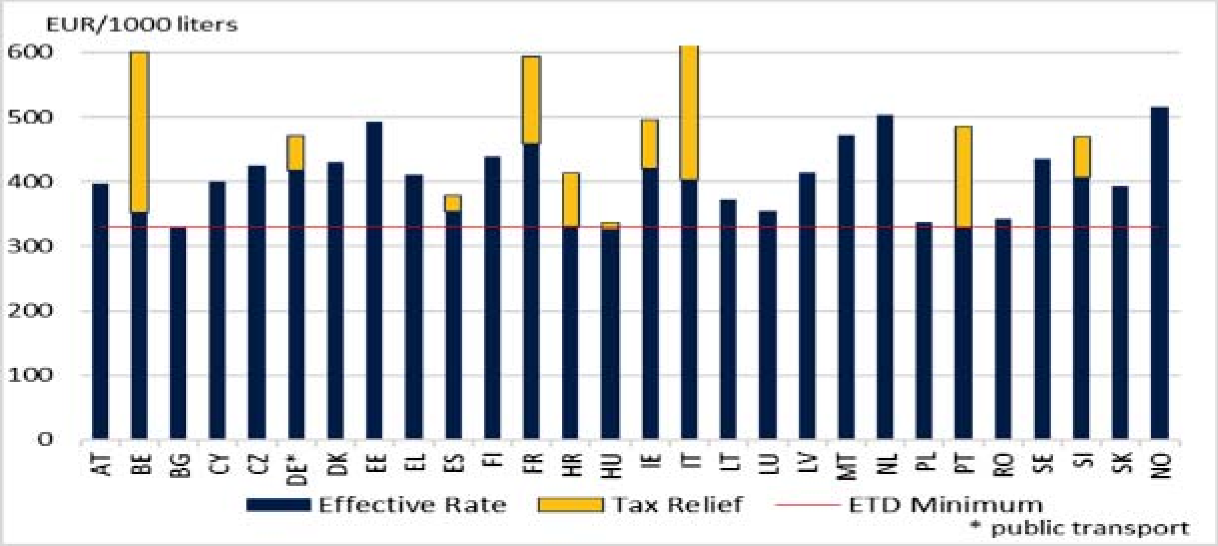
[29] At present only eight Member States (DK, FI, FR, IE, LU, PT, SE and SI) apply a carbon tax in combination with ETD rates mainly to non-ETS sectors.

[30] Used as motor or heating fuel

[31] Weighted average of motor and heating use

the functioning of the internal market, yet they remain an incentive for fossil fuel consumption, incentivising the use of a highly polluting, mostly imported energy product.

Figure 6: Effective Rates for Commercial Gas Oil in Road Transport, 2019/2020



Source: TEMS

The ETD does not define minimum rates for households nor for industry. Instead, while setting separate minimum rates for the business and non-business use, these rates are the same for gas oil, heavy fuel oil, kerosene and LPG and only differ for electricity, natural gas and coal. Households fall in the “non-business” category. Yet, “non-business” nominal rates are often no indication of the actual rates paid by **households**. When nominal rates are combined with optional tax reliefs, the resulting effective rate for household electricity use is zero in eight Member States. Seven[32] Member States exempt natural gas from excise duty. Others grant exemptions and reductions based on regional or social grounds, for example to vulnerable consumers. Tax reliefs for the household consumption of natural gas, coal and partly for electricity may increase fuel use and are fossil fuel incentives that constitute further challenges to realising the EU’s environmental and climate agenda.

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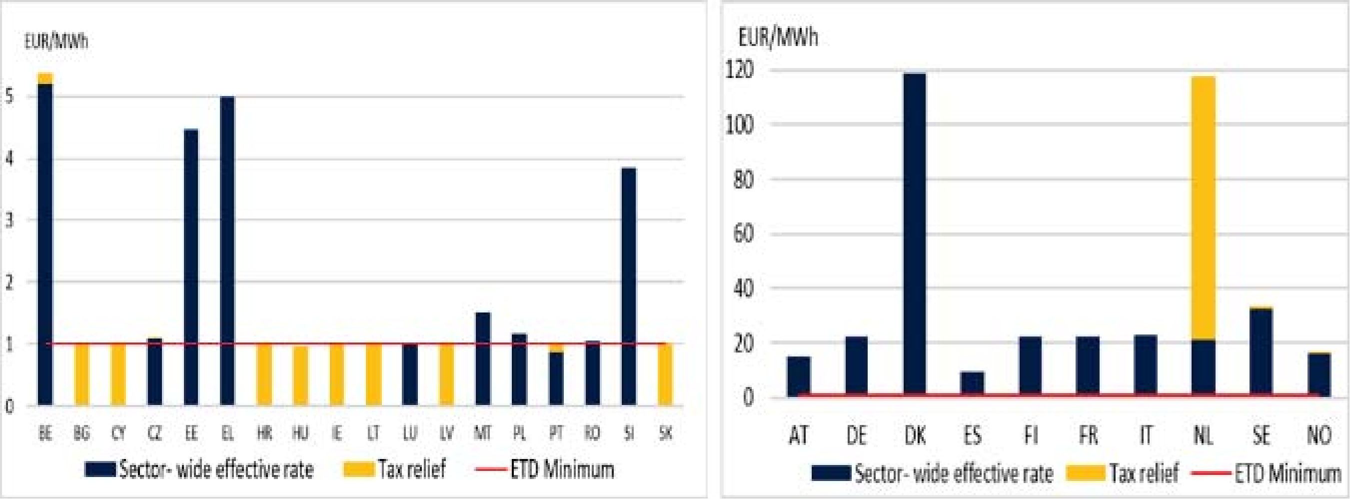
[32] Not all Member States that exempt the household use of electricity also exempt the household use of natural gas. For the exact lists, please see Annex 5 of this Impact Assessment.

Figure 7: Sector-wide effective rates of household electricity consumption[33] 2019/2020



Source: TEMS

2.4 How will the problem evolve?

The Evaluation of the ETD concluded that:

"The adoption of the ETD represented a positive contribution to the EU legislative framework in 2003 by updating and widening the scope of the harmonised common rules at the EU level for the taxation of energy products used as motor and heating fuel and of electricity………..

The ETD initially made an overall positive contribution towards its main objective of ensuring the proper functioning of the internal market, preventing double taxation or any distortion of trade and competition between energy sources and energy consumers and suppliers.

However, as technologies, national tax rates and energy markets evolved over the past 15 years, the ETD in its present form no longer makes the same positive contribution. Furthermore, the EU legislative framework and policy objectives developed significantly since the adoption of the ETD in 2003. As the ETD has not kept pace with such developments, there are some aspects of it, that now lack relevance and coherence. As a result the overall EU added value of the ETD has eroded significantly over time in particular due to the lack of indexation of the minimum rates and the extensive and highly divergent use of optional tax exemptions by Member States and because of the changing policy environment"

Therefore, considering the already obsolete nature of the Directive and the challenges the EU is facing in terms of climate change, the ETD will become more and more irrelevant in view of its objectives in case of no action. The present problems will evolve further and the ETD will become a patchwork of national legislations aimed at collecting revenues in a non-coordinated way with no effective harmonisation nor any environmental role. In such a situation, considering the evolving of the energy mix and the lack of effective harmonisation, the ability for Member State to effectively collect revenues could also be put under stress. As explained later on in this analysis, revenues for EU27 from this tax are expected to considerably drop in the medium term.

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[33] The ETD minimum rate applies as the benchmark

3. WHY SHOULD THE EU ACT?

3.1 Legal basis

The legal basis of the Energy Taxation Directive is Article 113 of the Treaty on the Functioning of the European Union (TFEU), which permits the EU to lay down harmonised rules in order to ensure the proper functioning of the internal market. Additionally, appropriate provisions of fiscal nature intended, inter alia, to preserve and protect the environment can be adopted according to Article 192(2), first subparagraph, of the TFEU.

3.2 Subsidiarity: Necessity of EU action

The problems identified can only be remedied by means of a revision of the ETD, in coordination with other EU policy measures. Under the existing ETD, Member States can increase the rates of their taxes on energy products and electricity, decide not to make use of possible exemptions and reductions or introduce environmental and climate related objectives. However, such national approaches risk distorting the internal market and undermining the EGD objectives due to the non-harmonised structure and level of the national taxes:

(1) The current minimum rates may limit the level of environmental ambition that Member States can pursue with taxes on energy, in particular because energy taxation may directly affect the costs for companies.

(2) The harmonisation of energy taxation through the Energy Taxation Directive should contribute to reducing the harmful effects of energy tax competition between the Member States, stemming for example from the possible relocation of businesses to Member States with more beneficial tax regimes.

(3) The EU Emissions Trading System (ETS) has proven to be an effective tool in reducing greenhouse gas emissions from installations covered by the scheme. A possible extension of the EU ETS to new sectors is envisaged in the EGD, but no decision of such a proposal has yet been taken at the time of the completion of this Impact Assessment Report. However, regardless of the scope of the EU ETS, the ETD needs to provide complementary policy actions, notably relating to transport, energy and other sectoral policies, to ensure that the EU incentives align and incentivise further investments in clean energy technologies and infrastructure or to overcome financing difficulties for low-income households. In that context, action at EU level can ensure the coherence between the application of the EU ETS and the taxation of energy products and electricity, as well as a common EU approach with respect to taxation of energy products including carbon taxes in the sectors not covered by the EU ETS.

(4) Climate objectives can be put into practice in a number of ways and an effective EU-taxation framework can, while supporting other EU policy measures, prevent the creation of national solutions, which can in turn lead to internal market distortions and/or double taxation.

3.3 Subsidiarity: Added value of EU action

The contribution of taxation to the EGD climate and environmentally-related objectives can be ensured most adequately at the EU level. In fact, only a harmonised framework can help to attain the EU levels of ambition in these areas while seeking to preserve both the competitiveness of the productive sectors and the adequate level playing field among sectors and energy uses. Similarly, the EU's contribution to achieve higher climate ambitions globally international) will be most effective if the EU coordinates all the possible policy instruments, including taxation, in the context of an ambition plan, which encompasses also the extension of the ETS and other relevant policy actions.

4. OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1 General objectives

The **general objectives** of the review of the Directive are:

I. **Contributing to the EU 2030 targets and climate neutrality by 2050 in the context of the European Green Deal.** This would involve aligning taxation of energy products and electricity with EU energy, environment and climate policies thus contributing to the EU efforts to reduce emissions and other harmful effects due to the use of fossil fuels. The alignment of the ETD objectives with climate policies should be pursued while ensuring the coherence with the ETS system, thus avoiding inconsistencies and overlaps.

II. **Preserving and improving the EU internal market** by updating the scope and the structure of rates as well as by rationalising the use of tax exemptions and reductions by Member States.

III. **Preserving the capacity to generate revenues for the budgets of the Member States**. It should be underlined that one of the main objectives of taxation is to provide sufficient revenues for investment in public goods. However, it should be clarified that it is not an objective of the review of ETD to ensure at least the same level of revenues in the coming years. The objective is to ensure a framework that allows Member States to be able to generate the revenues they estimate necessary in full coherence with the EGD objectives and also be able, within the ETD framework, to design their tax systems to successfully support these objectives. The ETD revision should therefore duly consider the existing trade-off between a shrinking taxable base due to successful environmental objectives and the need to contribute to the financing of our social models.

In fulfilling the above-mentioned objectives, their implications for competitiveness, connectivity, employment and sustainable economic growth should be carefully considered.

The respondents to the open consultation undertaken by the Commission (see Annex 2) share the general objectives of the review. More than 90% of them agree that the ETD has to be revised in order to better ensure the smooth functioning of the internal market. An overwhelming majority of the respondents[34] agree that the ETD should be revised in order to support the transition towards climate neutrality and a strong majority[35] agreed that it has to be revised in order to better tackle environmental concerns, like air pollution.

4.2 Specific objectives

The specific objectives of the review of the Directive are:

- Contributing to the reduction of emissions and ensuring consistency with Fit for 55 Package and other relevant policies of the EGD

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[34] 90% of businesses and more than 96% of other stakeholders

[35] 65% of businesses and more than 90% of other stakeholders

- Enhancing the relevance of the structure and minimum rates of the ETD by taking into account energy efficiency and ensuring that the system of minimum rates remains up-to-date
- Streamlining the product coverage of ETD
- Reducing fossil fuel dependency
- Ensuring equal tax treatment across modes of transport.

A strong majority of respondents to the public consultation agree that the ETD:

- should take into account energy content in the definition of rates (65% of citizens and more than 80% of other stakeholders),
- has to be revised in order to take into account the changed energy mix with higher share of renewables and electricity (more than 90%),
- should better promote energy saving/efficiency (more than 85%),
- de facto favours fossil fuels consumption (51% of businesses and more than 83% of other stakeholders) and should reduce the possibility of favouring fossil fuels via tax reductions, exemptions and rebates (65% of businesses and more than 85% of other stakeholders),
- is applied in a too diversified way across the Member States (85% of businesses and more than 95% of other stakeholders).

In contrast, only around 20% of the respondents to the public consultation agree that minimum tax rates of energy products and electricity should be indexed yearly.

5. WHAT ARE THE AVAILABLE POLICY OPTIONS?

5.1 What is the baseline from which options are assessed?

The baseline for this impact assessment represents the existing 2030 climate and energy legislative framework, namely the agreed climate and energy targets, as well as the main policy tools to implement these[36]. It is aligned with the latest available version of the new EU REF Scenario[37]. This includes primarily climate and energy legislation (ETS Directive, the Effort Sharing and LULUCF Regulations, the Energy Efficiency and Renewable Energy Directives), and notably reflects the European Commission’s current assessment of Member States National Energy and Climate Plans (NECPs) as required in the “Clean Energy for All European Package”.

This baseline (EU REF scenario) is expected to also be the baseline of the subsequent exercises under the ‘Fit for 55 Package’ this year. At EU27 level, the baseline achieves a 43.7% reduction in total GHG emissions (domestic and intra-EU maritime, inland shipping and aviation) in 2030, relative to a 32.6% reduction already achieved in 2020.

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[36] Operationally the baseline is built using the Commission (JRC’s) PIRAMID framework combining various data sources to produce a time series of input-output tables up to the year 2050 in five-year steps (see Annex 4). The baseline tables are projected by combining a base year dataset, external macroeconomic projections and results from energy models as constraints. For a number of sectors, especially energy intensive consumers, projections of economic output and energy use are aligned with detailed energy system models. In particular, for EU Member States, projections from the PRIMES model’s December version of the EU REF scenario are used.

[37] Version from mid-December 2020, as captured in the PRIMES modelling

As part of the “Fit for 55 Package”, the Commission is reviewing this climate and energy framework to achieve the new GHG emission reduction target of at least 55% by 2030. However, this evolving policy framework is under consideration at the moment of the preparation of this impact assessment and is not part of the baseline scenario.

In addition to the above, the baseline should reflect as close as possible the actual energy taxation levels in Member States in implementing the current ETD. In order to more accurately address this requirement the baseline was updated and recalibrated with the set of effective tax rates applied by Member States, as presented in section 2.2.1, and the relevant technical discussion in Annex 5 (Effective Tax Rates by DG TAXUD) and Annex 10 (Out of Scope by DG JRC).

These effective rates were further improved to derive effective tax rates in the sectoral/fuel dimensions of the core model employed for the quantitative analysis of the impacts, namely the JRC-GEM-E3 model. This is particularly relevant for industrial sectors, for which effective tax rates must account for the volume of energy consumed out-of-scope of the Directive. The methodological approach to this further processing of the effective rates is discussed in detail under Annex 4 (Analytical Methods).

The baseline outlined above allows the analysis of this impact assessment to explore how the ETD revision will impact upon the EU economy both in aggregate and by Member State, as well as critically asses how the proposed changes can contribute to emission reductions in view of the EU’s increased climate ambition by 2030.

By focusing the analysis against the existing 2030 climate and energy legislative framework we can isolate the impact of the ETD alone and thereby its own contribution to reach 55% emission reductions by 2030. Alternative pathways to achieve 55% emission reductions by 2030 are not explored in this impact assessment, as these are analysed by other exercises under the ‘Fit for 55 Package’, including the extension of the ETS to transport and buildings performed by other Commission services.

For the purposes of the analysis, the revised ETD is assumed to enter into force in 2023. The JRC-GEM-E3 model runs in 5-year steps, meaning that starting from today an equilibrium is achieved at goods and services markets, and for factors of production through adjustments in prices. As a result, the first visible impact on tax rates of the revision can be seen from 2025 onwards. The methodology and data source used to calibrate effective rates that fed into the modelling of economic impacts is shown by table 17. (See Annex 5).

5.2 Description of the policy options

Option 1: “Minimalistic” Option

This option would ***adjust the current minima*** for all products in line with inflation since 2018 (starting year of indexation). Although the Directive was adopted in 2003, adjusting for inflation since then would result in a too significant increase in the minimum rates. Furthermore, the inflation rate since 2018 would reflect the relative stability of the energy markets and overall economic growth in the EU. The minimum rates will be indexed every year on the basis of the annual variation of the Harmonised Index of Consumer Prices (Eurostat). The HCPI is chosen over an energy price index to ensure smoother adjustment to the ETD rates. Energy prices are in general more volatile and subject to unpredictable changes, which limits their usefulness as a basis of indexation. In addition, employing energy prices as the primary the basis of indexation, would have led to an erroneous situation in which any price change due to taxation would feed into the same index, which was used for the indexation itself.

In order to improve the legal certainty and to ensure a specific tax treatment, ***some products*** such as advanced biofuels and hydrogen would be included in the definition of energy products. The minimum rates for electricity would apply to these products.

Finally, this option would imply a stricter application of industrial tax reliefs, coupled –where applicable- to environmental performance, with no possibility for full exemptions or to go below the minima for energy intensive industries and other business sectors. The same limitation with exemptions and need to respect minima would also apply to the primary sector (agriculture, forestry and aquaculture).

Furthermore, the current mandatory exemptions for international aviation and maritime transport[38] would be removed and the two sectors would have a zero minimum rate. This would allow Member States to unilaterally tax these two sectors if they so wish without obliging them to do so.

Currently exempted households would reach the ETD minimum rates gradually (heating fuels and electricity), by means of an increase of the rates by 1/10 every year (to reach the minimum after ten years). The possibility for a full exemption would be limited only to vulnerable households.

Table 1: Proposed minimum tax rates under Option 1

Motor fuels			
	Metric	**Current ETD minima**	**Start of transitional period (2023)indexed**
Petrol	EUR/ 1000 litres	359,0	385,0
Gas oil	EUR/ 1000 litres	330,0	353,9
Kerosene	EUR/ 1000 litres	330,0	353,9
Kerosene (aviation)	EUR/ 1000 litres	0,0	0,0
LPG	EUR/ 1000 kg	125,0	134,0
Natural gas	EUR/ GJ	2,6	2,8
Heating fuels plus fuels for agriculture and stationary motors			
	Metric	**Current ETD minima**	**Start of transitional period (2023) - indexed**
Gas oil	EUR/ 1000 litres	21,00	22,52
Heavy fuel oil	EUR/ 1000 kg	15,00	16,08
Coal and coke, business	EUR/ GJ	0,15	0,16
Coal and coke, non-business	EUR/ GJ	0,30	0,32
Kerosene business and non-business	EUR/1000 litres	0,00	0,00
Kerosene agriculture and stationary motors	EUR/1000 litres	21,00	22,52
LPG business and non-business	EUR/1000 kg	0,00	0,00
LPG for agriculture and stationary motors	EUR/1000 Kg	41,00	43,96
Natural gas business	EUR/ GJ	0,15	0,16
Natural gas non business, agriculture and stationary motors	EUR/ GJ	0,30	0,32
Non- renewable hydrogen	EUR/ GJ	n/a	0,16
Electricity, advanced biofuels, e-fuels and renewable hydrogen (all uses)			
	Metric	**Current ETD**	**Start of transitional period (2023) -indexed**

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[38] While the current ETD allows Member States to enter into bilateral agreements to waive the tax exemption for air or maritime transport between the two Member States concerned, no such bilateral agreement has ever been concluded. That is why an EU coordinated approach is needed. In November 2019, nine Member States signed a joint political declaration asking for EU coordination for aviation pricing.

		minima	
Electricity business	EUR/ MWh	0,50	0,54
Electricity non business	EUR/ MWh	1,00	1,07
Advanced biofuels and e-fuels	EUR/GJ	n/a	Same as electricity
Renewable Hydrogen	EUR/GJ	n/a	Same as electricity

Source: European Commission

Option 2a: "Energy content" Option: tax rates based on the energy content of the products and according to their environmental performance as well as a widened taxable base

This option would define the ***minimum rates based on the energy content*** (in gigajoules) of each product, rather than on the traditional volume basis, which is currently the case for most of the fuels and electricity in the Directive. This provides a better reference to compare different products and eliminates the current possible disadvantageous tax treatment of biofuels. Moreover, as different uses of electricity and hydrogen become more wide-spread, direct comparison of per unit tax rates might be useful. Whereas it is to be noted that the energy efficiency of appliances (for example heat pumps or electric vehicles) might play a bigger role than the fuel price. This ambitious change of measurement would clearly align the ETD with the objectives of the EGD.

As part of this option, the proposed new minima would be increased to reflect 2023 prices and would be automatically adjusted each year on the basis of the annual variation of the Harmonised Index of Consumer Prices (Eurostat) as in the first option.

Box 3: Proposed minimum rates

In 2023, the base value for one unit of energy content is set at 0.15 EUR/GJ, which corresponds to 0.5 EUR/MWh, the lowest minimum rate in the current Directive for electricity[39]. Taking this value, this option proposes that the minimum rates would range from 0.15 EUR/ GJ to 10.75 EUR/GJ without taking inflation into account. These minima increase to 0.16 EUR/GJ to 11.53 EUR/GJ taking inflation into account (indexation), as in option 1[40].

The indexed rate for petrol in 2023 is set at 11.53 EUR/GJ to ensure consistency with the present minimum rate (indexed) expressed in volume (see table 2).

This option will determine that the level of taxation of petrol and of electricity are the two reference values to set all the other minimum rates. This will allow to differentiate rates to provide clear signals to consumers of better performing energy products and technologies.

The minimum rates applied to energy products for motor fuel use would be applied to the aviation sector. The maritime and inland shipping sector would be subject to the same minima as those for the primary sector. While both sectors are exposed to carbon leakage, the opportunity for tankering fuel outside the EU is significantly higher in the maritime sector[41].

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[39] As well as to the current minimum level of taxation for business use of some heating fuels (natural gas and coal and coke), excluding the zero rates (set for kerosene and LPG used as heating fuels).

[40] As in option 1, adjusting for inflation is from 2018. Adjusting for inflation since 2003 would result in substantial increase in the minimum rates, which could have too negative impacts on consumers of traditional fossil fuels.

[41] https://ec.europa.eu/clima/sites/clima/files/transport/shipping/docs/ghg_maritime_report_en.pdf

The relatively low tax rate on the intra EU maritime sector would reduce the economic incentive to purchase fuel outside the EU[42].

Furthermore, the current structure would be simplified by grouping energy products together based on their environmental performance into five ***categories*** for motor fuels and four categories for heating fuels (in terms of applicable rates). The same minimum rate would apply to each energy product within a category according to their use. The five categories are:

(i) Traditional fossil fuels (including e.g. petrol, gasoil, kerosene) and non-sustainable biofuels, bioliquids and certain solid biomass
(ii) Kerosene (for motor fuel in aviation)
(iii) LPG, natural gas and non-renewable hydrogen
(iv) Sustainable but not advanced biofuels, bioliquids and certain solid biomass
(v) Electricity, advanced biofuels, e-fuels and renewable hydrogen

The highest minimum rate would apply to traditional fossil fuels due to their poorer environmental performance compared to other energy products. The minimum rates would decrease (except for kerosene for aviation) for each subsequent category with the lowest minimum rate applied to category (v).

Electricity will increasingly come from renewable sources. Increasing the share of electricity in Europe's energy system is at the centre of the EU's ambitious plan to completely decarbonise by 2050. This will mean a higher penetration of electricity in transport, heating and industry displacing fossil fuels. In line with this, the minimum level of taxation for electricity is proposed to be set at a lower level for all uses.

At the end of a ***transition period***, the categories of energy products would be further reduced to three as category (ii) and (iii) would be merged with category (i) with the rest of the fossil fuels and non-sustainable biofuels.

Option 2 ranks the different fuels according to their environmental characteristics primarily without an explicit element that reflects carbon emissions – the latter addressed explicitly in Option 3.

The concept of 'environmental performance' and the correspondent ranking of applicable rates takes into account the specific energy characteristics of the different products, their treatment under the current ETD and in the Member States, the expected -or sought-after- evolution of the EU energy mix and more importantly, it mirrors the other proposals in the "Fit for 55 package" (in particular the ETS and RED II) to ensure coherence and contribute to the common objectives. The result is reflected in the differentiated rates expressed in energy content (EUR/GJ).

In line with the indications stemming from the EGD initiatives (see e.g. COM(2020) 562 final, Stepping up Europe's 2030 climate ambition, Investing in a climate-neutral future for the benefit of our people) **traditional less environmentally performant fossil fuels** would be taxed from the beginning with higher rates. The same would apply to **non-sustainable**

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[42] Including the use of off-shore bunkering platforms that could be located on the high seas outside the territorial waters of Member States

biofuels, bio liquids and certain solid biomass, following the “RED II” logic and definitions[43];

Kerosene used as motor fuel in aviation - which is mandatory exempted in the current ETD - would be taxed in line with the rates applied to transport, by means of a linear yearly increase, to reach in 10 years the minimum rate[44]. The transitional period is justified by the need to ensure a smooth application of a new tax to the aviation sector, taking also into account the effects of the present crisis situation.

LPG and natural gas –which in the current ETD are mostly subject to low or 0 rates-, would have initial applicable rates slightly lower (precisely 2/3) than the (highest) fossil fuel rates, with a linear increase and alignment over a transitional period of 10 years. This takes into account their less polluting impact compared to other fossil fuels (see in this respect e.g. Commission Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions) and that these fuels have been considered as a sort of ‘transitional’ fuels, i.e. capable to give a contribution to the green transition (in this regard see also the current Directive 2014/94/EU on the deployment of alternative fuels infrastructure -AFID- where both products are included in the definition of alternative fuels for transport).. Analogous considerations would apply to non-renewable hydrogen[45].

As regards **Renewable Energy Sources (RES),** their expected overall share in 2030 is below what would be needed to cost-effectively and sustainably achieve 55% reduction in GHG. In this context, sustainable but not advanced biofuels, bioliquids and certain solid biomass, following the logic and definitions of RED II, would be adjusted at ½ of the traditional fossil fuel rate[46]. Currently, Member States report in TEDB diversified fiscal treatments of biofuels, ranging from exemption, to reduction, to full rate Moreover, fixing the rates at a new common basis would avoid reported State aid issues.

In the last group, for **electricity** a greater direct electrification of end-use sectors has been taken on board as a relevant objective for decarbonisation (as also highlighted in the above-mentioned COM(2020) 562 final and COM(2020) 299 final, Powering a climate-neutral economy: An EU Strategy for Energy System Integration). For **advanced biofuels, bioliquids and biogases** -once again following RED II logic and definitions-, (e-fuels and renewable hydrogen[47]), it has been judged relevant to account for their potential role for decarbonisation, as well as, the fact that they are in pre-commercial phase and deserve support. This is why they deserve a better treatment with the lowest rate;

Member States may continue to set their national taxation rates above the new minima. However, Member States must ensure that the environmental performance and use of each product is reflected in their national tax rate by respecting the ranking between the different rates. This would ensure that better performing energy products and electricity would be taxed less than those with poorer environmental performances avoiding inconsistencies across Member States and the Directive losing its relevance.

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[43] The RED II defines a series of sustainability and GHG emission criteria that bioliquids used in transport must comply with to be counted towards the overall 14% target and to be eligible for financial support by public authorities. Some of these criteria are the same as in the original RED, while others are new or reformulated. In particular, the RED II introduces sustainability for forestry feedstocks as well as GHG criteria for solid and gaseous biomass fuels.

[44] The same transitional period would apply to other fuels and electricity potentially used in aviation.

[45] As well as to non-sustainable biogas.

[46] Within this category, a linear increase over ten years to reach fossil fuel rates would only apply to sustainable food and feed crop biofuels, bioliquids and biogases, due to their peculiar origin.

[47] See also COM(2020) 301 final: A hydrogen strategy for a climate-neutral Europe

Member States will maintain the flexibility to determine the differences in rates and will not be required to adopt the same "scaling" that is proposed for the minima. By this, they will retain the flexibility to define their different rates within the "ranking" obligation.

Table 2: Proposed ETD minima under Option 2a in EUR/GJ

Motor fuels				
	Non-indexed		**Indexed**	
	Start of transitional period (2023) – not indexed	**Final rate after completion of transitional period (2033) – not indexed**	**Start of transitional period (2023)- indexed**	**Final rate after completion of transitional period (2033) - indexed**
Petrol	10,75	10,75	11,53	13,25
Gasoil	10,75	10,75	11,53	13,25
Kerosene	10,75	10,75	11,53	13,25
Kerosene (aviation)	0	10,75	0,00	13,25
LPG	7,17	10,75	7,68	13,25
Natural gas	7,17	10,75	7,68	13,25
Non-sustainable Biofuels	10,75	10,75	11,53	13,25
Sustainable Biofuels (not advanced)	5,38	5,38	5,76	6,63
Non-renewable hydrogen	7,17	10,75	7,68	13,25
Heating fuels plus fuels for agriculture, stationary motors, maritime and inland shipping (including fishery)				
	Non-indexed		**Indexed**	
	Start of transitional period (2023) – not indexed	**Final rate after completion of transitional period (2033) – not indexed**	**Start of transitional period (2023)- indexed**	**Final rate after completion of transitional period (2033) - indexed**
Gas oil	0,9	0,9	0,97	1,11
Heavy fuel oil	0,9	0,9	0,97	1,11
Coal and coke	0,9	0,9	0,97	1,11
Kerosene	0,9	0,9	0,97	1,11
LPG	0,6	0,9	0,64	1,11
Natural gas	0,6	0,9	0,64	1,11
Non-sustainable biofuels, bioliquids and solid biomass fuels (wood and pellets)	0,9	0,9	0,97	1,11
Sustainable biofuels, bioliquids and solid biomass fuels[48] (wood and pellets)	0,45	0,45	0,48	0,55
Non- renewable hydrogen	0,6	0,9	0,64	1,11
Electricity, advanced biofuels, e-fuels and renewable hydrogen (all uses)				
	Non-indexed		**Indexed**	
	Start of transitional period (2023) – not indexed	**Final rate after completion of transitional period (2033) – not indexed**	**Start of transitional period (2023)- indexed**	**Final rate after completion of transitional period (2033) - indexed**
Electricity	0,15	0,15	0,16	0,18
Advanced biofuels	0,15	0,15	0,16	0,18
Renewable hydrogen	0,15	0,15	0,16	0,18

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[48] For tax implementation and enforcement practicality reasons, solid biomass with an output under 5 MW (e.g. private individual for residential heating) is out of the scope.

Source: European Commission

Table 3: Current and proposed ETD minima for Option 2a in current units

Motor fuels				
		Current ETD minima	**Option 2a**	
			Start of transitional period (2023) -indexed	**Final rate after completion of transitional (2033) period - indexed**
Petrol	EUR/ 1000 litres	359,0	385,4	443,2
Gasoil	EUR/ 1000 litres	330,0	419,0	481,8
Kerosene	EUR/ 1000 litres	330,0	363,2	467,6
Kerosene (aviation)	EUR/ 1000 litres	0,0	0,0	467,6
LPG	EUR/ 1000 kg	125,0	162,5	280,2
Natural gas	EUR/ GJ	2,6	7,7	13,3
Heating fuels				
plus fuels for agriculture, stationary motors, maritime and inland shipping (including fishery)				
		Current ETD minima	**Option 2a**	
			Start of transitional period (2023) -indexed	**Final rate after completion of transitional period (2033)- indexed**
Gas oil	EUR/ 1000 litres	21,0	35,1	40,3
Heavy fuel oil	EUR/ 1000 kg	15,0	36,7	42,2
Coal and coke, business	EUR/ GJ	0,2	1,0	1,1
Coal and coke, non-business	EUR/ GJ	0,3	1,0	1,1
Kerosene business and non-business	EUR/1000 litres	0,0	13,6	23,5
Kerosene agriculture and stationary motors	EUR/1000 litres	21,0	34,1	39,2
LPG business and non-business	EUR/1000 kg	0,0	13,6	23,5
Natural gas business	EUR/ GJ	0,2	0,6	1,1
Natural gas non business, agriculture and stationary motors	EUR/ GJ	0,3	0,6	1,1
Electricity (all uses)				
		Current ETD minima	**Option 2a**	
			Start of transitional period (2023) -indexed	**Final rate after completion of transitional period (2033) - indexed**
Electricity business	EUR/ MWh	0,50	0,58	0,67
Electricity non business	EUR/ MWh	1,00	0,58	0,67

Source: European Commission

In addition, this option would ***extend the scope*** of the Directive and ***remove certain differentiations, reductions and exemptions****,* therefore widening the tax base from the first year. The following would be the main areas of intervention:

- Intra-EU flights within the aviation[49] sector – the mandatory exemption would be removed for this fuel use (see box 4 below)
- Intra-EU maritime and inland shipping[50] sectors – the mandatory exemption of the maritime sector would be removed and the optional exemption of the inland shipping sector would no longer be possible. On the other hand, considering the increasing number of Member States requiring a derogation for the tax treatment of electricity directly supplied to vessels at berth in a port ("shore-side electricity" (SSE)), a possibility for a differentiated tax treatment (not below the minimum level) would be introduced (see box 4 below)
- Some of the "out of scope" processes, such as the use of energy products for mineralogical as well as metallurgical processes other than dual-use, will move to 'in scope'
- Industrial tax reliefs – the application of tax reliefs will be more stringent and will be coupled –where applicable- to environmental performance. Full exemption will be no longer be possible and minima for energy intensive industry and other business sectors will be applied
- Lower minimum rates will be applicable on energy products and electricity used in the primary sector with no possibility to benefit from exemptions
- Heating fuels and electricity for households will no longer benefit from rates below the minima, however the possibility for full exemption limited to vulnerable households will be retained
- Solid biomass fuels covered by Combined Nomenclature codes 4401 and 4402 will be included in the scope.[51]
- No possibility of differentiation between commercial and non-commercial use of gas oil
- Combined heat and power generation (CHP). The taxation of the share of input to produce heat in CHP generation would be set at not less than the minimum rates for the product used. The taxation of the share of input to produce electricity would follow the general rule for electricity generation (i.e. optional exemption with the possibility for Member States to tax on the grounds of environmental policy)
- Article 9(2) of the ETD, which provides for lower minimum levels of taxation for gas oil used for heating purposes in three Member States, would be abolished

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[49] The exclusion of international flights and possibly cargo flights from the scope is due to air services agreements concluded with certain third countries that do not allow for the taxation of fuels uplifted at EU airports by the carriers of these third countries.

[50] Refers to a voyage from one EU port to another EU port

[51] For solid biomass used in installations certified equally or above 5 MW. This allows securing state revenue with the growing use of these products since 2003 and taking into account the impact of their combustion on air quality.

Box 4: Aviation, maritime and inland waterway transport

Design of the tax treatment

Under this policy option the use of fuel in aviation, maritime (both transport and fisheries) and inland waterway transport will be taxed at harmonised EU minimum rates as far as intra-EU activities are concerned. The tax on kerosene for aviation will be phased in over a transitional period of 10 years.

In case of aviation, intra-EU activity is defined as a flight from one EU airport to another EU airport whereas in case of maritime and inland waterway transport it is defined as a voyage from one EU port to another EU port. The concept of intra-EU operations would replace the present concept of navigation within EU waters for maritime. For aviation, the exclusion of international flights from the scope of the revised tax is due to legal reasons as air services agreements with some third countries do not allow the taxation of fuel uplifted by the carriers of these third countries at EU airports[52]. Additionally, the tax treatment of intra-EU cargo only flights calls for special attention due to the special privileges granted to some third country and the number of intra-EU cargo-only flights carried out by these carriers[53].While similar privileges are also granted to operators from certain third countries for passenger transport; however, for operational reasons (it is often uneconomical to use the same passenger plane for long-range and short-range flights) those privileges have hardly been used.

Taxing fuel for cargo-only flights could affect the competitiveness of EU carriers for two reasons. Firstly, US carriers have a significant market share of in the intra-EU cargo market as under the US-EU Open Skies agreement some US cargo carriers are allowed to fly intra-EU flights without restriction. Secondly, the current exemption of US carriers from the taxation of aviation fuel uplifted in the EU for use in international (including intra-EU) flights does not allow the taxation of fuel uplifted by US carriers in the EU. Therefore it would be proposed that fuel uplifted by cargo-only flights also in intra-EU would be exempted from fuel tax, with a possibility for Member States to tax it on domestic flights or by virtue of bilateral or multilateral agreements between them. This would provide for a certain flexibility, for example in case of renegotiation of air service agreements with third countries allowing the introduction of the fuel tax for this market segment as well.

The rates for the fossil fuel tax for aviation are based on energy content in line with those applied to the road transport sector. In the study referred to in Annex 7 on aviation, the impacts of various sub options of an intra-EU fuel tax, a ticket tax and a combination of a ticket tax and a fuel tax are analysed. In this study, also a legal analysis and various sensitivity analyses are carried out (e.g. on a possible slower recovery of the sector after the COVID-crisis, the introduction of a blending obligation as proposed in the ‘ReFuelEU Aviation’ initiative and the introduction of fuel tax covering some extra-EU flights to the UK and Morroco[54]).For maritime and inland waterways, it is proposed to tax the fossil fuels as the

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[52] However, a fuel tax could in principle be applied to international flights to those third countries that do not have air services agreements with the EU or with the concerned Member States preventing the taxation of fuel uplifted. In any case, ticket taxes may be an appropriate instrument to be applied to those international flights that would be outside the scope of the fuel tax

[53] American carriers enjoy special provisions under the EU-US 'Open Skies' Air Transport Agreement permitting them to carry out hub operations within Europe using all-cargo aircraft permanently station in the EU

[54] These are third countries for which the implementation of fuel tax is not prohibited by air services agreements.

agriculture sector. The relatively low rate of the tax and the limitation to intra-EU shipping is designed to reduce the economic incentive to purchase fuel outside the EU[55].

The aviation and the shipping sectors are exposed to different degrees to possible carbon leakage due to tankering or bunkering (whereby fuel is bought outside EU jurisdiction to be used on subsequent intra-EU transport operations). Due to the limited size of the fuel tanks of aircrafts, the opportunities for fuel tankering in aviation are relatively limited[56] and depend on the distance to the third country concerned and the aircraft used. The risk of carbon leakage by tankering fuel outside the EU is much more significant in the maritime sector. Ships, in particular large ships, are able to undertake long voyages on a single bunkering and can carry additional fuel without significantly sacrificing their carrying capacity[57]. Ships carrying out extra-EU transport operations can avoid uplifting fuel in EU ports as they can simply uplift more fuel in third countries and thereby avoid the EU fuel tax . . According to the modelling done for the impact assessment, intra-EU transport will represent approximately 16% of all fuel use in the waterborne transport sector in 2030[58].

On the other hand, to be entitled to tax-free bunkering in the EU, vessels would have to justify the need to have access to tax exempt fuel. As an ex-ante conditionality, eligibility for tax-free bunkering would have to be proved by producing the relevant customs documents indicating the next port of call that is located outside the EU. To further strengthen enforcement, ex-post verifications could be carried out based on, for example, the positioning system of the vessels as part of random checks. The rules will be different for fishing vessels in the case of which there are no customs documents to be examined[59].

Interaction with other EU initiatives to reduce GHG emissions

The taxation of traditional fossil fuels used in the aviation and maritime sectors complement a possible extension of the EU ETS to the maritime sector and the review of ETS for aviation including an increase of the level of auctioned allowances for aviation and the implementation of CORSIA as proposed in the revision of the EU ETS. Taken together, these initiatives would ensure that also these economic sectors contribute to the financing of the general budgets under the ETD, while under ETS revenues are reinvested into low-carbon technologies, and reinforce the carbon price signal and the economic attractiveness of mitigation measures such as the implementation of energy efficiency measures or the switch to renewable and low-carbon fuels. Both measures can be modelled in a similar way, as a carbon price or a fuel tax. It is worth noting, however, that the price signal resulting from the options considered for application of ETS and CORSIA to aviation emissions are expected to be lower than the impact of the proposed fuel tax in the aviation sector. On the contrary, in the maritime sector, the possible ETS extension would lead to a much stronger carbon price signal in comparison to the proposed fuel tax on bunker fuel.

The taxation of traditional fossil fuels used in these sectors is also coherent with the logic of the 'ReFuelEU Aviation' initiative aimed at boosting the production and uptake of sustainable aviation fuels in the air transport sector and the 'FuelEU Maritime' initiative aimed at

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[55] Including the use of off-shore bunkering platforms that could be located on the high seas outside the territorial waters of Member States

[56] https://www.eurocontrol.int/publication/fuel-tankering-european-skies-economic-benefits-and-environmental-impact
The study estimated that full tankering could potentially be performed on 16.5% of the examined European flights, whereas partial tankering could be performed on further 4.5% of flights.

[57] https://ec.europa.eu/clima/sites/clima/files/transport/shipping/docs/ghg_maritime_report_en.pdf

[58] This includes both intra-EU maritime and inland waterways transport.

[59] As fishing vessels return to their home ports located in the EU, their activities will be considered intra-EU for the purpose of this Directive.

increasing the demand of renewable and low-carbon fuels in the maritime transport sector. As the sustainable and low carbon fuels promoted by these initiatives would be taxed at lower rates under the ETD, the gap between the total costs of traditional and sustainable fuels would narrow down over time and the cost of fuel switching would be reduced[60].

As regards the agriculture sector, the current ETD provides for differentiated and lower minima for motor fuels for certain uses, including agricultural, horticultural and piscicultural works, and forestry. The proposed rates are based on the envisaged need to align those minima and the ones for heating fuels in order to provide for a generally consistent treatment. Moreover, the proposed revision envisages the overall need to respect the applicable minima, leading to the removal of the -currently allowed- possible reduction down to zero for energy products and electricity used in the primary sector.

Finally, the option will **increase legal certainty** for all stakeholders:

- To address the risk of fraud and improve the legal certainty, an update or a revision of the list of energy products subject to control and movement provisions may prove necessary (e.g. for lubricating oils)
- Provisions regarding energy storage will ensure that the possible double taxation of electricity, which is stored for consumption at a later stage, is avoided.

This option includes a ***transitional period of ten years*** (2023-2033) for ***certain categories of products and uses*** to provide stakeholders with a clear price signal trend for the next years in order to adapt investments and technologies. Some relevant examples are:

- The tax on LPG, natural gas and non-renewable hydrogen for both motor and heating use would gradually reach the rate of fossil fuels
- Kerosene tax for the aviation sector will be gradually increased in a linear way to the corresponding minimum tax rates applicable to motor fuels used for road transport .
- A zero rate for advanced biofuels and e-fuels used in aviation will be applied for a limited period. This contributes to the uptake these types of fuels until their production is scaled up.
- The minimum rates for heating fuels for household use will be gradually increased during this period, as described in option 1.

Furthermore, proposing to introduce immediately the three categories with high rates for some traditional energy products could have negative impacts. This transitional period, among others, allows the development of electrification and advanced fuels, which are still in a pre-commercial phase.

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[60] In due course, the costs of some sustainable fuels could even be lower than the costs of the fossil fuels. . The impact on the cost of sustainable fuels could not be modelled. Instead, the assumptions of the Refuel Aviation study on the costs of sustainable aviation fuels have been used for this study.

Figure 8: Simplified representation of changes in ETD indexed minima 2023-2030

Source: European Commission

Two thirds of the respondents to the public consultation from businesses and from public authorities as well as 45% of the respondents from civil society consider relevant an energy tax based on energy content. Moreover, more than 90% of all types of respondents consider that the ETD revision should introduce incentives for alternative energy sources (e.g. sustainable biofuels, clean hydrogen) and reduce the possibility of favouring fossil fuels via tax reductions, exemptions and rebates[61]

A vast majority of citizens and civil society respondents but only a small minority of businesses and public authorities indicated that no exceptions should be granted to agriculture, forestry and fishery.

Overall, the public consultation revealed some support to equalising the taxes for different transport modes so that they can compete on a level playing field.
About one third of businesses and more than half of the other stakeholders support the taxation of the intra-EU flights and of the maritime sector based on standard energy tax rules for motor fuels.

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[61] 65% of businesses support the reduction of the possibility to favour fossil fuels

While a vast majority of all types of respondents to the public consultation would prefer a legal obligation to use Shore Side Electricity when available, a differentiated tax treatment for SSE is supported by 40% of businesses.
Almost all citizens, more than 70% of civil society and public authorities and half of the businesses support the removal of the differentiation between commercial and non-commercial use of gas oil in road transport.

Two thirds of citizens and half of civil society respondents to the public consultation consider the Industry sector should not be exempted; however only a bit more than 10% of public authorities and of businesses agree with the removal of this exemption.
About half of the citizens and civil society respondents to the public consultation support the removal of tax exemption or reduction to Combined Heat Power but more than 85% of businesses and public authorities respondents disagree.

Option 2b: Energy content option with a shorter transitional period of 7 years

This option includes the same elements of option 2a but with a reduced transitional period until 2030. This impact assessment assumes a period of 7 years (2023-2030).

With the 2030 Climate Target Plan, the Commission proposes to raise the EU's ambition on reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030. Taxation should also contribute to this objective. Reducing the transitional period to 2030 would ensure that the review of the ETD can deliver its objectives at the same time as the rest of the other initiatives of the “Fit for 55 Package”.

Accordingly, the option analyses a shorter transition period and the potential increased benefits by 2030, while taking into account the social and economic effects on users and consumers.

Option 2c: Energy content Option and pollution component

The option is based on option 2a with an additional explicit tax rate for air pollution. The calculation of this additional component is based on a low-end value of the external cost of air pollution due to the consumption of energy products. (See Annex 6 for further details).

This value would be incorporated in the minimum tax rates as set out in option 2a. While this pollution component would not be indexed, it would be revised at least every 5 years in order to take into account the evolution of technology in combustion and filtering systems as well as the evolution of air pollutant emissions in the EU.

It should be noted that the highest increase in the minima would correspond to coal and coke and to biomass (without differentiating between sustainable or non-sustainable) mainly used as fuels for stationary motors and/or heating in absolute and relative terms.

Table 4: Proposed ETD minima including the pollution component in EUR/GJ

	Rate energy component option 2a at the start of transitional period (2023) – not indexed	Rate Air Pollution component	Full rate option 2c at the start of transitional period (2023) – not indexed
Motor fuels			
Petrol	10,75	0,23	10,98
Gasoil	10,75	0,55	11,30
Kerosene (aviation, by the end of the transitional period)	10,75	0,05	10,80
LPG	7,17	0,19	7,36
Bioethanol E100	5,38	0,35	5,73
Biodiesel B100	5,38	0,83	6,21
Heating fuels **plus fuels for agriculture, stationary motors, maritime and inland shipping (including fishery)**			
Gasoil	0,90	0,37	1,27
Heavy fuel oil	0,90	0,37	1,27
Coal and coke	0,90	7,41	8,31
Kerosene	0,90	0,37	1,27
LPG	0,60	0,37	0,97
Natural gas	0,60	0,32	0,92
Non-sustainable biofuels and bioliquids	0,90	(*)	0,90 + (*)
Non-sustainable solid biomass fuels (wood and pellets)	0,90	7,40	8,30
Sustainable biofuels and bioliquids	0,45	(*)	0,45 + (*)
Sustainable biomass fuels (wood and pellets), including consumers with an inputunder 20 MW[48]	0,45	7,40	7,85

(*) same as the equivalent fossil fuel; e.g. the rate of the air pollution component for biodiesel is 0,37 €/GJ
Source: European Commission

Option 3: "Carbon content" Option (3a, 3b and 3c)

This option introduces taxation based on carbon content of energy products, to the sectors which are currently not covered by the ETS[62] (basically the transport and building sectors), in addition to the rates based on the energy content presented in option 2a and 2b. However, it should be recalled that the EGD has announced that the Commission will consider the possibility of extending the ETS to emissions from road transport, the maritime sector and buildings.

The introduction of this carbon content component in the ETD would be a form of explicit carbon pricing directly linked to the level of carbon emissions. This option provides an additional relative advantage to clean products, such as renewable hydrogen, advanced biofuels and electricity, as they have low or zero carbon content. The introduction of a carbon content also differentiates among various fossil fuels, such as less CO_2 intensive natural gas and more CO_2 intensive coal.

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[62] Aviation would therefore be exempt from the CO2 component as intra-EEA aviation is covered by the ETS but maritime and inland shipping would not be exempt as long as these sectors are not covered by the ETS.

Since the EU harmonised carbon price is the ETS, the value for the carbon content should be linked to its price. This value would also have to be adjusted regularly to ensure it remains relevant and pegged to the evolution of the ETS over time.

The value of the carbon content component from the introduction of the reviewed rules in the ETD should reflect the level of the price of ETS at that moment. For the purposes of this impact assessment, the carbon content rates have been applied as follows: 30 EUR per tonne of CO_2 in 2020, 35 EUR in 2025, 40 EUR in 2030 and 45 EUR in 2035. These values approximate the present and expected future market price of the EU ETS similar to the other impact assessment of the "Fit for 55 Package". These values take into account the fact that the effective cost in the EU ETS is lower if free allocation of allowances to many ETS sectors are also considered. These values will operate as a minimum rate to be added to the energy content component.

In option 3a a transitional period of 10 years is applied to the taxation of intra-EU aviation, as well as to heating fuels, whereas in option 3b a transitional period of seven years is considered. Finally, option 3c introduces a pollution component in an analogous way to option 2c. As option 2a and 2b, options 3a and 3b will also bring positive effects on air pollution emissions following the increase in taxation of the more air pollutant products with the additional introduction of the carbon content element.

Table 5: Tax rates with carbon content

	Energy component rate (EUR/GJ) Not indexed	**CO2 tax rate (EUR/tCO2) in 2030**	**Fuel emission factor (tCO2/GJ)**	**Carbon component (EUR/GJ)**	**Total minimum rate (energy + carbon component) (EUR/GJ) Not indexed**	**Total minimum rate at start of end of transition period (energy + carbon component) (2033 EUR/GJ)**
Motor fuels						
Petrol	10,75	40	0,07	2,80	13,55	16,05
Gasoil	10,75	40	0,07	2,80	13,55	16,05
Kerosene (aviation)	0	40	0,07	2,80	2,80	2,80
LPG	7,17	40	0,06	2,40	9,57	11,24
Natural Gas	7,17	40	0,06	2,40	9,57	11,24
Sustainable biofuels	5,38	40	0	0,00	5,38	6,63
Non- Sustainable Biofuels	10,75	40	eq. fossil alternative	eq. fossil alternative	eq. fossil alternative	eq. fossil alternative
Heating fuels plus fuels for agriculture, stationary motors, maritime and inland shipping (including fishery)						
Gasoil	0,9	40	0,07	2,80	3,70	3,91
Heavy fuel oil	0,9	40	0,08	3,20	4,10	4,31
Coal and cokes	0,9	40	0,09	3,60	4,50	4,71
Kerosene	0,9	40	0,07	2,80	3,70	3,91
LPG	0,9	40	0,07	2,80	3,70	3,91
Natural Gas	0,9	40	0,06	2,40	3,30	3,51
Non-sustainable biofuels, bioliquids and solid biomass fuels (wood and pellets)	0,9	40	0	0,00	0,90	1,11
Sustainable biofuels, bioliquids and solid biomass[48] fuels (wood and pellets)	0,45	40	0	0,00	0,45	0,55

Electricity, advanced biofuels and renewable hydrogen (all uses)						
Electricity	0,15	40	0	0,00	0,15	0,18
Advanced biofuels	0,15	40	0	0,00	0,15	0,18
Renewable hydrogen	0,15	40	0	0,00	0,15	0,18

Source: European Commission

5.3 Options discarded at an early stage

Option with rates based on energy content but without changes in the taxable base

This option would have included the same definition of rates as under option 2 and the same definition of the taxable base as in option 1. While such an option would have a more limited impact on the productive sectors, this would be at the expense of the main objective of the ETD under the EGD, namely to reduce fossil fuel dependency. Moreover, this option would not solve the one of the main problems detected in the evaluation, namely the puzzle of different and uneven national implementations due to use of reductions and exemptions. Finally, an option mainly based on revised rates would impose a disproportional burden to the Member States whose national rates are currently lower without incentivising changes for the other Member States.

Option with tax differentiation according to the source of electricity

This option would have included the differentiation of taxation of electricity according to its source. Electricity of renewable origin would have been taxed at a lower or zero rate. Due consideration was given to this option. Ultimately, in line with the Better Regulation Guidelines, it was discarded on the basis that the option lacks technical feasibility as there is no EU-wide functioning guarantee of origin system in place. Differentiated tax treatment would need to rely on a robust certification system that is not given. While tax differentiation based on origin of electricity is not proposed to become mandatory under harmonised EU legislation, all options of this Impact Assessment retain the current possibility to apply such differentiation on the national level. It remains at the discretion of Member States to apply optional tax reliefs to renewable electricity in accordance with Article 15(1)(b) of the Directive.

6. WHAT ARE THE IMPACTS OF THE POLICY OPTIONS?

This section gives an overview of the main impacts of the options considered under the revision of the ETD by comparing them to the baseline – the latter described in detail under Section 6.1. The analysis is based primarily on the JRC-GEM-E3 model, supplemented with input from the EUROMOD and DG ECFIN's E-QUEST models, the specifications of which are discussed in Annex 4.

Various alternative modelling assumptions were explored with the JRC-GEM-E3 model. For the purposes of this analysis, the focus is on the results based on budget neutrality, where government budgets are held fixed to baseline values in relative to GDP. All additional revenue from the changes in ETD are provided as lump-sums to households[63]. Moreover,

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[63] Budget neutrality is a common assumption in many CGE modelling assessments of indirect taxation. While the main results presented focus on lump-sums to households, alternative model closures were explored in the JRC-GEM-E3 modelling most notably labour tax recycling. The results were consistent with the results received on alternative recycling scenarios explored under the E-QUEST model. More specifically CO_2 emissions and tax revenue show little differentiation by the choice of lump sum / labour tax recycling. At the same time labour tax

modeling with the JRC-GEM-E3 further assumes imperfect labour markets, namely wages are held fixed allowing for unemployment to adjust after the policy shock.

The JRC-GEM-E3 model, like all CGE models, can consider technological changes and appliances/equipment substitution only in an aggregated way. Therefore, product substitution is not fully captured in the results. In particular, the model does not capture the treatment of advanced biofuels and hydrogen. Not covering these products may imply that the impact of the proposed tax changes on climate variables is underestimated whereas the macro economic impact (as driven by changes in demand) could be overestimated.

Moreover, the model does not consider substitution between petrol and diesel, which may lead to an overestimation of additional tax revenue as a result of the tax changes. Nevertheless, the model allows for product substitution between aggregate fuels: oil, gas, coal and electricity. The results overall confirm that that the outcome is in the expected direction, as a result the proposed policies.

Nevertheless, advanced biofuels, hydrogen and e-fuels are considered in the revision of Directive, as they may play a significant role in a decarbonised transport sector in the long run. Currently, the share of these fuels in transport is negligible, and it seems unlikely that the proposed revisions of the ETD alone would suffice to ensure a technological breakthrough in a time horizon of 10 years or less. In combination with other policies, however, the importance of these fuels in the fuel mix could increase over time. If this materialises over the next decade, the results of this impact assessment may -as noted before- overestimate the role of a reduction of activity (e.g. number of flights) as a response to higher energy taxation. Hence real-world GDP impacts could be lower than the ones presented in our assessment.

Concerning fossil fuels, the proposed Options 2 and 3 raise the minimum excise tax rate on diesel to the level of petrol. As a consequence, one might anticipate behavioural responses along four main channels. First, a shift from diesel to petrol. Second, a shift to electricity. Third enhanced energy efficiency (e.g. through modernisation of the vehicle fleet). And finally, activity reduction. The modelling does not capture the first channel, and this caveat may introduce a bias in the results in terms of air pollutant emissions. To a lesser extent, this could also affect estimates of tax revenue and emissions of CO_2, although the assumption of fixed diesel/petrol shares will overestimate the cost increase and the corresponding activity reduction, such that the sign of the overall bias is unclear a priori. Furthermore, for tax revenue estimates, the shift from diesel to petrol would not be particularly relevant, since the proposal includes an equalisation of tax rates across both fuels.

In the assessment of the impacts, coherence with other ‘Fit for 55’ proposals is ensured by placing the quantitative analysis of the different ETD options against the same baseline with all other proposals, namely the EU Reference Scenario (REF)[64]. This ensures that the basic assumptions underlying all modeling scenarios are consistent with other proposals and that in the simulations performed only the impact of the proposed changes of the ETD is accounted for.

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recycling, can mitigate the already limited GDP losses that arise under lump sum recycling. Moreover, using additional tax revenue to stimulate employment, in this case modelled as lower taxes on labour, and related social investments to support a smooth functioning of the labour market can limit up to nearly three quarters of the job losses experienced under lump sum recycling.

[64] Alternative pathways to achieve 55% emission reductions by 2030 such as the so called MIX scenario are not explored in this impact assessment’. The MIX scenario as stipulated in the Climate Target Plan includes the extension of ETS to transport and building sectors. As such, the MIX scenario would have been incompatible with the ETD Option 3.

In addition to the above, specifically for the proposal on extension of ETS to transport and buildings, coherence is safeguarded by ensuring that in the modeling of option 3, the CO2 component is not applied to any of the current ETS sectors. In this context, the analysis recognizes that the CO2 component of option 3 cannot coexist with ETS in any sector. Therefore, application of the carbon component in this option is strictly limited to sectors currently not covered by the ETS. This eliminates the potential for any overlap between the two. For all other options the proposed changes in fuel taxes can fully coexist (and in fact reinforce) the ETS.

The options considered include the main options discussed in Section 5 including variations as regards to transitional periods.

Table 6: Options considered in the modelling exercise

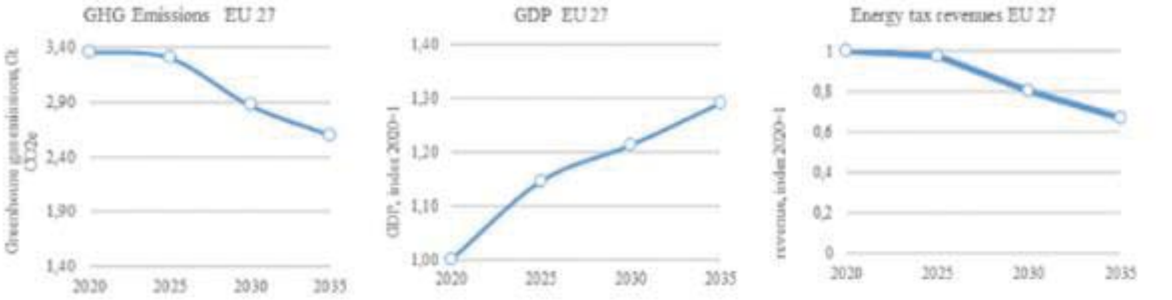
Scenario	Specifications
Option 0	Baseline scenario
Option 1	“Minimalistic” Option
Option 2a	“Energy content” Option with 10 year transitional period
Option 2b	“Energy content” Option with 7 year transitional period
Option 2c	“Energy content” Option with 10 year transitional period and pollution
Option 3a	“Carbon content” Option with 10 year transitional period
Option 3b	“Carbon content” Option with 7 year transitional period
Option 3c	“Carbon content” Option with 10 year transitional period and pollution

The discussion on impacts presented below provides results for all options and their variations.

6.1 Baseline

The baseline represents a projected evolution of the EU economy based on agreed energy and climate policies. As discussed in section 5.1, energy consumption and emissions are aligned with the aligned with the new EU REF, which includes the National Energy and Climate Plans of Member States.

Figure 9: Evolution of GHG emissions, GDP and energy tax revenues in the baseline with fixed nominal energy tax rates

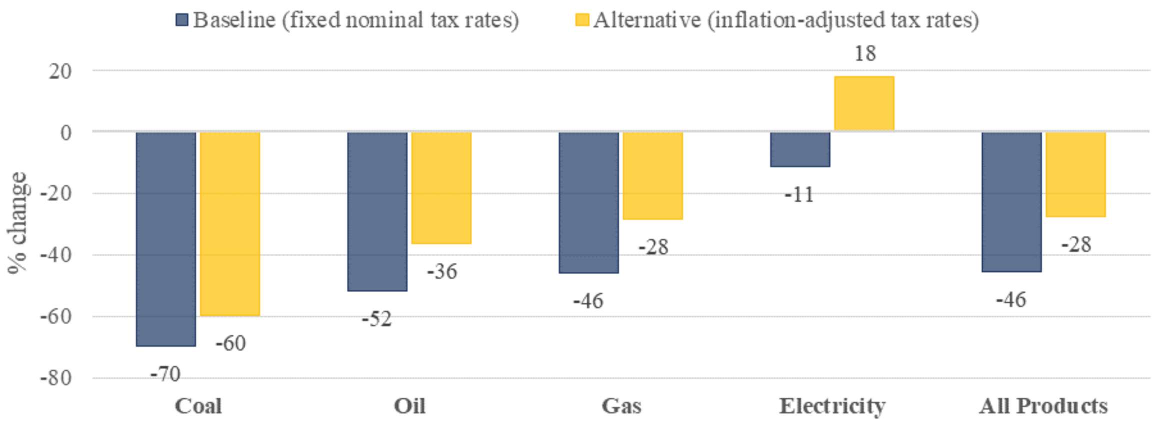


Source: JRC-GEM-E3

Despite a drop in economic activity in 2020 linked to the pandemic, the baseline projects sustained economic growth over the 2020-2035 period. Revenues from energy taxation, however, are projected to drop substantially in the baseline (c. -32% between 2020 and 2035). This is driven by two main factors, namely the projected evolution of the energy system under existing climate and energy policies and the assumption of fixed nominal excise tax rates. The decrease of tax revenues under the current climate and energy policies is noteworthy on its own, and merits attention in view of the relative stability that have characterized them over the last two decades. The baseline is based on stylized assumptions and does not consider possible increases in tax rates by Member States to react to a drop of revenues as they have done in the last twenty years to ensure a stability with the revenues.

The figure below provides more insight into this trend by breaking down tax revenues by energy products. The chart serves to illustrate two key effects: enhanced energy efficiency (all Products) and fuel shifting (stronger decrease in fossil fuel-related tax revenue while the dependency on electricity will go up) over the period 2020-2035. A simple calculation with a hypothetical alternative baseline (yellow bars), assuming fixed excise duty rates in real terms (inflation-adjusted), shows that revenues from energy excise duties would still drop significantly compared to 2015 levels even if rates applied in the Member States were to be adjusted upward to correct for inflation. Nearly two thirds of the projected drop in energy tax revenues can be attributed to the expected evolution of the energy system.

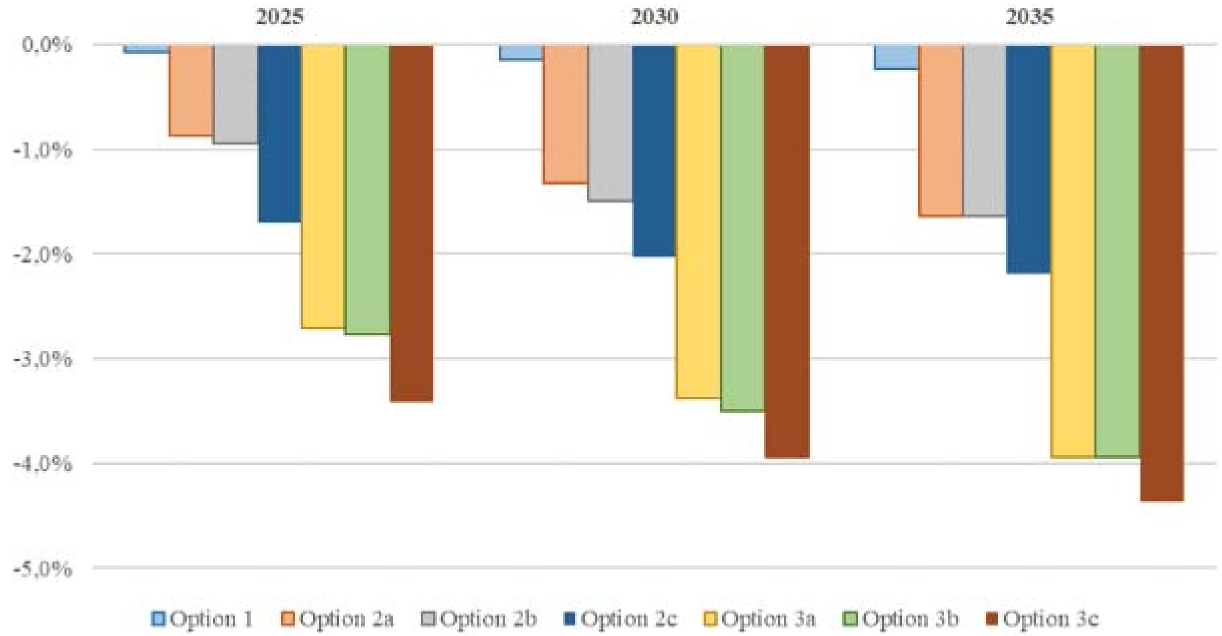
Figure 10: Comparison of change in tax revenue for EU 27 in 2035 relative to 2015 under alternative assumptions (fixed nominal rates and inflation adjusted)



Source: JRC-GEM-E3

6.2 Impact on environment: GHG and air pollutant emissions

Figure 11: Change in EU 27 GHG emissions (% change from baseline)



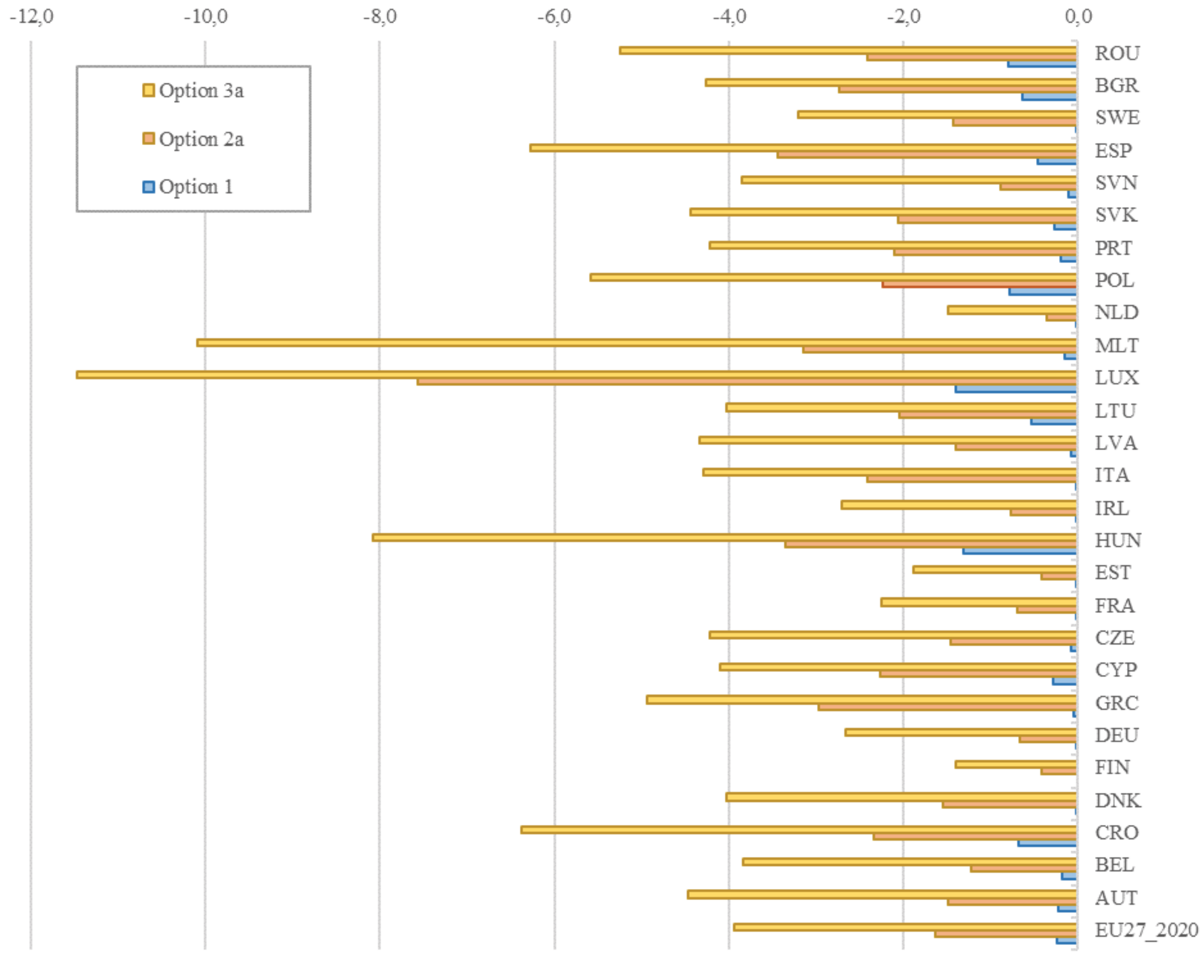
Source: JRC-GEM-E3

The proposed changes under the options considered clearly have the expected positive, albeit small in the case of option 1, impact on the reduction of GHG emissions. These results illustrate that the proposed tax reforms contribute to the objectives of the Green Deal. The results show that the scenarios will have a positive impact in this respect, due to the decrease in fossil fuel support, even when a CO2 component is not yet introduced in the proposed tax design.

The limited impact of option 1 is mostly the result of the indexation of rates in volumes' terms and the limitation imposed on Member States to set rates below the minima. By the end of the transitional period (2035), of the central option (Options 2a and 2b) the impact on GHG emissions is estimated to be more than seven times higher than the impact of the minimalistic option. The impact on GHG emissions is noticeable under the central option, considering the increase and wide restructuring of the tax rates, along with the broadening of the taxable base in this scenario.

When a CO2 component is introduced (Options 3a and 3b) the positive impact on GHG emission more than doubles the impact observed under option 2. This is obviously, because this option adds an explicit CO2 price on top of option 2, which already includes a remarkable reduction of fossil fuel incentives. The relative contribution towards GHG reduction differs noticeably among Member States, largely depending on the starting point of their energy tax design.

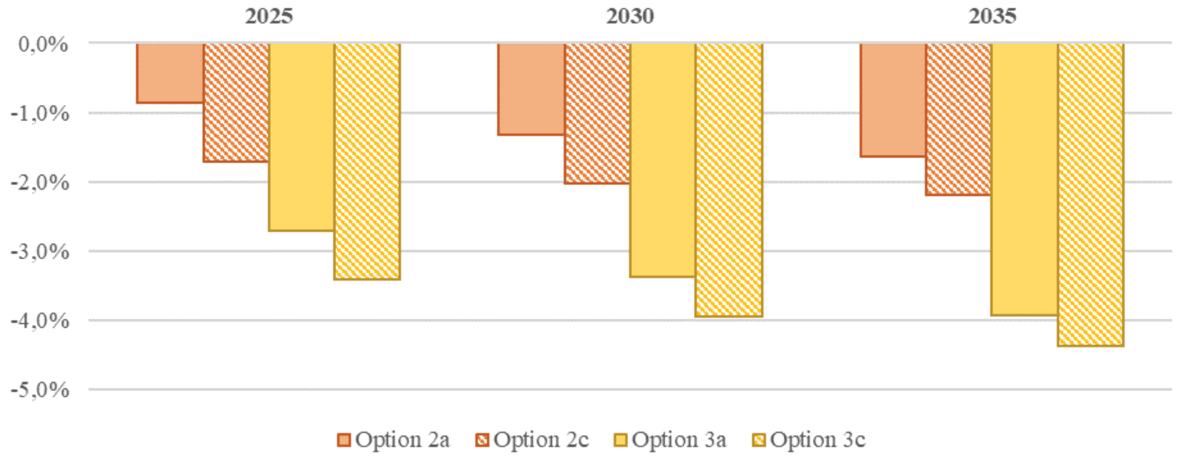
Figure 12: Change in GHG emissions by Member States compared to the baseline in 2035 (in percentage)



Source: JRC-GEM-E3

In the case of the minimalistic option (Option 1), the main driver of the impact is the increase in the minimum rates following their indexation, which will impact notably those Member States whose current national rates are fixed or close to the minima in the ETD. In the case of the central option (all variants of Option 2), the drivers of the impacts are deeper and more wide spread among Member States, considering, as mentioned earlier, the increase of the tax rates and wide broadening of the taxable base. In the case of the CO2 option (all variants of Option 3), the distributional impact among Member States is similar to the one observed under Option 2. Adding the air pollution component results in a stronger reduction in CO2 emissions as illustrated in Figure 13 below.

Figure 13: Change in EU 27 GHG emissions following the introduction of air pollution component compared to baseline

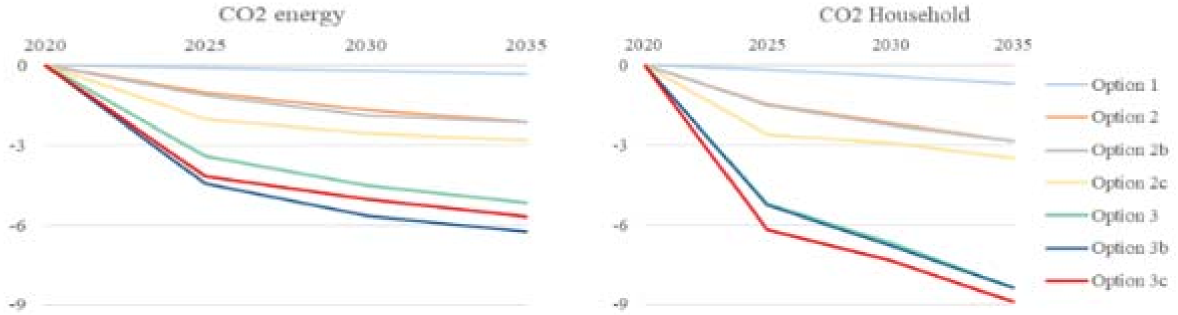


Source: JRC-GEM-E3

Comparing the CO2 emissions reduction by users, the figure below illustrates the contribution by households in relation to productive sectors. In all options, the main contribution to CO2 reduction appears to come from changes in demand by the household sector. However, under options 2 and 3 there is a noticeable increase in the effort made also by the productive sector. While households remain the biggest contributor, the increase in rates and wide broadening of the tax base under these options (Option 2 and 3) result relative greater contributions by the energy and process industries.

With the introduction of the air pollution component (Options 2c and 3c), CO2 emissions from energy in the EU27 aggregate are around 1% lower relative to Option 2 and 3 respectively. It is interesting to highlight that adding the air pollution component to Option 2 (i.e. **Option 2c**) results in a stronger carbon emissions reduction compared to when we add the air pollution component to Option 3, under Option 3c. This is explained by the fact that the inclusion of the carbon tax for the sectors outside the ETS already have a larger effect on the emissions of those gases. However, in absolute terms, the highest GHG (and air pollution) reduction compared to baseline is obtained under option 3c, which includes both the carbon content and the air pollutant component.

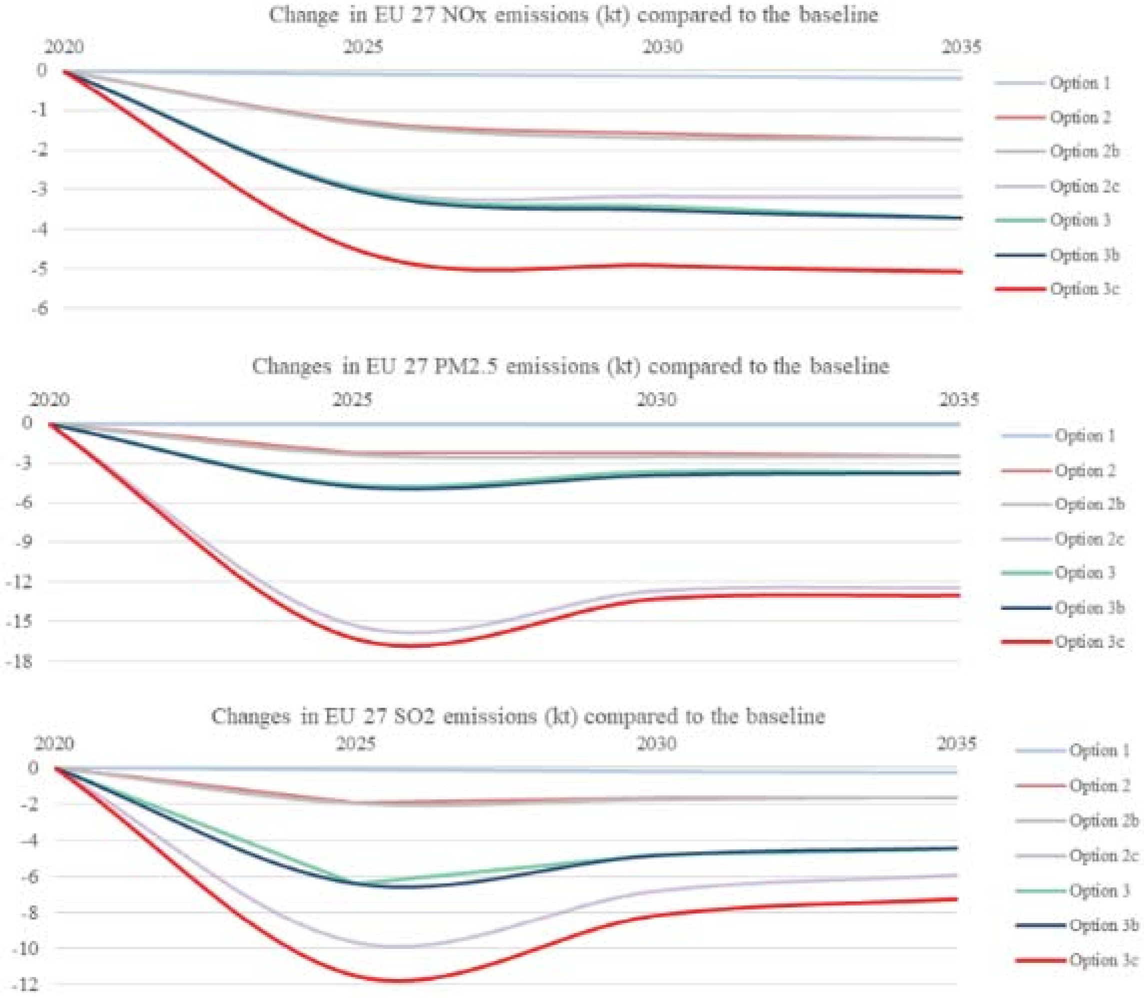
Figure 14: Changes in EU 27 CO2 emissions by users compared to baseline (in percentage)



Source: JRC-GEM-E3

Turning to impact on other pollutants, the analysis focused on the effects on NOx, PM 2.5 and SO2 emissions (aka here as "air pollution"). Figure 15 bellow illustrates the impact on the emissions of these gases by options until 2035. As indicated, only option 1 appears to have very negligible impact on the pollutant emissions. This is clearly due to the lack of significant changes in the levels and structure of tax rates along with a small impact on the taxable base. Option 2 has a noticeable impact on the reduction of all pollutants, even when a specific pollutant component is not added to the minimum tax rates. In fact, the increase and wide restructuring of the tax rates and broadening of the taxable base, clearly result in a behavioural change that reduces the use of more pollutant energy products. The introduction of a CO2 component (Option 3) has a relative limited additional impact on pollution reduction. As expected, when a pollution component is introduced (Options 2c and 3c) we observe a significant impact on pollution emission reductions – mostly noticed in 2025 if compared with 2035 in particular for PM 2.5 and SO2 emissions.

Figure 15: Changes in different pollutants compared to the baseline (in percentage)



Change in EU 27 NOx emissions (kt) compared to the baseline

Changes in EU 27 PM2.5 emissions (kt) compared to the baseline

Changes in EU 27 SO2 emissions (kt) compared to the baseline

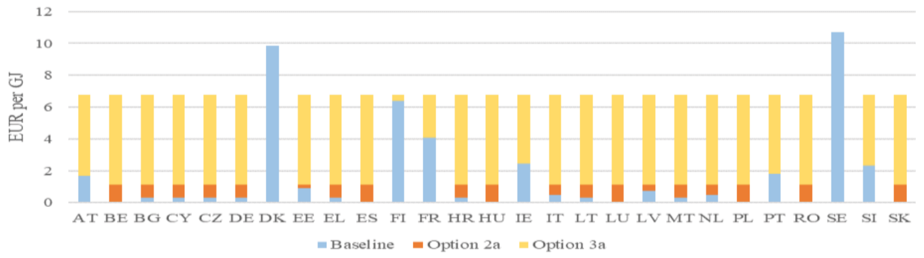
Source: JRC-GEM-E3

6.3 Impact on the internal market

The introduction of the new minima will contribute to greater convergence of tax rates across Member States. It should be noted again that all options are modelled on the hypothesis that only national rates that are below the new minima are increased to ensure alignment with the new minima. National rates that are already above the new and higher minima are kept at their present level. The following graphs illustrate the impacts of the proposed options on the effective tax rates applied to different users, uses and energy products (e.g. Households, Heating, Natural Gas). The baseline reflects how effective rates would look by 2035 in each Member State on the assumption that no change would be introduced, while the add-ons reflect the required increase to respect the new minima set by the revised ETD. The presented rates encompass both changes in rates and volumes of energy consumption. This was required by the need to illustrate the expected changes in effective rates in a comparative way across all Member States. Illustrating volumes separately would limit the possibility of cross-country comparisons.

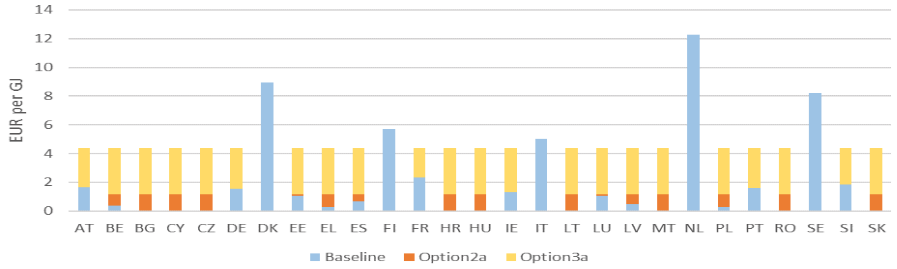
Starting with the effective tax rates applied to the **household sector for heating and transport**, it is evident that the "new" minima, both for option 2 and 3, would imply a strong convergence of rates as most of the effective national rates are at present below the new minima. This converging impact (to higher levels) is evident for coal and coke, as well as, for natural gas. Logically, the necessary increase due to the inclusion of a CO2 component would be higher than the increase observed for Option 2. Based on this analysis, it appears that, ceteris paribus eight Member States would by 2035 have effective rates higher than the new effective minima. As far as natural gas is concerned, eleven Member States are found by 2035 to have effective rates higher than the new effective minima for option 2. The following figures also show that a large number of Member States benefit from the present possibilities to tax below the minima and therefore apply a zero rate.

Figure 16: Tax rates by 2035 – Households, Heating, Coal and coke



Source: JRC

Figure 17: Tax rates by 2035 – Households, Heating, Natural gas

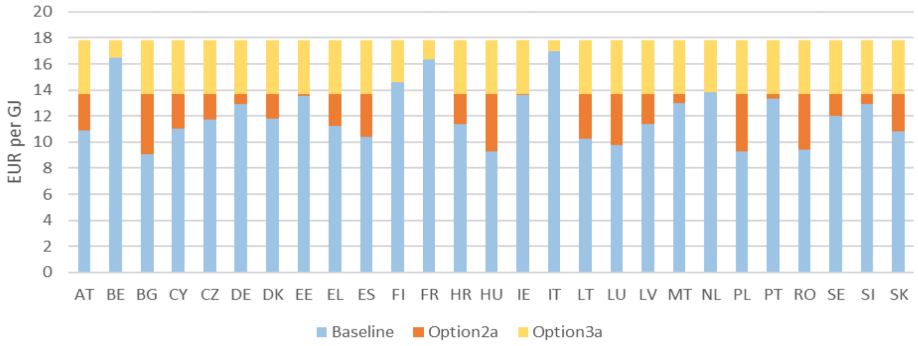


Source: JRC

In relation to fuels used by **households for transport use**, here again, the strong converging impact of options 2 and 3 is evident, both for gas oil and LPG. Considering the proposed minimum rates, the LPG product observes the highest converging value to higher level. In the case of gas oil five Member State are found, ceteris paribus, to have effective tax rates by 2035 higher than the new minima only for Option 2. Contrary to heating use, in this case the higher relative increase in rates is due to Options 2 features (especially energy content) and less to the CO2 component.

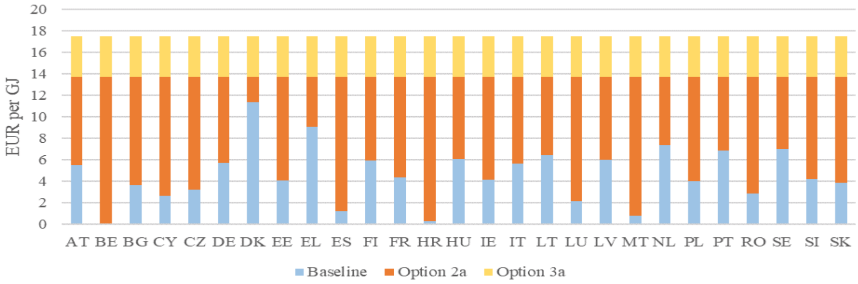
Overall, the increased taxation levels pushes to a convergence of national rates for all the situations as can be observed in the graphs.

Figure 18: Tax rates by 2035 – Households, Motor, Gasoil



Source: JRC

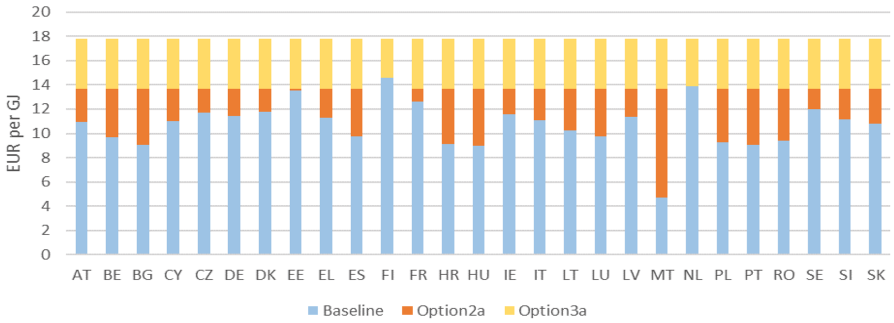
Figure 19: Tax rates by 2035 – Households, Motor, LPG



Source: JRC

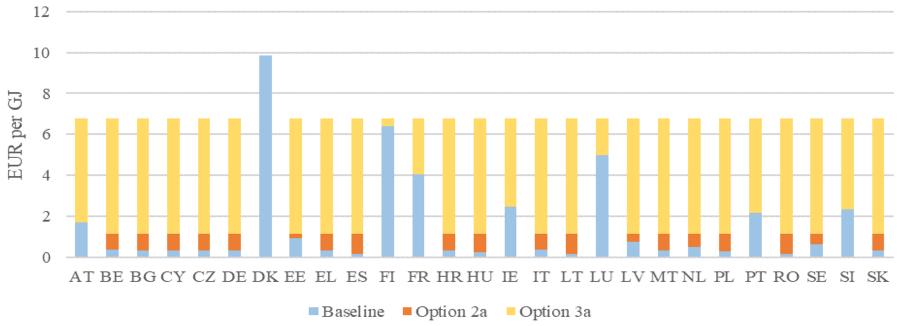
Turning to **manufacturing and commercial sectors,** in general the graphs below show that the proposed options 2 and 3 will also have an impact on the productive sectors albeit at a lower degree than the household sector. Here again, the converging impact is evident in all the situations presented. Overall, the graphs show that option 2 already has an important converging effect by increasing the taxation in almost all Member States.

Figure 20: Tax rates by 2035 – Commercial haulage, Gasoil



Source: JRC

Figure 21: Tax rates by 2035 – Industries other than ETS, Coal and coke



Source: JRC

6.4 Impact on energy tax revenues

As presented in section 6.1, revenues are projected to decrease substantially in the baseline mainly due to the expected evolution of the energy system with a decreasing dependency on fuels thanks to energy savings and a shift from fossil fuels as well as the assumption of fixed nominal rates. It is to be noted again that preserving the capacity to generate revenues for the budgets of the Member States, as it is the case now, is another element to take into due account. While it is not an objective of the review of ETD to ensure the same level of revenues in the coming years, there is some merit in providing insight into how different options fare in compensating to the revenue loss projected in the baseline.

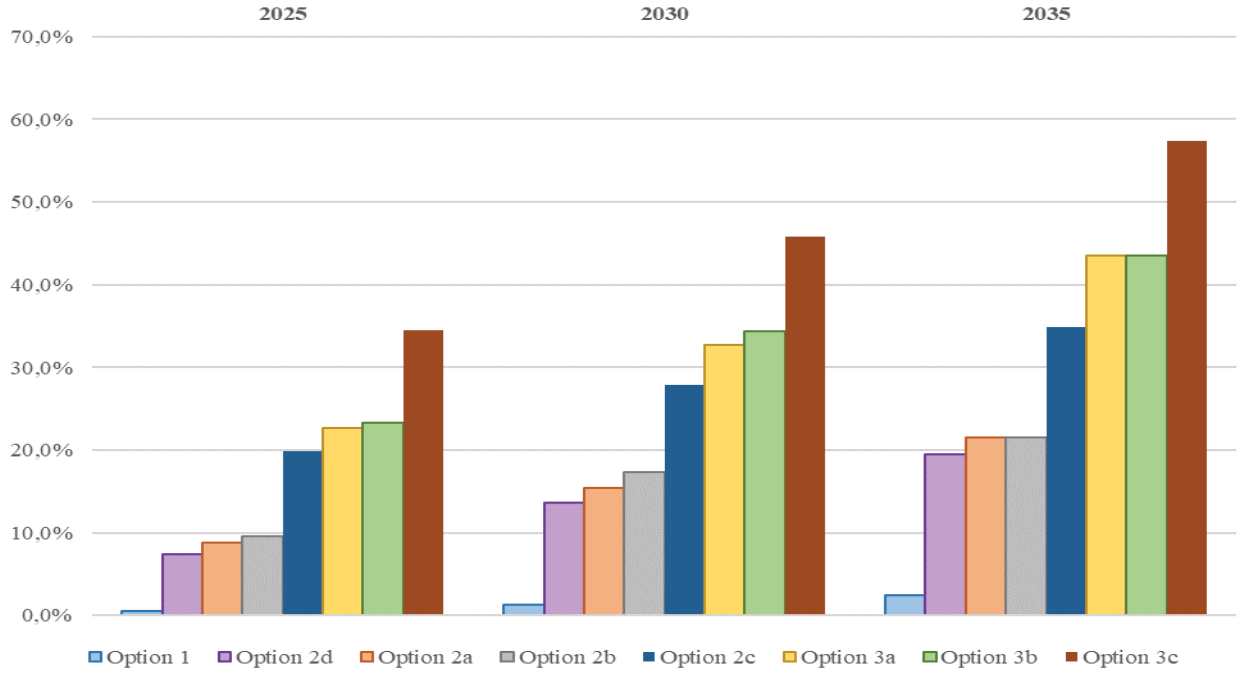
The estimated impact on revenues under each option (see figure 22) is based on the assumption that Member States will only increase their respective national rates, where needed, to reach the “new” minima in the Directive. In all options considered, the increase in minimum rates results in an increase in tax revenues compared to the baseline across the years.

With the indexation of minimum rates under Option 1, revenues only rise slightly compared to the baseline, as rates will only need to increase in those countries and sectors where the new nominal rates in the Directive will lead to crossing the current minimum threshold over time. Under Option 2, with the introduction of higher minima based on energy content and the broadening of the tax base (such as for energy-intensive industries, intra-EU aviation and maritime), effective rates and revenues increase notably compared to the baseline (c. +22% in 2035). In case of the options with a shorter transition period, the gains are observed earlier.

The carbon-content add-on to the energy content under Option 3 impacts rates and revenues strongly from 2025 onwards, as the value for the carbon content component will increase over time as explained in the description of the option. The difference with Option 2 also captures the elimination of the transition period on energy content for all consumers except

Households and the intra-EU aviation sector in Option 3, as well as the regular updates of the CO_2 component in line with the changes in the ETS price in the future.

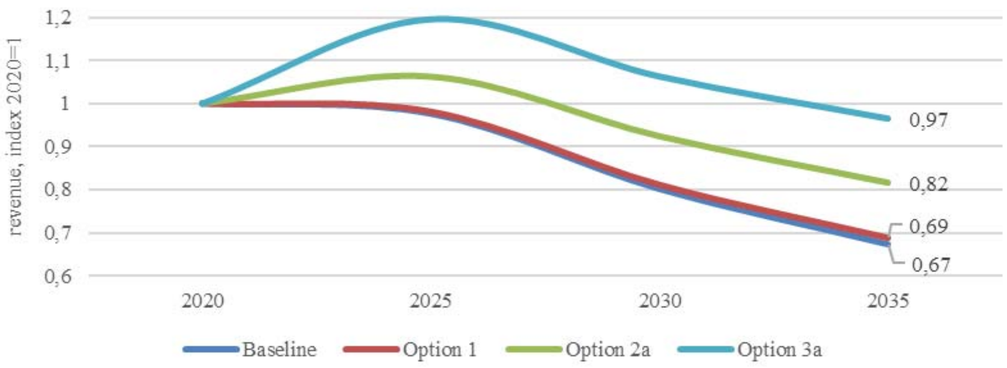
Figure 22: Evolution in EU27 of total tax revenues



Source: JRC-GEM-E3

As mentioned above, revenues will drop by 2035 in comparison to 2020 in the baseline. This reduction appears to be compensated in different degrees (partly or fully) under the different options. This is illustrated in figure 23 below.

Figure 23: Change in tax revenues between 2020 and 2035 for EU 27 (2020=1)

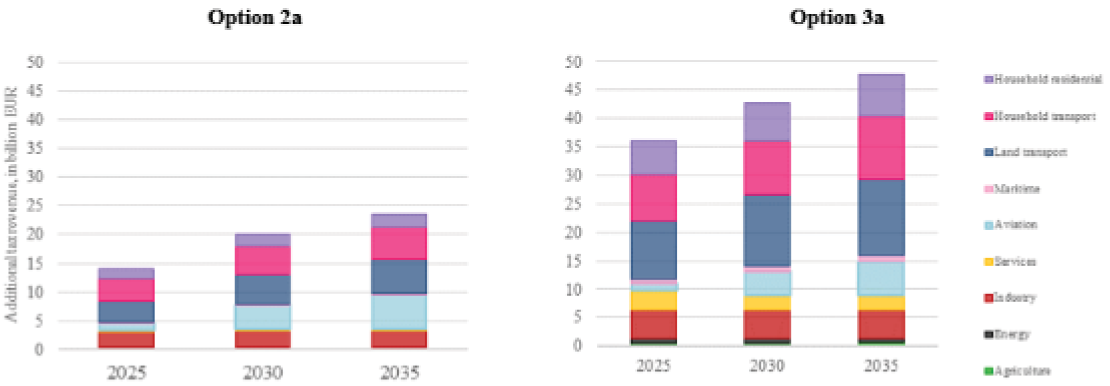


Source: JRC-GEM-E3

The increase in tax revenues under Options 2 and 3 comes mostly from transport fuels (oil products and biofuels), which already make the largest share of excise tax revenues. The introduction of the carbon component raises revenues from fossil fuels due to their higher carbon content (see list of emission factors provided). The introduction of an air pollution component to the minimum rates significantly increases Member States' revenues from 2025 onwards, both under Options 2a and 3a, as no transition period is assumed.

Considering the impact by type of consumers in Figure 24 below, revenues increase primarily from land transport (transport sector) and private household transport under Options 2 and 3. The carbon component affects all sectors, each contributing more to tax revenues under Option 3 than Option 2 (with the relative increase depending on their carbon intensity).

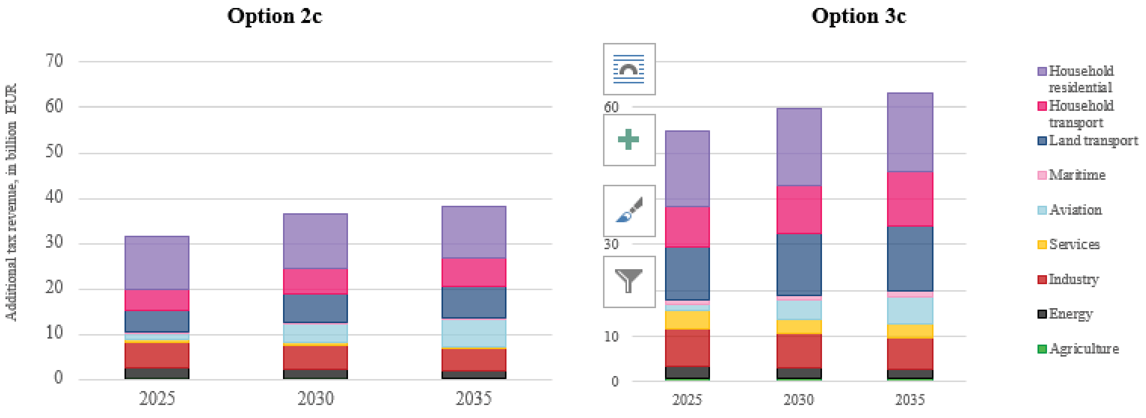
Figure 24: Additional revenue under Option 2a and 3a for EU 27



Source: JRC-GEM-E3

Introducing the air pollution component leads to significant increase in tax revenues of Option 2 and Option 3 compared to baseline. Additional tax revenues primarily come from households' use of fuels for heating purposes, already in a significant way from 2025, given that the pollution component increases in an extremely significant way the cost of coal and biomass. The household sector will bear a very substantial share of the increase in costs following the introduction of this option.

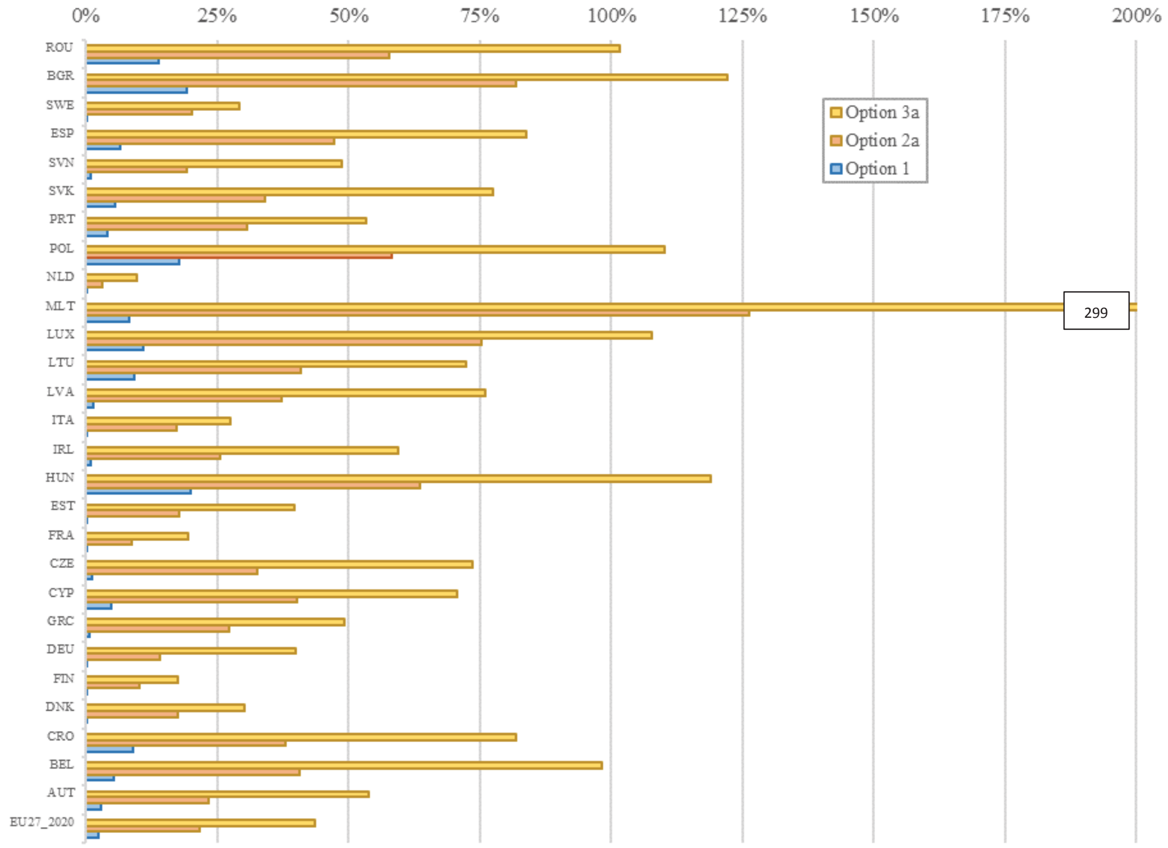
Figure 25: Additional revenue under Option 2c and 3c for EU 27



Source: JRC-GEM-E3

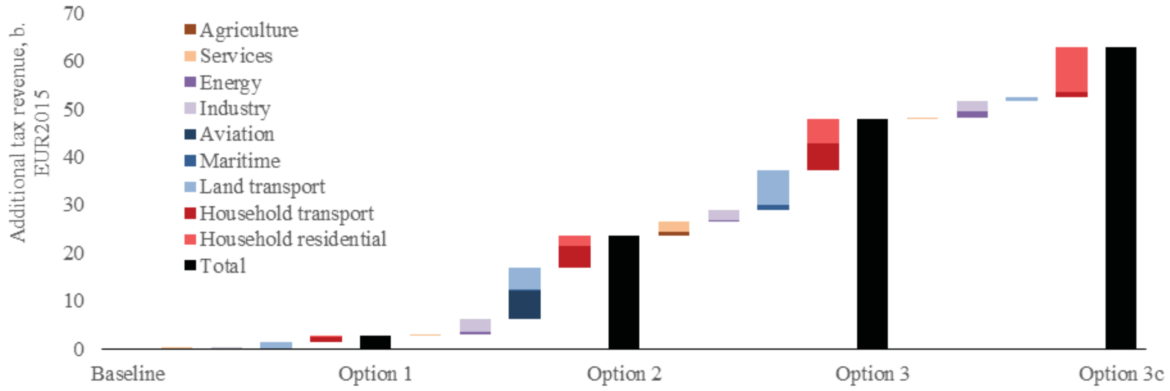
The impact on Member States (see Figure 26 below) depends on different factors such as i) the present level of national rates, ii) the national use of exemptions and reductions, iii) the energy mix of the economy and iv) the sectorial impact of the proposed options. In general terms, Option 1 will mainly affect those Member States whose national rates are fixed at the lowest levels, whereas Options 2 and 3 will also have a relevant impact on Member States who make extensive use of possible exemptions and deductions. Moreover, the Member States who base their energy mix more on fossil fuels will also be more affected. The application of a transitional period aims at taking into account all these different national circumstances in view of a smooth transition.

Figure 26: Change in Member States' tax revenues in 2035 relative to the baseline (in percentage)



Source: JRC-GEM-E3

Figure 27: Total additional tax revenues by users for EU27 in 2035



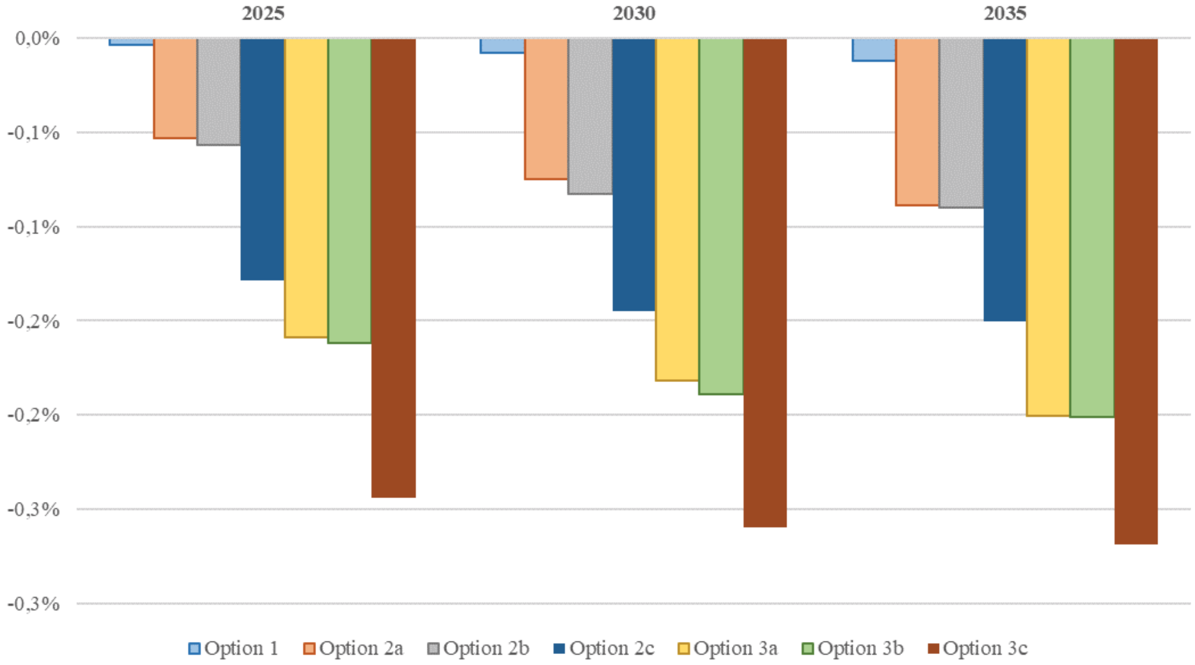
Source: JRC-GEM-E3

Figure **27** above illustrates the breakdown of total increase in revenues by users under the different options. Increases in minimum rates lead to an increase in tax revenues compared to the baseline across all options. With simple indexation under Option 1, revenues rise only slightly compared to the baseline, while under Option 2, with the introduction of higher minima based on energy content, and the broadening of the tax base effective rates, the tax revenues increase strongly compared to the baseline. Transport and aviation contribute most in this increase, followed by household transport and heating and industry. The addition of a pollution component has a higher impact upon households. This impact is evident and much more pronounced under Option 3c which includes also a CO2 component in the tax rates.

Annex 9 provides detailed data on the impact on Member States' revenues when the pollution component is introduced in Options 2 and 3. In both options, the introduction of a pollution component will impact more on lower income Member States. This is mainly the result of their national energy mix where the share of more pollutant products is higher.

6.5 Impact on GDP

Figure 28: Change in EU 27 GDP compared to the baseline (in percentage)



Source: JRC-GEM-E3

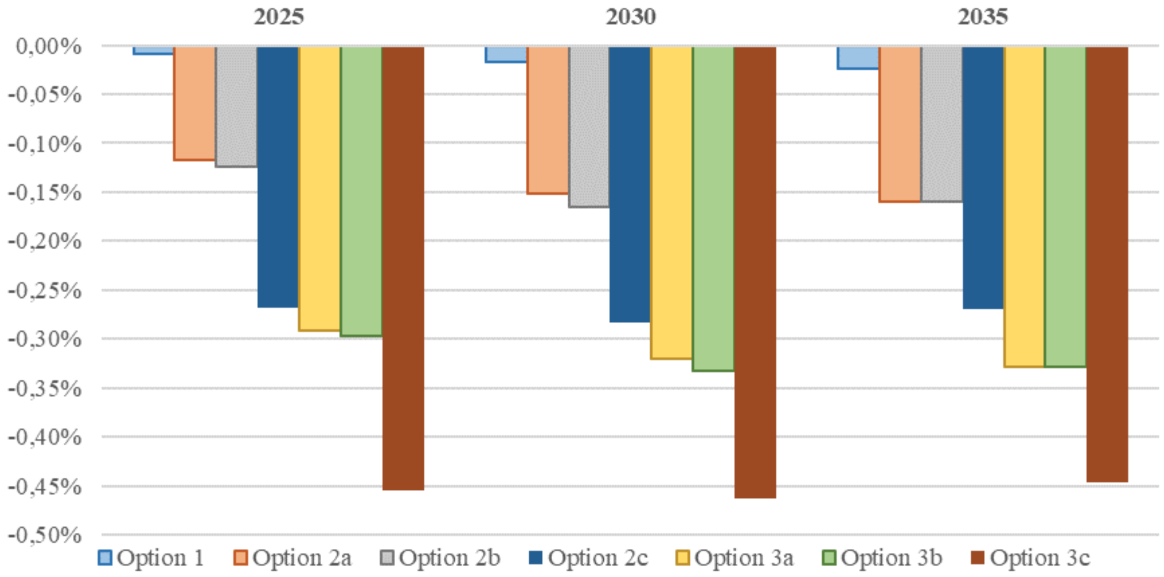
All options considered imply an increase in effective taxation in the economy, which in turn results in a minor decrease in GDP estimated at -0,09% under Option 2 relative to the baseline by 2035. This would indicate that the introduction of an increase in energy taxes achieve an important positive environmental impact with a very low impact on growth perspective.

This result should be seen in the context of the technology options that are included in the model and depend on a variety of factors, mainly on the fact that the increase in taxes is compensated through lump-sums to households.

Three underlying factors explain the differences among scenarios. First, under the minimalistic option the indexing of rates seems to be the main driver, resulting in price increases and thereby demand reduction. By contrast, under Options 2 and 3 the broadening of the taxable base affects the production sector by increasing input costs, which results in a decline in investment parallel to the even more pronounced demand decline. Introducing an air pollution component to the minimum rates leads to further reduction in GDP.

6.6 Impact on the labour market

Figure 29: Change in EU 27 employment compared to the baseline (in percentage)



Source: JRC-GEM-E3

Reflecting the minor negative impact on GDP, all the options considered will have a very small negative effect on the labour market at EU aggregate level. In fact, in the longer term the decrease in employment rate would range from -0.02% to -0.45%. These impacts are presented at a more disaggregated level below.

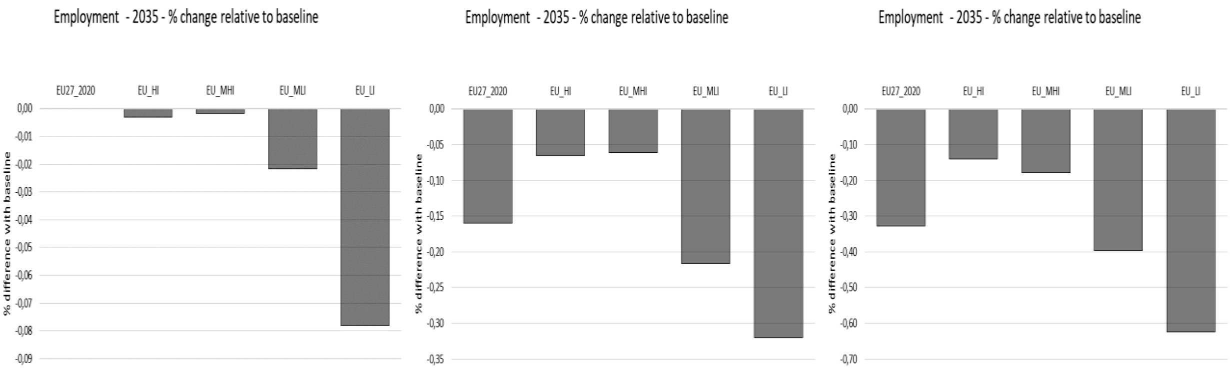
Similar to GDP, this result depends on the model assumptions of the functioning of the labour market and the recycling of additional tax revenues.

In sectoral terms the biggest impacts are as follows:

- Under Option 1 main impacts are realised in the energy sectors, namely coal, oil and gas production.
- Under Options 2 and 3 the biggest impacts are realised in the energy sectors and the energy intensive industries. Downstream sectors are also affected but to a lesser extent.

As regards differences between Member States, the higher impact on employment is found for low income Member States.

Figure 30 Changes in employment in 2035 by Member State group (% change from baseline)[65]

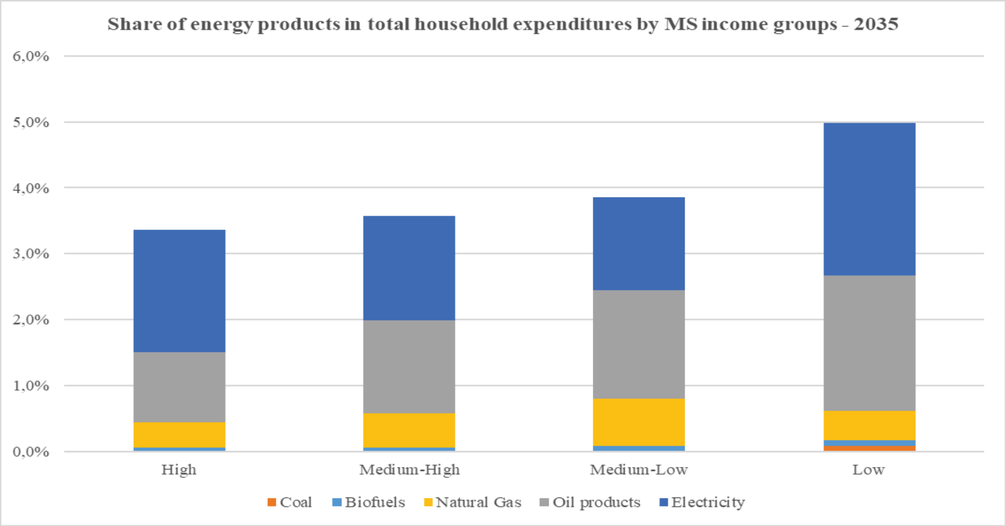


Option 1 **Option 2a** **Option 3a**

Source: JRC-GEM-E3

The higher impact on low income Member States is due to both higher tax rates increase (relative to the baseline) and higher shares of energy products in overall consumption (see figure below).

Figure 31: Share of energy products in total household expenditure in the baseline in 2035 by EU Member State Group



Source: JRC-GEM-E3

Energy sectors (coal, oil and gas) are estimated to experience the highest impacts in terms of employment losses. These sectors, as well as forestry in Options where biomass products are subject to the air pollution component (Option 2c and 3c), are found to experience losses in employment higher than the average of all sectors in the EU 27. Energy intensive industries

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[65] The classification of Member States by income is as follows:
- High includes AT, DK, FI, IE, LU, NL, SE
- Medium High includes BE, DE, FR
- Medium Low includes CY, CZ, ES, ET, IT, ML, PR, SI
- Low includes BG, EL, HU, LT, LV, PL, SK, RO, HR

(mostly ferrous, non-ferrous metals and non-metallic minerals), agriculture and the transport sector follow albeit with weaker losses.

Table 7: Changes in employment by sectors – EU 27, in 2035 (% change for baseline)

	Option 1	Option 2a	Option 2c	Option 3a	Option 3c
Crops	0,08	-0,48	-0,43	-0,49	-0,47
Coal	-0,30	-1,51	-6,55	-4,02	-7,57
Crude Oil	-1,21	-3,96	-5,43	-8,57	-9,98
Oil	-0,55	-2,03	-2,54	-4,20	-4,76
Gas	-0,71	-3,83	-3,43	-11,87	-11,42
Electricity supply	-0,04	0,02	0,52	0,23	0,74
Ferrous metals	-0,02	-0,40	-0,93	-0,50	-1,04
Non ferrous metals	-0,01	-0,39	-0,47	-0,40	-0,48
Chemical Products	-0,01	-0,07	-0,19	-0,13	-0,25
Paper Products	-0,02	-0,09	-0,18	-0,25	-0,34
Non metallic minerals	-0,04	-0,25	-0,41	-0,40	-0,57
Electric Goods	0,00	0,08	0,11	0,00	0,03
Transport equipment	-0,02	-0,06	-0,05	-0,20	-0,20
Other Equipment Goods	-0,01	-0,02	-0,06	-0,12	-0,16
Consumer Goods Industries	-0,03	-0,06	-0,13	-0,37	-0,45
Construction	-0,03	-0,17	-0,29	-0,36	-0,48
Transport (Land)*	-0,10	-0,50	-0,68	-0,92	-1,11
Market Services	-0,03	-0,17	-0,29	-0,39	-0,52
Non Market Services	-0,02	-0,11	-0,17	-0,21	-0,27
Livestock	0,04	0,23	0,32	0,07	0,13
Forestry	0,02	-1,33	-8,00	-1,01	-7,73

* Water and air transport effects are presented in the devoted sections bellow

Source: JRC-GEM-E3

6.7 Macro economic impact under alternative revenue recycling settings

The E-QUEST model was employed to compare the Central Option from the ETD revision proposals to a baseline under different revenue recycling settings. Exploring revenue recycling implications under other options was deemed to not to provide significant value added to the analysis. While it would proportionally change the macroeconomic effects, assessing other options would have only marginal impact at the EU-level results without changing the ranking of the recycling measures.

The baseline calibration accounts for the effect of existing climate mitigation policy measures and the current ETD framework. To ensure consistency across the different model simulations in the Impact Assessment, the E-QUEST simulation inputs were calibrated to be in line with those implemented in the JRC-GEM-E3 simulation scenarios.

Six alternative scenarios for the recycling of the additional revenue were explored, namely, (i) reduction in lump-sum taxes, (ii) consumption tax cuts (VAT), (iii) personal income tax (PIT) cuts for low-income households only, (iv) social security contributions cuts for employers, (v) reduction in capital taxes (excluding fuel-intensive capital) and (vi) recycling via ‘clean’ subsidies to support the purchase of “clean” capital goods.

Overall, the simulated scenarios at the EU level result in slightly negative or close to zero GDP effects relative to the baseline. The ranking of GDP results by recycling instruments reflects the ranking of taxes by their distortive effects in the economy. Reducing lump-sum taxes, which are the least distortive, shows a negative effect of about -0.07% relative to the baseline GDP. This is followed by social security contribution (SSC) and consumption tax (VAT) reductions by about 0.05% decline in GDP. Personal income tax cuts targeted at lower income groups with a higher marginal propensity to consume can also reduce the output losses to around 0.03% of baseline GDP. In the model labour supply, labour demand and wages are endogenous, therefore, this scenario works via stimulating low-skilled labour supply with higher net wages, lowering the compensation per (low-skilled) employees for firms and leading to higher overall employment. Taxes on capital are the most distortive taxes in the model, and recycling the additional revenue to reduce these has larger impact. The most beneficial scenario in terms of GDP effects is through the recycling of additional revenues into subsidies on the purchase of clean capital and capital tax reduction. Both recycling options can result in slightly positive GDP effects relative to the baseline. In terms of consumption, reducing VAT, cutting personal income taxes or providing green subsidies can mitigate the most the negative effects of the reform relative to the lump-sum tax recycling case. For investment, capital tax cuts and clean capital subsidies are the most beneficial recycling instruments. Targeted labour tax-cuts have the largest potential to increase employment as the slightly higher real wages stimulate labour supply.

Table 8. Macroeconomic effects of recycling measures, 2030

Scenarios	Lump-sum	VAT	SSC	Low-skilled labour tax	Capital tax	Clean subsidy
GDP	-0.07	-0.04	-0.05	-0.03	0.01	0.06
Investment	-0.07	-0.03	-0.05	-0.04	0.42	0.35
Consumption	-0.08	-0.04	-0.08	-0.04	-0.10	-0.05
Employment	-0.01	0.01	0.01	0.06	0.00	0.00

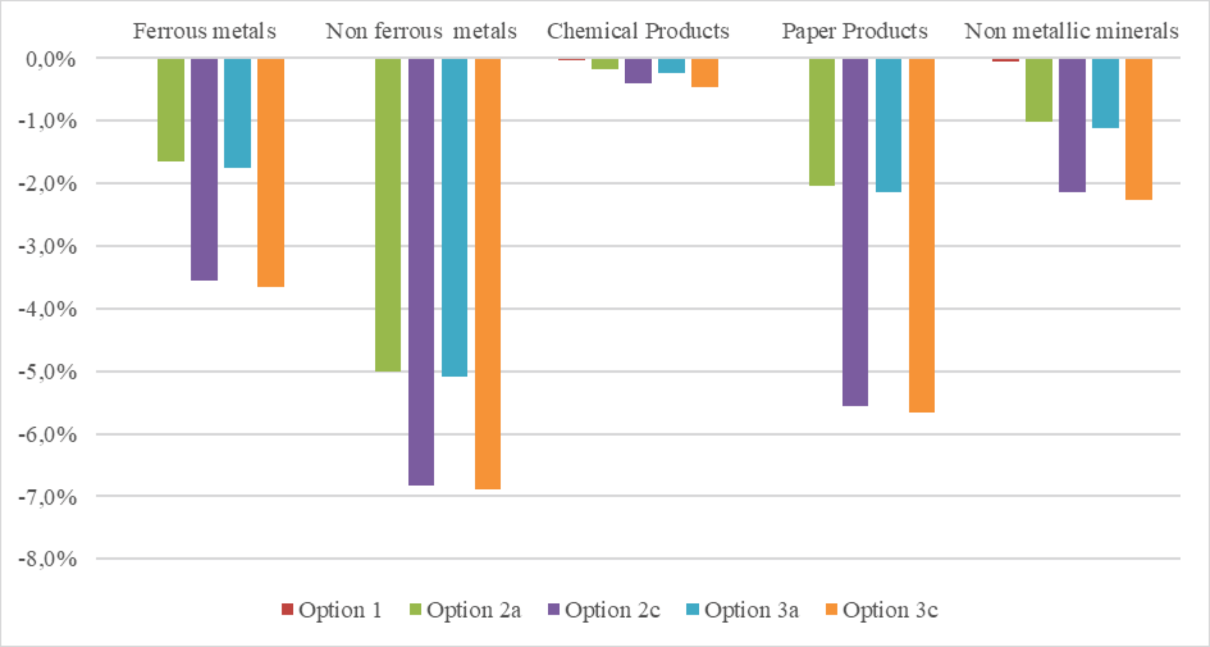
Note: percent deviations from baseline levels.

Source: E-QUEST simulations

6.8 Impact on industries that are more energy intensive

Industries in the EU that are more energy consuming will face an increase in their input costs under option 2 and option 3. Specifically, in option 2a and 3a these will be driven by the introduction of higher minima based on energy content and the broadening of the tax base, while the introduction of the pollution component in options 2c and 3c will bring in additional pressure as evidenced in the proportional reduction in GHG emissions in the figure bellow.

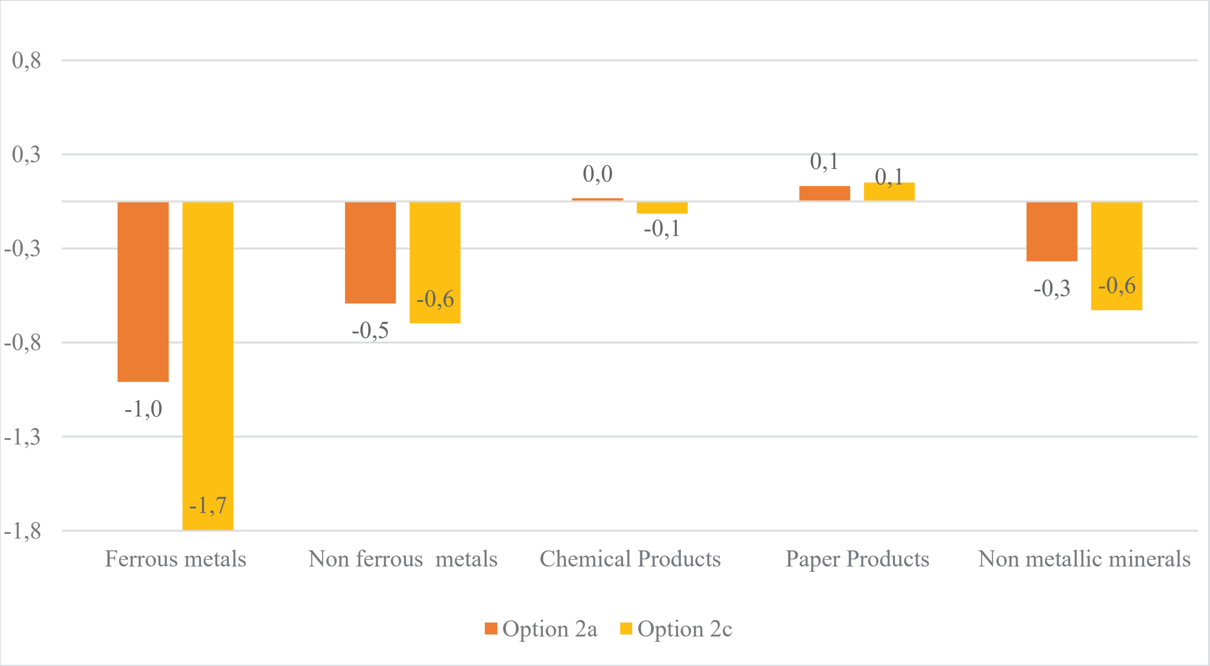
Figure 32: Change in EU27 industrial emissions of energy intensive industries (in percentage)



Source: JRC-GEM-E3

The increase in costs could impact on the energy intensive sectors' competitive position in international markets. The figure below illustrates the changes in exports for energy intensive industries relative to the baseline by different options. Within this group, the highest impact is observed in ferrous metals. Exports of chemicals and paper appear to be less affected. In fact generally at the Member State level these two sectors benefit from less exemptions than other energy intensive industries in the current ETD (baseline), and are therefore less affected by the scope extensions under Options 2 and 3.

Figure 33 Exports of energy intensive industries – EU 27 in 2035, as % change from baseline



Source: JRC-GEM-E3

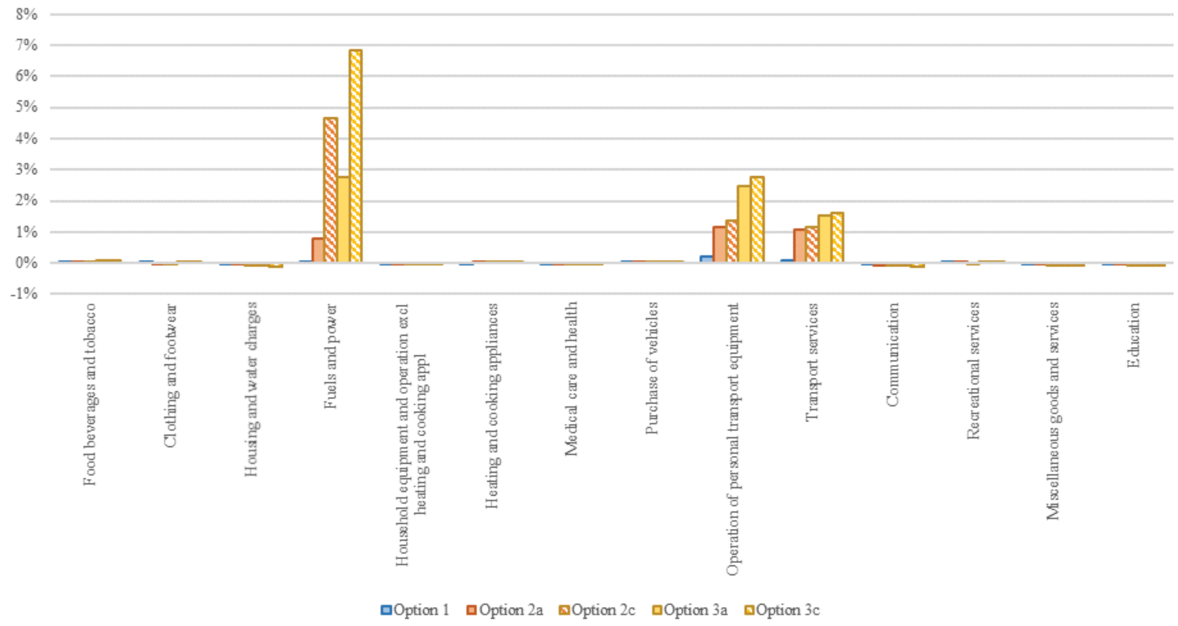
6.9 Distributional Impact

Households heating

Increased tax rates lead to an increase in consumer prices, both for motor and heating fuels. Option 1 minima have a very limited impacts on heating fuels, and a small impact on motor fuels. Under option 2a, this increase is similar across heating and transport fuel prices, around 0,8.% and 1.2% respectively. When a pollution component is added the heating fuel prices increases by around 5%. The addition of the carbon component in Option 3a leads to a 2.8% increase in the price of heating fuels compared to more than 2.5% increase in the case of motor fuels prices, due to the high emission factor of solid heating fuels.

The air pollution component mainly affects heating fuels for households (coal), and result in almost 5% increase in household prices for fuels and power compared to the baseline in Option 2 and nearly 7% increase for Option 3.

Figure 34: Change in EU27 household consumer prices between each Option and the baseline in 2035 (in percentage)



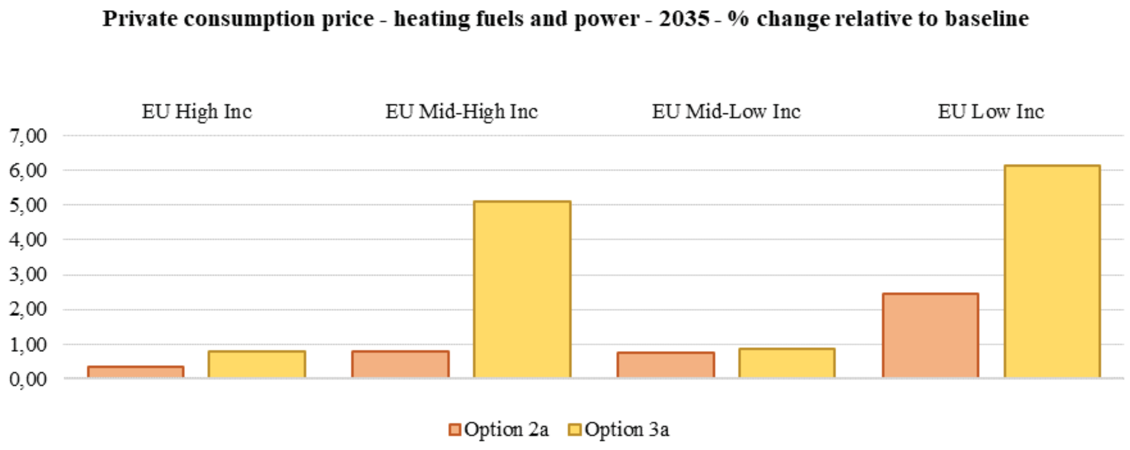
Source: JRC-GEM-E3

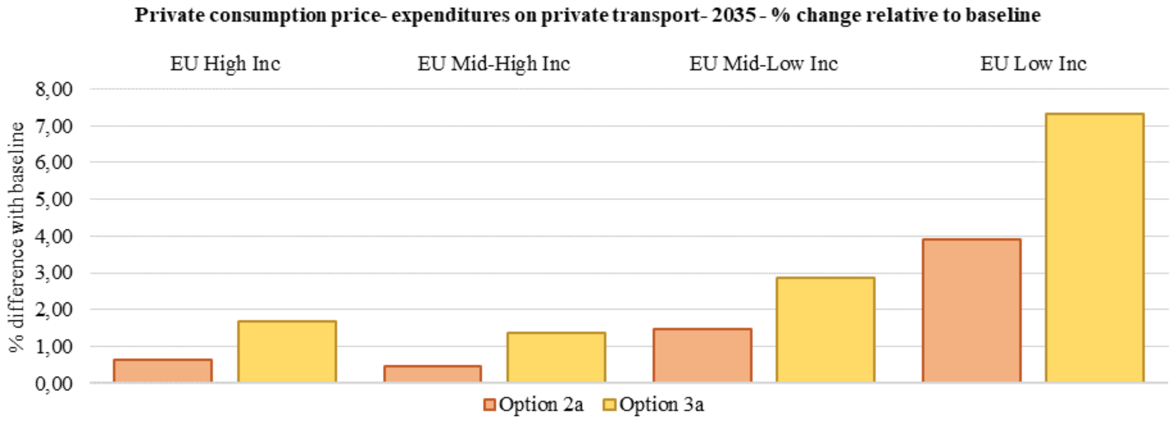
Member States with currently lower effective tax rates on households are relatively more affected by the increase in the minima based on energy content and the removal of exemptions. This generally corresponds to lower income Member States (plus Belgium).

Price increases for motor fuels from the inclusion of the carbon component (difference between Option 2 and 3) is relatively uniformly applied across Member States, as the carbon content of motor fuels vary relatively little across the EU27.

However, the increase in the price for heating fuels from the introduction of a CO2 tax is mostly felt by Member States with more carbon-intensive heating fuel mixes.

Figure 35: Change in private consumption prices (in percentage)





Source: JRC-GEM-E3

Impact on household incomes

Distributional impacts on household incomes by Member State[66] were analysed with the use of the Euromod micro simulation model, by effectively linking it with the JRC-GEM-E3 model thereby allowing the feeding of changes in key variables from the macro simulation to the micro model (see Annex 4 for details). By linking the two models in this way, the distributional analysis at the micro level was able to account for the economy-wide impact of the tax changes under consideration, capturing the effects of the policy option not only through its direct impact on the tax burden, but also through its broader implications on consumer prices and household incomes. The analysis of distributional impacts focused on options 1, 2a, 3a and 3c. Exploring other options was deemed not to provide significant value added to the analysis.

The results indicate that the considered ETD options reduce adjusted disposable income (the disposable income net of indirect taxes) of households, often in a regressive way, but that the distributive impact depends on the policy option and largely differs across countries.

In general, the four options considered show the following impacts on household incomes across the income distribution, for each of the three drivers (price and income effects, and a lump-sum compensation mechanism):

- A negative and regressive "price effect". All the options considered drive a price rise in a number of consumption goods, including transport-related services as well as in fuels and powers. Although other prices are expected to drop, overall, a negative impact on household adjusted disposable income is observed from the changes in consumption prices driven by the energy tax reforms, ranging from 0% to 2%. This generally affects more heavily households at the bottom of the income distribution, for their income share of consumption is notably larger. The lowest income decile loses around 2% of disposable income in Lithuania and between 1.5-2% in Poland and Hungary (option 3c).

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[66] The analysis is carried out for the 18 Member States, which are currently covered by EUROMOD's Indirect Tax Tool (ITT) extension. These countries are: BE, CY, CZ, DK, FI, FR, DE, EL, ES, HU, IE, IT, LT, PL, PT, RO, SI and SK. More information on this project can be found in https://EUROMOD-web.jrc.ec.europa.eu/about/extended-functionalities.

- A negative and progressive “income effect”. All the options considered generally lead to a decrease of gross labour and capital income, which analogously to the “price effect”, reduces household adjusted disposable income. However, this effect penalizes more households in the second half of the income distribution. That is because poorer households rely less on market income than the richer ones. As a result, the income effect tends to compensate and, in some cases, completely reverses the regressivity of the price increase. The final effect of the energy tax changes considered, after allowing for the price and income effects, is generally displaying either a regressive or a flat impact across the income distribution. Overall, the effect on the first decile from the joint effect or price and income ranges from a loss of -0.002% (Germany, option 1) to -2.3% (Hungary, option 3c) with respect to baseline disposable income.
- A positive and progressive effect of the compensatory measure. When the extra tax revenues (from indirect taxation) raised through each tax change are transferred back to households in a lump-sum fashion, the whole reform turns to be progressive, for these transfers determine a larger increase in disposable income for poorer households. EUROMOD-based simulations show that using all additional revenues to finance a lump-sum benefit to all individuals could, in relative terms, provide a larger support to poorer households compared to the rich ones. Therefore, the regressive or flat impact of energy taxes can be mitigated or even eliminated by accompanying measures.

The impact of the considered ETD options, including compensatory measures, on households’ adjusted disposable income is generally of small magnitude. Over the whole spectrum of the income distribution, the impact ranges from about 4% to about -1.5% of the baseline disposable income. That is because the predicted impact of the energy tax reforms under analysis over labour and capital income is mostly negligible, and so is the impact on the consumer price index (though variations in the price of individual good categories, such as transport and fuel, can be significant).

Option 1 has the lowest estimated impact on household incomes, while the option with the air pollution component shows the strongest impact. In this latter scenario, Lithuanian, Romanian and Spanish households in the first decile experience the largest increase in adjusted disposable income (i.e. more than 3%); whereas Hungarian, Romanian and Polish households in the 10th decile, experience the strongest income reduction (i.e. about 1.5%). On the other hand, in the minimalistic option the largest increase in adjusted disposable income is experienced by Romanian first decile (i.e. about 0.45%); whereas the largest reduction is for Hungarian, Romanian and Polish households in the 10th decile (i.e. about 0.2 %). The range for the remaining scenarios is in between these extremes.

Within each option considered, results substantially vary across countries. This is due to the different impact that the same policy change produces on prices of the different consumption categories and income in each country. Country disparities are also explained by the different consumption patterns across the income distribution and income structure of households. Another factor is the relative change that the energy tax changes bring onto the existing systems in each country. A detailed discussion of distributional impacts by Member State is provided in Annex 9.

6.9 Impact on aviation, maritime transport and inland shipping

Aviation

Impact on the aviation sector was analysed both through the JRC-GEM-E3 model and through a focused sectoral study - the results of which are presented in Annex 7. This focused study also performed detailed modelling of alternative scenarios for the revision of taxation in aviation. Modelling in the study was based on the combination of a dedicated sectoral model (AERO-MS) and a macro model (GINFORS). In line with the analysis so far, the discussion in this section also focuses on the results of the JRC-GEM-E3 model, but these are complemented with findings from the AERO-MS and GINFORS models to provide insight of the potential range of impacts under alternative assumptions. The results of all modelling exercises are largely comparable and any differences are explained by underlying technical specificities and assumptions of each model.

In view of the above, rates based on energy content in line with those applied to the road transport sector were introduced for the aviation sector under Option 2 with a 10 or 7 year transition period respectively (Options 2a and 2b). The resulting price increase reduces the total demand and output of the aviation sector. Based on the results of the JRC-GEM-E3 model the impact on output is found between -1.0% and -1.6% in 2025 and about -4,3% by 2035, as illustrated in **Figure 36**.[67] The results confirm the usefulness of introducing a longer transition period to allow the sector to adjust more smoothly to the proposed changes. Indeed option 2b results in a much stronger impact in 2030 relative to option 2a, with both converging by 2035. The sector being included in the ETS, is not eligible for the carbon content component under Option 3. The slight decrease in output compared to Option 2 is due to general equilibrium effects of a slightly more reduced total demand under Option 3.

The results obtained from of the sector specific AERO-MS model, as presented in detail in Annex 7, are largely in line with these estimates. For the case of a 10-year transition period (option 2a) AERO indicates a reduction in sector revenues of -1,1% in 2025, building up to -3,3% and -3,4% for 2030 and 2035 respectively.

Figure 36: Change in EU27 aviation output compared to baseline (in percentage)

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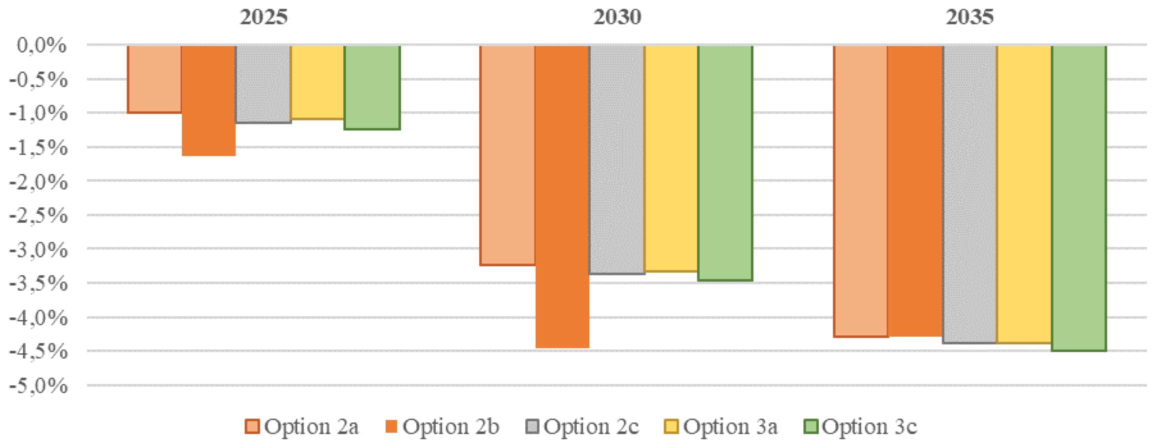
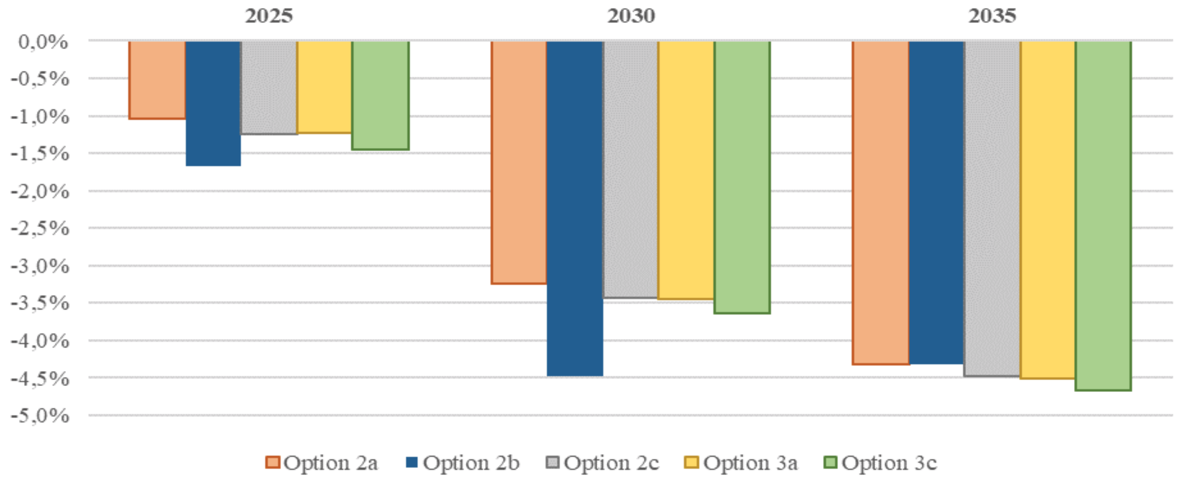
[67] Intra-EU aviation is assumed to represent approximately 47% of all fuel use in the aviation in 2030.



Source: JRC-GEM-E3

Impact on employment as estimated by the GEM E3 model largely reflects changes in sectoral output. In the JRC GEM E3 model, substitution elasticities that govern the ease with which the aviation sector can shift from energy to other inputs in the production process play an important role in determining how output changes relate to employment changes in the context of the ETD. For the aviation sector, the assumption is that the potential to substitute energy for labour is relatively limited, and indeed lower than in other sectors in the economy. Higher energy costs could lead to increased energy efficiency, resulting in higher capital and lower energy input shares. As such, the results of the JRC-GEM-E3 model reflect a situation with a gradual introduction of the policy changes. The implied employment elasticity in this context is close unity. As illustrated in **Figure 37** sectoral employment declines under option 2a by -1,04% in 2025 building up to -3,25% in 2030 and -4,32% in 2035.

Figure 37 Change in EU27 employment compared to baseline (in percentage)



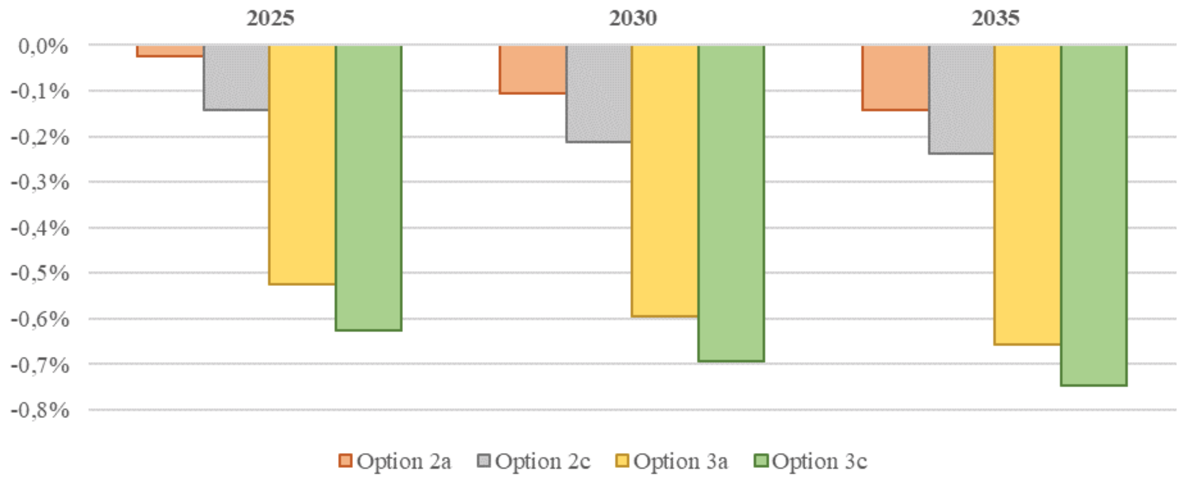
Source: JRC-GEM-E3

Estimated employment effects from the GINFORS-E model were found to be lower that the JRC-GEM-E3 estimates at -1,03% and 1,04% for 2030 and 2035 respectively. This difference can be interpreted as resulting from different assumptions in the GINFORS-E model about the degree to which the sector correctly anticipates the output changes due to the proposed revision of the Energy Taxation Directive. In the GINFORS-E model, the response of jobs to output changes in the aviation sector is governed by the employment elasticity, which is calibrated to historical time series. Typically, historical fluctuations in output are stronger than changes in employment, due to labour market rigidities. As a result, the estimated employment elasticity is well below unity, such that employment changes in the aviation sector are less pronounced than output changes in the sector.

Maritime transport and inland shipping

Taxing energy use on intra-EU activity[68] (with a transitional application of the rates applied to the primary sector and to household) also leads to a decrease in sectoral output in maritime transport across all the options. Since maritime transport and inland shipping is taxed both on energy content and carbon content in Option 3, and the transitional period on energy content is dropped in this option, the sector experiences its largest drop in output in 2025 under Option 3.

Figure 38: Change in EU27 maritime transport and inland shipping output compared to baseline (in percentage)



Source: JRC-GEM-E3

The changes in sectoral output are also reflected in equivalent changes in employment for maritime transport and inland shipping sector. As no transitional period is provided for in the energy content option, employment drops immediately from 2025 following the drop in output as illustrated in **Figure 39** bellow. In this context, sectoral employment declines under option 2a by -0,03% in 2025 building up to -0,13% in 2035. The introduction of carbon content (option 3a) leads to stronger employment losses by -0,56% in 2025 building up to -0,8% in 2035.

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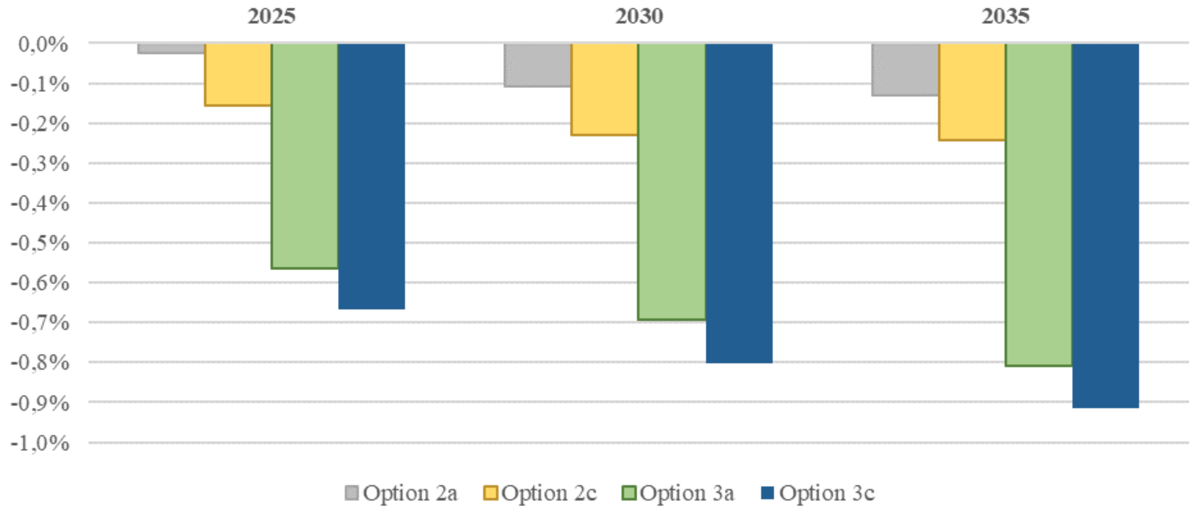
[68] Intra-EU transport is assumed to represent approximately 16% of all fuel use in the EU maritime and inland shipping in 2030.

Figure 39: Change in EU27 maritime transport and inland shipping employment compared to baseline (in percentage)



Source: JRC-GEM-E3

7. COMPARING THE POLICY OPTIONS

7.1 Comparison of the policy options against selected criteria

This chapter evaluates the policy options presented and analysed in Chapter 5 and 6 against a set of three key criteria: i) Effectiveness, ii) Efficiency and iii) Coherence.

<u>i)</u> Effectiveness

This criterion relates to the extent to which the policy options are able to effectively achieve the general and specific objectives as outlined in section 4.2.

- Contributing to the EU 2030 targets and climate neutrality by 2050 in the context of the European Green Deal. The policy options are assessed in terms of their impact on energy efficiency, CO2 and air pollution emissions of the various fuels as well as their contribution to reduce fossil fuel dependency (specific policy objectives 1, 3, 4 and 5).

- Preserving the integrity of the EU internal market and ensuring fair competition: All the options are assessed to check their contribution to remove possible distortions in the internal market. The latter include distortions between energy users in different Member States due to differences in national tax rates and national applications of exemptions and derogations and distortions between competitors using different energy products. This criterion therefore reflects specific policy objectives 2, 3 and 4.

<u>ii)</u> Efficiency

The efficiency criterion allows to compare options with respect to cost-effectiveness, In the present impact assessment this criterion can be understood to relate to two core elements as follows:

- Budgetary impacts. This criterion is considered because, while meeting the objectives of the ETD revision, the ability of Member States to use energy taxation for revenue raising purposes, remains a key function of this type of excise duties.

- Equity. This criterion reflects the constraint that even if overall an option leads to positive environmental and economic results, this might come at the cost of undesirable distributional side-effects, both at the level of different Member States and different income taxpayers.

The macro economic impacts of all the policy options in terms of GDP and employment, are negligible as emphasised in Chapter 6. Therefore, further discussion of this aspect is not needed for the purposes of this chapter.

iii) Coherence

This criterion relates to the coherence of ETD revision with other initiatives under the 'Fit for 55' Package (specific Options 1 and 3) and other relevant EU policies. All the policy options are assessed in terms of their complementarity and coherence with other initiatives in contributing to the increased ambition of reaching 55% reduction in GHG emissions by 2030 as related to 1990.

Table 8 below provides a comparison of the policy options against the selected key criteria: illustrated above.

Table 9: **Comparison of the policy options in terms of selected assessment criteria**

Policy option	**Baseline**	**Option 1**	**Option 2a**	**Option 2b**	**Option 2c**	**Option 3a**	**Option 3b**	**Option 3c**
	Effectiveness							
Contributing to the EU 2030 targets and climate neutrality by 2050 in the context of the European Green Deal		+	++	++	+++	+++	+++	++++
Preserving the EU internal market and ensure fair competition		+	++	++	++	++	++	++
	Efficiency							
Budgetary impacts		+	++	++	++	++	++	+++
Equity		-	-	-	--	-	-	--
	Coherence							
Coherence with other initiatives of ‘Fit for 55’ Package and other relevant EU policies		+	++	++	+	-	-	-

Annotation: Options are compared against the baseline scenario

7.2 Effectiveness

7.2.1 Contributing to the EU 2030 targets and climate neutrality by 2050 in the context of the European Green Deal

All the proposed options contribute to the environmental objective. The proposed tax reforms are in line with the objectives of the European Green Deal.

Three features of the proposed scenarios affect different outcomes: the level and structure of rates, the extent to which the taxable base is broadened (altogether contributing to the increase in effective rates) and the introduction of a CO2 or pollution component. The first two options would have a positive impact in this respect, due to the increase in the taxation of in fossil fuel and more air pollutant products , even when a CO2 or/and an air pollution component is not yet introduced in the proposed tax design. The application of different transition periods (10 and 7 years) for Options 2 and 3 will not alter the expected outcome in 2035. The introduction of a pollution component positively affects the reduction of CO2 emission, as a result of increased taxation.

Not surprisingly, Option 1 has more limited, albeit positive, impact on emissions. In fact, the impact of this option is mainly driven by demand's adjustments to price increases expressed in volumes' terms. The products' substitution impact is very limited. The current unfavorable tax treatment of biofuels is only removed in a very limited way, considering that rates are still fixed in volumes and the lower energy content of most biofuels would be still penalised.

The impact is higher under the central scenario (Option 2) considering the Increasing in rates and the wide restructuring of the tax rates and the broadening of the taxable base in this scenario. In this case, the taxation of products according to energy content, the introduction of the taxation of biomass together with a more favourable tax treatment of sustainable biofuels and the much lower taxation of electricity and advanced biofuels contribute to the objective of energy efficiency while encouraging the shift towards the use of less polluting fuels. The broadening of the tax base, including the taxation of intra-EU aviation, maritime and inland shipping further stimulates the positive climate impact *via* the reduction of the favourable fossil fuel's provisions embedded in the present Directive.

By the end of the transitional period of the central option (2035), the impact on emissions is estimated to be more than three times higher than the impact of the minimalistic option.

On the other hand, as opposed to the options introducing CO2 based taxation, Option 2 (different variants) would not reflect the natural advantage in terms of CO2 neutrality.

Since policy Option 3 requires Member States to apply CO2 taxation on top of existing rates, it is not surprising that it has the biggest effect on GHG emissions. The introduction of a CO2 component would double the positive effects of option 2. In relative terms, CO2 taxation reduces emissions more than energy-content based taxation. Biofuels differ when it comes to the question which of the two effects is more important. The Commission's impact assessment of the 2011 proposal suggested that, while correcting for the difference in energy content is very significant for ethanol, non-application of CO2 taxation has more relevance for most types of biodiesel. [69]

The options introducing a pollutant component would reflect the natural advantage in terms of air pollution neutrality. However, it should be noted that Option 2a do have a positive effect on reducing air pollution.

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[69] Table 11, page 39 of document SEC(2011) 409

The relative contribution towards GHG reduction differs noticeably among Member States, largely depending on the starting point of the national energy tax design and on their present energy mix.

In the case of option 1, the main driver of the impact is the increase in the minimum rates following indexation, which will impact notably the Member States whose current national rates are fixed at the minima.

In the case of the central Option the drivers the impacts are deeper and more wide spread among Member States, considering, as mentioned earlier, the wide restructuring of both the tax rates and taxable base.

When we include air pollution in the proposed rates and considering that this component increases in a very substantial way the taxation of two products (coal and coke, and biomass), the impact on Member States is even more diverse and depends on the national energy mix). In general, lower income Member States are more affected by this option.

In all options, the main contribution to CO2 reduction is due to the changes in demand by the household sector.

However, under Options 2 and 3 there is a noticeable increase in the effort made also by the productive sector. While the households remain the biggest contributor, the wide broadening of the tax base results in the energy and process industries contributing relatively more.

When a pollution element is introduced, this increases very much the household effort since coal and coke for heating is heavily impacted.

As far as the contribution of transport, heating and other sectors is concerned, both Options 1and 2 can contribute to widespread the EU's efforts to reduce emissions. The taxation based on energy content (Option 2), energy content plus CO2 (option 3), the introduction of the taxation of the intra-EU aviation and shipping, the increase of taxation for the primary sectors and the energy intensive industries as well as the increase of the taxation of heating fuels, will imply that all sectors of the economy will improve their contribution to the EU climate objective and to a more equal tax treatment.

Concerning the application of different transitional period of 10 or seven years, (Option 2b and 3b) it has to be noted that the 2035 expected outcome will not differ. The only difference is that the effects will be more concentrated in the first years with subsequent increase of costs for lower income Member States (Option 1) and for Member States with less stringent system of energy taxation (Option 2 and 3) in the short term.

Preserving the EU internal market and ensuring fair competition

First, all policy options assessed would improve the current situation, in the sense that they would ensure a more consistent treatment of energy products. This is as a result of indexing the minimum rates (Option 1) or indexing and aligning their tax treatment on an objective basis – either energy content or CO2 emissions (option 2 and 3) and reducing exemptions and derogations (all options at different degrees).

However, option 1 has some shortcomings because it maintains the volumes' based taxation, does not revise the structure of rates according to "energy" criteria and considers a much more limited broadening of the tax base (only eliminating the possibility to fix the rates below the minima) as compared to the other options. In option 1, the value added in terms of internal market is mostly due to indexation of the minimum rates and to the impossibility to fix the rates below the minima.

Under Option 2 and 3, the introduction of energy content base taxation, the more homogenous treatment of different energy products as well as the wide restructuring of the taxable basis, will have the effect to induce a considerable convergence of the effective tax rates.

Option 2 and 3 meets the specific objective of tax neutrality between energy sources and, hence, improve the functioning of the internal market. Taxing on the basis of the energy content is also the most neutral way of generating revenue from energy consumption. Furthermore, it would also partly resolve the disincentive effect that taxation can currently generate for renewables, generally having lower energy content.

Proposed Option 2 does not provide a consistent price signal for CO_2 emissions in the non-trading sectors of the EU ETS.

Option 3 would meet the objective of introducing a CO2 price signal in sector at present not covered by the ETS, and would therefore ensure consistency with the EU ETS.

As regards the distribution of burden between the ETS and non-ETS sectors, the option introducing a specific CO_2 based tax element can be considered beneficial as introduces a CO_2 tax element, which would be complementary to the EU ETS and thereby remove current differences. On the other hand, option 3 which proposes the introduction of an additional CO_2 tax on top of existing national rates, i.e. it would not take the differences in existing national rates into account for the purposes of complying with the new structure, which would tend to penalise those Member States which already have an elevated level of taxation in force.

As regards distortions of competition between Member States, all options show a positive effects. In fact, all options propose to widen the tax base, increase the tax rates and abolish the below de minima exemptions, and they represent a big step in reducing the competition distortions mentioned above. However, here again, options 2 and 3 introduce more elements (as the elimination of the distinction business and non-business, commercial and non-commercial,

All options proposed will have a convergence effects on effective tax rates. The most converging scenarios are Option 2 and 3. The application of different transitions period will not affect the 2035 outcome. The increase in convergence will be the most beneficial effect in terms of internal market outcome.

7.3 Efficiency

Budgetary impacts

For modelling purposes it is assumed that all additional revenue would be recycled back to the economy (in different ways) and that the overall effects are budget neutral. The scenarios presented in chapter 6 present the outcome when revenues are recycled through lump-sums to households, although alternative revenue recycling options were presented also in the analysis of the E-QUEST model.

Notwithstanding the above, the decision on how to use any potential additional revenue remains of course with Member States. This criterion therefore only assesses how the different policy options would affect the initial revenue that Member States could raise with energy taxation independently of their decision how to recycle it subsequently.

All options safeguard Member States' ability to raise revenues with energy taxation appropriately and will preserve the revenue raising capability of Member States by compensating for the decreasing energy tax revenues trends projected under the baseline. The decrease of energy tax revenues in the baseline is driven by multiple factors, including the assumption of fixed nominal rates, increasing energy efficiency and fuel shift under current climate policies.

Option 1 is clearly the weakest from the point of view of ability to increase revenues because it restricts the increase of the tax base only as a result of the impossibility to fix the rates below the minima. Option 2 in contrast, would imply a consistent increase of revenues following the wide broadening of the tax base.

A stronger increase in revenues is observed under option 2c, and options 3c which introduce a pollution component or/and a CO2 taxes on top of existing rates for non-ETS sectors.

For the first option, the increase in revenues would mostly be demand driven, whereas for option 2 and 3, the contribution of the productive sectors will be more relevant following the elimination of many exemptions and reductions. The CO2 component of option 3 would further increase tax revenues.

In reality, however, the budgetary impacts would very much depend on national budgetary choices (possible compensation methods) and also on the choices of Member States when fixing national rates and using the left flexibility.

Equity

As already observed, the relative contribution towards GHG reduction differs noticeably among Member States, largely depending on the starting point of the national energy tax design and on their present energy mix. Under Options 1, 2c and 3c, in general terms lower income Member States, which have lower national rates, will be the most affected.

Also the same holds for the increase in revenues and the impact on revenues differs among Member States. Option 1 will mainly affect those Member States whose national rates are fixed at the lowest levels, whereas Options 2 and 3 will also have a relevant impact on Member States who make extensive use of possible exemptions and deductions. Moreover, the Member States who base their energy mix more on fossil fuels will also be more affected. The application of a transitional period aims at taking into account all these different national circumstances in view of a smooth transition.

In all options, the main contribution to the expected changes appears to come from changes in demand by the household sector. However, under options 2 and 3 there is a noticeable increase in the effort made also by the productive sector. While households remain the biggest contributor, the increase in rates and wide broadening of the tax base under these options (option 2 and 3) result in a relative greater contributions by the energy and process industries. The analysis presented in Chapter 6 also shows that options 2c and 3c show the worst impact among taxpayers in terms of equity because the pollution component mostly hits households.

Increased tax rates lead to an increase in consumer prices, both for motor and heating fuels. Option 1 minima have a very limited impact on heating fuels, and a small impact on motor fuels. Under Option 2a, this increase is similar across heating and transport fuel prices. When a pollution component is added the heating fuel prices increase.

The air pollution component mainly affects heating fuels for households (coal), and result in almost five times increase in household prices for fuels and power compared to the baseline in Option 2 and more than nine times for Option 3.

Concerning the impact on income, the expected increase in consumer prices and the contemporary decline in disposable income will have a small negative distributional effects on household adjusted disposable income. The magnitude of the negative effect over adjusted disposable income is broadly comparable across countries.

7.4 Coherence

The initiative for the revision of the ETD forms part of the EGD and a wider package of initiatives that cover in particular the review of sectorial legislation in the fields of climate, energy, transport, and taxation. Different options fare differently in terms of coherence with other initiatives. Option 1 maintains a level of coherence albeit weak. Options 2a and 2b exhibit the highest level of coherence with other EU initiatives considering that they limit substantially fossil fuel dependency. The taxation of products according to energy content along with the more favourable tax treatment of sustainable biofuels and the much lower taxation of electricity and advanced biofuels contribute to the objective of energy efficiency while encouraging the shift towards the use of less polluting fuels.

As far as coherence with the ETS is concerned, the ETD focuses on setting tax minima for the consumption of energy products. The objective pursued in this context as discussed before is not only contributing to climate targets but also, generating revenues for Member States and minimising distortions on the internal market. The ETS, by contrast focuses exclusively on climate targets and is targeted at pricing CO2 emitted at the production level of energy intensive installations. On the basis of this distinction the two policies are complementary and do not introduce double price mechanisms on energy products.

The introduction of the pollution component, under option 2c and 3c, would have an extremely high impact on taxation rates for sustainable biomass, which may play against reaching 2030 and 2050 target, while being coherent with commitments made with regards to pollution reduction in particular in the Zero Pollution Action Plan and under the Clean Air legislation. The addition of the CO2 component under option 3 needs to be assessed in the context of the future with the ETS and in particular the extension to the transport and building sectors to avoid undesired overlaps that could have an excessive impact on stakeholders, therefore resulting in incoherence with other initiatives under the Fit for 55 Package.

8. THE PREFERRED POLICY OPTION

When proposing its updated 2030 greenhouse gas emissions reduction of at least 55%, the European Commission also described the actions across all sectors of the economy that would complement national efforts to achieve the increased ambition. A number of impact assessments have been prepared to support the envisaged revisions of key legislative instruments.

Against this background, this impact assessment has analysed the various options through which the revision of the Energy Taxation Directive could effectively and efficiently contribute to the delivery of the updated target as part of such a wider “Fit for 55” policy package while fulfilling the internal market objective avoiding revenues erosion.

Drawing conclusions about preferred options from this analysis requires tackling two methodological issues.

First, as often the case in impact assessment analysis, ranking options may not be straightforward as it may not be possible to compare options through a single metric and no option may clearly dominate the others across relevant criteria. Ranking then requires an implicit weighting of the different criteria that can only be justifiably established at the political level. In such cases, an impact assessment should wean out as many inferior options as possible while transparently provide the information required for political decision-making. This is what this report does for the introduction of the ETD, based on the objectives of the measure and intervention logic.

Secondly, when a policy package involves a high number of initiatives underpinned by individual impact assessments, the preference for any specific measure may be a function of the policy preferences expressed in other impact assessments. The same can also be true, for instance, for the intensity of any specific measure or the nature and level of a target.

Given the complex interdependence across policy tools and the interplay with the previous methodological issue, no simultaneous determination of a preferred policy package is thus possible. A sequential approach was therefore necessary.

First, the common economic assessment, underpinning the "Communication on Stepping up Europe's 2030 climate ambition" looked at the feasibility of achieving a higher climate target and provided insights into the efforts that individual sectors would have to contribute. It could not, however, discuss precise sectoral ambitions or detailed policy tools. Rather, it looked at a range of possible pathways/scenarios to explore the delivery of the increased climate ambition. It noted particular benefits in deploying a broad mix of policy instruments, including strengthened carbon pricing and increased regulatory policy ambition.

An update of the pathway/scenario focusing on a combination of carbon pricing and medium intensification of regulatory measures in all sectors of the economy, while also reflecting the COVID-19 pandemic and the National Energy and Climate Plans, confirmed these findings.

Taking this pathway and the Communication on Stepping up Europe's 2030 climate ambition as central reference, individual impact assessments for all "Fit for 55" initiatives were then developed with a view to provide the required evidence base for the final step of detailing an effective, efficient and coherent "Fit for 55" package.

At the aggregate level, these various impact assessments provide considerable reassurances about the policy indications adopted by the Commission in the Communication on Stepping up Europe's 2030 climate ambition, notably with regard to reinforcing and expanding the role of pricing mechanisms, energy efficiency and renewable energy policies, and the instruments supporting sustainable mobility and transport - all while revising the Energy Taxation Directive.

Based on the above comparison as well as on the analysis of the specific policy options described in Chapter 6, Option 2 and 3 would fulfil the objectives in a desirable way.

Option 3 appears to comply with the climate objective as the option that helps to reduce a higher number of GHG and pollution emissions. Option 2 also contributes to the Climate and Energy objectives as well as to the rest of the objectives presented above. A well-calibrated extension of the ETS to road transport, maritime and inland shipping and buildings coupled with option 2 for ETD review could help to achieve the EU's ambitious climate objective of 55% emission reductions while allowing attain the rest of the objectives with the ETD review.

Concerning the transitional period, both periods (10 years or 7 years) will have the same impact by 2035 in every option. However, the options with a transitional period of ten years (option 2a and 3a) provide the best results compared to a shorter transitional period if we look at equity aspects.

When the pollution component is considered, the positive impact on emission reductions is outweighed by the negative distributional impact on households. Moreover, the treatment of biomass (in particular sustainable biomass) under the options including the air pollution component is not consistent with other EU policies. In this respect, it has to be underlined that the quality of wood together with the efficiency and state-of-the art of the bioenergy technology determine the air-pollution from biomass. For domestic use, modern appliances emit almost zero air pollutants and large-scale combined heat and power generated from biomass is more than 80% efficient in some European countries. Considering also that sustainable use of biomass is an important part of bioenergy for reaching carbon neutrality, and also for the RES energy mix, it might be considered whether regulatory measures would be better tailored to address the quality of wood and the use of bioenergy technology.

This being said, options 2a and 3a already have a sizable impact on air pollution reduction.

Therefore, considering that the ETS system should be extended to cover the emissions of transport and buildings, in order to avoid double taxation, option 2a would be the preferred option.

9. HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

Monitoring of taxation of energy consumption is regularly carried out at least once a year through the collection of information from Member States on the occasion of the meetings of the Indirect Tax Expert Group (ITEG). Moreover, twice yearly DG TAXUD together with the Member States update the information database on the applicable energy tax rates (Tax in Europe Database).

Moreover Article 29 of the ETD provides for a regular examination, on the basis of a report and, where appropriate, a proposal from the Commission, of the various provisions of the Directive and the minimum levels of taxation. This examination shall take into account the proper functioning of the internal market and the wider objectives of the Treaty. Once the ETD will be reviewed, this examination will have to focus in particular, on the following:

i) how Member States have implemented the new framework for the taxation of energy products and electricity in their national systems,
ii) how it has allowed them to better integrate environmental and energy efficiency considerations and
iii) what is the economic impact taking into account the way in which Member States have used any additional revenues

Table 10**:** provides the objectives, progress indicators and data sources/measurement tools which would be used to inform against these indicators. The monitoring indicators are expected to be collected on a yearly basis. For evaluation purposes, annual statistics will be computed and compared between successive years.

Table 10: Monitoring and evaluation indicators

	Indicators	Measurement tools/data sources
Ensuring that the system of minimum rates remains up-to-date and works as a "safety net" to prevent a possible race to the bottom by indexing the minimum rates to consumer prices.	– Applicable energy tax rates by Member States	– Tax in Europe Database
Ensuring that the structure of effective rates is in line with the energy efficiency by fixing rates on the basis of energy content and not on the basis of volume.	– Energy effective tax rates by Member States – Updated tax rates (effective) in the Excise Duty Tables	– Volumes of consumption in view of computing effective tax rates – Tax in Europe Database updated
Ensuring that the product coverage in the Directive follows the present EU energy mix, by updating and streamlining the list of covered products.	– Products coverage under the revised ETD	– Products coverage under the revised ETD – Sector statistics
Ensuring the consistency of the EU products coverage under ETD with the other EU policies, by duly considering the specificities of renewable and alternative energy products.	– Products coverage under the revised ETD – Evolution of the EU ETS carbon price	– Products coverage under the revised ETD – Sector statistics – Statistics on EU ETS carbon price
Reducing fossil fuel dependency, by broadening the taxable basis (out of scope and optional exemptions and derogations)	– Application of the revised ETD by Member States – Applicable energy tax rates by Member States in line with new minima	– Feedback from industry and public authorities – Tax in Europe Database
Contributing to the reduction of CO2 emissions, by taking into consideration energy efficiency and the environmental specific impact of different products.	– Level of emissions in the EU	– Climate statistics – Sector statistics
Ensuring a more equal energy taxation treatment across the different modes of transport, by eliminating the mandatory exceptions for the aviation, maritime and inland waterways sector' intra-EU traffic.	– Application of the revised ETD by Member States – Applicable energy tax rates by Member States in line with new minima	– Feedback from industry and public authorities – Tax in Europa Database

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PART 2/3

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Council Directive

restructuring the Union framework for the taxation of energy products and electricity (recast)

{COM(2021) 563 final} - {SWD(2021) 640 final} - {SWD(2021) 642 final} -
{SEC(2021) 663 final}

ANNEX 1: PROCEDURAL INFORMATION

1. *Lead DG, DEcide Planning/CWP references*

The lead DG is the Directorate-General for Taxation and Customs Union. The Decide reference of this initiative is PLAN/2020/6493.

The Commission Work Programme for 2021 provides, under heading European Green Deal, the "Fit for 55 Package", which includes the initiative for a revised legislation on energy taxation (legislative proposal, including impact assessment, planned for Q2 2021).

2. *Organisation and timing*

The Inter-service Steering Group was set up by the Secretariat-General to assist in the preparation of the initiative. The representatives of the following Directorates General participated in the ISSG work: Legal Service, CLIMA, TRADE, JRC, COMP, GROW, ECFIN, ENER, MOVE, BUDG, ENV, AGRI, RTD, MARE, TAXUD.

A total of three Inter-Service Steering Group meetings took place, with the last being on 2 February 2021.

In addition to the Inter-Service Steering Group, DG TAXUD held numerous informal Interservice meetings and technical expert group meetings to gather information, views, policy orientation and technical input from competent DGs on the treatment of energy products and electricity and the way in which the ETD can complement other policies. Representatives from the following Directorates General have been involved: ENER, CLIMA, MOVE, RTD, ENV and JRC. The last meeting took place on 06 November 2020.

3. *Consultation of the RSB*

An informal upstream meeting with Regulatory Scrutiny Board took place on 15 September 2020. On 19 February 2021, DG TAXUD submitted the draft Impact Assessment to the Regulatory Scrutiny Board and the Board meeting took place on 17 March 2021. The opinion of the Board, as issued on 19 March 2021, was positive with reservations.

The Board's recommendations have been addressed as presented below.

(1) The report should better explain how the objectives of the ETD have evolved to include environmental and climate policy objectives. It should better explain the coherence of the ETD with other initiatives in the 'Fit for 55' package, and in particular the ETS. It should further develop how these instruments interplay and what the optimal combination of the instruments and their ambition levels should be. It should explain how the ETD will contribute to reaching the agreed targets in the most cost-efficient way. It should clarify to what extent the success of the other 'Fit for 55' initiatives will be dependent on this one, and vice-versa.

These recommendations have been addressed in Chapters 1 (both in the text and in the box) 2.1, 6 and 7.4.

In chapter 1, explanation on the role of ETD in the context of the "Fit 55" package and the coherence with the ETS system have been added. In particular it has been underlined the different role and the complementarity of the two instruments in contributing to the overall "Fit 55" objective. The review acknowledges that the main role in the decarbonisation of the

EU economy corresponds in any case to the ETS and to the Effort Sharing Decision. At the same time, it explains that without the contribution of the ETD, other initiatives would have to contribute more. This, for example, could result in a higher ETS price. The coordination of the two initiatives (ETD and ETS) can help to achieve the targets in 2030 and beyond in a more cost-efficient way.

Moreover, Chapter 1 and 2.1 now address the double role of ETD as a revenue raising instrument as well as an environmental instrument, underlining the relevance of the two roles and also that the proposed review overcomes a possible trade-off, by simultaneously adjusting rates and broadening the taxable basis, thus increasing the effective tax rates.

Chapter 6 explains the coherence of the quantitative analysis with the FIT 55 in terms of baseline (EU Reference Scenario) and the considerations on the inclusion of the extension of the ETS system to transport and buildings.

Chapter 7.4 explicitly refers to the coherence with the existence and possible extension of ETS.

(2) The report should nuance its finding that the current minimum tax rates no longer serve their purpose to prevent a race to the bottom. For several energy products, many countries are still at or close to the minimum rates. The report could better explain that avoiding a race to the bottom is not sufficient to harmonise rates, unless the minimum rates are set at a sufficiently high level, which is currently not the case.

Sections 2.1 and 2.2 have been revised in order to focus on the converging role of minimum rates in the internal market. These sections shows that, in the absence of an indexation mechanism, the real value of rates has eroded over time and they no longer have a converging effect on national rates as the vast majority of Member States tax most energy products and, in some cases electricity, considerably above the ETD minima. Highly divergent national rates are applied in combination with a wide range of tax exemptions and reductions in order to safeguard the competitiveness of EU industries as well as to pursue other national policies. The chapter on effective tax rates summarises the dispersion of these national situations.

(3) The report should clarify the Directive's role in generating energy tax revenues. It should consider introducing an objective on tax collection, as a basis for the analysis of tax revenues in the comparison of options.

Chapters 2 and 4 have been modified in order to clarify the role of the Directive in preserving revenues generation. The need of preserving the capacity to generate revenues for the budgets of the Member States is now defined as one of the general objectives of the review and is included in the intervention logic. The intervention logic has been modified and no more presents operational objectives, but just general objectives and specific objectives. Section 6 has been expanded to include more analysis on the impact on revenues.

(4) The report should better explain the rationale for some proposed minimum rates. It should clarify the evidence behind the concept of 'environmental performance' that determines the minimum rates. In this context, it should better justify the proposed rates for the primary sector, aviation and maritime transport. It should specify how it proposes to tax cargo-only flights within the EU and sustainable airline fuel. The report should better explain how the indexation of minimum rates to inflation would affect effective taxation. It should discuss whether there are plausible alternative combinations of key policy design measures (in terms of minimum rates, scope extension or removal of differentations, reductions and exemptions) under the preferred option(s) that might become politically relevant and, if so why such variants were not assessed.

Explanation on the rationale for minimum rate as well as clarifications of the concept of "environmental performance" have been introduced in Chapter 5.2 both for different categories of products and uses. In box 4 the rationale for the proposed rates for the aviation and maritime sectors as well as the exemption of cargo flights and the taxation of biofuels have been addressed. The rationale of the choice of the indexation criterion is also explained and the tables presenting the new minima illustrate how (expected) inflation affects the level of rates. In Chapter 5.3 it has been included an alternative consisting in a mix of option 1 (definition of the taxable basis) and 2 (definition of rates) and it is explained why this option has been discarded.

(5) The report should reinforce its analysis of impacts on employment, international competitiveness and air pollution. It should expand the economic impact analysis for energy intensive and transport sectors (in particular air transport), including on their international competitiveness. It should differentiate between the equity effects on households and Member States. The report should better explain regulatory costs and benefits. In particular, it should clarify the consequences of the initiative on administrative costs. The report should expand on the distribution across affected groups.

In Chapter 6, the section on the labour market impacts has been extended to include information both on the Member States impact on employment and on sectorial impact. In the same chapter under sections devoted to the aviation and maritime information on the impact of the proposed options on employment were also presented. A new section 6.8 analysing the impact of the proposed options on more energy intensive industries has been included. The section on distributional impact has been extended to provide more detailed analysis and differentiate between the equity effects on households and Member States. Supplementary detailed results and analysis of distributional impacts across households by Member States for the main options considered was also included in Annex 9. On administrative cost supplementary information was included in Annex 3.

(6) The report should strengthen its analysis on why the options that also tax air pollution perform worse than the preferred option(s). The comparison of options should better recognise the benefits of reduced air pollution, and balance them against negative distributional effects. The analysis could consider transition periods for the introduction of such a tax, take into account the local character of some emissions, and reflect the effects on technical innovation.

The analysis of the reasons why a pollution component should be discarded has been strengthened in section 8 by adding technical considerations on biomass emissions linked to the quality of burnt products and the biotechnologies developments. In the comparisons of the options the benefits of reduced air pollution is better recognised.

The Board notes the estimated costs and benefits of the preferred option(s) in this initiative, as summarised in the attached quantification tables.

The table has been checked

4. Evidence, sources and quality

The evidence for the impact assessment report was gathered through various activities and from different sources:

- TEDB (Taxes in Europe Database)
- TEMS -TAXUD Energy Metadata Survey (Effective Tax Rates)
- DG JRC: Quantification of the industrial energy consumption within the scope of article 2 of the Energy Taxation Directive) (Annex 10)
- DG JRC and DG ECFIN (macro and micro economic modelling for the Impact Assessment
- Validation by external validators (from academia and other international organizations) of JRC's study on out-of-scope provisions and of data collected via TEMS
- Study on aviation
- Replies from citizens, stakeholders and public authorities to the published Inception Impact Assessment and to the Open Public Consultation (OPC)
- Desk research
- Cost assessment of air pollution:
- EMEP/EEA air pollutant emission inventory guidebooks 2019
- EEA Air quality in Europe — 2019 report
- EEA European Union emission inventory report 1990-2017 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)

ANNEX 2: STAKEHOLDER CONSULTATION

1. Consultation activities carried out

Stakeholders were consulted via the Inception Impact Assessment feedback mechanism and via a Public Consultation.

2. Inception Impact Assessment Feedback

The large majority of the 182 replies comes from the business sector, in particular from the energy intensive industries, other business (producers and distributors of energy products and electricity), businesses associations and transport sector. Three Member States two municipalities (Lille and Stockholm), a few public bodies and NGOs and three citizens sent comments.

Member States all underline the need to respect the current rules of unanimity and generally stress the importance of EU competitiveness. One MS seems open to consider negative externalities for the taxation of energy products, whereas another strongly addresses the problem of connectivity in case of maritime taxation. The third MS encourages to tax energy based on energy content and CO2 and to withdraw the exemption for the aviation sector.

In general, the energy intensive sector, as well as the business associations and producers of traditional energy products, overall claim for maintaining the current legislative framework in the context of the internal market objectives, the role of ETS for climate objectives and the preservation of the EU international competitiveness. They also stress the need to extend and render mandatory the current exemption framework. Moreover, they ask to stop to apply the state aid rules in the context of the exemption.

The aviation and maritime businesses strongly plead in favour of maintaining the current exemption, because of their need to devote resources to investments for alternative fuels (and not taxation), the need to respect international agreements and the possibility to escape a tax by tankering abroad. They also stress the need of a favourable tax treatment of alternative source of energy.

The producers and distributors of electricity and alternative fuels broadly support the analysis presented in the Evaluation and the Inception Impact Assessment and the use of energy taxation as an environmental tool. There is an overall request to tax energy products on the basis of energy content, CO2 and other polluting emissions. Moreover, they underline the need to favourably treat electricity output, while taxing the polluting sources of electricity and to restructure the products' coverage of the Directive. Some organisations warn for unintended effects of decarbonisation on the security of supply and demand lower rate for natural gas as a transition energy product.

The NGOs present the usual arguments in favour of an environmental based approach and the use of ordinary legislative initiative.

3. Public Consultation - Stakeholder participation

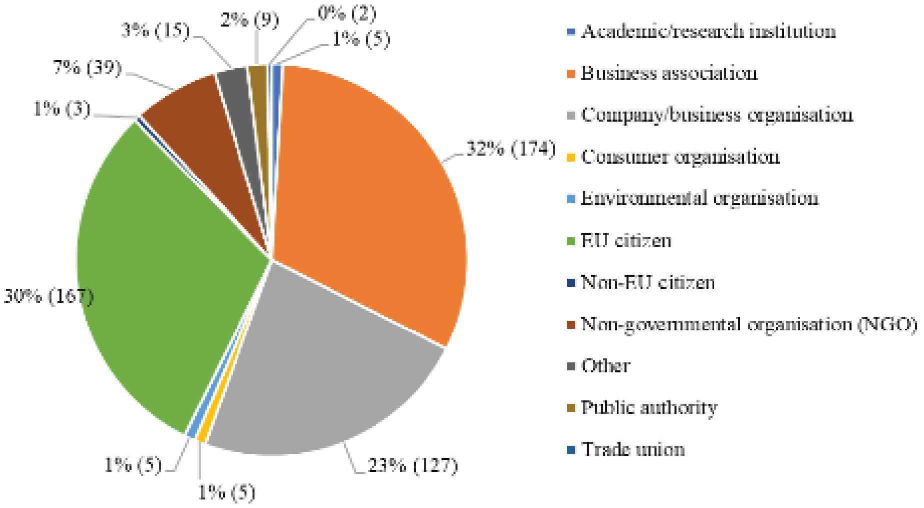
3.1 Respondents

The public consultation was open for 12 weeks from 22 July 2020 to 14 October 2020.

In total, 563 responses were received, together with 129 position papers. During the data cleaning process, 12 blank submissions were found and removed from the dataset. Therefore, 551 responses from 25 Member States and 5 third countries were considered throughout the remainder of the analysis.

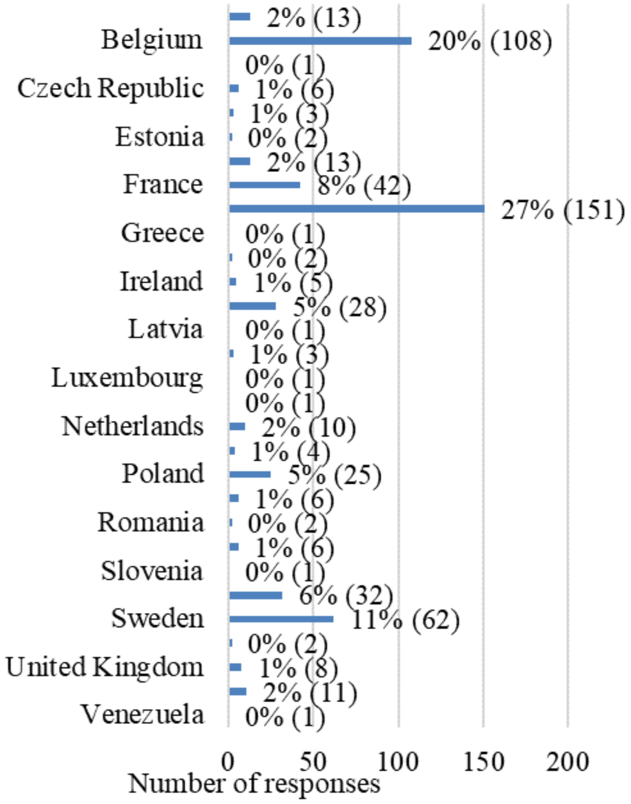
Figure 1 and Figure 2 summarise the respondent types and their geographical location.

Figure 1: Total number and percentage (%) of responses by stakeholder type (N = 551), values = % (n)



Source: Public consultation questionnaire responses

Figure 2: Public consultation survey – respondent geographical location



Source: Public consultation questionnaire responses

Stakeholders providing a response on behalf of the companies and business organisations were asked about the size of their organisation: 30% were from large companies, 16% were from medium, 23% from small, and 31% from micro-organisations. Of the nine public authorities that responded, three were local, four are regional, and two are national.

3.2 Context

As shown in the tables below, an overwhelming majority of respondents agree with the general EU objectives of fighting climate change and pollution and with the application of these objectives to the revision of the ETD. However the support to the revision of the ETD for better tackling environmental concerns, like air pollution, is lower from businesses (even though still majority) but is also present in position papers.

Table 1: Do you agree with the following statements about the EU Energy Taxation Directive (ETD)?

	EU's plans to increase climate ambition for 2030		***EU's economy and society becoming climate-neutral by 2050***		***EU's Green Deal zero-pollution ambition for a toxic-free environment***	
Stakeholder type	***agree***	***disagree***	***agree***	***disagree***	***agree***	***disagree***
Companies & business associations	86.6%	13.4%	96.8%	3.2%	90.7%	9.3%
EU & Non-EU citizens	95.9%	4.1%	95.8%	4.2%	98.8%	1.2%
Public authorities	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Civil society (all other stakeholders)	97.0%	3.0%	98.5%	1.5%	100.0%	0.0%

Source: Public consultation questionnaire responses

Table 2: Do you agree with the following statements about the EU Energy Taxation Directive (ETD)?

	The ETD should be revised in order to support the transition towards climate neutrality		**The ETD has to be revised in order to better tackle environmental concerns, like air pollution**		**The ETD has to be revised in order to better ensure the smooth functioning of the internal market**		**The ETD has to be revised in order to take into account the changed energy mix with higher share of renewables and electricity**		**The ETD should better promote energy saving/efficiency**	
Stakeholder type	***agree***	***disagree***	***agree***	***disagree***	***agree***	***disagree***	***agree***	***disagree***	***agree***	***disagree***
Companies & business associations	90.0%	10.0%	65.9%	34.1%	85.3%	14.7%	89.4%	10.6%	86.7%	13.3%

Stakeholder type	The ETD should be revised in order to support the transition towards climate neutrality		The ETD has to be revised in order to better tackle environmental concerns, like air pollution		The ETD has to be revised in order to better ensure the smooth functioning of the internal market		The ETD has to be revised in order to take into account the changed energy mix with higher share of renewables and electricity		The ETD should better promote energy saving/efficiency	
	agree	*disagree*	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*
EU & Non-EU citizens	96.4%	3.6%	95.7%	4.3%	89.9%	10.1%	94.9%	5.1%	97.0%	3.0%
Public authorities	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	87.5%	12.5%
Civil society (all other stakeholders)	98.5%	1.5%	89.1%	10.9%	94.6%	5.4%	100.0%	0.0%	98.4%	1.6%

Source: Public consultation questionnaire responses

Respondents were asked about their **priorities for the ETD** and the responses are shown in table 12, which shows that the highest levels of agreement were for the ETD revision taking into account greenhouse gas emissions in the definition of rates, followed by introducing incentives for alternative energy sources such as clean hydrogen and sustainable biofuels. Overall, people disagreed with the following options: the ETD should not tax the energy use in sectors of activity which are at risk of carbon leakage, and the ETD revision should support the objective of minimising the use of whole trees and food and feed crops for energy production, whether produced in the EU or imported.

270 respondents gave details about other priorities that they considered important in the associated open text question. The two commonest priorities were to “take into account greenhouse gas emissions in the definition of rates” (31), and to “reduce the possibility of favouring fossil fuels via tax reductions” (21). A further 24 respondents wanted to avoid the possibility of double taxation. All these opinions were also expressed in position papers. The latter also mentioned that the ETD should contribute to a stable and attractive investment environment with long-term investments in low carbon technologies and products. Some papers insisted on the necessity to take into account individual Member State requirements (e.g., peripheral EU countries) and promoted to promote EU internal competition via differential tax systems across Member States. Others preferred a homogeneous energy taxation in Europe.

Table 3: Which of the following priorities are important for the EU Energy Taxation Directive (ETD)?

Stakeholder type	The ETD should ensure adequate amounts of tax revenues		The ETD should not tax the energy use in sectors or companies which are at risk of carbon leakage		The ETD revision should reduce the possibility of favouring fossil fuels via tax reductions, exemptions and rebates		The tax system should ensure compensations for low income households when implementing energy taxation		The ETD revision should take into account energy content in the definition of rates	
	agree	*disagree*	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*
Companies & business associations	51.6%	48.4%	70.2%	29.8%	65.8%	34.2%	63.6%	36.4%	80.9%	19.1%
EU & Non-EU citizens	86.5%	13.5%	15.3%	84.7%	95.2%	4.8%	91.6%	8.4%	65.3%	34.7%
Public	66.7%	33.3%	33.3%	66.7%	88.9%	11.1%	42.9%	57.1%	87.5%	12.5%

	The ETD should ensure adequate amounts of tax revenues		The ETD should not tax the energy use in sectors or companies which are at risk of carbon leakage		The ETD revision should reduce the possibility of favouring fossil fuels via tax reductions, exemptions and rebates		The tax system should ensure compensations for low income households when implementing energy taxation		The ETD revision should take into account energy content in the definition of rates	
Stakeholder type	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*
authorities										
Civil society (all other stakeholders)	76.5%	23.5%	18.9%	81.1%	85.0%	15.0%	85.5%	14.5%	80.4%	19.6%

Source: Public consultation questionnaire responses

Respondents' views on the extent to which they agree with statements regarding **environmental and efficiency goals and functioning of the internal market** are presented below. By far the statement gaining the most agreement, was "the ETD can play a significant role in supporting production of energy from renewable sources". Option "the ETD should particularly support self-consumption and small producers of electricity coming from renewables" also has high agreement. However, respondents broadly disagreed with all other options.

Table 4: To what extent do you agree with the following statements taking into account environmental and efficiency goals and the functioning of the internal market?

	The relevant provisions of the Energy Taxation Directive (ETD) are sufficiently comprehensive also in relation to the new technologies (e.g. production of hydrogen, biofuels, synthetic fuels, e-fuels, etc.)		*The provisions related to the tax exemption for energy products used to produce energy products and the uses of energy products and electricity considered out of scope (e.g. industrial processes such as chemical reduction, electrolytic, metallurgic*		*The mandatory exemption for energy products for electricity production, which can be waived for reasons of environmental policy, is sufficiently clear and comprehensive*	
Stakeholder type	***Agree***	***Disagree***	***Agree***	***Disagree***	***Agree***	***Disagree***
Companies & business associations	17%	83%	48%	52%	41%	59%
EU & Non-EU citizens	11%	89%	12%	88%	9%	91%
Public authorities	0%	100%	40%	60%	60%	40%
Civil society (all other stakeholders)	6%	94%	18%	82%	15%	85%

	The ETD can play a significant role in supporting production of energy from renewable sources		*The ETD should particularly support self-consumption and small producers of electricity coming from renewables*		*The possibility of granting tax exemptions or reductions related to combined heat and power generation (CHP) should be restricted*	
Stakeholder type	***Agree***	***Disagree***	***Agree***	***Disagree***	***Agree***	***Disagree***
Companies & business associations	92%	8%	71%	29%	14%	86%
EU & Non-EU citizens	91%	9%	80%	20%	55%	45%
Public authorities	100%	0%	71%	29%	0%	100%

	The ETD can play a significant role in supporting production of energy from renewable sources		*The ETD should particularly support self-consumption and small producers of electricity coming from renewables*		*The possibility of granting tax exemptions or reductions related to combined heat and power generation (CHP) should be restricted*	
Stakeholder type	*Agree*	*Disagree*	*Agree*	*Disagree*	*Agree*	*Disagree*
Civil society (all other stakeholders)	97%	3%	88%	13%	41%	59%

Source: Public consultation questionnaire responses

3.3 Social impact

Respondents' views on the accompanying measures considered to be the **most relevant social policies** are summarised in table 14. The three most relevant options are the same for all stakeholders, except for public authorities, where a tax-free threshold for heating and electricity taxes is considered the most relevant (although the number of public authority respondents is low). The order of relevance differs slightly: citizens and civic society both considered lower taxation for public transport most relevant, with social welfare programmes for poor households second. Companies and business associations think that reduction of other taxes are most relevant and lower taxation for public transport is second.

A further 127 respondents gave details of other measures they believe relevant, and the argument made by the most (29) is that social measures should be linked to energy efficiency measures. The second most popular argument is "Carbon Fee & Dividend" (17). Among these respondents, a group of Swedish citizens (9) refers to the position of the Swedish Klimatsvaret, summarising it as "equal distribution of energy tax revenues to all citizens as a conversion allowance". Some position papers advocate to redirect fiscal instruments for a green recovery stimulus: public revenues generated could be used to fairly redistribute the economic burden across society and support the most vulnerable, while also providing an opportunity to reduce labour taxation.

Table 5: Which of the following accompanying measures do you consider as most relevant social policies?

	Reduction of other tax e.g. taxes on labour or social contributions		**Direct compensation to lower income groups via a lump sum**		**Direct compensation to all households via lump sum**		**Social welfare programs directed at poor households**[1]	
Stakeholder type	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*	*agree*	*disagree*
Companies & business associations	81.7%	18.3%	52.9%	47.1%	24.5%	75.5%	75.5%	24.5%
EU & Non-EU citizens	46.1%	53.9%	57.7%	42.3%	48.2%	51.8%	85.5%	14.5%
Public authorities	100.0%	0.0%	60.0%	40.0%	33.3%	66.7%	100.0%	0.0%
Civil society (all other stakeholders)	67.9%	32.1%	58.3%	41.7%	42.0%	58.0%	84.0%	16.0%

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[1] reducing their energy costs for both home owners and rental dwellings

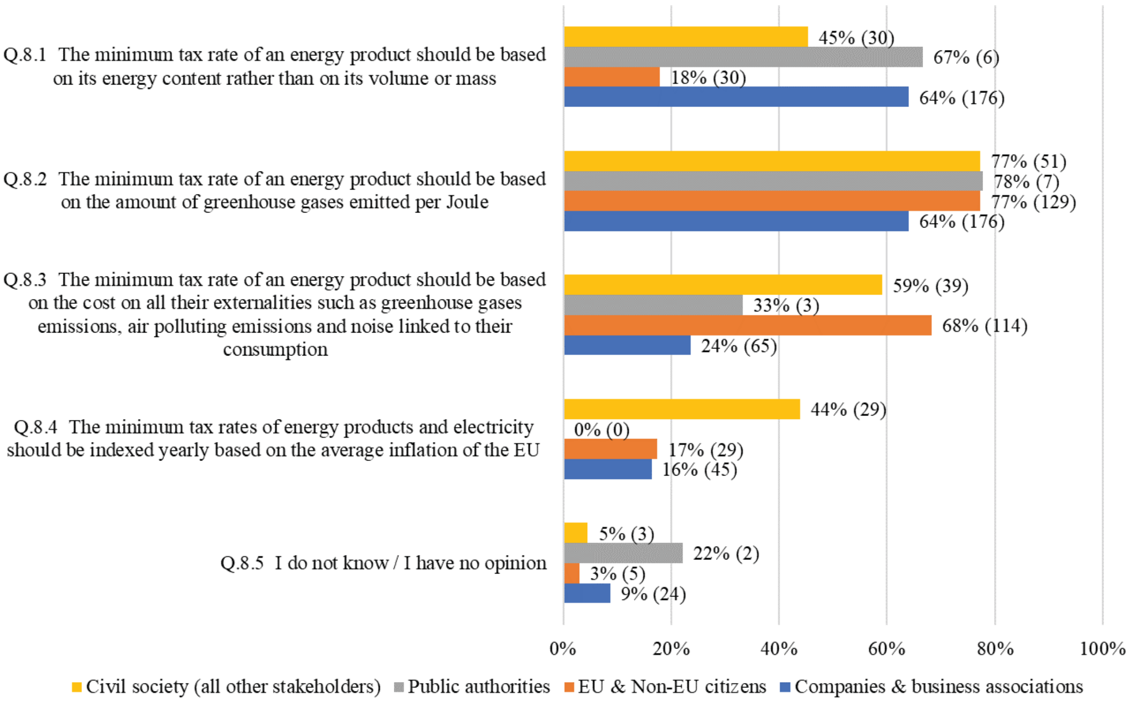
	Tax-free base/ threshold for heating and electricity taxes for basis energy consumption.		**Q.7.6 The possibility for lower taxation for local public transport should be kept**		**Q.7.7 No accompanying social measures are needed**	
Stakeholder type	***agree***	***disagree***	***agree***	***disagree***	***agree***	***disagree***
Companies & business associations	45.4%	54.6%	78.0%	22.0%	12.6%	87.4%
EU & Non-EU citizens	25.2%	74.8%	86.7%	13.3%	5.7%	94.3%
Public authorities	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Civil society (all other stakeholders)	39.1%	40.6%	83.6%	6.6%	17.2%	65.5%

Source: Public consultation questionnaire responses

3.4 Standard Rules for energy taxation

Respondents' views on the basis that should be used for setting **minimum tax rates** for energy products are summarised in Figure 37, and the majority (70%) believe they should be based upon the amount of greenhouse gases emitted per Joule. There are similar percentages for two other options: based upon their energy content rather than on their volume or mass (47%); and based upon the cost of all externalities such as greenhouse gases emissions, air polluting emissions, and noise linked to their consumption (43%). 14% of respondents indicated that they did not know or had no opinion. There are considerable differences between stakeholder type, with companies and business associations favouring the first and second options, whereas citizens prefer the second and third options, and civic society prefers the second and third options, although some civic society respondents also opt for the first and fourth options. Stronger support for "indexing minimum tax rates annually to the average inflation in the EU" can be seen in Belgium and Poland.

Figure 3: Which options do you consider as relevant for minimum tax rates. Multiple options are possible



Source: Public consultation questionnaire responses

3.5 Sector exceptions

3.5.1 Agriculture, Forestry and Fishery

Respondents were asked their opinions on specific exemptions and policies relating to several specific sectors of activity. When asked about energy tax treatment exceptions for **agriculture and forestry**, and for **fishery**, a vast majority of citizens and civil society respondents and a small minority of businesses and public authorities indicated that no exceptions should be granted[2]. For both questions, high numbers of respondents indicated that they did not know or had no opinion, with 36% and 43% respectively.

For fishery, position papers recommended that harmful incentives are abolished, and public funds are redirected to improved fisheries management and biodiversity protection. They also advocated support designed to target small-scale fisheries that operate in a way that minimises their impact on the environment.

3.5.2 Transport

Overall, the public consultation revealed some support to equalising the taxes for different transport modes so that they can compete on a level playing field, the development of more energy efficient and low carbon transport modes as well as the incentivisation and deployment of transitional and lower carbon technologies and fuels particularly natural gas, LNG, CNG and fossil-based hydrogen. Moreover, position papers advocate to increase the use of biofuels

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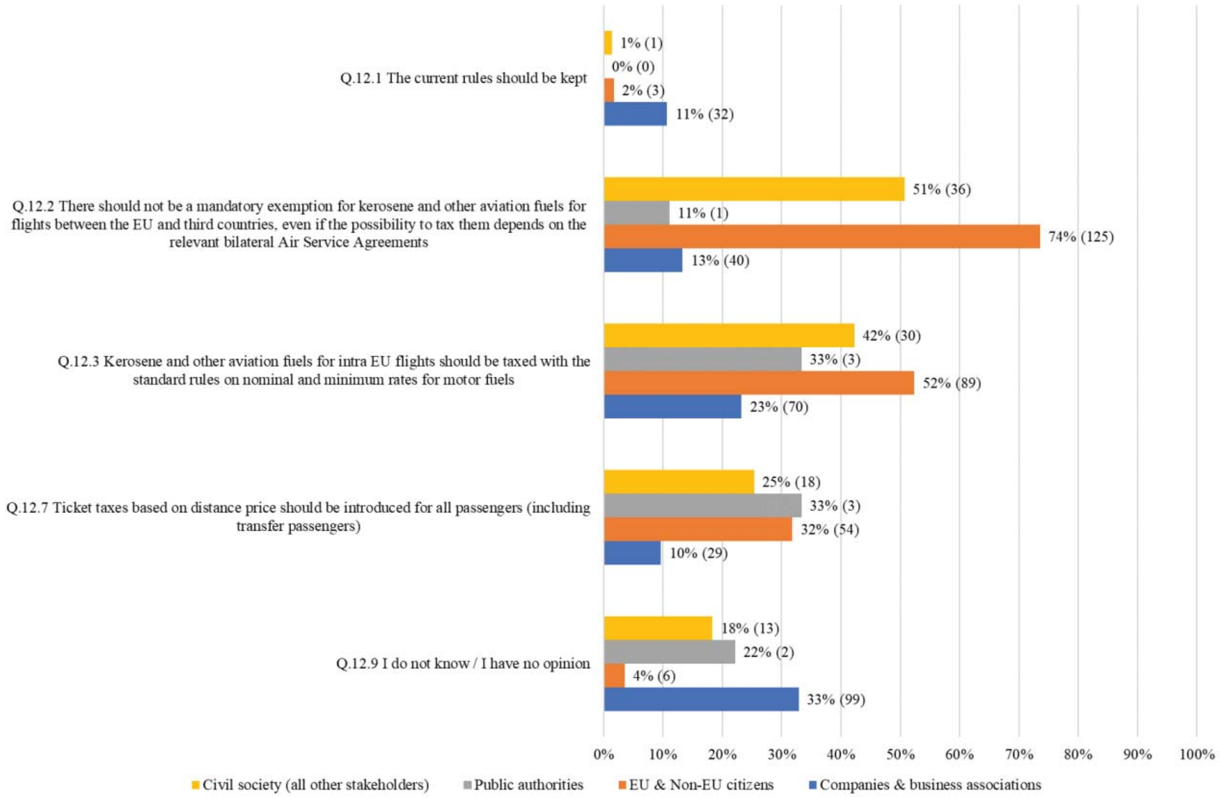
[2] Agriculture & Forestry: 63% of civil society, 82% of citizens, 25% of public authorities, 16% of businesses
Fishery: 67% of civil society, 87% of citizens, 13% of public authorities, 14% of businesses

and hydrogen in vehicles, incentivise the development of new technologies and alternative fuels, exempt buses and coaches from the scope of the revised ETD and envision rail as a main future land-based transport mode.

Respondents were asked their opinion on the tax treatment of energy products and electricity for the **aviation** sector. There was reasonable support for two options. For the option gaining the most support, 44% indicated that "there should not be a mandatory exemption for kerosene and other aviation fuels for flights between the EU and third countries, even if the possibility to tax them depends on the relevant bilateral Air Service Agreements". The second most popular option, with 41% of responses being in favour, is that "kerosene and other aviation fuels for intra EU flights should be taxed with the standard rules on nominal and minimum tax rates for motor fuels". Only 22% of all stakeholders believe that "ticket taxes based on distance price should be introduced for all passengers (including transfer passengers)". Furthermore, 26% of all respondents indicate that they do not know or have no opinion. The remaining response options all receive minimal support with less than 10% of respondents choosing these. Position papers wish to incentivise a commercial alternative to kerosene and the development of sustainable aviation fuels.

Figure 4: What is your opinion on the energy tax treatment for the aviation sector? (Multiple options)



Source: Public consultation questionnaire responses

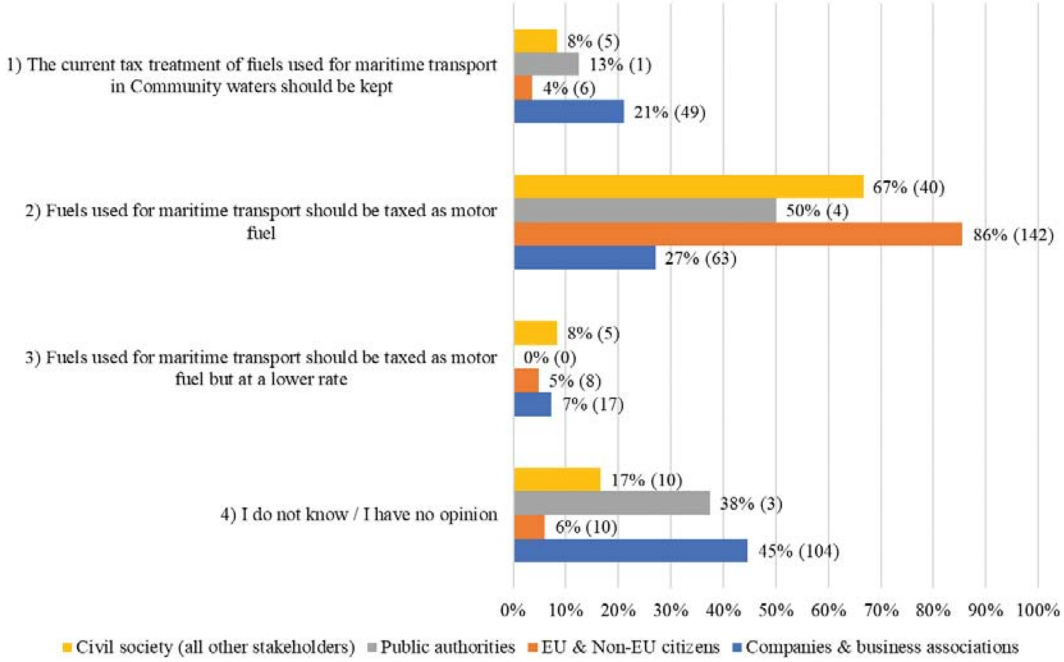
Regarding respondents' opinions on the energy tax treatment of energy products and electricity for **maritime** transport and **inland waterways**, 53% and 54%, respectively, indicated that fuels in these sectors should be taxed as motor fuel. In both questions, high numbers of respondents indicated that they did not know or had no opinion, 27% and 30% respectively.

Respondents were also asked about their views regarding **shore side electricity** (SSE) and they favoured two options. The most selected option (61%) is that "SSE should be stimulated by regulation, for instance by an obligation to use shore side electricity in harbours when available". The second most selected option (53%) is that "instead of giving a special tax treatment for SSE, the use of fossil fuels on board of ships in harbours should be subject to energy taxation".

Position papers for navigation highlighted the following main points

- Support alternative solutions in the maritime sector and European ports by facilitating and incentivising investments in a sustainable fuels infrastructure, including development, production, and use of renewable hydrogen and derived e-fuels.
- the EU ETS may be more effective in the maritime sector than an EU-wide fuel tax.
- Maintain the exemption for gasoil until the sector can fully transition to low carbon alternatives.

Figure 5: What is your opinion on the energy tax treatment for maritime transport? (Multiple options)



Source: Public consultation questionnaire responses

When asked about the tax treatment of **diesel or other motor fuels used as a propellant for commercial purposes**, a large majority of responses (70%)[3] supported the option that any motor fuel used in road transport should be taxed with the standard rules, whether used for commercial purposes or not. Position papers favour the incentivisation of zero-emission alternatives and no differentiation of tax treatment between commercial and non-commercial.

When asked about the **tax treatment of electricity used in electric vehicles in road transport**, 49% of responses[4] indicated that there is no need for a specific treatment of electricity used in electric vehicles (road transport). Only 19%[4] indicated that a specific lower tax rate should be introduced for the use of electricity for electric vehicles, but this option was the most frequent response to the open text accompanying question, with 28 people raising this issue. In the open text responses, 25 people would like electricity from renewable sources

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[3] 75% of civil society, 94% of citizens, 71% of public authorities, 50% of businesses

[4] No specific treatment: 43% of civil society, 66% of citizens, 43% of public authorities, 39% of businesses
Lower tax: 26% of civil society, 17% of citizens, 14% of public authorities, 19% of businesses

to be subject to special conditions, and 24 people would like it to be based on CO_2 content. Position papers advocate for electromobility and the use of electricity over fossil fuels as well as the incentivisation of efficient energy use and storage.

3.5.3 Industry

Respondents were asked about their opinions on the **energy tax treatment of energy products in industry**, and although there was a mixed reaction overall, a clearly preferred treatment could be identified. The highest number of respondents (34%)[5] consider that "energy products and electricity in the industry sector should not be differentiated when used for heating (including Combined Heat & Power generation) and motor fuels and industrial processes". All three remaining choices have similar, relatively low levels of support.

39%[6] of respondents preferred the option "energy products and electricity consumption by industry should be taxed with the EU standard rules on nominal and minimum rates". However, 35% of respondents indicated that they do not know/have no opinion. The second most supported option (28%)[6] is 'energy products and electricity consumption by industry should be taxed with the EU rules only for the energy content and not for the carbon content because the latter is, for an important part, covered by the EU Emissions Trading System'.

In addition, position papers advocate to incentivise electricity over fossil fuels and energy efficiency as well as mandatory exemptions and low minimum tax rates to support international competitiveness of EU businesses, prevent carbon leakage, and keep the internal market balanced. Some recommend a modification of the current taxation on lubricants and harmonisation at European level.

3.6 Lower carbon energy products

When asked about differentiated tax treatments for **low-carbon fuels and applications**, and for **selected fuels (e.g. advanced biofuels and synthetic fuels)**, in both cases the majority said 'Yes', with 75% and 63% of respondents, respectively and position papers confirm this opinion. On the same wave length, some position papers advocated for an evaluation of bioenergy on the basis of utility from a holistic viewpoint, for a differentiated treatment for advanced biofuels to encourage emissions reductions with no preferential tax treatments for other types of biofuels.

About **hydrogen**, the highest level of support (51%)[7] is for option "only if it is green hydrogen, e.g. from electrolysis with renewable electricity, in any of the above". Some position papers are in favour of green or blue hydrogen (from natural gas).

When asked about their views on tax differentiation for Compressed Natural Gas (**CNG**) and Liquefied Natural Gas (**LNG**), the most frequent response (43%)[8] was tax differentiation on these products is not acceptable. The second most frequent response (23%)[9] was that preferential treatment is permissible but should be linked to the standard energy tax components (e.g. energy content and greenhouse gas emissions). Some position papers consider LNG/CNG is currently the only suitable alternative fuel for heavy road transport, public transport, aviation and maritime use and thus, should be incentivised as a transition fuel.

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[5] 43% of civil society, 67% of citizens, 13% of public authorities, 11% of businesses

[6] Standard rules: 40% of civil society, 58% of citizens, 25% of public authorities, 27% of businesses
Energy content (not CO2): 17% of civil society, 9% of citizens, 50% of public authorities, 43% of businesses

[7] 58% of civil society, 77% of citizens, 78% of public authorities, 33% of businesses

[8] 61% of civil society, 63% of citizens, 56% of public authorities, 26% of businesses

[9] 21% of civil society, 15% of citizens, 22% of public authorities, 28% of businesses

Inputs from the related open text question and from position papers favour taxation on fuels to be differentiated based on energy content and/or on GHG emissions. They consider that the ETD should favour biofuel as a replacement of fossil fuel-derived energy sources (or at least ensure a level playing field, as sustainable renewable fuels cannot compete with fossil fuels if minimum excise rates are based on volume). They also wish to incentivise the use of transitional "lower carbon" fuels (natural gas, LNG, CNG, fossil-based hydrogen) and technologies that make efficient use of these fuels, in particular for district heating and CHP. Other papers however prefer to remove all fossil fuel incentives and accelerate decarbonisation of the grid and allow only specific exemptions for 'energy communities', self-consumption and self-production. Several papers insist on a clear definition of clean energy, taking into account the lifecycle impact, which would contribute to a gradual change towards a low carbon economy.

3.7 Additional information

Respondents were allowed to leave comments about any aspect of the survey and 300 provided comments covering 547 different issues, with three issues mentioned over 50 times:

- Taxation should be set according to the GHG emissions (well-to-wheel) of all fuels (89);
- The ETD must not result in double taxation (77);
- Incentives for investment in innovative and clean technologies and fuels are required (59).

4. Consultation results summary

The majority (70%) of respondents believe that the **minimum tax rates** of an energy product should be based upon the amount of greenhouse gases emitted per Joule. There is also support for two other options: basing it upon energy content rather than on its volume or mass (47%); or upon the cost of all externalities such as greenhouse gas emissions, air polluting emissions, and noise linked to their consumption (43%). This trend is confirmed in position papers. Overall businesses tend to prefer taking the energy content into account, whereas citizens and civil society prefer the idea of basing the cost on all the externalities.

This was studied in policy options 1 to 3 (energy content), 2c and 3c (air pollution) and 3 (greenhouse gas).

Regarding **nominal tax rates,** the strongest support (61%) is for national nominal tax rates to follow the same structure as those introduced for minimum tax rates. There is considerable unanimity between all the stakeholder groups except public authorities which would prefer no restrictions on national nominal tax rates.

This was studied in policy options 2 and 2 in terms of tax rate ranking between energy products.

Regarding the different **sectors of activity**, approximately half of respondents do not want to see tax exemptions in aviation (44%) and would prefer fuel to be taxed as motor fuel for maritime and inland waterways (50%). Similarly, approximately half the respondents do not want to see special treatment for electric vehicles (49%). Regarding commercial road transport, over two thirds of respondents would like to see fuel taxed as normal (70%). Citizens and civil society tend to favour an abolition of tax exemptions and reductions while businesse would prefer to keep part or all of their sector's preferential tax treatments. Overall, there is strong agreement that the ETD can play a significant role in supporting the production of energy from renewable sources.

A great simplification of the different sectors' and uses' exemptions and reductions was studied in policy options 2 and 3. The removal of the EU-wide mandatory exemption for aviation and maritime and the removal of the optional exemption for inland shipping is also part of policy options 1, 2 and 3.

There is strong support for differentiated tax treatments for **low-carbon fuels and applications**, and for **selected fuels (e.g. advanced biofuels and synthetic fuels)**; in both cases, over two thirds of respondents agreed with this. Regarding policy options addressing the uses of hydrogen, about half support the option of "only if it is green hydrogen, e.g. from electrolysis with renewable electricity, in any of the above". There was a positive but less enthusiastic response to the idea of tax differentiation for Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) (43%).

The differentiated tax treatment for low carbon and selected fuels was studied in policy options 2 and 3. In these options, LPG and CNG are considered transitory fuel for decarbonation of transport and have a lower minimum tax rate than traditional fuels for a transitional period.

ANNEX 3: WHO IS AFFECTED AND HOW?

1. Practical implications of the initiative

The revision of ETD aims at introducing improvements and simplification in the tax rates and taxable base, as well as clarifications of the legal text. The envisaged changes however should not fundamentally alter the actual levy and administration of excise taxation on energy products and electricity. Energy suppliers or big energy consumers remain the main taxpayers or operators registered for excise purposes. They are responsible for the payment and collection of the tax proceeds, as well as the management of possible reductions and exemptions. The number of taxpayers therefore remains limited (energy suppliers or big energy consumers) and as a result, the administration costs are practically quite limited.

Notwithstanding the above some additional regulatory costs may arise as a result of the new energy products proposed to be introduced in the ETD's scope (e.g. hydrogen and solid biomass). Such costs, albeit limited may arise for the traders in the new energy products and for administrations as these new products will be subject to some provisions of the excise general arrangements. In order to provide an illustrative overview of the key processes and obligations related to the production and trade in energy products and electricity, see the following table, referring to the current Energy Taxation Directive[10]:

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[10] See the Commission report: evaluation of the Energy Taxation Directive, SWD(2019) 329 final, and the final report on Technical and legal aspects of Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.

ADMINISTRATIVE BURDEN	For economic operators	For Member States	Source
Declaration and payment of excises			
Excise declaration	* Register for the use of the electronic declaration system * Prepare data for the declaration * File the declaration (electronically)	* Set up and maintain IT system * Control the correctness of declarations * Ensure all consumptions have been duly declared --> perform physical and document-based audits	National legislation Horizontal Directive Commission Regulation EMCS
Payment of duties	* Establish a payment method * Ensure continuous operability (E.g. provide for sufficient amount on bank account)	* Set up payment system * Control payment is made	National legislation
Respect of minimum rates	/	* Ensure compliance with EU minimum levels of taxation	**Energy Taxation Directive (art. 4)** National legislation
Excise classification	* Ensure that categorization of products is up to date * Inform on the categorization of taxable products not explicitly listed in the legislation	* Update the IT system with Combined Nomenclature changes	**Energy Taxation Directive (art. 2)** National legislation
Exemptions and reductions			
Provide direct tax exemption/reduction (in practice, based on licensing schemes)	* Prepare and submit request for licenses/authorizations	* Assess and issue licenses/authorizations	**Energy Taxation Directive (Art. 6)** National legislation
Request for a refund	* Prepare and submit request for refund	* Assess and grant refunds	**Energy Taxation Directive (Art. 6)** National legislation
Record keeping and reporting requirements (fiscal control)	* Ensure compliant record keeping	* Perform physical and document-based audits	**Energy Taxation Directive (Art. 5, 14-18, 21)** National legislation
State aid	/	* Verify that State aid rules are not breached	State aid rules (EU and national)
Movement			
Under suspension - Operate EMCS	* Register to the EMCS system	* Set up and maintain EMCS system	Horizontal Directive Commission Regulation EMCS
Under suspension - Placing and release from goods in EMCS	* Prepare the data and use EMCS to place and subsequently release the movement under suspension of goods	* Ensure the movement under suspension of goods is compliant --> perform physical and document-based audits	Horizontal Directive Commission Regulation EMCS National legislation
Under suspension and duty-paid - Guarantee	* Foresee a guarantee	* Calculate the amount of guarantee	Horizontal Directive National legislation
Duty-paid - Request for a refund	* Prepare and submit request for refund in case of MS movements of duty-paid goods	* Assess and grant refunds	Horizontal Directive National legislation
Storage and production			
Request for a license	* Prepare and submit request for licenses/authorizations	* Assess and issue licenses/authorizations	Horizontal Directive National legislation
Guarantee	* Foresee a guarantee	* Calculate the amount of guarantee * Ensure guarantee is in place	Horizontal Directive National legislation
Record keeping and reporting requirements	* Ensure compliant record keeping	* Perform physical and document-based audits	Horizontal Directive National legislation
Member States derogations			
Monitor MS derogations	/	* Introduce request for further exemptions or reductions for specific policy considerations	**Energy Taxation Directive (art. 19)** National legislation
Statistical reporting			
Report to the EU Commission	/	* Inform the EU Commission about the levels of taxation applied and about the exemptions, reductions, differentiations and tax refunds adopted	**Energy Taxation Directive (art. 25-26)** National legislation

Source: Study on "Technical and legal aspects of Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity"

2. Summary of costs and benefits

I. Overview of Benefits (total for all provisions) – Preferred Option 2a		
Description	***Amount***	***Comments***
	Direct benefits	
Contributing to the EU 2030 targets and climate neutrality by 2050 in the context of the European Green Deal	Change in EU 27 emissions in 2035 compared to the baseline: • • GHG: -1,6% • • NOx: -1,7% • • PM2.5: -2,5% • SO2: -1,6% (see the relevant section on impacts of the policy options, results on option 2a)	By reducing emissions, the ETD will enable the EU to achieve its increased targets for 2030 and become carbon neutral by 2050
Preserving the EU internal market and ensure fair competition	The introduction of the new minima and the broadening of the tax base will contribute to greater convergence of effective tax rates across Member States (see the relevant section on impacts of the policy options, results on option 2a)	The envisaged provisions on product coverage, tax rates and taxable base aims at fostering more harmonised rules to the benefit of the internal market (and national administrations, economic operators, citizens)
Budgetary impacts	Revenues in Member States are expected to increase. The evolution in EU27 of total tax revenues is expected as follows: • • +22% in 2035 corresponding to c. 24 billion EURThis additional revenue compensates for around 70% of the loss in revenue projected under the baseline (see the relevant section on impacts of the policy options, results on option 2a)	Due to the widened product coverage, increased minimum rates and enlargement of taxable base, revenues generated from energy taxation are expected to increase significantly.
Equity	Equity has been taken in due consideration in the policy design for the revision of the current legal system • The relative contribution towards GHG reduction differs noticeably among Member States. • The same holds for the increase in revenues. • In general, lower income Member States, which have lower national rate, will be the most affected. • The effect on income distribution is of small magnitude and seems just slightly larger in the first half of the income distribution. (see the relevant section on impacts of the policy options, results on option 2a)	As expected due to the very different national situations the proposed option will have distributional impact. This is one of the reasons why some changes are proposed following a transitional period of implementation.
Coherence with other initiatives of 'Fit for 55' Package and other relevant EU policies	The preferred option is fully coherent with other initiatives of 'Fit for 55' Package and relevant EU policies. (see the relevant section on impacts of the policy options, results on option 2a)	This option does not overlap with but in fact usefully complements other policy actions under the 'Fit for 55' Package.

For the **costs** of the Directive's functioning, the specific implementation of the ETD is dependent upon several other factors. These include aspects such as specific national or other EU policies being applied in the same domain, national priorities and industrial legacy, prevailing economic and trading conditions or business models of individual sectors or companies.

According to the (already published) evaluation of the current ETD[11], due to the wide ranging flexibility left by the current ETD to Member States to apply exemptions, reductions and refunds it was vastly complicated to even calculate effective rates in a harmonised way

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[11] See the Commission report: evaluation of the Energy Taxation Directive, SWD(2019) 329 final

across the EU. Particularly that at the time of the evaluation no official data collection existed that was equipped to capture effective tax rates. Altogether means that it was difficult to single out and quantify some effects of the Directive's working.

However, in the current exercise, some economic costs have been identified in the relevant section on impacts of the policy options.

Moreover some regulatory costs (mostly managing authorisations, declarations and IT systems update) will arise for the traders in energy products newly introduced in the ETD’s scope and for administrations as these products will be subject to some provisions of the excise general arrangements[12]; however these costs should be limited for hydrogen and solid biomass traders as these products will be allowed the same movement control simplifications as natural gas and coal respectively. The termination of excise duty exemptions for some fuels or sectors of activity (e.g. aviation and maritime) does not change the regulatory costs related to general arrangements as exempted fuels were anyway subject to holding and movement controls.

The collection of a fuel tax in the aviation sector is not expected to be problematic from an administrative perspective. Member States already have experience in collecting fuel taxes in other transport modes (mainly road transport). It is expected that an aviation fuel tax would be collected in a similar manner, with the fuel suppliers collecting the tax when they supply kerosene at airports, then transferring those funds to the relevant tax authorities.

In terms of efficiency, the costs of collecting the current motor fuel taxes can be used as a proxy for how much it would cost to collect an aviation fuel tax. A 2012 study carried out for DG MOVE[13] found that administrative costs for public authorities represented between 0.65% and 0.85% of the revenue of fuel tax. It is estimated that the collection of a kerosene fuel tax would be somewhat simpler, as the supply of kerosene is concentrated at airports, of which there are only a few in each Member State. Given this, the lowest figure of 0.65% of revenue is considered as representing the administrative costs of collecting a fuel tax.

Those costs can be summarised as follows.

II. Overview of costs – Preferred option 2a							
		Citizens/Consumers		Businesses		Administrations	
		One-off	Recurrent	One-off	Recurrent	One-off	Recurrent
Increase in effective taxation in the economy and broaden of the scope of the Directive	Direct costs	- Loss of employment by 0.2% at EU 27 level	- Increase in household heating and transport prices	As consumers: - Cost increase due to reduced exemptions including for new	As consumers: - Increase in fossil fuel prices As	limited regulatory costs for authorisations of new traders and new products	limited regulatory costs for declarations management and authorisations follow

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[12] Council Directive 2008/118/EC of 16 December 2008 concerning the general arrangements for excise duty and repealing Directive 92/12/EEC

[13] CE Delft et al. (2012). An inventory of measures for internalising external costs in transport. Brussels: European Commission.

				taxed sectors (e.g. aviation and maritime) As suppliers: - Limited regulatory costs for traders that store or move cross-border new energy products	suppliers: - declarations management and authorisations follow up		up Cost of collecting tax revenues.
	Indirect costs						
Action	Direct costs	None as stated in the evaluation report					
	Indirect costs	None as stated in the evaluation report					

ANNEX 4: ANALYTICAL METHODS

*1. **Introduction***

In order to assess the environmental, macro-economic, and distributional impacts of the proposed revisions to the ETD, the analysis used three modeling tools: (1) JRC-GEM-E3, a computable general equilibrium model; (2) EUROMOD, a static microsimulation model; and (3) DG ECFIN’s E-QUEST, a New-Keynesian dynamic stochastic general equilibrium model that has recently been enriched with a representation of the energy system.

2. ***The JRC-GEM-E3***

2.1 Overview

The JRC-GEM-E3[14] (General Equilibrium Model for Economy-Energy-Environment) is a recursive dynamic Computable General Equilibrium model. It is a global model, covering the European Union, alongside 13 other major countries or world regions. With a detailed sectoral disaggregation of energy activities (from extraction to production to distribution sectors) as well as endogenous mechanisms to meet carbon emission constraints, the JRC-GEM-E3 has been extensively used for the economic analysis of climate and energy policy impacts.

Divided into 31 sectors of activity, firms are cost-minimizing with CES production functions. Sectors are interlinked by providing goods and services as intermediate production inputs to other sectors. Households are the owner of the factors of production (labour, skilled or unskilled, and capital) and thereby receive income, used to maximize utility through consumption. Government is considered exogenous, while bilateral trade-flows are allowed between countries and regions.

In 5-year steps, an equilibrium is achieved at goods and services markets, and for factors of production through adjustments in prices.

The model also integrates (in particular for the baseline building) inputs from energy system models (generally PRIMES for EU Member States and POLES-JRC for the rest of the world) on a number of variables of interest, such as a detailed use of energy products by consumers, global fuel prices, etc. More information on the integration of energy system model inputs in macroeconomic modelling in JRC-GEM-E3, can be found in the Impact Assessment of the Climate Target Plan (CTP) - Annex 9.3 [15]

The JRC-GEM-E3 model is normally used to compare policy options against a baseline scenario, representing the evolution of the global economy under current energy and climate policies. This is the case in this analysis: a baseline is defined, which represents the European Union’s current ETD.

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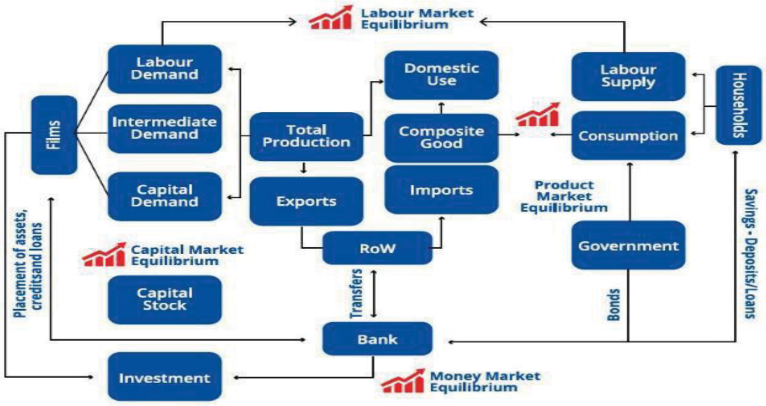
[14] https://ec.europa.eu/jrc/en/gem-e3/model

[15] Impact Assessment SWD(2020) 176 final part 2.https://eur-lex.europa.eu/resource.html?uri=cellar:749e04bb-f8c5-11ea-991b-01aa75ed71a1.0001.02/DOC_2&format=PDF

Figure 6: A schematic representation of the GEM-E3 model.



Source: JRC-GEM-E3

The model has been used to provide the macro-economic, sectoral and trade economic assumptions as input for this Impact Assessment. JRC-GEM-E3 produces consistent sectorial value added and trade projections matching GDP and population projections by country taken from other sources such as the ECFIN t+10 projections for economic activity and the Ageing Report. The model can also be used to assess the impacts of the energy and climate targets on macroeconomic aggregates such as GDP and employment.

The most important results, provided by GEM-E3 are: Full Input-Output tables for each country/region identified in the model, dynamic projections in constant values and deflators of national accounts by country, employment by economic activity and by skill and unemployment rates, capital, interest rates and investment by country and sector, private and public consumption, bilateral trade flows, consumption matrices by product and investment matrix by ownership branch, GHG emissions by country, sector and fuel and detailed energy system projections (energy demand by sector and fuel, power generation mix, deployment of transport technologies, energy efficiency improvements).

2.2. Adjustments and data extensions to the GEM-E3 model

2.2.1 Taxing energy use – model enhancements to introduce excise taxes

In the model, both firms and households consume energy. For firms, energy products are used as inputs to the production. For households, energy products are used to render two types of utility-deriving services, namely fuels for heating and appliances and fuels for private transportation. Energy products are supplied through five different sectors of activity: coal products, oil products, natural gas, electricity and agriculture (for biofuels).

For the purpose of analyzing the impacts of changes to the ETD, two new model parameters we introduced, for firms and households respectively, which represent a unit excise tax per volume of energy consumption (ton of oil equivalent in the model). The new model parameters are created in four dimensions: per country, per year, per energy consumer (also distinguishing between heating and motor fuels for households) and per energy product.

In the baseline, these new model parameters must reflect as close as possible the existing energy taxation levels in the EU under the current ETD. The most up-to-date information on tax rates and tax bases were used to derive effective tax rates (net of rebates/exemptions) in the required format for the JRC-GEM-E3 modelling exercise.

2.2.2 Deriving effective tax rates for the JRC-GEM-E3

Context

The calculation of effective tax rates, in its simplest form can be summarized as follows:

$$Effective\ tax\ rate\ (in\ €\ per\ toe) = \frac{Nominal\ tax\ rate\ (€\ per\ toe) \times Taxable\ volume(toe)}{Total\ Consumption\ Volume\ (toe)}$$

Identifying total consumption volumes per sector requires inputs from a highly detailed energy consumption database covering all Member States. The 2020 Eurostat Energy balances[16], which also enables us to ensure compatibility with the JRC-GEM-E3 baseline building process[17].

The calculation of effective tax rates is implemented in four steps:

1) Using the 2020 Eurostat Energy balances, the total consumption of fuels by consumers (production sectors and households) was employed at the level of detailed energy products reported in the balances (63 products);
2) Building on additional Commission analysis, the in-scope versus out-of-scope consumption volumes for each user was identified at the detailed energy product level;
3) Tax rates were mapped to the 33 consumers in the model, and 63 products in the energy balances (in consistent 2018€ per energy unit).
4) For each consumer, effective tax rates were derived by applying tax rates and tax bases, aggregating the detailed energy products to the level of the five energy-supplying sectors in the model.

The Eurostat energy balances present the supply and consumption of energy commodities throughout the economy in consistent units (tons of oil equivalent). The latest edition (2020) of the Eurostat energy balances was used for the most-recent available year, i.e. 2018, to derive the total use of energy products by JRC-GEM-E3 consumers.

Total consumption of energy products (*fu*) for each country(*ct*) and for each of the 33 consumers (*co*, 31 sectors and two households uses) was defined as the sum of inputs for transformation processes (e.g. for heat generation) and final consumption, as below:

$$TotCons_{fu,co,ct} = Trans\_inp_{fu,co,ct} + Fin\_cons_{fu,co,ct}$$

In-scope energy consumption

While the total consumption for JRC-GEM-E3 sectors and households represents how much energy products are actually consumed overall, this consumption is not fully subject to excise taxes. In the absence of full-fledged dataset on the actual volumes of energy subject to taxation across the Member States, further analysis was undertaken to identify the amount of energy consumption that is completely exempt from taxation according to article 2 of the ETD for energy intensive industries.

Using the same matching methodology as above to calculate total consumption, the in-scope energy consumption was identified at the level of JRC-GEM-E3 sectors as the difference between total consumption, and the identified out-of-scope volumes inputs for transformation processes and final consumption:

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[16] https://ec.europa.eu/eurostat/web/energy/data/energy-balances

[17] The JRC-GEM-E3 model relies on input from energy system models to represent the present and future evolution of energy consumption for firms and households in the baseline. For EU MS, the projections of the PRIMES model are used, for which the Eurostat energy balances are the starting point.

$$InScopeCons_{fu,co,ct} = TotCons_{fu,co,ct} - OutScopeTransinp_{fu,co,ct} - OutScopeFC_{fu,co,ct}$$

Furthermore, a number of Member States apply special rates to industry on certain out-of-scope processes, as well as for products used for heat generation in CHP.

Therefore, the calculation of effective tax rates also requires the identification of volumes for the various out-of-scope processes at the disaggregated product level. Therefore an out-scope volume with a process dimension[18] ($OutScopeCons_{fu,co,pro,ct}$) was computed for each of the out-of-scope processes, namely: *Chemical reduction, Electrolysis, Metallurgical processes, Mineralogical processes, Dual use* and *Uses other than motor or heating fuel*[19].

The volume of products used to generate heat in CHP processes ($CHPScopeCons_{fu,co,ct}$) was also computed. In the absence of data on the volume of fuels used for heat or for power in CHP, we use the heat/power output split in each sector and country provided in comments to JRC.C7 by the International Energy Agency[20].

Finally, full exemptions to a set of activities were assigned namely: energy products for electricity generation, fuels used for aviation and navigation. For these sectors, in-scope volumes are zero.

Mapping tax rates to consumers and products

First tax rates per sector and product groups -currently in volume (1000L), weight (1000kg) or energy units (GJ, MWh)- were converted into consistent units across fuels, namely per ton of oil equivalent (€/toe). For this exercise conversion rates based on Eurostat's 2019 calorific values from the Energy Balances Guide were employed Table 6.

Detailed tax rates were assigned to the JRC-GEM-E3 consumers, namely the 31 sectors of activity and two households uses as described in Table 7

Table 6: Conversion factors for original tax rate units to EUR per toe

Units provided by TAXUD →	EUR/ 1000 litres	EUR/ 1000 kg	EUR/ GJ	EUR/ MWh
Petrol	1.25			
Gasoil	1.15			
LPG		0.89		
Heavy Fuel		1.04		
Coal and Coke			41.87	
Natural gas			41.87	
Kerosene	1.19			
Electricity				11.63

Source: JRC

Table 7: Mapping tax rates to JRC-GEM-E3 consumers

JRC-GEM-E3 energy consumers		Tax database
1	Crops	Agriculture
2	Coal	Industry

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[18] For instance, the consumption of natural gas for metallurgical processes in the Iron and Steel sector.

[19] Note that in Article 2, another exemption exists: Electricity accounting for more than 50% of the cost of a product. However, due to lack of data on production costs, we were unable to identify the corresponding volumes.

[20] For 22 out of 27 Member States, which are also members of the OECD; the five remaining MS are assigned EU average values.

3	Crude Oil	Industry
4	Oil Products	Industry
5	Gas	Industry
6	Electricity supply	Industry
7	Ferrous metals	Industry (ETS)
8	Non-ferrous metals	Industry (ETS)
9	Chemical Products	Industry (ETS)
10	Paper Products	Industry (ETS)
11	Non-metallic minerals	Industry (ETS)
12	Electric Goods	Industry
13	Transport equipment	Industry
14	Other Equipment Goods	Industry
15	Consumer Goods Industries	Industry
16	Construction	Industry
17	Transport (Air)	None - exempted
18	Transport (Land)	Commercial Haulage- Public transport
19	Transport (Water)	None - exempted
20	Market Services	Services
21	Non Market Services	Services
22-29	Power technologies	None - exempted
30	Livestock	Agriculture
31	Forestry	Agriculture
n/a	Household heating	Household heating
n/a	Household private transport	Households motor

Source: JRC

Effective tax rates

Finally, using consumption volumes and tax rates for each of the 33 consumers by detailed energy product, effective tax rates at the JRC-GEM-E3 dimensions, were derived aggregating energy products into five energy-supplying sectors (su).

$$efftax_{su,co,ct} = \frac{\sum_{fu} \begin{array}{c} [InScopeCons_{fu,co,ct} \times Inscope\ rate_{fu,co,ct} \\ + OutScopeCons_{fu,co,pro,ct} \times Outscope\ rate_{fu,co,pro,ct} \\ + CHPScopeCons_{fu,co,ct} \times CHP\ rate_{fu,co,ct}] \end{array}}{\sum_{fu} TotCons_{fu,co,ct}}$$

In addition to reflect out-of-scope volumes, this method allows us to differentiate tax rates between sectors (particular industrial sectors) based on their underlying energy mix. For instance, while the gasoil nominal tax rates for the Iron and Steel and non-ferrous metal sectors might be the same, the effective tax rate on oil products (supply sector 04) will vary based on (i) the ratio of in-scope over total consumption for each sector and (ii) the composition of their consumption of oil products (e.g. I&S might consume higher or lower volumes of LPG or gasoil than NFM).

2.2.3 Introduction of air pollutant emissions in the JRC-GEM-E3

To study the impact of the various proposal on air pollutant emissions, the JRC-GEM-E3 model was further developed to cover emissions of NOx, PM2.5 and SO2 for all sectors, energy carriers and countries in the EU. Air pollutant emissions were provided by the GAINS model (IIASA, https://iiasa.ac.at/web/home/research/researchPrograms/air/GAINS.html), and corresponding emission control policies are in line with the baseline of the Second Clean Air Outlook (COM/2021/3 final) for the year 2030.

After mapping the sectors of both models, these emissions were converted into emission factors by dividing with the corresponding drivers: energy use or economic activity. Emissions that could not be clearly linked to either energy use or sectoral activity were kept fixed across scenarios. Emission factors for 2030 were then applied to the years 2025 and 2035, which could lead to slight underestimation (overestimation) of emission reductions in 2025 (2035) if emission factors are decreasing faster in regions were the ETD scenarios are particularly impactful.

While the JRC-GEM-E3 model combines economy-wide coverage with sector- and fuel-specific detail, a few caveats should be considered when interpreting the results on air pollutant emissions. First, emissions related to the use of solid biomass for energy in industry are not accounted for. Second, the model does not capture the split between diesel and petrol, hence may underestimate the benefits of the air pollution component in the minimum rates in terms NOx emission reductions.

3. EUROMOD

EUROMOD (EM) is the European Union tax-benefit microsimulation model[21]. The EM model combines country-specific coded policy rules with representative household microdata (mainly from the European Union Statistics on Income and Living Conditions database, EU-SILC). The model employs information on countries' tax codes and on household characteristics and economic circumstances to simulate tax liabilities and cash benefit entitlements. Taxes and transfers that are not possible to simulate because of lack of relevant information are used as recorded in the original surveys. The model simulations take into account the role played by each tax-benefit instrument, their possible interactions, and generate the disposable (i.e. income after taxes and cash benefits) household[22] income. Therefore, the model results are particularly suitable for the analysis of the distributional, inequality and poverty impact of tax reforms, by household or by individual groups according to socio-economic variables of interest. Cross-country comparability is enabled by coding the policy systems of the EU Member States according to a common framework. EM simulations also provide estimations of the budgetary effects and indicators which are commonly used to measure work incentive effects of the policy reform scenarios.

It should be kept in mind that EUROMOD simulations do not incorporate any behavioural effects that may also affect the fiscal as well as the distributional outcome of a reform. Thus, the model is static and delivers the first-round effects (`the overnight effect').

The analysis of the energy taxation reform scenarios is based on the recently developed Indirect Tax Tool version 3 (ITTv3) extension of the Euromod model.[23] The ITT allows the simulation of indirect taxes (such as VAT and excises) and their impact on household disposable income and government budgets. In a first step, the ITT augments the micro–data

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[21] https://euromod-web.jrc.ec.europa.eu/about/what-is-euromod

[22] The main income inequality and poverty indicators which are used to evaluate the impact of reforms are generally based on *equivalised* household disposable income, considering economies of scale in consumption within the household: *equivalised* income refers to the fact that household members are made equivalent by weighting them according to their age, using the so-called modified OECD equivalence scale.

[23] https://euromod-web.jrc.ec.europa.eu/about/what-is-euromod#inline-nav-3

underlying Euromod with information on household expenditures. This is accomplished by imputing private household expenditure information for more than 200 commodity categories from the harmonised Eurostat Household Budget Surveys (EU HBS henceforth) into the microdata underlying EUROMOD. In a second step, the tool applies the indirect taxation rules in place in each country (including VAT, specific and ad-valorem excises) to compute households' indirect tax liabilities based on their imputed consumption basket. Currently, the ITT rests on the assumption of full tax compliance and of full pass-through, and it is available for 18 countries (BE, CY, CZ, DK, FI, FR, DE, EL, ES, HU, IE, IT, LT, PL, PT, RO, SI and SK).

The simulations used in this analysis are based on EUROMOD version I2.0. The tax-benefit systems simulated in the baseline refer to those in place in each country as of June 2019, while the underlying input data mainly come from the 2010 EU-SILC[24] and the 2010 HBS. Incomes reported in the EU-SILC of 2010 refer to 2009-2010. Uprating factors are used to update income and prices from the date of the input data to the year of interest, in this case 2019.

The impact of the energy tax reforms on household budgets is analysed by estimating the changes in household post-fiscal income (post-fiscal income = household disposable income[25] – indirect taxes) across the income distribution. Distributional, inequality and poverty risk indicators are calculated on household post-fiscal income for the total population or for specific groups. Their variations in the environmental tax reform scenario under consideration[26] are compared against the baseline. EM simulations are also performed for a scenario in which the energy tax reforms are accompanied by a budget-neutral compensatory measure that redistributes the additional revenue through lump-sum transfers among households.

For the simulations of these energy taxation reforms, EM has been linked to the GEM-E3 macroeconomic model to account for the economy wide impact of the reforms. Two main steps are followed to link the two models. In the first step, the baseline scenarios of the two models are aligned.[27] For this end, the consumption of each household in the ITT is adjusted proportionally in order to ensure that the aggregate share of consumption expenditure by each group of goods and services (e.g "Education", "Food" etc) matches the one in the GEM-E3 model. In the second step, EM is fed with the impact of the simulated tax reform over prices and incomes, as simulated by the GEM-E3. In more detail, the consumption expenditure of each household is adjusted to account for the changes in prices (while keeping constant quantities). Such consumer price changes reflect both the tax change as well as the impact that the reform has on producer prices. Furthermore, household income is also adjusted to account for the changes in labour and capital income triggered by the reform, as simulated by the GEM-E3.

It should be noted that for the scenario with a compensatory measure, the tax revenues to be redistributed among household are estimated within the EM framework. Revenues estimated

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[24] While there are more up to date EU-SILC data, the 2010 version was chosen to match latest EU-HBS dataset available for the imputation of consumption data.

[25] Household market income net of direct taxes and cash benefits.

[26] For impact assessment EUROMOD was used for the analysis options 1/2.

[27] There are a number of reasons for the baselines of Euromod and GEM-E3 not to be necessarily aligned in a given year. One of them is that EM and GEM-E3 variables are constructed in accordance to different sets of statistics: for example, while in GEM-E3 household consumption is aligned with National Account data, consumption is recorded from survey data in EM.

from the macro model are larger, because they account for the increase in taxation in other sectors of the economy as well (e.g. the corporate sector).

This procedure rests on two key assumptions affecting the estimation of the change in the indirect tax burden for households. First, in the reform scenario, households are assumed to continue consuming the same quantities of all goods as before the tax hike. This can be interpreted as demand being inelastic or the "morning-after effect" (households do not adapt their consumption basket after the change in price). That effectively rules out any offsetting effects via reduced demand.[28] Second, changes in indirect taxation are measured by the variations in consumer prices resulting from the tax reforms. That amounts to assume constant producer prices and a full pass-through of the tax burden to consumers. This is a restrictive assumption since depending inter alia on market conditions, the pass-through could be imperfect and producer prices could vary to offset or to reinforce the impact of tax changes over consumer prices. Accordingly, the estimates from this approach might result in either an over-estimation (driven by the inelastic demand assumption) or an under-estimation (driven by eventual shifts of producer prices) of the additional tax burden borne by consumers. We nonetheless expect any estimation error to affect the different percentiles of the income distribution in a proportional manner, therefore preserving our qualitative conclusions.

4. QUEST

QUEST[29] is the global macroeconomic model that the Directorate General for Economic and Financial Affairs (DG ECFIN) uses for macroeconomic policy analysis and research. It is a structural macro-model in the New-Keynesian tradition with rigorous microeconomic foundations derived from utility and profit optimisation and including frictions in goods, labour and financial markets.

There are different versions of the QUEST model, estimated and calibrated, each used for specific purposes. In this impact assessment we used the E-QUEST model, which builds on the structure of dynamic stochastic general equilibrium (DSGE) models[30]. For this project, the model is set-up for two-regions, the European Union (EU) and the rest of the world (R). In each region, the economy consists of households, firms, a monetary and a fiscal authority. Following the standard DSGE literature, households can be liquidity or non-liquidity constrained depending on their access to financial markets. Households offer differentiated labour services to firms in three skill levels, low-, medium-, and high-skilled. In each region, firms produce differentiated goods and services for domestic and foreign markets. Production requires labour, general (non-energy) capital, a composite of intermediate goods and a composite of fuel and electricity-intensive capital-energy bundle. In the fossil fuel-intensive capital-energy bundle, capital is combined with fossil fuel energy while in the electricity-intensive bundle electricity is required to use the corresponding capital. The main innovation

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[28] It is generally the case that when the price of a good raises (e.g. because an increase in taxation) its demanded quantity decreases. Empirically, price elasticity of demand are typically found to be in the range of (-1, 0).

[29] https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/economic-research/macroeconomic-models_en

[30] The model is an extension of the European Commission's QUEST III model (Ratto et al. 2009, Burgert et al. 2020). Ratto, M., Roeger, W., and in 't Veld, J. (2009). QUEST III: An Estimated Open-Economy DSGE Model of the Euro Area with Fiscal and Monetary Policy. Economic Modelling 26: 222-233. Burgert, M., Roeger, W., Varga, J., in 't Veld, J. and Vogel, L. (2020). A Global Economy Version of QUEST. Simulation properties. European Economy Discussion Papers 126. Directorate General Economic and Financial Affairs, European Commission.

in the E-QUEST model compared to the standard DSGE models is the inclusion of energy-input substitution allowing for a more detailed description of substitution possibilities in different energy sources for the economic agents. Firms have imperfect substitution possibilities between fossil fuel and electricity-intensive capital-energy bundles.

The model also differs from standard DSGE models by introducing sectoral disaggregation in order to address climate policy related measures targeting fuel and electricity-intensive sectors. There are seven sectors in the model: a fossil fuel and a fossil fuel-intensive capital producing sector, an electricity and an electricity-intensive capital producing sector, a sector manufacturing general, non-energy related capital goods, an emission-intensive sector and an aggregate of the remaining economic sectors.

The model features fully forward looking intertemporal optimization and it is calibrated and solved at annual frequencies. There is endogenous labour supply, demand and wage setting, imperfect (monopolistic) competition with real and nominal frictions in all sectors of the economy. The fiscal authority receives its revenue from taxes on domestic and imported goods and taxes on factor incomes. On the expenditure side, we assume that government consumption, government transfers and government investment are proportional to GDP and unemployment benefits are indexed to wages. The monetary authority follows a standard Taylor-rule reacting to the deviation from an inflation target.

ANNEX 5: EFFECTIVE TAX RATES

1. *Introduction*

This paper delivers a systematic overview of tax reliefs in the EU27 and Norway. Much of the EU's energy consumption is not taxed at the nominal levels listed in national legislation. A wide range of energy consumers benefit from various tax reliefs, in the form of rebates, refunds, differentiation and exemptions. This Impact Assessment quantifies tax reliefs in the transport, agriculture, households, services and industry sectors. In addition the criteria attached to tax reliefs are inventoried.

Effective tax rates are best suited to serve as the basis for policymaking. Effective tax rates are synthetic indicators, which present nominal rates adjusted by tax reliefs. The difference between nominal and effective rates show that the tax burden eventually born by consumers-can vary significantly from the nominal rate. Therefore, it is important to use duly computed effective tax rates to measure the impact of proposed policy changes. Effective tax rates – unlike their nominal counterparts- also allow for cross country and cross sector comparison.

Effective tax rates are also the best indicators to summarise the shortcomings of the current ETD and consequently the drivers for its revision. While nominal rates themselves provide no clear indication for the environment or internal market related problems of the EU's current energy taxation design, effective rates can serve the purpose. They illustrate the ETD's shortfalls in terms of preserving the EU's internal market as well as contributing to the 2030 targets and climate neutrality by 2050 in the context of the European Green Deal. Effective rates demonstrate harmful fossil fuel incentives in the form of sector and use specific tax reliefs and show the real differences in energy taxes paid by consumers across Member States.

The tax code can be changed in two ways. Firstly, by altering nominal tax rates. In other words, increasing or decreasing the rates applied to energy products and different uses. Secondly, by altering the taxable base. This can be achieved by changing the list of beneficiaries or eligibility criteria attached to tax reliefs. Such measures impact volumes of energy that benefit from various tax reliefs. Where applicable, this report builds sector- wide weighted averages, combining volumes of energy that are taxed at nominal rates - and therefore do not benefiting from any tax relief- with volumes of energy that are subject to zero or reduced rates.

Findings of the report are based on a survey completed by 28 Finance Ministries. In early 2020, DG TAXUD conducted a survey that was completed by all 27 EU Member States and Norway (further EEA28). TEMS- Taxud Energy Metadata Survey allowed for the collection of systematic information on tax reliefs and the national criteria attached to their application. TEMS also covered the taxation of various environmentally friendly technologies that are important drivers of the blocks energy transition. Amongst them, hydrogen, energy storage and renewables. In order to keep the reporting burden low for Member States, the survey was designed to be complemented by external data sources. Most notably, Taxes in Europe Data Base and Eurostat energy balances.

The table below illustrates the source and methodology of effective rates that fed into the modelling of economic impacts by sector. It also shows that the analysis, based on effective rates, covers a large proportion of fuels and uses. The figures represent the share of fuel consumption, based on 2018 energy balances for all Member States.

Table 8: Sector coverage of effective tax rates (2018 energy balance)

		Petrol	Gasoil	HFO	Kerosene	LPG	Natural Gas	Coal	Electricity	Biofuels
Households	Motor									
	Heating	0.5%	8.9%	0.2%	13.0%	34.7%	37.9%	35.8%	28.2%	63.7%
Agriculture		0.2%	6.6%	2.9%	0.1%	4.6%	1.6%	4.2%	2.1%	8.7%
Transport	Road	98.5%	76.1%	0.0%	0.0%	34.5%	0.8%	0.0%	0.1%	87.6%
	Air	0.1%	0.0%	0.0%	76.7%	0.0%	0.0%	0.0%	0.0%	0.0%
	Rail	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.1%
Services		0.4%	4.1%	3.4%	8.8%	10.1%	19.2%	4.3%	29.5%	4.3%
Industry		0.4%	3.8%	93.5%	1.3%	16.2%	40.5%	55.7%	38.2%	35.5%
Total		100%	100%	100%	100%	100%	100%	100%	100%	100%

🟩	Effective Rates (Source: TEMS)
🟩	Effective Rates (Source: JRC- Petten, TEMS)
🟩	Effective Rates (Source: TEDB**)
🟦	Nominal Rates (Source: TEDB)
⬜	No rate defined for the modelling*** or no rate defined by the current ETD ***

* DG JRC: Quantification of the industrial energy consumption within the scope of article 2 of the Energy Taxation Directive (JRC124019)

** no significant tax reliefs apply or mandatory exemption applies

** due to relatively insignificant share in the energy mix

**** rate of the fuel of equivalent use and optional tax reliefs apply

Source: European Commission

Well designed tax reliefs are not always harmful. A country that sets its nominal tax rates relatively high, thereby using taxation as an instrument of environmental policy, might decide to grant tax reliefs to certain consumers or uses. These tax reliefs might allow this country to maintain this relatively high nominal rate, thus increasing energy conservation and energy efficiency across its economy, while safeguarding selected users. Such measures are used in order to pursue certain national policy goals (particularly for industries exposed to international competition or to protect vulnerable consumers).

Exemptions and reductions for any use of fossil fuels remain fossil fuel incentives. Tax reliefs for the consumption of fossil fuels increase their price advantage over less polluting alternatives and lock- in the use of fossil fuels.

2. *Transport*

This chapter presents effective rates in the transport sector, the sector that accounts for 30% of the EEA28's energy consumption. Aviation, maritime and inland shipping are covered by tax exemptions. Therefore, effective rates are automatically zero for these modes of transport. Most transport on inland water- ways is also untaxed.

Road transport accounts for 95% of all energy consumed in transport. Road transport is dominated by fossil fuels, as they provide 94% of all energy consumed on the EEA28's roads. Among fossil fuels, gas oil is the most prevalent. It accounts for over two- thirds of all energy used in road transport (67%), followed by motor petrol as a distinct second (24%). Renewables and biofuels account for the remaining 6%[31]. In road transport, commercial gas oil is the most notable beneficiary of tax reliefs. In line with the ETD, commercial gas oil may be used exclusively for the transport of goods and passengers. 14% of all gas oil used in transport benefits from commercial gas oil tax reliefs.

Table 9: Energy Mix of Road Transport.

Gas Oil	Gasoline	Blended biofuels	Pure Biofuels	LPG	Natural gas	Electricity
67.1%	24.2%	5.5%	0.3%	2.2%	0.6%	0.1%

Source: Eurostat FC_TRA_ROAD_E 2018

Tax reliefs to gas oil in road transport result in EUR 3.85 billion tax expenditure. This amount incentivizes the use of a fossil fuel. Consequently, it also constitutes part of fossil fuel incentives the EU aims to decrease in the context of its G20 commitment and the Paris Agreement. In line with these international commitments, the Clean Energy for All Europeans communication states: "the remaining but still significant public support for oil (…) continues to distort the energy market, creates economic inefficiency and inhibits investment in the clean energy transition and innovation." [32]

Ten countries provide some type of tax relief for the commercial use of gas oil. Eight of them implement refund schemes. In Germany, the scheme covers only public transport and not the transport of goods. Two apply a rebate, in the form of providing gas oil with fiscal marking at a differentiated price or refueling from special tanks. This means, that 17 MS and Norway apply the standard propellant rate to the commercial use of gas oil in road transport. In addition, Malta defines various rates for the use of gas oil in water borne transport. These include the conveyance of passengers between Malta, Comino and Gozo as well as certain maritime commercial activities[33].

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[31] Source: Eurostat. Complete Energy Balances nrg_bal_c

[32] COM(2016) 860 final, p.12.

[33] Also conveyance of passengers and goods between shore and ocean- going vessels or Separate rates for inland navigation between Malta and Gozo for vessels below and above 3500 tonnes weight.

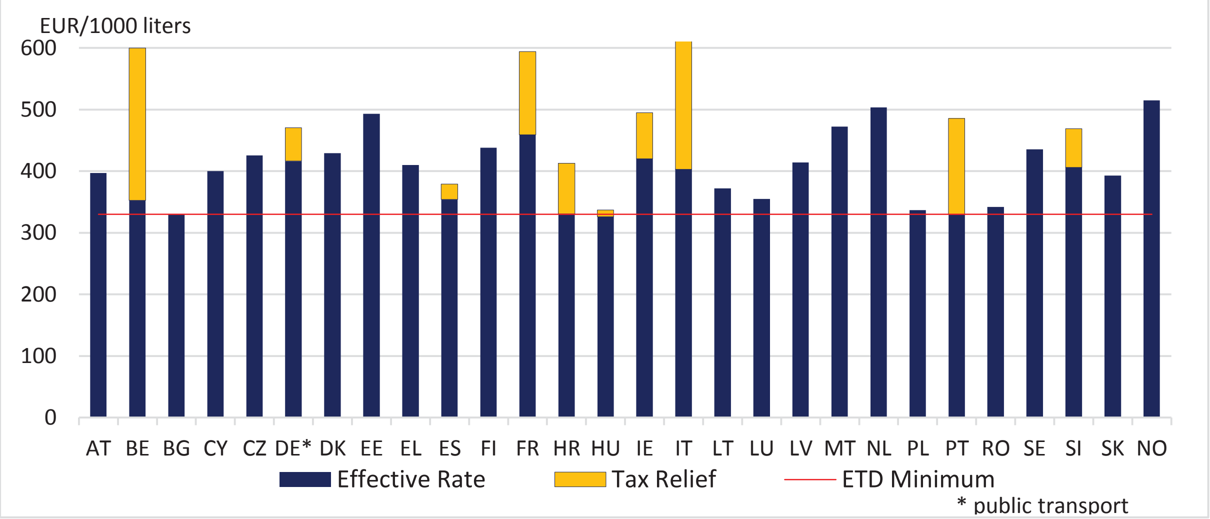
Table 10 **Share of Commercial Gas Oil Benefiting from a Tax Relief in Total Gas Oil Consumption in Road Use 2018/19. Source: TEMS and Eurostat FC_TRA_ROAD_E**

Source: TEMS and Eurostat FC_TRA_ROAD_E

AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU
0%	37%	0%	0%	0%	4%	0%	0%	0%	17%	0%	32%	13%	30%
IE	**IT**	**LT**	**LU**	**LV**	**MT**	**NL**	**PL**	**PT**	**RO**	**SE**	**SI**	**SK**	**NO**
7%	29%	0%	0%	0%	0%	0%	0%	7%	0%	0%	40%	0%	0%

Effective rates range from 330 to 530 EUR/1000 litre. This report presents effective rates in a harmonized way, therefore the type of tax relief applied by each MS does not make a difference when displaying them. Yet, all effective rates must respect the following provisions laid down by the ETD: countries may differentiate between commercial and non-commercial gas oil, provided that Community minimum levels are observed. In other words, the effective rate may be lower than the national standard propellant rate, but may not fall below the ETD minimum. In the case of some other uses of gas oil, the effective rate may go below the minimum, even to zero. The ETD also defines a weight criteria: the gross laden weight of vehicles fueled by commercial gas oil must be at least 7.5 tonnes.

Figure 7: Effective Rates for Commercial Gas Oil in Road Transport, 2018/19.



Source: TEMS

The ETD allows for the tax exemption of certain public transport and freight modes. The directive states that MS may apply, under fiscal control exemptions or reductions in the level of taxation to energy products and electricity used for the carriage of goods and passengers by rail, metro, tram and trolley bus. This provision allows MS to set tax rates that go below the minima, including zero rate. The list however excludes some environmentally friendly modes of public transport, such as electricity and hydrogen- fueled buses. The environmental performance of these low carbon transport modes could mandate their inclusion in the list of modes eligible for a full exemption.

The energy mix of rail transport[34] is dominated by electricity. Electricity accounts for 68% of all energy used by railways to transport goods and passengers. Taking into account

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[34] Local and high speed railways (excluding metro)

the share of renewable electricity in each EEA28 country's power generation mix and adding blended biodiesel consumption, we find that 39% of energy used by the EEA28's railways is of renewable origin. Consequently, rail transport is one of the most environmentally friendly modes of transport available today. Railway transport makes up only half a percent of the EE28's final energy consumption and 2% of all energy used by the block's transport sector.[35]

Table 11: Electricity Mix of the EU's rail transport sector.[36]

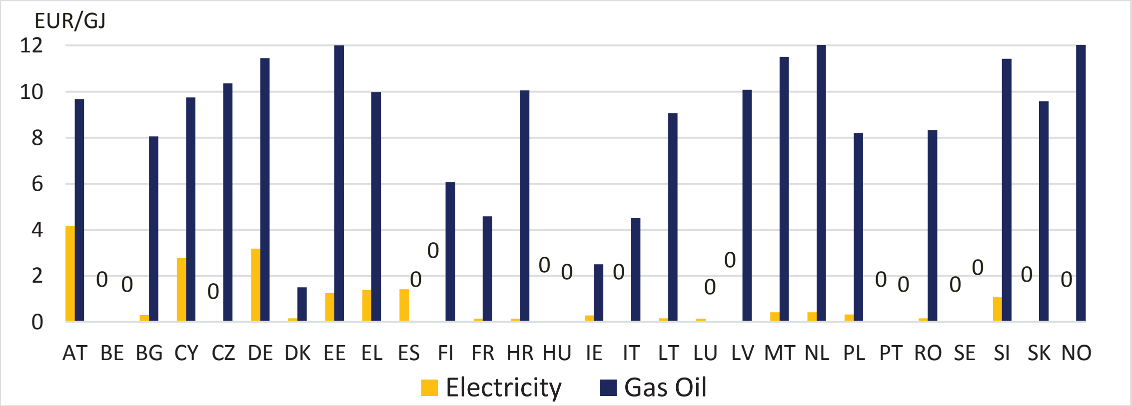
Renewable elec.	Fossil elec.	Gas Oil	Coal	Biodiesel	Other
38%	30%	27%	2%	0.4%	3%

Source: Eurostat FC_TRA_RAIL_E, SHARES nrg_ind_ren

EEA28 tax expenditure on electricity in rail transport is 8 times less than on commercial gas oil. Tax expenditure on electricity in rail transport amounts to approximately EUR 445 million . This amount comprises of exemptions in ten countries and refunds in three others. Belgium, Czechia, Finland, Hungary, Italy, Latvia, Portugal, Sweden, Slovak Republic[37] and Norway[38] do not tax electricity used in rail transport. Therefore, the effective rate is zero. The cumulative rail transport electricity consumption of these countries, accounts for 27% of all electricity consumed by the EEA28's railways. Germany, France and Denmark provide refunds, resulting in effective rates of EUR 11.42 (DE), 0.5358 (DK) and 0.5 (FR) per MWh.

Ten countries apply tax reliefs to gas oil consumption in rail transport. Less than 1% of all gas oil used in the EU's transport sector is consumed by railways. Therefore, the economic and environmental impact of these tax reliefs is limited compared to other tax reliefs for the consumption of oil products, be it in road transport, households or industry. Seven Member States, Belgium, Spain, Luxembourg, Hungary, Portugal and Sweden exempt gas oil in rail transport. Denmark, Finland, France, Italy, Ireland apply reductions resulting in effective rates ranging from 62 to 249 EUR/1000 litres.

Figure *8*: Effective Tax Rates in Rail Transport - Electricity and Gas Oil.



Source: TEDB, Eurostat FC_TRA_RAIL_E

Other modes of public transport and services may also benefit from tax reliefs. Provided, that they respect the minimum levels of taxation prescribed by the ETD, differentiated rates of

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[35] Source: Eurostat Complete Energy Balance nrg_bal_c

[36] Assuming that the share of renewable electricity is the same in rail transport as in each country's energy mix.

[37] Source for EU MS: TEDB Taxes in Europe Data Base.

[38] Norwegian Tax Administration https://www.skatteetaten.no/en/business-and-organisation/vat-and-duties/excise-duties/about-the-excise-duties/electrical-power-tax/

taxation may be applied by MS in the following cases: local public passenger transport (including taxis), waste collection, armed forces and public administration, disabled people, ambulances. Under this provision, MS may apply rates that go below the national standard rates but do not go below the ETD minima. Table 12 provides a list of these tax reliefs, which are socially justified by the countries, without quantifying volumes of energy subject to them, as their economic and environmental impacts are limited.

There are no significant tax reliefs for petrol used in transport. Unlike for gas oil, there are no wide spread refund schemes for the propellant use of petrol. Only two Member States Germany and France, grant tax reliefs for the use of petrol, by local public transport and taxis respectively. Taxis running on gas oil also benefit from tax reliefs in Belgium, Spain, and Italy. In France the effective rate for the gas oil use by taxis is 359 EUR/1000 litres, resulting in 190 EUR tax expenditure per 1000 litres. In Italy and Spain tax reliefs bring down the effective rate of gas oil to 330 EUR/liter, which corresponds to the ETD minimum. Tax expenditures per 1000 litres of gas oil used in taxis equal 270 EUR and 49 EUR, in Italy and Spain respectively. In Belgium, tax expenditure on gas oil used in taxis equals 248 EUR per 1000 litres. These tax reliefs incentivize the use of a fossil fuel.

Table 12: Tax Reliefs Applied to Public Transport, Motor Fuels for Public Services and Taxis, as of July 2020

MS	Product	Beneficiary and unit	Rate
BE	Gas oil	Taxis and use by disabled persons. Per 1000 litreslitres.	352.54
DE	Petrol	Local public passenger transport (sulfur content not exceeding 10 mg/kg). Per 1000 litreslitres. Unleaded.	600.48
	Petrol	Local public passenger transport (sulfur content exceeding 10 mg/kg). Per 1000 litres. Unleaded.	615.78
	Gas Oil	Local public passenger transport (sulfur content not exceeding 10 mg/kg). Per 1000 litres. Unleaded.	416.38
	Gas Oil	Local public passenger transport (sulfur content exceeding 10 mg/kg). Per 1000 litres. Unleaded.	431.68
	LPG	Local public passenger transport. Per 1000 litres	251.62
	Natural gas	Natural gas and hydrocarbon gases, used for local public passenger transport. MWh.	12.90
	Electricity	Local public passenger transport. MWh.	11.42
ES	Gas Oil	A partial refund for the transport of goods or passengers and taxis. The refund equals 49 EUR /1000 litres of gas oil purchased. The amount of gas oil refunded shall not exceed 50,000 litres (per vehicle and year). A different limit applies for taxies: 5,000 litres (per taxi and year).	330.00
FR	Petrol	Taxis benefit from a refund of 331.0€/1000 litres. Unleaded.	384.60
	Gas Oil	Taxis benefit from a refund of 305.3€/1000 litres	289.00
	Gas Oil	Public passenger transport and haulage operators benefit from a refund of 175.4€/1000 litres	418.60
	Petrol	Taxis, ambulances, armed forces. Per 1000 litres. Unleaded.	359.00

IT	Gas Oil	Local public passenger transport. Per 1000 litres.	403.22
	Gas oil	Taxis, ambulances motor fuel for armed forces. Per 1000 litres	330.00

Source: TEDB.

3. Households

This chapter presents two types of tax rates paid by households for various energy products. Firstly, the rate paid by the average household. Secondly, a sector- wide effective tax rate. The latter, in the form of a weighted average that is built taking into account exemptions, reductions and differentiated rates. The ETD itself does not define tax rates for households, instead it sets minimum rates for business and non- business use. Households fall under the second category. However, the ETD allows countries the apply exemptions and reductions. Therefore, the combination of non- business rates and tax reliefs yield the effective rates.

Households account for 22% of the EU's total energy consumption. Electricity, natural gas and renewable thermal energy are the sources households use most commonly. On average across the EU, the energy mix of households consists of 32% natural gas, 24% of electricity and 20% renewable energy, most of which (16%) consists of primary solid biofuels, such as firewood and wood pellets[39]. These wood products as well as heat output, accounting for 9% of household energy consumption are not taxed by the ETD. Oil products make up further 11% and solid fossil fuels, including coal 3%. This average however, conceals highly different national energy mixes.

The following sections analyze the taxation of electricity, natural gas and coal consumed by households. Electricity is used by households for lighting and heating purposes, including the provision of hot water, space heating and cooking as well as to power appliances. The prevalence of electric heating differs significantly across countries. Coal and natural gas are used for heating purposes in many countries. Due to social considerations, heating fuels are typically taxed at lower rates than transport fuels. This includes tax differentiation for the same fuel: when used for heating, rates are commonly lower for the same product used for other purposes. For example the ETD minimum rate for natural gas used as propellant is 2.6 EUR/GJ compared to 0.15 and 0.30 EUR/GJ for business and non- business heating respectively.

Table 13: Energy Mix of Households in the EEA28.

Natural gas	Electricity	Wood products	Oil products	Heat	Thermal RES	Coal
32%	25%	16%	11%	9%	4%	3%

Source: Eurostat

Eight countries exempt all electricity consumption of households. These countries do not condition the exemption on any criteria. All households are exempted, irrespective of their income or geographical location. The cumulative electricity consumption of households in these countries make up 6.8% of all electricity consumed by households in the EE28. In all but 2 of these Member States[40] the per capita GDP does not reach 60% of the EU 2013 average (as defined by the Modernization Fund).

Eight countries exempt all natural gas consumption of households. Together, their consumption accounts for 11.5% of all natural gas consumed by households in the EE28. The list of the countries exempting natural gas is not identical with the list of countries exempting

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[39] Excluding peat, which is also untaxed by the current ETD. Peat exceeds 1% of the household energy mixes of IE (7%) and LV (1%).

[40] CY, IE.

electricity. In 5 Member States[41] both products are exempted. In Czechia, Romania and Poland natural gas is exempted, while electricity is taxed. In Ireland and Latvia the opposite holds. In Cyprus electricity is exempted. Natural gas is not used on the islands of Cyprus and Malta.

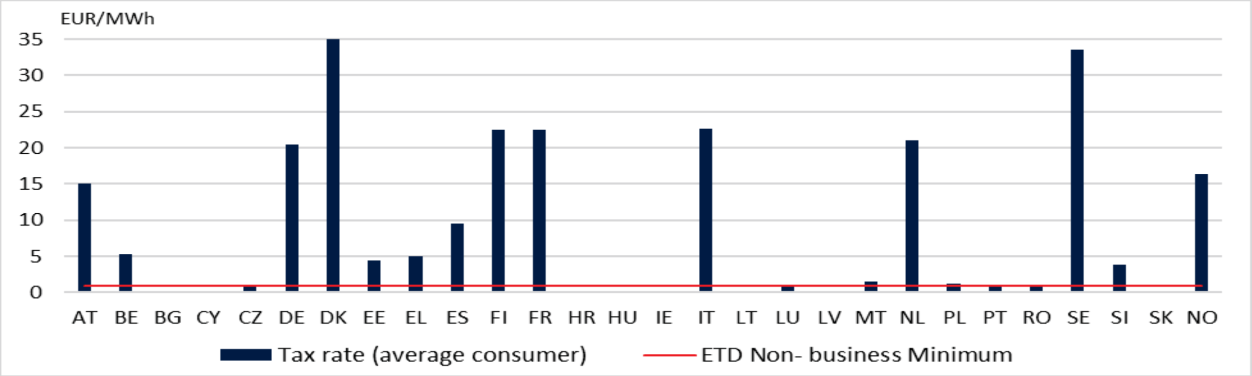
Table 14: Tax exemption of household gas and electricity consumption. X= exemption applies.

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU
Elec			X	X									X	X
Gas			X		X								X	X
	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	NO
Elec	X		X		X								X	
Gas			X					X		X			X	

Source: TEMS

Other countries grant partial exemptions based on social and regional grounds. These exemptions typically apply only to a small share of total consumption and apply to defined groups, mostly vulnerable consumers. In Belgium 3.3% of household electricity and 11% of gas consumption is exempted, being delivered to "residential protected clients with a low income or in a vulnerable position”. [42] In Portugal 12% of household electricity and 1.4% of gas consumption is delivered to economically vulnerable households[43]. In Norway, the household electricity consumption of the two northernmost municipalities, Troms and Finnmark is exempted. Their consumption accounts for 2.6% of all household electricity consumption.

Figure 9: Taxation of Household Electricity Use – Tax Rate paid by the average consumer



Source: TEDB

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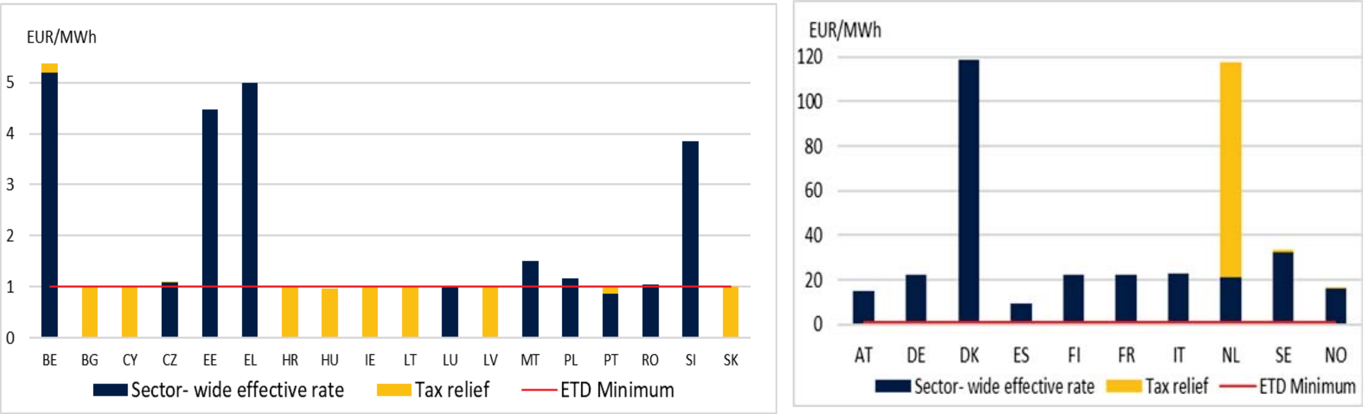
[41] BG, HR, HU, LT, SK.

[42] As defined by Article 20, § 2 of the law of the 29th of April 1999 concerning the organisation of the electricity market.

[43] These households are characterized by receiving a social benefit or having an annual income of € 5808 or less. The beneficiary must be the electricity supply contract holder and the installation must be low voltage, with a contracted power less or equal to 6,9 KVA.

Figure 10: Sector- wide effective rates of household electricity consumption[44]



Source: TEMS

Two countries differentiate energy taxes according to regions.

In France, the national electricity tax rate of 22.5 €/MWh applies to all households. In addition to the national rate, a local rate is applied. This local tax for households is the result of a uniform rate of 0.75 €/MWh multiplied by a coefficient according to departments (2, 4, 4.25) or town councils (0, 2, 4, 6, 8, 8.5). Hence, the local tax on electricity consumption can vary between 1.50€ /MWh and 9.56 €/MWh. As a result, total households electricity taxes range from 24€/MWh to 32.06 €/MWh. In Sweden, a lower tax rate is applied in the northern parts of the country. The lower rate is set at 257 SEK/MWh, compared to the general level of 353 SEK/MWh.

Yet other countries differentiate household rates based on consumption volume. In these countries the consumption bands and corresponding rates constitute of tiers. These systems are explained in detail under the section **Tiered Systems.**

In the Netherlands, a tiered system with regressive rates is applied to all consumers. In other words, households and businesses are all assigned to one of four consumption bands. In this degressive system, the higher the consumption band, the lower the per unit tax rate. Almost all households fall in the first tier. The Netherlands also grants a lump sum per connection annually, which is automatically deducted from consumer's combined electricity and natural gas bill. This report presents an effective rate for Dutch households taking into account this lump sum.

In Malta, also a consumption volume based, tiered system applies. The tariff structure is composed of consumption bands and similarly to the Netherlands, it applies to both business and non- business consumers.[45] The rates however, are degressive. In other words, the per unit tax rate increases as consumption increases. Beyond consumption volume, 2 other factors

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[44] The ETD minimum rate applies as the benchmark

[45] The tariffs are based on a cumulative consumption per annum and are applied pro rata on basis of the number of days covered by the bill. The kWh tariff structure applicable for the consumption of electricity differentiates between registered primary residence premises (household, primary residence), domestic premises (household, not primary residency) and non-residential premises (non household).

vary along a specific tariff structure. Connection capacity[46] and eligibility for an "Eco-Reduction"[47] also contribute to determining the final price.

In Denmark, consumption indirectly differentiates the effective rates paid by households. There are two different rates applied to the household consumption of electricity. A lower rate applies to electricity used for heat production. Households that are electrically heated, typically by heat pumps, pay a reduced rate for monthly consumption over 4000 kWh. This limit is based on the average household´s consumption of electricity for purposes other than heating. In other words, a lower rate applies to heating, while a higher rate applies to uses other than heating. The effective rate for each individual household results from the amount of power they use above 4000 kWh. Differentiating the taxation of electricity according to its specific uses is a challenge in all Member States. The Danish system, with a specific tax rate applied to a lump sum of consumption assigned to heating, does not require households to measure and separate their electricity consumption by end use.

Several countries exempt the auto- production of electricity. Slightly different definitions apply across countries, but auto- production basically means that the producer and consumer of electricity are the same legal entity and the consumption takes place at the site of generation. Solar panels installed on the rooftop of a family house are a common example. Additionally, some countries set upper or lower limits to the name plate capacity of installations that can benefit from an exemption. Therefore, households are unlikely to benefit from the exemption. On the other hand, Spain sets an upper limit. Tax exemption is granted when the installed capacity of cogeneration, renewable and waste electricity auto- producers does not exceed 50 MW.

Unlike for all other exemptions, the impact of auto- production could not be quantified. Volumes subject to the above listed tax reliefs could be quantified, included in the TEMS data base and taken into account for the calculation of effective rates. The same couldn't be done for auto- production. The reason for this is that most national authorities do not distinguish between auto- production by households and auto- production by other consumers. As an exemption, Czechia reported that 25 GWh renewable auto- production, equalling 0.25% of the countries household electricity consumption is exempted.

79% of household coal consumption is untaxed. Only seven countries tax exempt the household consumption of coal. However, the cumulative coal consumption of Belgium, Spain, Hungary, Luxembourg, Poland, Romania and the Slovak Republic accounts for 79% of

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[46] Beyond the kWh tiered tariff structure as described briefly in the box above, a fixed annual service charge that differentiates between a single-phase service and a three-phase service and a maximum demand tariff €/kW is payable in the case of household consumers with a service connection capacity rating exceeding 60Amps/phase.

[47] The rebate, referred to as 'eco-reduction' is not on the electricity excise tax, but on the applicable tariff rates according to consumption, whereby a lower applicable tariff rate in the form of an automatic rebate applies when the level of electricity consumption is below a certain applicable threshold. Registered primary residence premises (households' primary residence) only, shall be eligible for an eco- reduction of the amount due for consumption of electricity for the billing period in question, which shall be calculated in accordance with set rates and thresholds, on a pro rata basis of the relative annual cumulative consumption. The reduction will not be applicable if the indicated thresholds are exceeded. Household consumers may receive a percentage reduction of electricity rates, an 'eco reduction', on their electricity consumption bill on one registered primary residence as follows: Households composed of two or more persons may benefit from a two tier eco reduction mechanism provided that the consumption per person does not exceed 1750kWh per annum. A reduction of 25% in the consumption bill is possible if the consumption does not exceed 1000kWh per person for the first tier. The
second tier consists of a reduction of 15% in the bill on the next 750 kWh per person/household, Single person households receive a reduction of 25%.

all coal consumed by households in the EEA28. The prevalence of coal differs significantly across national household energy mixes. It is virtually zero in half of the EEA28 countries and is typically higher in the countries that grant an exemption.

Table 15: Share of Coal in Households Energy Mix.

AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU
0.3%	0.9%	5.1%	0.0%	11.2%	0.9%	0.0%	0.1%	0.1%	0.5%	0.0%	0.1%	0.1%	1.6%
IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	NO
4.7%	0.0%	2.8%	0.0%	0.5%	0.0%	0.0%	31.9%	0.0%	0.4%	0.0%	0.0%	1.5%	0.0%

Source: Eurostat

4. *Services and Data Centers*

This chapter presents tax rates paid by services, accounting for 14% of the EE28's energy consumption. This includes both commercial and public service providers. Electricity (47%) and natural gas (30%) make up most of the sector's energy consumption, with a wide range of other products accounting for smaller shares. Therefore, the taxation of these two products is further examined below.

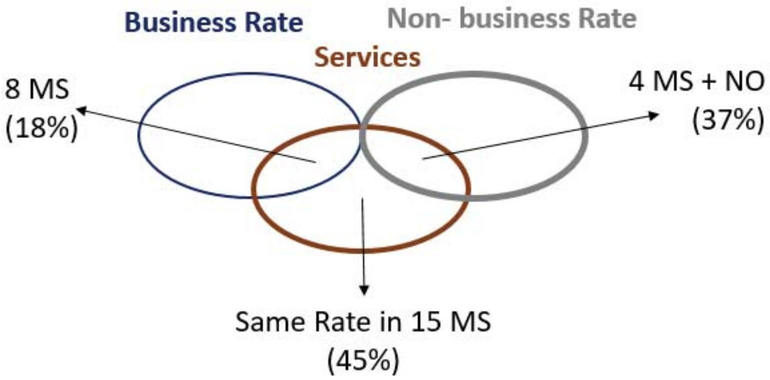
Table 16: Share of Services in Final Energy Consumption.

AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU
10%	14%	13%	17%	13%	14%	14%	17%	14%	14%	12%	17%	12%	12%
IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	NO
13%	17%	12%	13%	15%	24%	15%	11%	15%	8%	13%	9%	13%	17%

Source: Eurostat FC_OTH_CP_E and FC_E

Neither the ETD, nor Member States set specific rates for services. Moreover, the ETD doesn't define minimum rates neither for industry nor for households. Instead, minimum rates are set for business and non –business uses of electricity, natural gas and coal[48]. In the case of gas oil, commercial use is distinguished. Non- business rates are higher in the ETD minima as well as in the national implementation of each country. Given the business versus non-business distinction, it would be natural to assume that the energy use of services is taxed at the business rate. This is however far from the actual situation.

Figure 11: Taxation of the electricity consumed by services[49]



Source: TEMS and Eurostat FC_OTH_CP_E

5 countries tax services at the higher, non- business rate. In Germany, Finland, Spain, Sweden and Norway the definition of business is narrower, as the ETD allows Member States to limit the scope of business. Together these countries account for 37% of all electricity consumed by the EEA28's services. In Germany the non- business rate applies to all consumers not classified as companies in the manufacturing, agriculture or forestry sectors. In Finland business rate is restricted to industry, mining, data centers and agriculture. In Norway, the non- business rate applies to all consumption outside of industrial manufacturing and

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[48] The ETD also defines separate minimum rates for the business and non- business use of heavy fuel ol, gas oil and kerosene. However these minimum rates are identical for business and non- business respectively.

[49] The graph assumes that the distribution of electricity consumption between private and public services does not vary highly across countries.

mining as well as CHP.[50] Additionally, Denmark taxes non- VAT registered services at the non- business rate, alongside its households.

15 countries do not distinguish between business and non- business. They apply one rate. The cumulative electricity consumption of services in these countries accounts for 45% of all electricity consumed by EEA28 services. Among them, Croatia, Lithuania, Luxembourg and Romania apply the ETD minima[51]. As 5 countries tax services at the higher "non- business rate" and 15 countries do not differentiate, 8 countries tax services at the lower, "business" rate. This means that only 18% of electricity consumed by services is taxed at a dedicated business rate, be it the minimum rate or higher. The Netherlands applies the same tiered system to all electricity consumption, be it by households or industry. However, business and non- business are distinguished in the largest consumption band, covering annual consumption of 10 GWh and above.

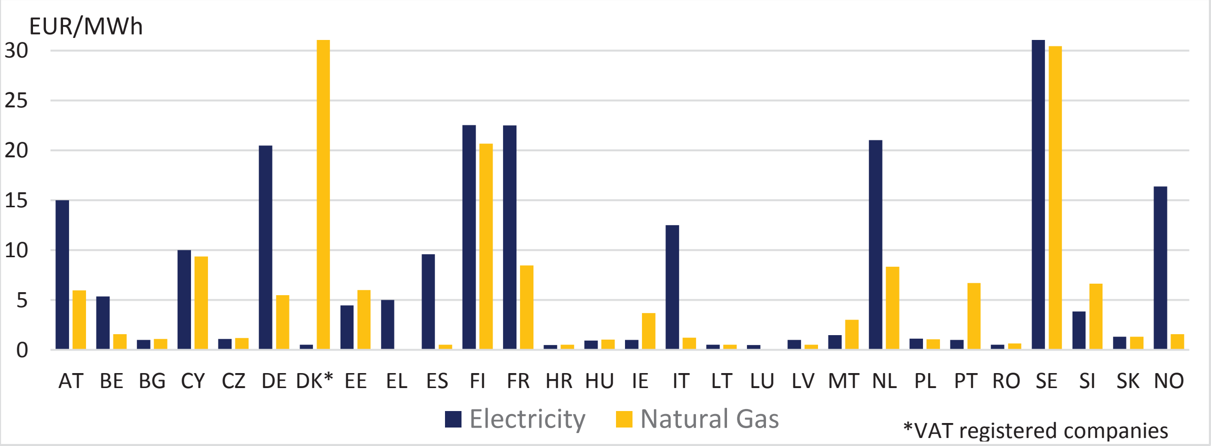
Table 17: Electricity rate applicable to commercial services. B= Business. NB= Non- business. SR= Same Rate.

AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU
SR	SR	B	B	SR	NB	B	SR	SR	NB	NB	SR	B	SR
IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	NO
SR	B	B	B	SR	SR	SR	SR	SR	B	NB	SR	SR	NB

Source: TEMS and TEDB

Even less countries differentiate the business and non- business use of gas. In Finland and France, the business versus non- business distinction, that is applied to electricity, does not exist for gas. Neither does the Netherlands apply a differentiation for the highest bracket of gas consumption, that is applied for electricity. In Italy, all gas is taxed at the non- business rate when used for other than industrial purposes. In Spain, the non- business rate applies to uses other than fuel, as well as to natural gas intended for use as fuel in stationary engines.

Figure 12: Nominal Tax Rates applicable to Services.



Source: TEDB

Public services are usually taxed at non- business rates. Local and national administrations, educational institutions, hospitals, welfare institutions, lightning of public roads and squares were commonly listed by countries as public services in the TEMS survey. In Cyprus, all uses defined as non- business, including public services, can benefit from an

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[50] The lower, business rate applies also to all commercial activity in Finnmark and certain municipalities in Nord-Troms, to data centres with an output in excess of 0.5 MW and to commercial vessels.

[51] 0.5 EUR/MWh for business and 1 EUR/MWh for non- business.

exemption. In the northernmost parts of Sweden, similarly to households and service sector companies, public services may benefit from a lower rate. In the countries where all households are exempted, its only pubic services that fall under the non- business category. For example, households pay no tax on natural gas, while public services pay the non-business rate.

Data centers benefit from special provisions in some countries. Data centers are energy intensive services**.** In Finland, data centers can benefit from the lower, business rate, alongside industry, mining and agriculture. In France, data centers can benefit from a reduced tax rate of 12 €/MWh for the fraction of their annual consumption that exceeds 1 GWh, if their total consumption of electricity equals or exceeds 1 kWh/€ of added value. Norway also attaches a criteria: data centers with an output in excess of 0.5 MW can benefit from the business rate. In Sweden, the lower tax rate of SEK 5/MWh for business use applies to electricity used in data centers, alongside manufacturing and shore- side electricity.

Services can benefit from tax reliefs as long as resulting effective rates respect the ETD minima. The ETD allows national administrations to grant tax exemptions and reductions to businesses based on a range of criteria, including energy intensity, trade intensity and energy efficiency. Services typically do not fulfill these criteria, with the exemption of tax reliefs conditioned on annual consumption volume. Services can consume large volumes of energy and therefore qualify for this type of tax relief. Services also pay differentiated rates in countries that apply tiered systems. Where such tax regimes are applied, services like all other consumers, might pay different rates based on the volume of their energy consumption.

Tiered Systems

Article 5 of the ETD allows countries to differentiate tax rates according to consumption volumes. Several countries make use of this provision for various areas of use of electricity and natural gas. Several countries make use of this provision for various products and uses. In these countries the bands of consumption volumes and corresponding rates built tiered tax systems. These systems are typically degressive: the higher the consumption band the lower the per unit tax rate. These tiered systems are used in multiple sectors of the economy, including industry, households and services. They are typically not applied in the transport and agriculture sectors where the use of liquid fuels is dominant. Where applied, such tiered systems pose particularly difficult challenges to the establishment of effective tax rates. While households are generally taxed at the rate of the first bracket (lowest consumption band and highest rate), individual companies in industries and services sectors can fall in multiple brackets. Therefore, the taxation of users in these sectors can be highly differentiated. The following table provides and overview of tiered systems applied by countries based on the TEMS Survey and Taxes in Europe Data Base.

Table 18: Overview of tiered systems applied by countries based on the TEMS Survey and Taxes in Europe Data Base

BE	Elec	Business	I	-0%	annual	0-20,000 MWh; reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			II	-15%	annual	20,000-50,000; reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			III	-20%	annual	50,000-250,000; reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			IV	-25%	annual	250,000-1000,000, reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			V	-45%	annual	>1000,001 (starting with 1000,001), reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			VI	cap	annual	Federal contribution is capped at 250.000 EUR
BE	Gas	Business	I	-0%	annual	0-20,000 MWh; reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			II	-0.15	annual	20,000-50,000; reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			III	-0.2	annual	50,000-250,000; reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			IV	-0.25	annual	250,000-1000,000, reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			V	-0.45	annual	>1000,001 (starting with 1000,001), reduction in federal contribution. Base rate: 3.4439 EUR/MWh
			VI	cap	annual	Federal contribution is capped at 750.000 EUR
EL	Gas	Business	I	1.5	annual	0-36,000 GJ
			II	0.45	annual	36,000-360,000 GJ
			III	0.4	annual	360,001-1,800,000 GJ
			IV	0.35	annual	1,800,001-3,600,000 GJ
			V	0.3	annual	> 3,600,000 GJ
IT	Elec	Business	I	12.5	monthly	0-200 MWh
			II	7.5	monthly	For the share of monthly consumption in excess of 200 MWh but below 1200 MWh.
			III	cap	monthly	If the monthly consumption exceeds 1200 MWh a flat rate of 4,820 EUR applies for the share in excess of 200 MWh.
LU	Gas	Non- bus.	I	1.08	annual	Cat. A
		Business	II	0.54	annual	Cat. B
			III	0.30	annual	Cat. C2
			IV	0.05	annual	Cat. C1
NL	Elec	Both	I	125	annual	0-10
			II	88.33	annual	10-50 MWh
			III	34.04	annual	50-10,000
			IV	0.95	annual	>10,000
NL	Gas	Both	I	9.82	annual	0 – 5,978.9 GJ (National rate 0 – 170,000 Nm3; conversion rate 0.03517GJ/Nm3)
			II	2.32	annual	5,978.9 – 35,170 GJ (National rate 170,000 – 1,000,000 Nm3)
			III	0.85	annual	35,170 – 351,700 GJ (National rate 1,000,000 – 10,000,000 Nm3)
			IV	0.45	annual	> 351,700 GJ (National rate > 10,000,000 Nm3)
SI	Elec	Both	I	3.05	annual	0-20
			II	3.05	annual	20-160
			III	3.05	annual	160-10,000
			IV	1.08	annual	>10,000

Agriculture accounts for 3% of the EEA28's total energy consumption. Gas oil is the dominant fuel in the sector: half of all energy consumed is covered by gas oil. Gas oil in agriculture is used both as propellant (for example driving tractors) and for heating (for example heating green houses). As a distant second, electricity accounts for 16% of the sectors energy mix, followed by natural gas (12%), biofuels (4%) and other renewables (6%), including solar- and geothermal. Coal use is negligible in all countries but Poland, where it accounts for 22%. The following sections analyze the taxation of the three products with the highest shares in the sector's energy mix, namely gas oil, natural gas and electricity.

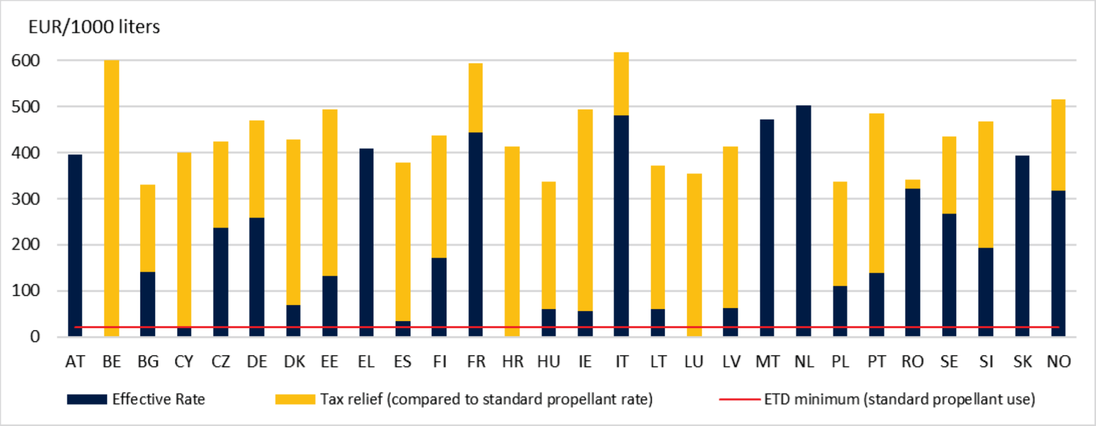
Table 19: Energy Mix of the EEA28's agriculture sector.

Gas oil	Electricity	Natural Gas	Biofuels	Other RES	Other FF
52%	16%	12%	4.0%	6%	10%

Source: Eurostat

Twenty- one countries provide some form of tax relief to tax gas oil used in agriculture. Three of them apply a full exemption. The aggregate consumption of Belgium, Croatia and Luxembourg equals to 18265 TJ or 3% of the total EU27 gas oil consumption in the agriculture sector. 18 other countries provide other forms of tax relief**.** Eleven grant a refund and 7 apply differentiated rates. Most of these countries use fiscal marking to fight abuse of rebated fuel. A colorant is added to the fuel allowing for on-spot visual as well as for laboratory testing. Irrespective of the type of tax relief, the ETD allows for agriculture rates that go below the ETD minimum of standard propellant use.

Figure 13: Effective Rates for Gas Oil Use in Agriculture.



Source: TEMS

Total EEA28 tax expenditure on gas oil in agriculture amounted to EUR 3.2 billion Euros in 2019. This amount was incentivizing the use of a fossil fuel. Furthermore, it constitutes an implicit loss of revenues. It is to be remembered that per liter and total tax expenditures cannot be compared across countries. A country that applies the minimum rate to both standard propellant and agricultural use, would show zero per liter incentive. Another country that applies a high standard propellant rate, thus fostering energy conservation, and at the same time grants a large refund to agricultural use only, would show a large per liter incentive.

The tax code of 6 countries distinguishes different agricultural uses of gas oil. Germany, Denmark, Ireland and Sweden distinguish between propellant and other uses of gas oil, which mostly consist of heating. Czechia applies different rates to plant- and livestock production. Romania lists gas oil used for agriculture and aquaculture separately, albeit the same rate applies to both. For these countries, a weighted average that takes into account respective rates and consumption volumes, is presented in this report.

Table 20: Differentiated Taxation of Gas Oil in Agriculture

Country	CZ	DE	RO	SE
Category 1	Plant production, forestry, fishpond	Propellant	Agriculture (all)	Propellant
Category 2	Livestock	Heating	Aquaculture	Heating
Rate 1	0.255	0.215	0.211	0.257
Rate 2	0.055	0.015	0.211	0.342
% Vol. 1	26%	99%	99.8%	89%
% Vol. 2	74%	1%	0.20%	11%

Source: TEMS

The role of natural gas shows high divergence on the national level. While natural gas makes up less than 1% of the agriculture sector's energy consumption in 11 Member States, it reaches 57% in the Netherlands, 35% in Belgium and 20% in Romania. In these countries, natural gas is typically used to heat green houses. Biofuels and thermal renewable energy (geothermal and solar thermal) also provide a sizeable share of the sectors energy consumption in Sweden (37%), Austria (35%) and Finland (29%).

Three countries apply total or partial exemptions to electricity used in agriculture. Belgium and Greece exempt all power use in agriculture. The consumption of these two countries accounts for 7% of all electricity used in the EEA28's agriculture sector. Norway exempts electricity supplied to commercial green houses. Sweden also provides a tax relief for electricity in agriculture: the same lower tax rate applies to electricity used in agricultural, forestry and aquacultural works as the one applied to data centers, shore side electricity and industrial manufacturing processes.

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PART 3/3

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT REPORT

Accompanying the document

Proposal for a Council Directive

restructuring the Union framework for the taxation of energy products and electricity (recast)

{COM(2021) 563 final} - {SWD(2021) 640 final} - {SWD(2021) 642 final} -
{SEC(2021) 663 final}

ANNEX 6: COST ASSESSMENT OF AIR POLLUTION

1. Objective

The objective of this methodology is to assess the cost of non-GHG air pollutants emitted by the consumption of energy products (e.g. fuel combustion) and to take it into account in the EU-wide minimum rates defined in the Energy Taxation Directive (ETD).

The amount of air pollution emitted by individual sources depends a lot on the combustion characteristics and filtering systems. In addition, the impact of the pollutants emitted depends on the location of air pollutant emissions (notably on the proximity to densely populated areas). The ETD however relies on EU-wide minimum rates for types of energy products (e.g. gasoil, petrol, coal, natural gas) and for two usages (motor fuel and heating fuel). For these reasons, the methodology adopts a conservative approach and targets an approximate low-end value for the air pollution cost assessment so that it can be applied to the ETD's types of fuels and usages for all motors and heating systems independently of combustion and filtering devices or of location.

2. Scope

The methodology focusses on the types of energy products and usages that are in the scope of the proposed revision of the ETD.

Consequently, only the end use or final consumption of energy products are in the methodology's scope and, in particular, energy products used for the production of electricity are out of scope.

3. Overview

An ETD air pollution component, expressed in €/quantity of fuel[1] used, can be computed for (non-GHG) air pollution as the sum of a PM2.5 tailpipe emission component and a NOx emission component, where each of these components is computed by multiplying an emission factor, by a mortality ratio (in terms of premature deaths or years of life lost), by a compatible valuation of mortality (also related to premature deaths or years of life lost):

$$A_p * \frac{B_p\ (or B_p{}^*)}{C_p} * D\ (or D^*) = \frac{€_p}{quantity\ of\ fuel}$$

Where

- A_p = pollutant emission factor for the fuel and user category considered (in g per quantity of fuel), as used to compute the pollutant p Emission Inventories under the National Emission reduction Commitments (NEC) directive;
- B_p or $B_p{}^*$ = premature deaths or Years of Life Lost (in number per year) attributable to the pollutant p, as computed and reported by the European Environment Agency;
- C_p = are the emissions of pollutant p (in kt per year), as reported by the MS in their inventories under the NEC directive;
- D or D* = Value of Statistical Life or Value of Life Years for the EU (in € per premature death or Year of Life Lost), as computed by the OECD and used in

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[1] In this explanation we use "fuel" to mean any type of energy source used by activities under the scope of the ETD, be it in liquid, gas or solid form, of renewable or fossil source, and including electricity.

different impact assessments. Each of these components has to be used in an internally consistent way, specifically use Value of Statistical Life (D) to value premature deaths due to the emissions (B), and Value of Life Years (D*) to value Years of Life Lost (B*).

In other words, the ETD air pollution component is computed as

$$\frac{€_{PM2.5}}{quantity\ of\ fuel}+\frac{€_{NOx}}{quantity\ of\ fuel}$$

This can be expressed in € per mass (kg), or € per volume (litre), or € per energy content, through simple multiplication with the appropriate conversion factors for each fuel considered.

4. Detailed description and Assumptions

It should be noted that this approach limits the computation to covering only the main health impacts of air pollution (i.e., ignores non-health impacts such as impacts on resource availability, ecosystem impacts -including on agricultural output-, impacts to buildings and aesthetic/ethical impacts), and even then only a sub-set of the health impacts are covered (e.g., it ignores impacts on morbidity). It is generally considered in the literature that in the EU, health impacts account for about 90% of the value of air pollution impacts[2].

Moreover, we also only cover the impacts arising from PM2.5 and from NOx emissions, thus ignoring other air pollutants relevant under the NEC. This choice to cover only PM2.5 and NOx is based on the fact that these are generally considered to be the two main health concerns in terms of air pollution in the EU[3]. A third air pollutant of concern is ozone. However, whereas ozone results from primary pollutants emissions related to fuel combustion, ozone is not directly emitted and its formation is strongly driven by weather patterns, making it extra difficult to establish stable links to fuel consumption. As such, although fuel combustion does play an important role in ozone formation, we choose to ignore it in the computations and restrict the calculation to primary pollutants (directly emitted by the vehicles) to avoid the introduction of assumptions that would increase complexity and uncertainty.

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[2] See for instance the Second Clean Air Outlook report (COM(2021)3) and its supporting reports:
https://ec.europa.eu/environment/air/pdf/CAO2-MAIN-final-21Dec20.pdf
https://ec.europa.eu/environment/air/pdf/CAO2-ANNEX-final-21Dec20.pdf
But also : https://epha.org/wp-content/uploads/2018/11/embargoed-until-27-november-00-01-am-cet-time-ce-delft-4r30-health-impacts-costs-diesel-emissions-eu-def.pdf; See in particular table 2 (page 8) and the 1st para in the executive summary *"(…)the total of the health and non-health related costs of road traffic related air pollution in the EU28 in 2030 is estimated at €19.5 billion; of which € 18.3 billion are health-related (…). When using the adjusted emission factors (TRUE), the sum of the 2030 health and non-health related costs amount €25.6 billion (of which € 23.3 billion are health-related) (…)"*. The first sentence in page 24 "*Most of the damage costs for traffic air pollution are related to health costs (90-100%)*" and Table 9 (page 27) also states the same thing.

[3] The WHO (https://www.who.int/airpollution/ambient/pollutants/en/) and EEA state that the pollutants with the strongest evidence of health effects are particulate matter (PM), ozone (O3), nitrogen dioxide (NO2) and sulphur dioxide (SO2).
While remains pertinent in other regions of the world, SO_2 is by now a much smaller issue in the EU where its emissions went from 7604 Gg in 2005 to 2031 Gg in 2018 (https://www.eea.europa.eu/data-and-maps/dashboards/necd-directive-data-viewer-3).

The overall goal is to capture the value of the externality generated by the combustion of the fuels covered, following the segmentation of fuel types, user categories and usages allowed/used in the ETD. The separation of distribution channels for each fuel type should also be taken into consideration, as it is relevant for the practical feasibility of the segmentation. For instance Diesel used for road transport might be differentiated for Diesel used for Agriculture or for diesel used for Rail transport (to the extent that these have different distribution channels), but it is only feasible to segregate Diesel used by road passenger cars from diesel used by trucks if these would be effectively segregated in the distribution channel (eg by always using separate pumping/measuring facilities). Since this is currently not the case, all uses for road fuels are aggregated together by fuel type.

It should also be noted that usage of electricity (for instance, in battery-electric vehicles) and of hydrogen in fuel cells generates no combustion air pollution emissions and as such the corresponding ETD air pollution component for these energy sources is always zero.

Beyond this general setup there are a series of specific choices to be made about each of the components of the computation regarding:

1) Valuation of Mortality (D)
   This expresses the social cost of the health impacts, in terms of €/premature death, or €/Year of Life lost attributable to emissions of the pollutant. This is the same for all air pollutants.
   One option is to do the computations based on the number of premature deaths (i.e., using Value of Statistical Life and mortality factors in terms of Premature Deaths). Another option is to do the computations based on the number of Years of Life Lost, combined with the Value of Life Years (VOLY).
   Under both options we use the **same VSL/VOLY value for the whole EU population**, rather than MS-specific values.
   We use the VSL/VOLY values recommended by DG ENV's consultants when valuing air pollution (which are based on the latest OECD meta-study of VSL and VOLY). These are 3,060,000€ for VSL and 79,500€ for VOLY, both expressed in 2005€s, which are then converted to 2019€ to account for EU 27 inflation since then (about 26%). We do this by considering the values of the Annual Consumer Price Index for the EU, as published by Eurostat.
   We eventually used the **Years of Life Lost and VOLY** for the assessment of the cost of air pollution due to fuel combustion. Indeed, Premature Deaths and VSL are more appropriate for assessing the impact of sudden deaths such as in car accidents.

2) Mortality ratios (B/C)
   This expresses the number of Premature Deaths/kg of emissions, or the number of Years of Life Lost /kg of emissions. This varies with each air pollutant.
   Consistent with using the same VOLY for the whole EU, we use **EU27 average mortality ratios**, rather than MS-specific values (i.e. we consider B/C, where B is EU number of Years of Life Lost attributable to emissions of the pollutant and C is EU total emissions of the pollutant).
   It is important to recognise that the measures of mortality B are computed based on actual measurements of pollutant concentrations at different locations in the EU 27 and considering the populations exposed to them. As such, these concentrations (and the resulting mortalities) capture the effects of all sources of emissions, including primary and secondary pollutants, as well as both natural and anthropogenic sources. It is thus important to ensure that the same scope of emissions driving the mortality (the numerator B) is captured in the denominator (C) of the mortality ratio. If some of

the emission sources explaining the mortality values are not counted in C, then we would be charging fuel-consuming entities for the damage attributable to non-anthropogenic and secondary pollutants. As such, in order that the emission amounts considered for the denominator C have the same scope as the mortality numbers used in the numerator B of the mortality ratio, we compute C using the emission data from the CLRTAP emission inventories with the following rules:

a. We include all sources of primary pollutants, except for international maritime and cruising aviation emissions
b. We compute secondary PM2.5 pollution based on non-PM2.5 primary pollutants, using the MS specific mortality equivalent conversion factors used for the NEC Directive impact assessment (TSAP report 15, Annex 2), ie

$$PM2.5sec_i = K_{SO2i}*SO_{xi}+ K_{NOxi}*NO_{xi}+ K_{NH3i} *NH_{3i} + K_{VOCi} *NMVOC_i$$

One may note that B/C*D gives a measure of the damage value of the air pollutant, i.e. €/kg of emissions. This will vary with each air pollutant.

3) Emission Factors (A).

These express the amount of emissions which results from the combustion of one unit of the fuel.
We take the emission factor values from the EMEP/EEA guidebook[4] , which Member States must use[5] when submitting their national emission inventory data.
Regardless of the unit used to measure fuel used (be it energy, mass, or volume), the emission factors will vary depending not only on the fuel considered, but also on the broad user category (e.g., road transport vs residential heating), specific type of usage (e.g., large cars/small cars/vans/trucks), and technology used in the combustion and emission after-treatment (each with different emission factors). In this regard, it should be noted that the emission factor for a given technology and user category will vary from one type of usage to another, based on the different usage patterns of each usage type. Moreover, for each fuel/user category/usage combination, the emission factors used by MS for the determination of their national emissions inventories are in many cases presented in a range (capturing the different technologies available), with the MSs then using the values from those ranges that best capture their specific realities of usage in each MS (the validity of this process is assessed by the Commission at the moment of submitting the emission inventories).

In our computations, we chose to always **use the minimum value of emission factors** available in the EMEP/EEA guidebook for a given fuel/user category combination, to provide a conservative measure of the externality, consistent with it being used for establishing minimum rates.

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[4] https://www.eea.europa.eu/publications/emep-eea-guidebook-2019
[5] unless they can provide better data more suited to national circumstances

Specific attention is also devoted to several user categories, where there is more detailed information about the distribution of usages and technologies for each fuel in the EU is available.

a. Road Transport

  i. Aggregating emission factors for multiple usages of a given fuel up to a value per fuel.

  Road transport emission factors vary with the category of vehicle used (passenger car vs light commercial vehicle, vs buses vs heavy-duty trucks vs L-category vehicles), segment within each category (small vs large-SUV-Executive passenger cars, rigid heavy duty trucks <7.5T vs articulated heavy duty trucks 50-60T), the technology used (older vehicles tend to equip less efficient emission reduction technologies), but also the patterns of usage inherent in each vehicle category (cold-engine combustion typically represent a much smaller proportion of fuel consumption in buses or heavy duty trucks than in small passenger cars.

  We compute the powertrain type & vehicle type-weighted average emission factor for each fuel under the conservative **assumption that all the users of a given fuel would only have vehicles with the cleanest technology as of 2020**. This is implemented by only considering the emission factors of the new vehicles as of 2020, based on the SIBYL 2015 dataset projections for 2020.

  In other words, we treat all the dirtier, older vehicles on the road as if they were brand-new vehicles with the cleanest technologies on the market by 2020. It is clear that this conservative hypothesis captures only a fraction of all the road emissions that will actually take place in 2020. Indeed the overwhelming majority of road transport fuel consumption in 2020 will be made by vehicles with more than 1 year, which generally have dirtier technologies (sometimes by several multiples for vehicles only a few years apart) and in reality will generate more pollutants per amount of fuel consumed than what assign them with our estimates.

  For each of the vehicle categories and segments within a given fuel, we compute the disaggregated “new 2020 vehicle” emission factors as the EU27 average emission factor for new vehicles as of 2020 (total EU27 emissions by each vehicle category and segment divided by total EU27 TJ of fuel consumed by the vehicle category and segment). These disaggregated “new 2020 vehicle” emission factors are then aggregated up to a value per fuel as the weighted average of the disaggregated “new 2020 vehicle” emission factors of each vehicle category and segment, weighted by the share of total 2020 fuel consumption by new vehicles that comes from the new vehicles of each vehicle category and segment.

For a given fuel F (e.g. diesel), the calculation described above is summarised by the following formula:

$$weighed\ EF\ (F) = \sum_{C,S} \left(\frac{emission\ (C,F,S,A=0)}{consumpion\ (C,F,S,A=0)} \right) \times weight\ (C,F,S,A=0)$$

where

- "weighed EF" is the weighed emission factor of a given pollutant (e.g. PM2.5) for fuel F, in mass of pollutant per quantity of fuel (e.g. t per TJ); it is calculated by summing elements (see below) for all categories and segments for vehicles of age zero (i.e. new) in 2020;
- "emission" is the 2020 forecast pollutant emissions for a given vehicle category C, fuel F, segment S and Age zero, in mass of pollutant (e.g. ton);
- "consumption" is the 2020 forecast fuel F consumption for a given category C, segment S and Age zero, in quantity of fuel (e.g. TJ);
- "weight" is the ratio of the 2020 forecast fuel F consumption of vehicles of a given category C, segment S and Age zero over the total consumption of all vehicles that consume fuel F.

Note: for PM2.5, the term of the sum in the formula above is multiplied by the exhaust emission factor (see item "ii" below).

This allows us to capture the relative weight of different types of vehicles and usages in the relative consumption of each fuel as of 2020 (e.g. medium passenger cars of all ages are expected to consume about 35% of all diesel in 2020, but only about 31% of the diesel consumed by new vehicles in 2020).

Considering in the formula that all vehicles use the 2020 technology takes into account the revised ETD's date of application (2023 at the earliest) and the rapidly evolving composition of the road vehicles fleet towards newer and cleaner technology.

ii. Exhaust vs other road transport emission sources

In the ETD we aim to **cover only the air pollution emissions arising from the combustion of fuel**.

However, the EMEP road transport emission factors cover not only emissions arising from fuel combustion, but also evaporative emissions, emissions arising from brake and tyre wear, and emissions arising from the combustion of lubricants. This issue is particularly pertinent for PM2.5 emissions, where the non-combustion/exhaust share of emissions can be particularly large.

The share of exhaust emissions in total emissions depends on the filtering and catalysing technologies used (which are themselves fuel-specific), as well as on the usage patterns, and on the types of vehicles they are applied to. Generally, the heavier the vehicles the greater the

amount of emissions, and the more recent the technology the lower the exhaust emissions, per amount of fuel used. Whereas hydrogen fuel cell and purely electric driven vehicles have no exhaust emissions, for other fuels (e.g. diesel, petrol) we need to determine the % of the EMEP emission factors which corresponds to combustion/exhaust emissions.
This is computed for each type of road fuel, but considering the COPERT data on total and on non-exhaust PM2.5 emissions.
This data allows to compute the non-exhaust % of total PM2.5 emissions for each fuel/ technology type and usage, given the actual patterns of technology use in the EU (i.e. EURO6 may be used in smaller or in larger petrol vehicles, and EURO VI may be used in buses or in different types of heavy-duty trucks, all of them with different usage patterns). We then compute the average exhaust % of total PM2.5 emissions for each fuel, as the weighted average of the exhaust % of total PM2.5 emissions for each fuel/technology type and usage, considering only the cleanest technologies available in 2020 for each fuel and usage type. The weights used are the share that each of these cleanest 2020 technology usages has in all the 2020 PM2.5 emissions done with the cleanest technologies. The resulting number captures the EU average % of total PM2.5 which would be combustion driven for a given fuel, if all the usages of that fuel only had the cleanest technology as of 2020.

For a given type of fuel F (e.g. diesel), the calculation described above is summarised by the following formula:

$$\begin{aligned}\% \, exhaust\ (F) \\ = \sum_{C,S,Tech2020} \left(1 - \frac{non\ exhaust\ (C,F,S,T)}{total\ (C,F,S,T)}\right) \\ \times \frac{total\ (C,F,S,T)}{total\ Tech\ 2020\ (F)}\end{aligned}$$

where

- “% exhaust” is the percentage of the 2020 forecast exhaust PM2.5 emissions on the total emissions, for a given fuel F; it is calculated by summing elements (see below) for all categories, segments and latest 2020 technologies;
- “non exhaust” and “total” are the 2020 forecast PM2.5 emissions (non-exhaust only and total respectively) for a given category C, fuel F, segment S and technology T;
- “total Tech 2020” is the sum of the 2020 forecast total PM2.5 emissions for a given fuel F and for all categories and all segments of vehicles of the latest technology available in 2020

The resulting values (ranging from 0% for purely electric, to 7.9% for Diesel, to 14.8% for CNG) are then applied to the aggregation of the EMEP road transport emission factors described in the previous step.

b. Aviation

Only the Landing-and-Take-off (LTO) portion of the emissions from aviation are considered for the purposes of the NEC directive (cruising air pollutant emissions are considered not to have impacts on human health). As such, only a fraction of all the air pollutant emissions from the fuel combusted in aviation activities is to be covered in the ETD. The actual share of LTO in total air pollutant emissions depends on the departure and arrival airports taxing time and flight distance.

Based on CLRTAP cruise and LTO emission factors for international and domestic aviation, we compute the share of LTO emissions in aviation emissions and therefore apply a correction coefficient to the EMEP emissions, leading to the following values:

PM2.5	26.0%
NOx	12.9%

EMEP/EEA Tier 1 data provides data for aviation gasoline and we tentatively assume the emission factors for jet gasoline (kerosene) are the same as for aviation gasoline.

5. Experts review

The methodology was reviewed by members of the following organisations:

- European Environment Agency (EEA)
- Joint Research Centre (JRC) units C4 (Sustainable Transport) and C5 (Air and Climate)
- IIASA – Markus Amann (external reviewer)
- Economics Research Consulting – Mike Holland (external reviewer)

Reviewers all support the idea of pricing instruments via ETD to reduce air pollution. Overall the reviewers believe our approach underestimates the cost of air pollution and does not take into account the local aspect of it. The former is due to the conservative approach chosen and the latter is inherent to having an EU-wide tax component for minimum rates. Several comments were requests for clarification which were implemented in the methodology description above.

The main more detailed comments were as follows:

1) General:

   a. JRC performed an **alternative calculation** for a part of our methodology (number of years of life lost per kg of pollutant), came up with similar results and concluded “The obtained values in proposed ETD methodology therefore appear to be justifiable”;
   Mr Holland (ERC) made an alternative calculation from EEA and ETC-ATNI[6] work which led to a similar environmental cost (€ per kg of pollutant emission) for PM2.5 and an about twice higher cost for NOx. This is explained, inter alia, by not taking into account secondary formation of fine particulate matter arising from NOx emissions.

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[6] European Topic Centre on Air Pollution, Transport, Noise and Industrial Pollution

   b. The **scope** of the methodology should be extended to other pollutants and/or to other impacts than mortality impact as the current approach underestimates the cost of air pollution; however this proved to be difficult due to the lack of data and the time constraints on the exercise.
   c. **National environmental performance and/or the location** (e.g. urban area or countryside) of air pollutant emissions should be taken into account. This is impossible in the ETD where the minimum tax rates apply EU-wide; however Member States have the flexibility to take these factors into account by taxing above the minimum rates.
   d. Solid **biomass** should be in the ETD's scope, especially but not only in an option with a tax component on air pollution
2) Road transport:
   a. Considering that **all vehicles use 2020 technology** is very "generous". This is due to the conservative approach, which intends at not penalising new technology; moreover, the ETD will be applicable as of 2023 at the very earliest, at which time the 2020 technology will be more spread out in the road vehicle fleet.
   b. Counting only the **exhaust emissions** (directly due to fuel combustion) and not the non-exhaust ones such as tyre/brake wear was perceived as generous too but is consistent with the scope of the ETD.

6. Results

Environmental Cost of air pollutants

The environmental cost of an air pollutant computed by the methodology presented above is summarised below (in euro per kg of air pollutant emission):

Air Pollutant	**Environmental cost (€ / kg)**
PM2.5	103.1
NOx	8.1

Cost of Air Pollution per ETD type of fuel and usage

The cost of air pollution computed via the methodology described before, per ETD type of fuel and usage is provided in option 3c. This cost is also the value of the air pollution component in the EU minimum energy tax rate.

ANNEX 7: AVIATION TAXATION

1. *Introduction*

In support of the impact assessment on the revision of the Energy Taxation Directive, DG TAXUD commissioned an external study specifically on the taxation of the air transport sector for various reasons. There is increasing international pressure for appropriate pricing measures properly reflecting the environmental and climate impacts of aviation activities. Several Member States have introduced or are considering introducing aviation ticket taxes, partly because there is no fuel tax applied to aviation fuel. Therefore, the Study compares the possible impacts of a harmonised fuel tax to the possible impacts of ticket taxes on aviation. Furthermore, the taxation of air transport is a legally complex issue and specific impacts like connectivity, fuel tankering, economic competitiveness and competition within the sector need to be taken into account.

A consortium led by Ricardo together with the partners GWS, Ipsos NV, TAKS/Vital Link and Alice Pirlot have carried out this Study.

The study provides an analysis of the impact of various sub options of a fuel tax on the traditional aviation fuel (kerosene) and used the same baseline (EU Reference Scenario) as in the impact assessment of the ETD. One of the analysed sub options of a fuel tax of 0.33 €/1.000 litre or 9.35 €/GJ, is comparable with the proposed rate for kerosene for aviation in the Impact Assessment of the ETD and has been analysed on basis of the GINFORS model (section 6.8 of the |IA ETD). The GINFORS model includes the aggregates of the whole aviation sector. The JRC modelled the impact of the intra EU fuel tax by multiplying the rate of intra EU fuel tax with a factor that represents the share of intra-EU fuel use. Thus, instead of applying a high rate to a small sector, JRC applied a lower rate to a broader sector.

In the support study, as described in this annex, a more sector specific model is used, the AERO-MS model. This model differentiates for example between the types of flights (between intra and extra EU, low cost carriers and traditional carriers, passenger and cargo) and uses different elasticities per type of flight. Despite the different models used, we can conclude that the outcomes of impact of the proposed intra EU fuel tax on the aviation sector do not deviate substantially and seem to be coherent.

Additionally, the study provides an analysis of the possible use of ticket taxes in air transport (this is beyond the scope of the ETD) and given the possible limitation on the use of fuel taxation beyond intra-EEA aviation the study also looks into a possible combined application of a ticket tax and a fuel tax.

The study covers the whole of the European Economic Area (EEA), namely the EU27 plus Norway and Iceland. It assumes that potential policy options would be implemented in 2023, with the impacts being assessed for the period up to 2050.

This annex describes the approach and methodology of the study and summarizes the outcome of the assessment and presents the comparison of the different options.

2. Approach and methodology

The analysis assesses the impacts of the proposed policy options against two baseline scenarios. The use of two baselines was motivated by the severe impacts on the aviation sector, and society more widely, from the global COVID-19 pandemic. The health and economic crises generated by the pandemic have affected and will continue to impact demand for travel, potentially inducing long-term changes to businesses and people's habits, making any forecast of aviation demand very uncertain. Therefore, a main baseline scenario reflecting developments under current trends and adopted policies is used. It builds on the baseline scenario underpinning the impact assessment accompanying the 2030 Climate Target Plan and the staff working document accompanying the Sustainable and Smart Mobility Strategy, but it additionally considers the impacts of the COVID-19 pandemic and the National Energy and Climate Plans. In this scenario, air passenger traffic recovers by 2025, with a return to growth rates akin to historic rates in subsequent years. A sensitivity baseline with lower future growth is also used, based on EUROCONTROL's scenarios for the post-COVID recovery for the aviation sector.

The following tools are used to assess the impacts:

- A model, AERO-MS, focussed on the aviation sector, with detailed data at an airport pair level. This model is used to quantify impacts on the aviation sector of the various policy options.
- Results from the AERO-MS are transferred to a macro-economic model, GINFORS-E. This model, which includes bilateral world trade data, is used to quantify wider economic impacts on other transport modes and other economic sectors for the different policy options.
- The use of both models provides a comprehensive overview of impacts in comparison with each of the baselines included in the study, with results produced for short-term (2025), mid-term (2030) and long-term (2050) impacts.
- The study also includes a thorough legal analysis of the EU and international legal framework currently in place, in order not only to ensure the effectiveness of the different policy options under current legislation, but also to assess the potential legal consequences of the interventions.
- A focused field research programme is also part of the study, with conversations held with experts in the competent ministries of Austria, Germany, Sweden and the Netherlands. All of these are Member States with experience in levying national air ticket taxes.
- A case study on peripheral and island regions is also conducted, to investigate and quantify possible negative socio-economic impacts that could take place on those regions, given their reliance on aviation for their economic activities, if taxation on the aviation sector is implemented in the EU. The regions and Member States under analysis were the Canary Islands (Spain), Crete (Greece), Ireland and Malta.

3. Assessment of policy options

3.1. Fuel tax

3.1.1. Overview of policy options

The policy options implementing a fuel tax for intra-EEA aviation activity would amend the current exemption from excise duty of aircraft fuel in Article 14(1) of the ETD. This responds to the need for a harmonised approach, since the capacity to waive current exemptions for domestic flights or intra-community flights via bilateral agreements between Member States under Article 14(2) has not been used so far. The current minimum excise duty rate for kerosene, according to the Energy Taxation Directive, is € 330/1,000 L (or 33 cents/L). The sub-options consider variations around (above and below) the minimum kerosene tax rate that would be applicable to commercial aviation, as well as a number of exemptions. This is summarised in the table below.

Summary of policy options for the implementation of a fuel tax

Policy package	Tax rate	Other considerations
Harmonised fuel tax for intra-EEA aviation under the revised ETD	€0.17, €0.33 and €0.50/litre[7] (equivalent to approximately €4.82, €9.35 and €14.17 per GJ, respectively) Tax applies to passenger flights but not to cargo-only flights[8] Tax is either implemented at once or over a ten-year period (increments of 10% of the full value in each year) Sustainable aviation fuels are exempt from fuel tax	Exemptions for flights operated under public service obligations Exemptions for flights to and from EU outermost regions No earmarking of revenues

The tax rates shown in the table above can also be related to the CO_2 emissions produced from the combustion of the fuel. The three rates shown are equivalent to approximately €67, €131 and €198 per tonne CO_2, respectively.

A tax on the fuel loaded for (or used on) a flight can help towards internalising the external costs of greenhouse gases and air pollutants emissions, related to the quantity of fuel consumed. The airline is expected to pass through the cost to consumers by raising ticket prices, leading to a reduction in passenger demand and hence fuel consumption. To a more limited extent, airlines are also incentivised to choose more efficient aircraft for their operations to reduce the fuel consumed. The effectiveness of the fuel tax in achieving those goals could be reduced if the airlines use the practice of ‘tankering’ to reduce their tax burden (i.e. filling up the aircraft in destinations where there is no fuel tax and then using the same aircraft to fly intra-EEA flights where fuel would be taxed) or if they shift some of their intra-EEA flights to destinations in third countries.

From an efficiency perspective, the collection of a fuel tax is not expected to be problematic. Member States already have experience in collecting fuel taxes in other modes, namely on road transport. It is expected that an aviation fuel tax would be collected in a similar manner, with the fuel suppliers collecting the tax when they supply kerosene at airports, then transferring those funds to the relevant tax authorities.

From a legal perspective, no issues are identified for the implementation of a tax on fuel loaded for intra-EU flights by EEA carriers. Furthermore, most air services agreements (horizontal agreements, HAs, and comprehensive air transport agreements, CATAs) between

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[7] Prices are modelled, and presented in the report, in constant 2019 Euros

[8] Due to modelling limitations, the impact results presented include the application of the fuel tax to cargo-only flights. The contribution of such flights to the overall emissions is small, so the effects of including the tax on them is also considered to be small.

the EU and third countries also allow the taxation of fuel used by their carriers on intra-EU flights. Updates to these agreements might be needed to allow the taxation of fuel used by their carriers on flights between the EU and the other EEA countries.

3.1.2. Assessment of impacts

Overall, the options implementing a tax on fuel loaded for intra-EEA flights all have noticeable impacts on CO_2 emissions in the long-term, with reductions of between 6% and 15% for intra-EEA flights, relative to the baseline, for tax rates from €0.17 to €0.50 per litre (the short-term impacts depend on whether a transition period is included). This result corresponds closely to the level of the reduction in passenger demand – while the fuel tax leads to a small improvement in aircraft fuel efficiency, the large majority of the reduction in emissions is due to a reduction in demand due to increased ticket prices. These results are only marginally affected when considering them against a lower baseline demand (representing a slower recovery following the COVID-19 pandemic).

The impacts of the fuel tax and the consequent changes in demand reduce total GDP in the EU27 by approximately €9 billion (about 0.05%) by 2050, under the assumption that revenues collected are used for deficit reduction purposes. Should the revenues be recycled, for example to fund reduction in other taxes, the negative impact on GDP would be smaller. In terms of tax revenue, the existing national ticket taxes contribute €2.6 billion of revenue from intra-EEA flights in 2025; under the €0.33 per litre option, the tax on fuel contributes about €6.7 billion per annum in 2050. The wider impacts on the economy from the reduction in aviation demand then reduce the rise in total tax revenue over the baseline to €5.4 billion per annum.

Regarding the impact on connectivity, the lower demand resulting from the introduction of a ticket tax would be expected to reduce flight frequencies across all routes. In principle, this could potentially lead to the loss of air transport on some routes, should these cease to be financially viable for air carriers to operate. However, this negative effect may be limited. This is because the expected number of intra EEA flights in the baseline for 2025 is 21% higher compared to base year 2016. By 2025, the introduction of a fuel tax of €0.33/litre (with no transition period) would lead to a reduction of 10% in the number of flights when compared to the baseline. Given this, it is expected that, overall, the flight frequency on most routes would be still higher than it was in 2016, although some variations are expected and specific regions could indeed see their connectivity reduced.

In terms of competitiveness of EEA carriers in relation to third country carriers (and between different EEA carriers) there could negative impacts on the former. This is because non-EEA carriers might be subject to a more lenient tax regime in their ‘home’ market, allowing them to be more profitable overall and be in a better position to compete with the EEA carriers on the routes on which the two sets of carriers compete.

The implementation of a fuel tax on intra-EEA flights could give rise to concerns regarding ‘hub switching’, as carriers change the connection airport on an indirect flight (between an EEA departure and a non-EEA destination) from an EEA airport to a non-EEA airport, to take advantage of the lack of fuel tax on the initial leg. This is more likely to impact traditional network carriers than low-cost carriers, as the latter tend to fly mainly direct flights. However, the extent to which hub switching may occur depends on a number of factors, including slot availability at airports and passenger preferences, so it is not possible to quantify the likely impact at this stage.

3.2. Ticket tax

3.2.1. Overview of policy options

The policy options implementing a fuel tax define a minimum, EU-wide ticket tax applicable to passenger services and, potentially, to air freight services. A number of EU Member States and their neighbours (Austria, France, Germany, Italy, Netherlands, Portugal and Sweden, together with Norway and the UK) already implement a ticket tax – in some jurisdictions better defined as a levy or charge – on all departing air passengers. While the applicable rates of existing national ticket taxes vary significantly, most of them share some common features: exemptions for transit and transfer passengers; differentiation between short haul and long haul flights, based on different criteria; and no earmarking of revenues to a dedicated fund. Air freight services are typically not affected by national taxes on the ground of international competitiveness. Many of these features also characterise the ticket tax policy option, as summarised in the table below.

Summary of policy options for the implementation of a ticket tax

Policy package	Tax rate	Other considerations
Harmonised ticket tax across the EU	Different types of passenger taxes considered: • Flat tax ○ €10.43 for all passengers • Tax increasing with the distance flown ○ €10.12 for intra-EEA flights ○ €25.30 for extra-EEA flights of up to 6,000km ○ €45.54 for extra-EEA flights over 6,000km • Tax decreasing with the distance flown ○ €25.30 for flights of up to 350km ○ €10.12 for flights over 350km Tax could be the same for all passengers in a flight, or be differentiated depending on the class of travel (non-premium/premium tickets).	Exemptions for flights operated under public service obligations Exemptions for flights to and from EU outermost regions No earmarking of revenues

In terms of efficiency, conversations with Member States government officials indicate that the administrative burden of implementing and managing a ticket tax is relatively low both for public administrations and airlines. Overall administrative costs are expected to be lower than equivalent costs for implementing a fuel tax. Analysis indicates administrative costs of €465 thousand to €1 million per Member State per year (€12.6 million to €27.6 million across the EU).

From an effectiveness perspective, unlike a fuel tax, ticket taxes can at most have an indirect relationship with fuel consumption (e.g. if they increase with distance). They do not provide direct incentives for increased fuel efficiency (passengers on two different aircraft with different fuel efficiencies would pay the same ticket tax) but are essentially a demand management measure, as they essentially increase the price of air tickets. This gives a small disadvantage of ticket taxes compared to fuel taxes. An advantage of a ticket tax is that it can be more easily applied (from a legal perspective) to an increased scope (intra-EEA, extra-EEA flights or both), which increases the potential demand effects of such a measure and reduces the need for renegotiating some international air transport agreements.

3.2.2. Assessment of impacts

The impacts of the different types of ticket tax considered were as follows:

- For the flat ticket tax, where a single tax rate applies to all flights, the reduction in demand is 9% on intra-EEA flights and 1.5% on extra-EEA flights. The total tax revenue is about €6.7 billion in 2025, rising to €9.9 billion in 2050, representing increases of €4.1 billion to €6.2 billion above the baseline values.
- The stepped rate option, with a higher tax rate applying to longer flights (over 6,000 km), has a slightly lower impact on intra-EEA demand, but a significantly greater impact on extra-EEA demand (about 4.5% reduction in demand), compared to the flat rate option. The tax revenue from this option in 2050 is €6 billion over the baseline.
- The inverse stepped rate, with a higher rate applying to short flights (below 350 km), has a slightly higher impact on intra-EEA demand, and a very similar impact on extra-EEA demand, compared to the flat rate option. The tax revenue from this option in 2050 is €7 billion over the baseline.

In terms of CO_2 emissions, the different ticket tax options lead to reductions of between 8% and 10% on intra-EEA flights and between 3% and 5.5% on extra-EEA flights.

Regarding other potential sub-options, the application of tax multipliers of 3.0 and 7.5 for premium seats has only a small effect on the demand impacts of the tax options as they target passengers with more inelastic demand. Multipliers have a more significant effect on the tax revenue, increasing revenue to about €13 billion in 2050 under the flat rate tax with a 7.5 premium multiplier. The relative impacts of the ticket tax (as percentage changes) do not change when considering them against a lower baseline demand (representing a slower recovery following the COVID-19 pandemic).

With respect to the impact on connectivity, and not unlike the options introducing a fuel tax, the lower demand resulting from the fuel tax would be expected to reduce flight frequencies across all routes. However, under the different policy options that introduce a ticket tax, by 2025 demand is expected to be above 2016 levels – e.g., under a stepped ticket tax with no reduction in national ticket taxes, by 2025 number of flights by legacy carriers is expected to be 12% higher than in 2016, and for low-cost carriers 9% higher. That is, the introduction of a ticket tax, while reducing the expected growth in demand, is not expected to reduce demand when compared to 2016 levels and thus the impacts on connectivity are expected to be limited.

The implementation of a ticket tax, covering both intra-EEA and extra-EEA flights, might also raise concerns on the potential for hub switching. The ticket tax options considered in this study all exempt passengers travelling from a non-EEA origin to a non-EEA destination, connecting via an EEA airport; this exemption is expected to reduce the risk of airlines deciding to move their hubs away from EEA airports. The risk of passengers electing to travel from the EEA to a non-EEA destination, with a connection at a non-EEA airport (rather than connecting at an EEA airport) will depend on the exact design of the tax (e.g. whether the tax is calculated on the 'ticket' for the full journey or individual legs). Overall, the impact of hub switching on the competitiveness of EEA carriers and airports is expected to be limited.

3.3. Combined tax options

3.3.1. Overview of policy options

Different combinations of the two types of taxes were developed to identify whether there are advantages in having such combinations. Sub-options include the case where the ticket tax is applied to all flights (intra-EEA and extra-EEA), to intra-EEA flights only and to extra-EEA flights only. Otherwise, the combined tax options have the same considerations in terms of efficiency, effectiveness and legal issues as the fuel and ticket taxes considered individually.

3.3.2. Assessment of impacts

All the combined tax options considered in this study include a tax on the fuel supplied for intra-EEA flights and a ticket tax on extra-EEA flights. The cases considered have combined a €0.33 per litre fuel tax on intra-EEA flights and a ticket tax (flat, stepped or inverse stepped) on extra-EEA flights.

All tax options analysed have significant impacts on CO_2 emissions in the long-term, with reductions of about 10% on intra-EEA flights and up to almost 5% on extra-EEA flights. The option with the stepped ticket tax on extra-EEA flights has a greater impact than the other two combined tax options considered. The impacts on demand are very similar to those on emissions, with slightly lower magnitudes of change (up to 9.7% on intra-EEA flights and 4.0% on extra-EEA flights).

The additional tax revenue from aviation under the combined tax options ranges from €14 billion to €16 billion per annum by 2050. The impacts on the economy from the reduction in aviation demand reduce the rise in total tax revenue from the transport sector to about €12 billion per annum. A similar reduction in GDP is also expected by 2050 in the EU27 Member States.

4. Comparison of options

The table below presents a quantitative comparison of the impacts of the main indicators for the 'main' sub-option of each policy option – the heading of the table provides the details of the sub-option under consideration. All impacts are presented for the year 2030. To simplify the table, all increases in parameters (demand, tax revenue, etc.) are marked as '+', while all reductions are marked as '-'.

Comparison of main policy options

	Policy option 1: €330 per 1,000 litres fuel tax on fuel loaded for intra-EEA flights	Policy option 2: Stepped rate ticket tax (€10.12 per ticket on intra-EEA flights, €25.30 per ticket on extra-EEA flights up to 6,000km, €45.54 per ticket on extra-EEA flights over 6,000km)	Policy option 3: €330 per 1,000 litres fuel tax on fuel loaded for intra-EEA flights, €25.30 per ticket on extra-EEA flights up to 6,000km, €45.54 per ticket on extra-EEA flights over 6,000km
Economic impacts			
Total flights	-9.1% intra-EEA; 0.0% extra-EEA	-8.1% intra-EEA; -8.9% extra-EEA	-9.1% intra-EEA; -5.9% extra-EEA[9]
Total aviation passenger demand (p-km)	-9.2% intra-EEA; 0.0% extra-EEA	-8.3% intra-EEA; -4.6% extra-EEA	-9.2% intra-EEA; -2.7% extra-EEA
Total rail + aviation passenger demand (p-km)	-5.6% (1,078.8 billion p-km)	-5.0% (1,097.0 billion p-km)	-5.6% (1,090.3 billion p-km)
Revenues in aviation sector[10]	-0.5% intra-EEA; 0.0% extra-EEA; -3.2% total net revenue	-0.7% intra-EEA; +0.8% extra-EEA; -8.5% total net revenue	-0.5% intra-EEA; +0.5% extra-EEA; -6.5% net revenue

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[9] Although the ticket tax rates on extra-EEA flights are the same under policy options 1 and 2, the impacts of policy option 3 are lower in 2030 as the tax (including both fuel tax and ticket tax elements) is implemented with a 10-year transition period starting in 2024, whereas under policy option 2 the tax is implemented in full from 2024.

[10] The aviation sector revenues are the incomes to the airlines from passenger tickets and freight charges. The gross impacts (presented for intra-EEA and extra-EEA flights) include additional incomes from passing through the ticket taxes to passengers (and cargo taxes to freight companies), while the impact on net revenues includes the payment of the ticket and cargo taxes collected, and fuel taxes, to the tax authorities.

	Policy option 1: €330 per 1,000 litres fuel tax on fuel loaded for intra-EEA flights	Policy option 2: Stepped rate ticket tax (€10.12 per ticket on intra-EEA flights, €25.30 per ticket on extra-EEA flights up to 6,000km, €45.54 per ticket on extra-EEA flights over 6,000km)	Policy option 3: €330 per 1,000 litres fuel tax on fuel loaded for intra-EEA flights, €25.30 per ticket on extra-EEA flights up to 6,000km, €45.54 per ticket on extra-EEA flights over 6,000km
Revenues from taxation (aviation), including existing ticket taxes	€7.44 billion intra-EEA; €10.36 billion total	€7.44 billion intra-EEA; €19.14 billion total	€7.43 billion intra-EEA; €15.87 billion total
GDP	-0.04%	-0.06%	-0.04%
Environmental impacts			
CO_2 emissions (aviation sector)	-9.9% intra-EEA; 0.0% extra-EEA; -3.7% total	-7.8% intra-EEA; -5.2% extra-EEA; -6.2% total	-9.9% intra-EEA; -3.6% extra-EEA; -6.0% total
Social impacts – number of persons employed			
Air transport services	-1.0%	-1.8%	-1.3%
Total transport services	+0.02%	+0.04%	+0.02%

All three policy options are found to have similar impacts on intra-EEA flights: introducing a tax (either fuel tax or ticket tax) on commercial aviation increases ticket prices and reduces demand. Options 2 and 3 add in the extra impacts of including extra-EEA flights in their scope and, therefore, give greater total reductions in emissions and total tax revenues. Although options 2 and 3 include the same ticket tax rates on extra-EEA flights, the impacts are slightly greater in the table for option 2 as the taxes are assumed to be implemented immediately (in 2024) under that option, while option 3 assumes a 10-year transition period (in line with that used for the fuel tax on intra-EEA flights).

.ANNEX 8: ENERGY SYSTEM IMPACT OF THE CENTRAL OPTION OF THE ETD REVISION (CONTRIBUTION BY DG ENER)

By increasing the minima applied to energy taxes, the proposed energy content option of the ETD in the context of the “Fit for 55” package will contribute, to a limited extent, to the required evolution of the EU’s energy mix away from fossil fuels.[11] Changes occur in Member States that apply taxes below the proposed minima and in those that are affected by the changes of the tax base.

End-user prices for fuels, sectors and Member States are differently affected, depending on the current tax levels. On the one hand, the impacts on end-user fuels with relatively high levels of existing taxation across the EU, like diesel and gasoline end-user prices for private road transport or electricity for households, are limited. On the other hand, the ETD energy content option would lead to an increase of end-user prices for fuels with low levels of existing of taxation. This is the case of the fossil fuels end-user prices for households, up to 5.8% for coal prices on average at EU level in 2030, and higher for gas and LPG in the road transport sector.

As a consequence, the ETD energy content option would contribute to reduced final energy consumption of fossil fuels through energy efficiency and fuel switch. In particular, coal consumption sees a significant impact (-3.5%) in final energy consumption in 2030. While the renewable energy shares in transport (RES-T) and in electricity (RES-E) would not be affected by the ETD energy content option, the contribution of renewables in heating and cooling (RES-H&C) in final energy consumption would increase, by one percentage point, notably through electrification and ambient heat in buildings.

Overall, the changes lead to an increase in system costs by 2030 due to the increase in energy related expenses. In absolute terms, the transport sector sees the highest increase compared to a world in which the ETD was not revised but where other initiatives of the ‘Fit for 55’ package are implemented.

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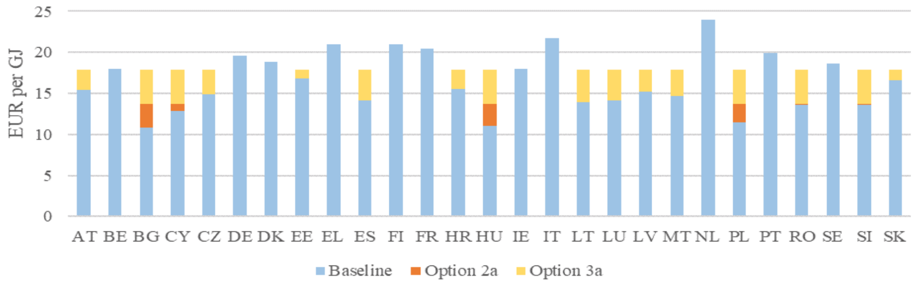
[11] The analysis is based on stylised modelling with the PRIMES model using the MIX scenario used by several initiatives of the “FitFor55” package which includes the revision of the ETD under the energy content option with a counterfactual setting removing the changes proposed by the ETD revision but keeping all other policy elements and drivers of the modelling constant.

ANNEX 9: STATISTICAL ANNEX

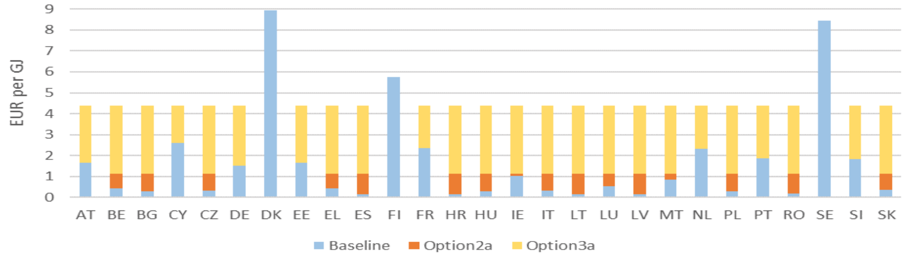
Additional statistics on the convergence of tax rates against the minima (impact on the internal market)

Figure 1: Tax rates by 2035 – Households, Motor, Petrol



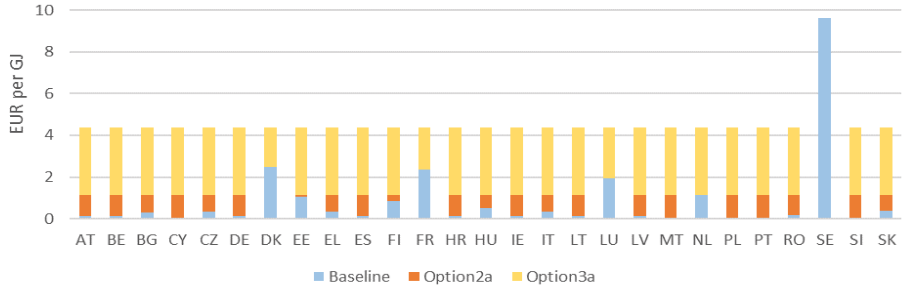
Source: JRC

Figure 2: Tax rates by 2035 – Services, Natural gas



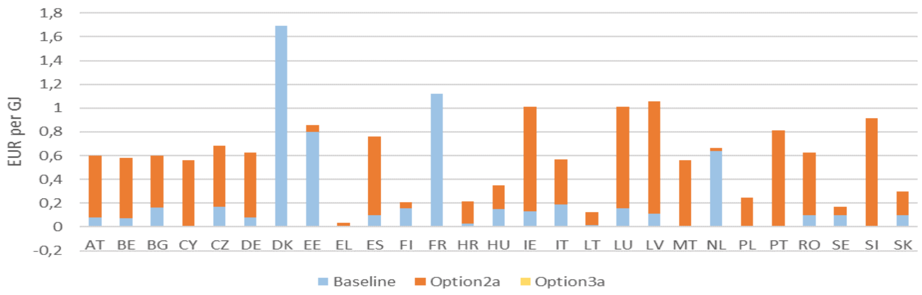
Source: JRC

Figure 3: Tax rates by 2035 – Other industries not covered by ETS, Natural gas



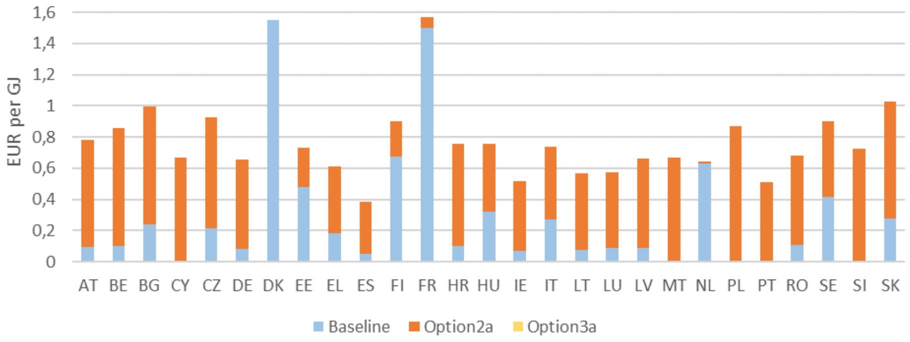
Source: JRC

Figure 4: Tax rates by 2035 – Chemicals, Natural gas[12]



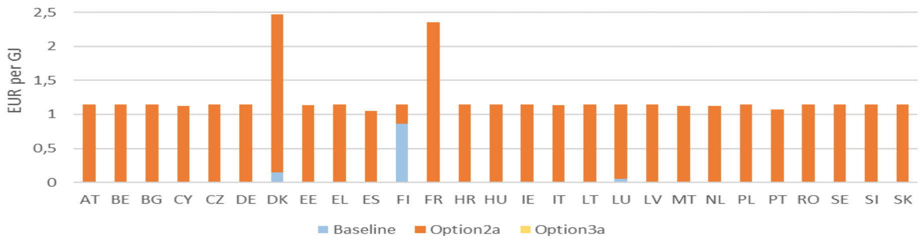
Source: JRC

Figure 5: Tax rates by 2035 – Paper and pulp, Natural gas



Source: JRC

Figure 6: Tax rates by 2035 – Non-metallic minerals, Natural gas



Source: JRC

Additional statistics on GHG

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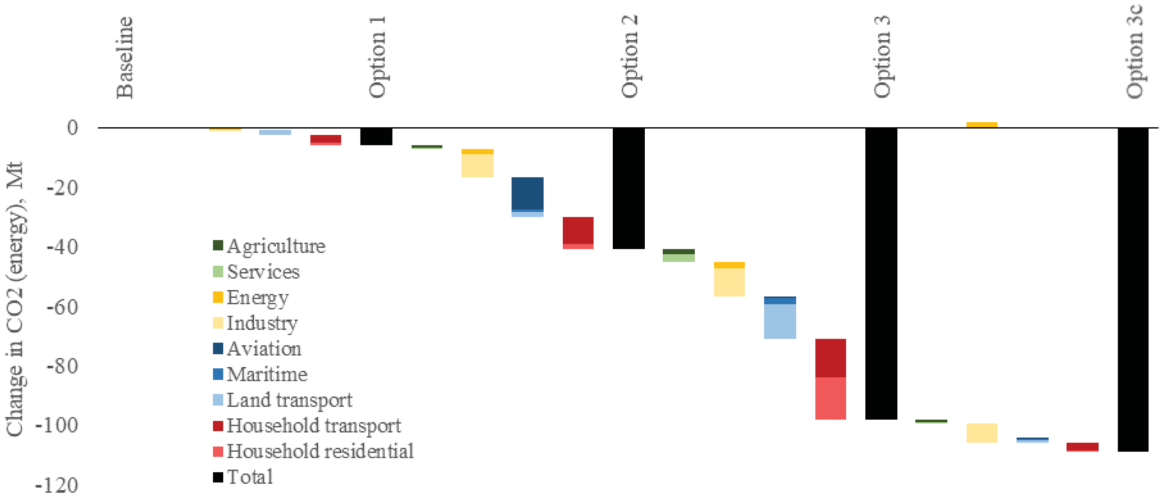
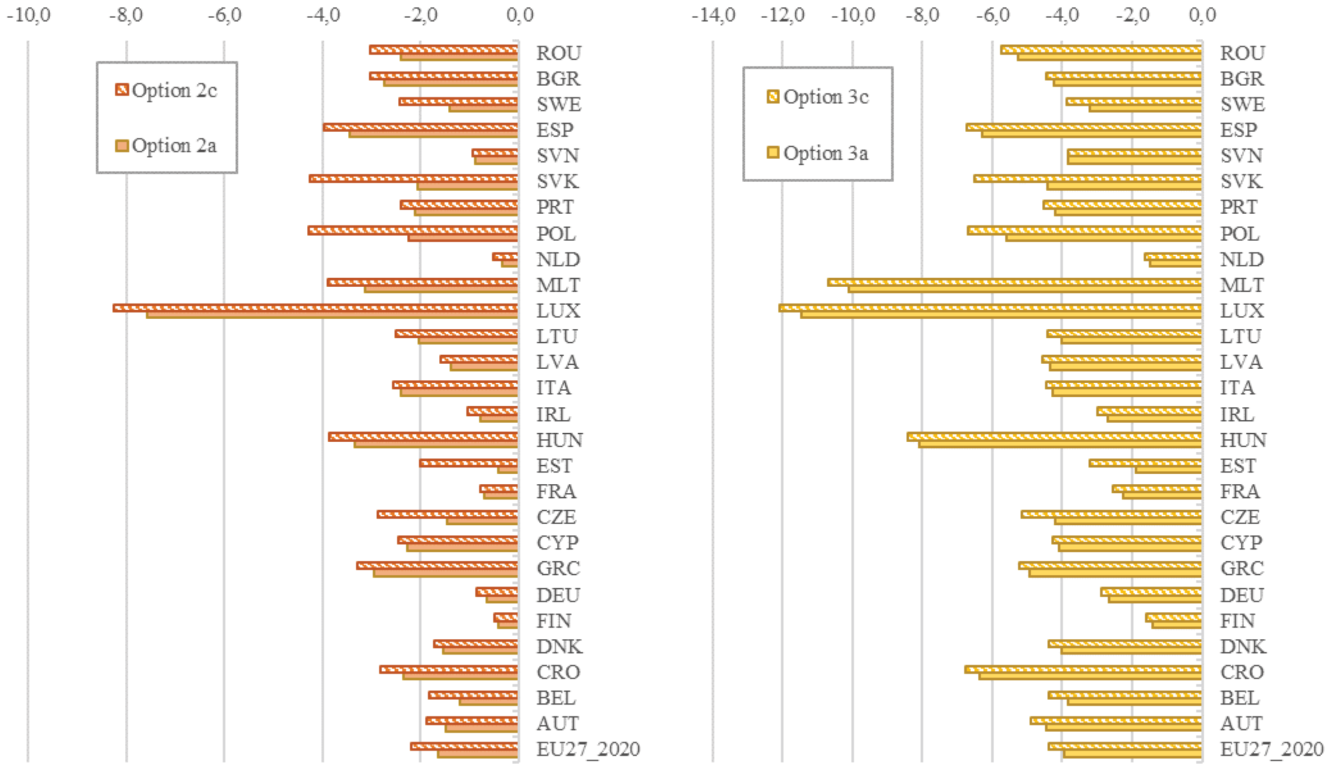
[12] For energy intensive industries, the effective tax rates are calculated net of energy volumes defined as out-of-scope of the Directive (therefore not taxed). Some out of scope processes (such as dual use) remain outside the revised ETD. Hence the extent to which each Member States relies on those processes remaining out-of-scope defines how much the rates will change. This explains the remaining national differences in effective rates for EIIs in Options 3a, 3b and 3c, despite the equalisation of most rates in EUR/GJ by 2035.

Figure 7: Change in CO2 emissions, Mt under different options



\Source: JRC-GEM-E3

Figure 8: Member States percentage decrease in GHG emissions for options inclusive of pollution component compared to baseline in 2035

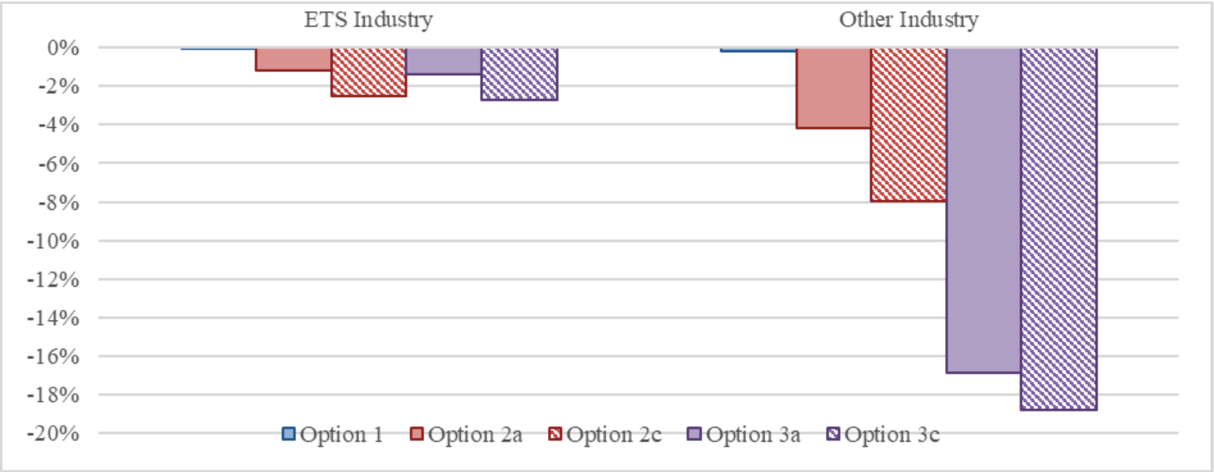


Option 2a and 2c

Option 3a and 3c

Source: JRC-GEM-E3

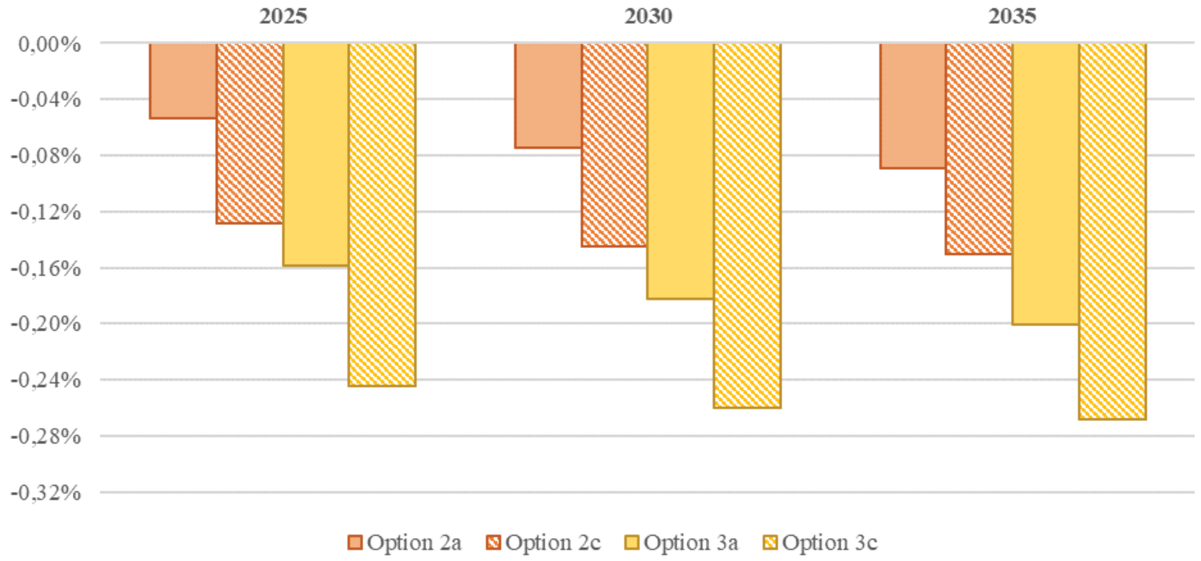
Figure 9: Decrease in industrial GHG emissions for all options compared to baseline in 2035



Source: JRC-GEM-E3

Statistics on macroeconomic and revenue impact

Figure 10: Change in EU 27 GDP compared to the baseline Options 2 and 3 with and without the pollution component

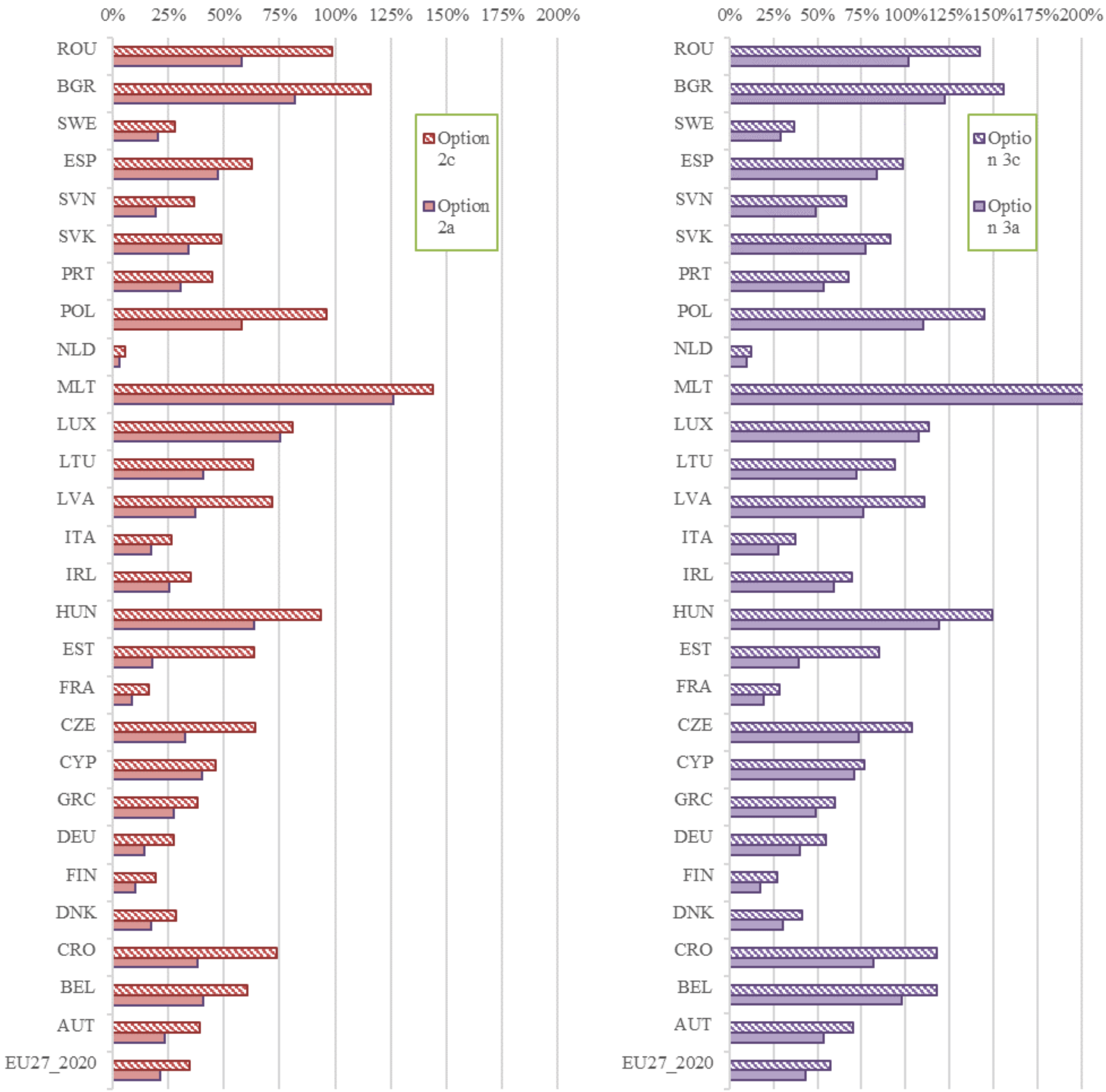


Source: JRC-GEM-E3

Figure 11: Change in tax revenues by Member State inclusive of the pollution component in 2035 (% change relative to the baseline)

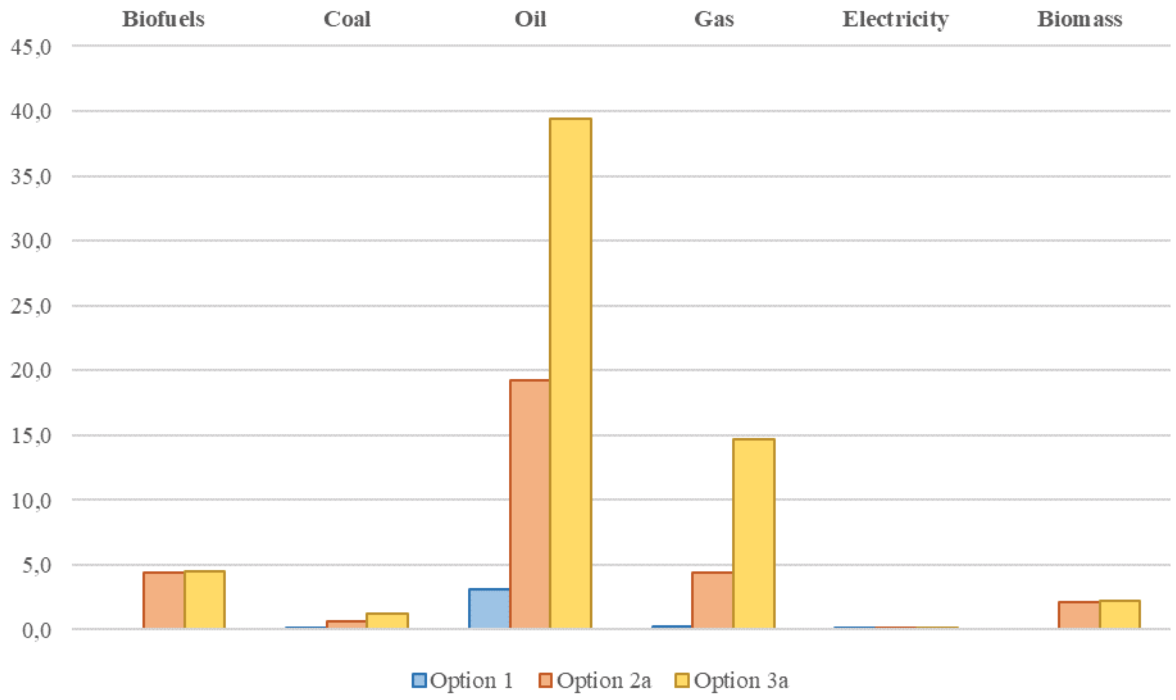
Option 2a

Option 3a



Source: JRC-GEM-E3

Figure 12: Change in revenue by product group compared to baseline EU27 – 2035 (% change for baseline)



Source: JRC-GEM-E3

Statistical details on distributional effects by Member State

a. Methodological issues

Input microdata

This analysis uses EUROMOD´s ITT extension and microdata from two household surveys:

- the European Union Statistics on Income and Living Conditions database, EU-SILC, which contains information on household income and other household- and individual-level characteristics.
- and the EU Household Budget Surveys, from where information on household consumption expenditures at the 4-digits COICOP categories of goods/services is extracted.

The EUROMOD´s ITT extension uses as input a database obtained from matching these two surveys, in order to compute indirect tax liabilities (VAT and specific excises) for each household. These are calculated on top of the direct taxes, social contributions and cash benefits simulated by the core EUROMOD model.

Link between GEM-E3 and EUROMOD

First, the macroeconomic impacts of the energy tax reform scenarios are simulated in the GEM-E3 macro model. Then, in order to study the distributional impacts of the ETD options on households at the micro level, key variables from the macro simulation are used to feed the micro model. By linking the two models in this way, the distributional analysis at the micro level is able to account for the economy-wide impact of the tax policy reform under consideration and captures the effects of the policy option not only through its direct impact on the tax burden, but also through its broader implications on consumer prices and household incomes.

It is important in this sense to mention the variables that are passed on from the macro model GEM-E3 to the micro model EUROMOD, as this can help interpret the microsimulation results. Firstly, on the expenditure side, EUROMOD is fed with the tax policy-induced consumer price changes, relative to the baseline, as simulated by GEM-E3. This concerns 14 aggregate consumption categories based on COICOP groups.[13] Since expenditures are imputed for each household at the commodity level, the mapping into these 14 categories only requires aggregation (without further assumptions nor correspondence matrices). These price changes include both direct effects of tax changes and indirect price changes through inputs along the supply chain. Secondly, on the household income side, the relative changes to the baseline for both labour and capital income also feed the microsimulation. In this way, the economic environment of EUROMOD is approximated to the one foreseen by the GEM-E3 model.

Besides, an additional scenario is analysed for each of the policy options, which assumes the recycling of the energy taxation revenues through a lump-sum transfer, equally distributed among individuals. This compensation mechanism ensures budget neutrality within the EUROMOD environment.

The impact of each policy option on household budgets, across the income distribution, is disentangled across three effects:

- The ´price effect´, which captures the distributional effect of the energy tax reform under analysis arising only from the predicted changes in consumer prices.
- The ´price and income effect´, which adds the predicted changes in market income to the changes in consumer prices for the distributional analysis.
- The ´price, income and compensation mechanism effect´, which draws on the results of the scenario with the lump-sum transfer to analyse the distributional impacts.

All options are compared against the baseline, given by the tax-benefit policy system in place in 2019 in the Member State under consideration.

b. Results

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[13] The 14 categories are: food beverages and tobacco, clothing and footwear, housing and water charges, fuels and power, household equipment and operation excluding heating and cooking appliances, heating and cooking appliances, medical care and health, purchase of vehicles, operation of personal transport equipment, transport services, communication, recreational services, miscellaneous goods and services and education.

Option 1

Figure 13 presents the change in equivalized[14] household adjusted disposable income[15], relative to disposable income, resulting from ETD revision option 1, and including the compensation mechanism.

Each figure groups a number of countries, classifying them according to the magnitude of the impact of the reform over the first decile of the income distribution. Figure a shows the group of countries with strongest impact on the first decile, c the countries with the mildest impact and b those in between.

Results for the 18 Member States suggest:

- For all countries, the policy impact of the energy tax reform together with the compensation mechanism over households' income is negligible. Whether positive or negative, the impact on adjusted disposable income is – in absolute terms - less than 0.5% (with respect to baseline disposable income) for countries in figure 1a, and less than 0.05% for all the remaining.
- Except for Portugal, the overall impact of the reform (including the compensatory measure) in the first decile is positive. This impact is however very small. On average, adjusted disposable income for the first decile is expected to increase by 0.1% with respect to disposable income in the baseline.
- Overall, the tax reform when combined with the compensation mechanism is progressive.

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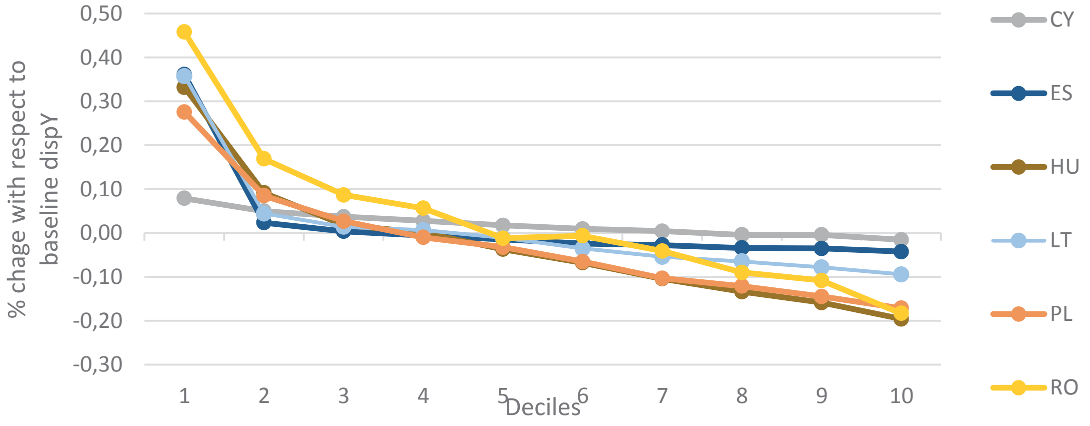
[14] Indicators reported here are based on *equivalised* household disposable income, considering economies of scale in consumption within the household: *equivalised* income refers to the fact that household members are made equivalent by weighting them according to their age, using the so-called modified OECD equivalence scale.

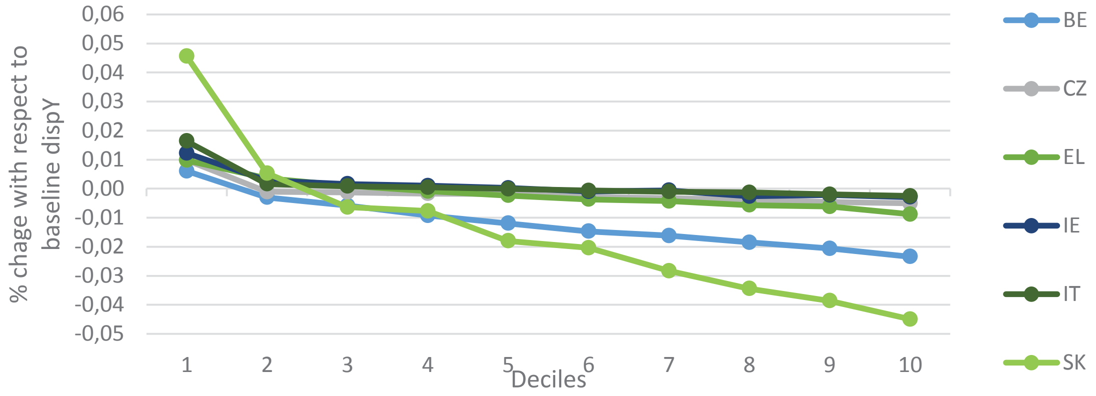
[15] Disposable income is household market income (gross wages and capital income, among others) net of direct taxes and social contributions, including cash benefits (unemployment benefits, social assistance, among others). To take into account the effect of indirect taxes, here we report the *adjusted* disposable income, which is defined as disposable income minus indirect tax payments (VAT and excises).

Figure 13. % change in adjusted disposable income resulting from ETD option 1, including the lump-sum compensation mechanism: country grouping

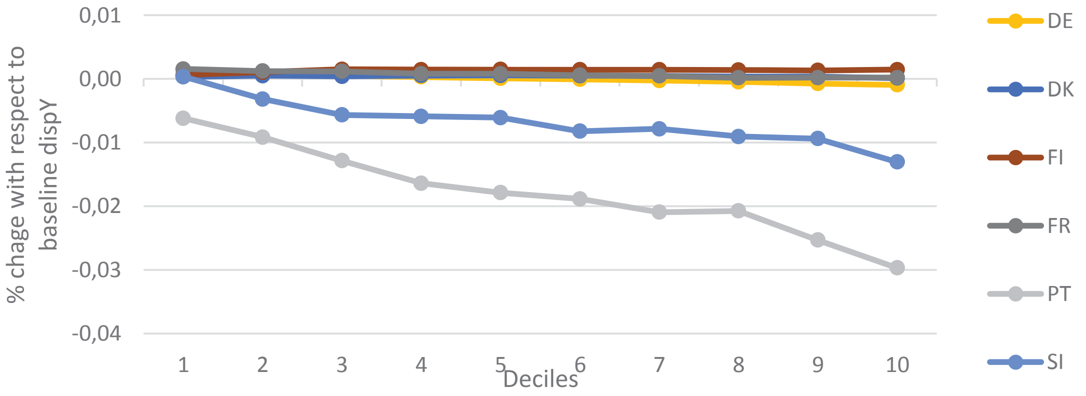
a. Strongest positive effect on the first decile



b. Moderate (intermediate) effect on the first decile



c. Mildest negative effect on the first decile



Note: Plots show the **total effect of the energy tax reform and the budget-neutral compensatory measures** expressed as the % change in equivalent adjusted disposable income in relation to equivalent household disposable income in the baseline. Households are classified in deciles based on equivalent household disposable income in the baseline. Adjusted disposable income is the residual of household disposable income after the subtraction of indirect taxes (VAT and excises). The scaling of y-axis differs across the three groupings. Equivalence scales used are the standard "OECD-modified" ones.

Source: European Commission's Joint Research Centre, based on the EUROMOD model.

Figure 14 shows the disaggregated 'price', 'price and income' and 'price, income and compensation' effects country by country for this reform scenario. There we can note that the policy is progressive when combined with compensation mechanisms. Without compensation, it is generally regressive in most countries with the exception of Belgium, Hungary, Portugal, Romania and Slovakia. In these countries, instead, changes in prices and income predicted by the macro model harm more households at the middle and top of the income distribution for the income effect more than offset the regressive impact of the price increase.

Figure 14 % change in adjusted disposable income resulting from ETD revision option 1: disaggregated effects country by country

Note: Plots show the total effect of the energy tax reform and the budget-neutral compensatory measures expressed as the % change in adjusted disposable income in relation to household disposable income in the baseline. Deciles of equivalent household disposable income in the baseline. Adjusted disposable income is the residual of household disposable income after the subtraction of indirect taxes (VAT and excises). Equivalence scales used are the standard "OECD-modified" ones. Source: European Commission's Joint Research Centre, based on the EUROMOD model.

Option 2a

Figure 15 presents the change in equivalized household adjusted disposable income, relative to disposable income, resulting from ETD revision option 2, and including the compensation mechanism.

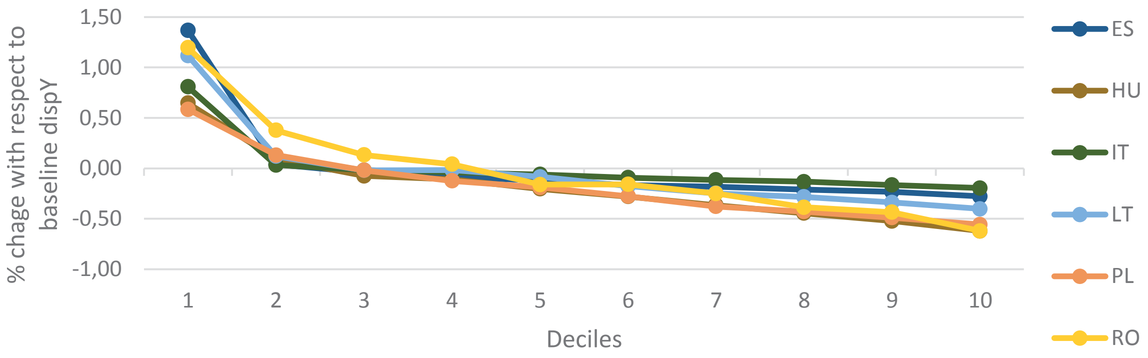
Each figure groups a number of countries, classifying them according to the magnitude of the impact of the reform over the first decile of the income distribution. Figure a shows the group of countries with strongest impact on the first decile, c the countries with the mildest impact and b those in between.

Results for the 18 Member States suggest:

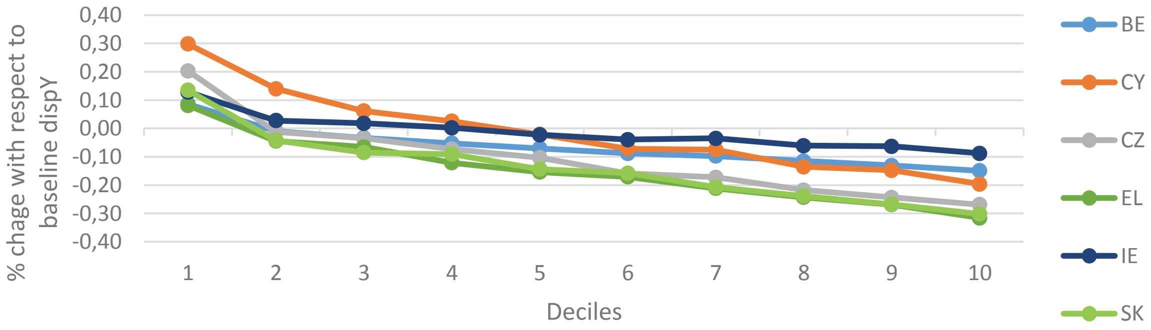
- The impact of this energy tax reform along with the compensation mechanism on household adjusted disposable income ranges from -0.62% of baseline disposable income (Hungary, tenth decile) to 1.37% (Spain, first decile).
- As in option 1 above, except for Portugal, the impact of the reform in combination with the lump-sum transfers over household adjusted disposable income is positive for all households in the first decile. The largest increase takes place in Lithuania, Romania and Spain, where adjusted disposable incomes increase by more than 1%. For the rest of the households (i.e. second decile of the distribution onwards), the impact is generally very small (being – in absolute terms – typically less than 0.5%,).
- Overall, this energy tax reform when combined with the compensation mechanism is progressive.

Figure 15 % change in adjusted disposable income resulting from ETD option 2a, including the lump-sum compensation mechanism: country grouping

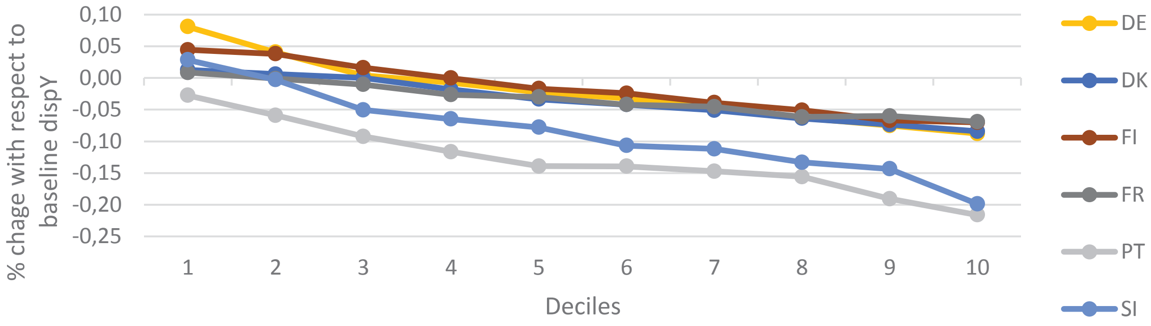
a. Strongest positive effect on the first decile



b. Moderate (intermediate) effect on the first decile



c. Mildest positive effect on the first decile



Note: Plots show the total effect of the energy tax reform and the budget-neutral compensatory measures expressed as the % change in equivalent adjusted disposable income in relation to equivalent household disposable income in the baseline. Households are classified in deciles based on equivalent household disposable income in the baseline. Adjusted disposable income is the residual of household disposable income after the subtraction of indirect taxes (VAT and excises). The scaling of y-axis differs across the three groupings. Equivalence scales used are the standard "OECD-modified" ones.

Source: European Commission's Joint Research Centre, based on the EUROMOD model.

Figure 16 % change in adjusted disposable income resulting from ETD revision option 2a: disaggregated effects country by country

Figure 16 shows the disaggregated 'price', 'price and income' and 'price, income and compensation' effects country by country for this reform scenario. There we can note that the reform is progressive when combined with compensation mechanisms. Without compensation, the most affected households tend to be at the bottom and top of the income distribution. The reform is in many countries regressive or shows no clear impact on inequality, with the main exception of Czech Republic, Romania, Slovenia and Slovakia. In these countries, the income effects more than offset the price effects, which makes the overall reform (price + income) progressive.

Option 3a

Figure 17 presents the change in equivalized household adjusted disposable income relative to disposable income, resulting from ETD revision option 3a, and including the compensation mechanism.

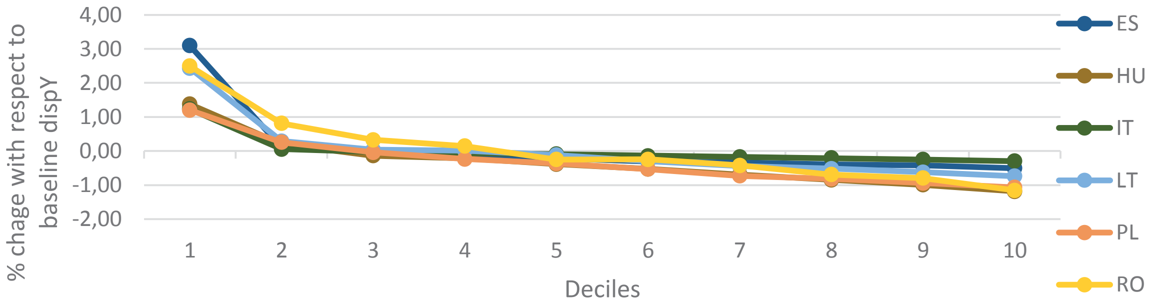
Each figure groups a number of countries, classifying them according to the magnitude of the impact of the reform over the first decile of the income distribution. The figure show the group of countries with strongest impact on the first decile, c the countries with the mildest impact and b those in between.

Results for the 18 Member States suggest:

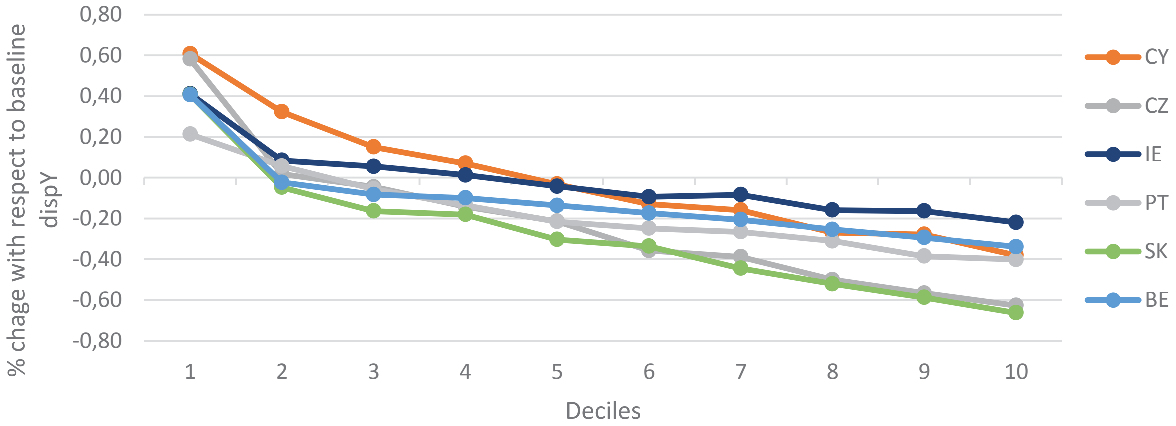
- The impact of this energy tax reform combined with the compensation mechanism on household adjusted disposable income ranges from -1.2% with respect to baseline disposable income (Hungary, tenth decile) to 3.1% (Spain, first decile).
- The impact of the energy tax reform in combination with the lump-sum transfers over household income is positive for all households in the first decile. The larger increase takes place in Lithuania, Romania and Spain, where income increases by more than 2%. For the rest of the households (i.e. second decile of the distribution onwards), the impact is generally small. The largest impact is experienced by Romanian and Polish 10th decile, seeing an income reduction of about 1%.
- Overall, this energy tax reform when combined with the compensation mechanism is progressive.

Figure 17 % change in adjusted disposable income resulting from ETD option 3a, including the lump-sum compensation mechanism

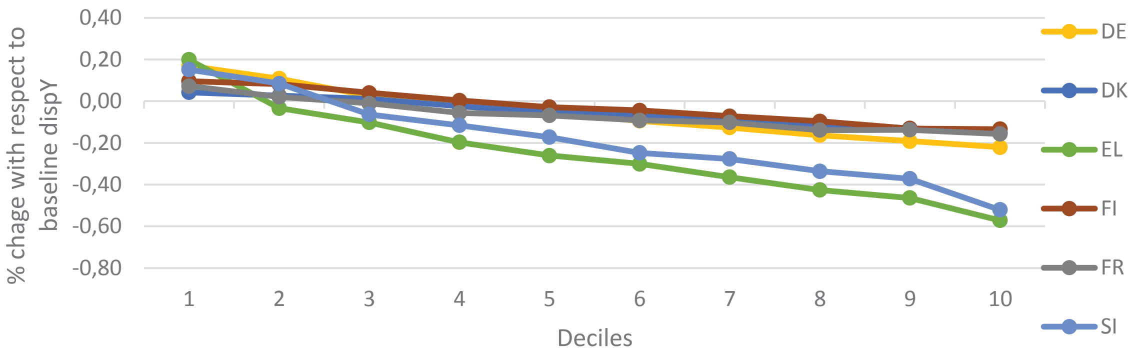
a. Strongest positive effect on the first decile



b. Moderate (intermediate) effect on the first decile



c. Mildest positive effect on the first decile



Note: Plots show the total effect of the energy tax reform and the budget-neutral compensatory measures expressed as the % change in equivalent adjusted disposable income in relation to equivalent household disposable income in the baseline. Households are classified in deciles based on equivalent household disposable income in the baseline. Adjusted disposable income is the residual of household disposable income after the subtraction of indirect taxes (VAT and excises). The scaling of y-axis differs across the three groupings. Equivalence scales used are the standard “OECD-modified” ones.

Source: European Commission’s Joint Research Centre, based on the EUROMOD model.

Figure 18 shows the disaggregated ‘price’, ‘price and income’ and ‘price, income and compensation’ effects country by country for this reform scenario. There we can note that the reform is progressive when combined with compensation mechanisms. Without compensation, it is either neutral or regressive. Although, again, Romania and Czech Republic represent two important exceptions. Once more, in these countries the income effects more than offset the price effects causing the impact of the reform without compensation mechanisms to be progressive.

Figure 18 % change in adjusted disposable income resulting from ETD revision option 3a: disaggregated effects country by country

Note: Plots show the total effect of the energy tax reform and the budget-neutral compensatory measures expressed as the % change in adjusted disposable income in relation to household disposable income in the baseline. Deciles of equivalent household disposable income in the baseline. Adjusted disposable income is the residual of household disposable income after the subtraction of indirect taxes (VAT and excises Equivalence scales used are the standard “OECD-modified” ones. Source: European Commission’s Joint Research Centre, based on the EUROMOD model.

Option 3c

Figure 19 presents the change in equivalized household adjusted disposable income relative to disposable income, resulting from ETD option 3c with air pollution component ("wap"), and including the compensation mechanism.

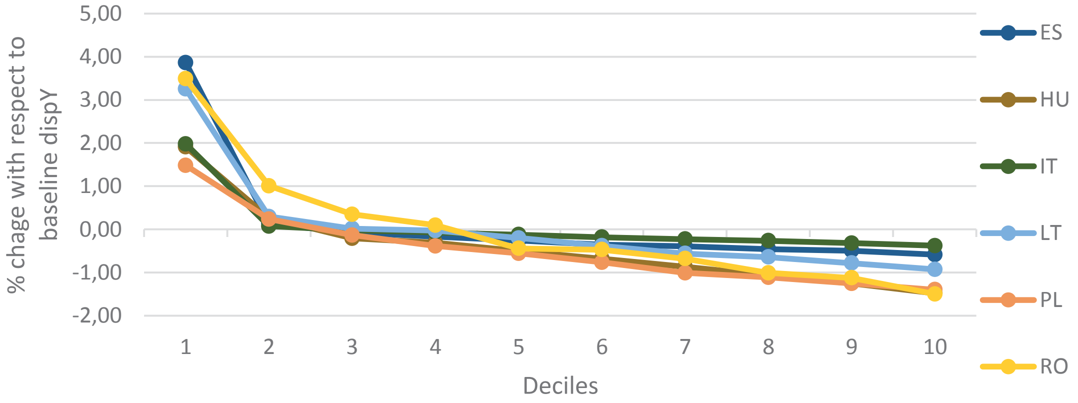
Each figure groups a number of countries, classifying them according to the magnitude of the impact of the reform over the first decile of the income distribution. Figure 68a shows the group of countries with strongest impact on the first decile, 68c the countries with the mildest impact and 68b those in between.

Results for the 18 Member States suggest:

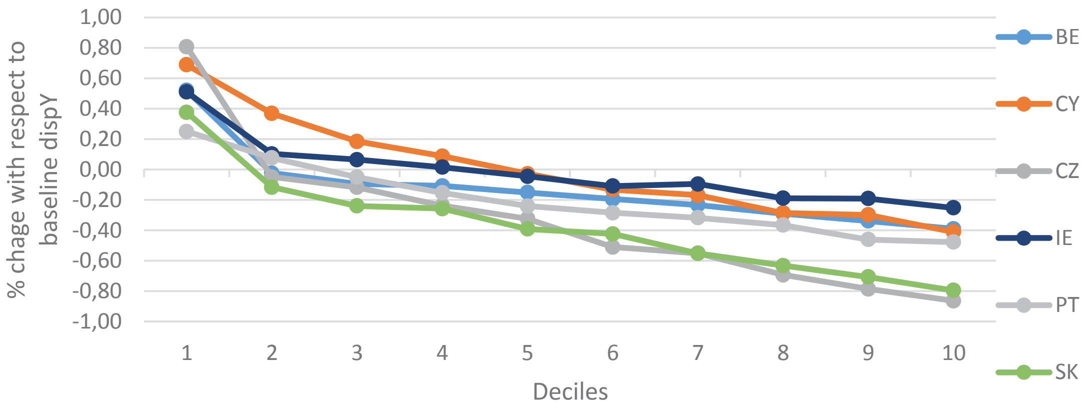
- The impact of this energy tax reform option, combined with the compensation mechanism, over household adjusted disposable income is positive for all households in the first decile. The larger increase is taking place in Lithuania, Romania and Spain, where income increases by more than 3%.
- For the rest of the households (second decile of the distribution onwards) the impact is generally small. The largest impact is experienced by Romanian and Polish 10th decile, seeing an income reduction of about 1.5%.
- Overall, this energy tax reform, when combined with the compensation mechanism, is progressive.

Figure 19. % change in adjusted disposable income resulting from ETD option 3c, including the lump-sum compensation mechanism: country grouping

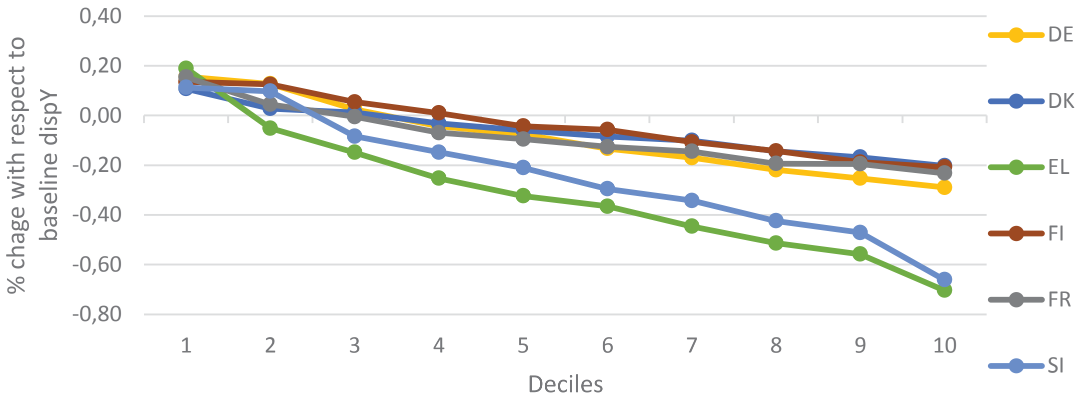
a. Strongest effect on the first decile



b. Moderate (intermediate) effect on the first decile



c. Mildest negative effect on the first decile



Note: Plots show the total effect of the energy tax reform and the budget-neutral compensatory measures expressed as the % change in equivalent adjusted disposable income in relation to equivalent household disposable income in the baseline. Households are classified in deciles based on equivalent household disposable income in the baseline. Adjusted disposable income is the residual of household disposable income after the subtraction of indirect taxes (VAT and excises). The scaling of y-axis differs across the three groupings. Equivalence scales used are the standard "OECD-modified" ones.

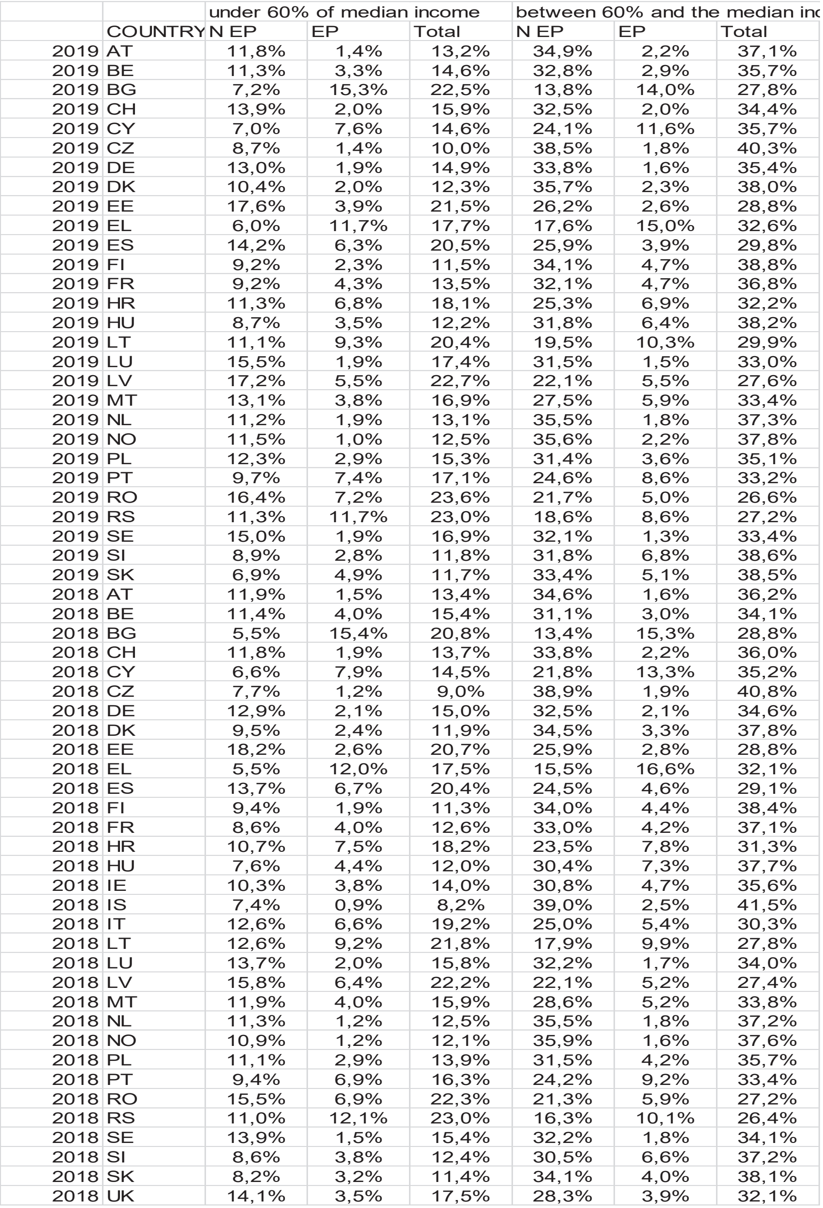
Source: European Commission's Joint Research Centre, based on the EUROMOD model.

Figure 20 shows the disaggregated 'price', 'price and income' and 'price, income and compensation' effects country by country for this reform scenario. There we can note that the overall reform is progressive when combined with compensation mechanisms. Without compensation, it is either neutral or regressive. Although, again, this is not true for some countries, such as Romania and Czech Republic where the income effect more than offset the price effect therefore implying that the reform without compensation mechanisms is already progressive.

Figure 20. % change in adjusted disposable income resulting from ETD option 3c.: disaggregated effects country by country

Note: Plots show the total effect of the energy tax reform and the budget-neutral compensatory measures expressed as the % change in adjusted disposable income in relation to household disposable income in the baseline. Deciles of equivalent household disposable income in the baseline. Adjusted disposable income is the residual of household disposable income after the subtraction of indirect taxes (VAT and excises Equivalence scales used are the standard "OECD-modified" ones. Source: European Commission's Joint Research Centre, based on the EUROMOD model.

Table 1 Energy poverty in low income and (lower) middle-income households, by Member State (population shares in % of total population in the Member State)



		under 60% of median income			between 60% and the median inc		
	COUNTRY	N EP	EP	Total	N EP	EP	Total
2019	AT	11,8%	1,4%	13,2%	34,9%	2,2%	37,1%
2019	BE	11,3%	3,3%	14,6%	32,8%	2,9%	35,7%
2019	BG	7,2%	15,3%	22,5%	13,8%	14,0%	27,8%
2019	CH	13,9%	2,0%	15,9%	32,5%	2,0%	34,4%
2019	CY	7,0%	7,6%	14,6%	24,1%	11,6%	35,7%
2019	CZ	8,7%	1,4%	10,0%	38,5%	1,8%	40,3%
2019	DE	13,0%	1,9%	14,9%	33,8%	1,6%	35,4%
2019	DK	10,4%	2,0%	12,3%	35,7%	2,3%	38,0%
2019	EE	17,6%	3,9%	21,5%	26,2%	2,6%	28,8%
2019	EL	6,0%	11,7%	17,7%	17,6%	15,0%	32,6%
2019	ES	14,2%	6,3%	20,5%	25,9%	3,9%	29,8%
2019	FI	9,2%	2,3%	11,5%	34,1%	4,7%	38,8%
2019	FR	9,2%	4,3%	13,5%	32,1%	4,7%	36,8%
2019	HR	11,3%	6,8%	18,1%	25,3%	6,9%	32,2%
2019	HU	8,7%	3,5%	12,2%	31,8%	6,4%	38,2%
2019	LT	11,1%	9,3%	20,4%	19,5%	10,3%	29,9%
2019	LU	15,5%	1,9%	17,4%	31,5%	1,5%	33,0%
2019	LV	17,2%	5,5%	22,7%	22,1%	5,5%	27,6%
2019	MT	13,1%	3,8%	16,9%	27,5%	5,9%	33,4%
2019	NL	11,2%	1,9%	13,1%	35,5%	1,8%	37,3%
2019	NO	11,5%	1,0%	12,5%	35,6%	2,2%	37,8%
2019	PL	12,3%	2,9%	15,3%	31,4%	3,6%	35,1%
2019	PT	9,7%	7,4%	17,1%	24,6%	8,6%	33,2%
2019	RO	16,4%	7,2%	23,6%	21,7%	5,0%	26,6%
2019	RS	11,3%	11,7%	23,0%	18,6%	8,6%	27,2%
2019	SE	15,0%	1,9%	16,9%	32,1%	1,3%	33,4%
2019	SI	8,9%	2,8%	11,8%	31,8%	6,8%	38,6%
2019	SK	6,9%	4,9%	11,7%	33,4%	5,1%	38,5%
2018	AT	11,9%	1,5%	13,4%	34,6%	1,6%	36,2%
2018	BE	11,4%	4,0%	15,4%	31,1%	3,0%	34,1%
2018	BG	5,5%	15,4%	20,8%	13,4%	15,3%	28,8%
2018	CH	11,8%	1,9%	13,7%	33,8%	2,2%	36,0%
2018	CY	6,6%	7,9%	14,5%	21,8%	13,3%	35,2%
2018	CZ	7,7%	1,2%	9,0%	38,9%	1,9%	40,8%
2018	DE	12,9%	2,1%	15,0%	32,5%	2,1%	34,6%
2018	DK	9,5%	2,4%	11,9%	34,5%	3,3%	37,8%
2018	EE	18,2%	2,6%	20,7%	25,9%	2,8%	28,8%
2018	EL	5,5%	12,0%	17,5%	15,5%	16,6%	32,1%
2018	ES	13,7%	6,7%	20,4%	24,5%	4,6%	29,1%
2018	FI	9,4%	1,9%	11,3%	34,0%	4,4%	38,4%
2018	FR	8,6%	4,0%	12,6%	33,0%	4,2%	37,1%
2018	HR	10,7%	7,5%	18,2%	23,5%	7,8%	31,3%
2018	HU	7,6%	4,4%	12,0%	30,4%	7,3%	37,7%
2018	IE	10,3%	3,8%	14,0%	30,8%	4,7%	35,6%
2018	IS	7,4%	0,9%	8,2%	39,0%	2,5%	41,5%
2018	IT	12,6%	6,6%	19,2%	25,0%	5,4%	30,3%
2018	LT	12,6%	9,2%	21,8%	17,9%	9,9%	27,8%
2018	LU	13,7%	2,0%	15,8%	32,2%	1,7%	34,0%
2018	LV	15,8%	6,4%	22,2%	22,1%	5,2%	27,4%
2018	MT	11,9%	4,0%	15,9%	28,6%	5,2%	33,8%
2018	NL	11,3%	1,2%	12,5%	35,5%	1,8%	37,2%
2018	NO	10,9%	1,2%	12,1%	35,9%	1,6%	37,6%
2018	PL	11,1%	2,9%	13,9%	31,5%	4,2%	35,7%
2018	PT	9,4%	6,9%	16,3%	24,2%	9,2%	33,4%
2018	RO	15,5%	6,9%	22,3%	21,3%	5,9%	27,2%
2018	RS	11,0%	12,1%	23,0%	16,3%	10,1%	26,4%
2018	SE	13,9%	1,5%	15,4%	32,2%	1,8%	34,1%
2018	SI	8,6%	3,8%	12,4%	30,5%	6,6%	37,2%
2018	SK	8,2%	3,2%	11,4%	34,1%	4,0%	38,1%
2018	UK	14,1%	3,5%	17,5%	28,3%	3,9%	32,1%

Source: ESTAT EU-SILC UDB 2019; own calculations.

Note: The table shows the respective population shares (not) in energy poverty by income groups (income below 60% of national median income; and income between 60% and 100% of national median income). Energy poor (EP) households are defined as households that have arrears with utility bills or are unable to keep their home adequately warm.

ANNEX 10: QUANTIFICATION OF THE INDUSTRIAL ENERGY CONSUMPTION WITHIN THE SCOPE OF ARTICLE 2 OF THE ENERGY TAXATION DIRECTIVE

Contents

1. *Introduction*

Upon request of the Directorate General for Taxation and Customs (TAXUD), the JRC has estimated, using the most recent and detailed data available, the amount of energy consumed by the industry that is exempt from taxation according to article 2 of the Energy Taxation Directive 2003/96/EC (ETD). In order to estimate these amounts, two questions have to be addressed:

- **How much energy is actually consumed by each industrial sector?**
- **What share of the energy consumed by each industry is exempt from taxation and why?**

As regards the first question, three aspects have to be considered:

- The energy consumed by each industry is reported in the "final non-energy consumption" and "final energy consumption" blocks of EUROSTAT's energy balances (EUROSTAT, 2020) but the sum of both terms is not the total industrial energy use. The industry also consumes energy for the autoproduction of electricity and heat and those energy inputs are registered partially in the "transformation input" and "energy sector" blocks of the energy balances. These energy inputs are not disaggregated by industry in the energy balances and need to be estimated in order to calculate the total energy used by each sector.
- Some outputs of the energy transformation processes (coke ovens, blast furnaces, and autoproducers' power plants) are fed back into autoproduction and final energy and non-energy consumption, but those energy flows should be deducted in order to prevent double counting of the taxed energy.
- The consumption of energy for non-energy uses accounts for a significant share of the total energy use in the industry (26% for the EU in 2018, 87 061 ktoe of 329 288 ktoe, varying between 4% and 55% depending on the MS) but it is not disaggregated by industry in the energy balances.
- A small, but non-negligible part of the industrial energy consumption is reported as "not elsewhere specified" (3.8% for the EU in 2018, 12 580 ktoe out of 329 288 ktoe).

With respect to the second question, article 2 of the ETD establishes a series of energy carriers and energy uses that are out of the scope of the directive:

- Fuel wood, wood charcoal, and peat.
- Energy products used for "purposes other than as motor fuels or as heating fuels".
- "Dual use of energy products", including chemical reduction, electrolytic, and metallurgical processes.
- Electricity used for chemical reduction, electrolytic, and metallurgical processes.
- Electricity when it accounts for more than 50% of the cost of a product.
- Energy used in mineralogical processes for the manufacture of non-metallic mineral products.

However the ETD does not define further those exceptions nor provide any list of chemical reduction, electrolytic, metallurgical and mineralogical processes. Therefore, additional information and assumptions (subject to interpretation) are needed to determine the amounts of energy within the scope of the ETD.

The remainder of the report is structured as follows:

- Section 1 describes the four steps followed to estimate the results, detailing the assumptions made and the limitations of this approach.
- Section 2 contains summary tables with the results for each industry in each EU MS.
- Section 3 closes with some conclusions and recommendations for further work.

2. *Methodology*

The estimations are calculated in four main steps, described in the following sub-sections:

- Section 1: Disaggregation of the inputs for autoproduction in the energy balances of 2018 for the 12 industrial sectors considered in EUROSTAT's energy balances (listed in Table 1).
- Section 2.2: Disaggregation of the inputs for non-energy uses consumed by each industry in 2018.
- Section 2.3: Estimation of the total energy used (net inputs) by each industry in 2018.
- Section 2.4: Breakdown of the total energy use of each industry into in and out of scope categories.

The analysis described in this annex provides a plausible quantification of the amounts of energy consumed by the industry (detailed by groups of energy products) that can be considered within the scope of article 2 of the ETD. These results cover all the industrial sectors considered in EUROSTAT's energy balances, including non-energy uses of energy product, and are consistent with the latest data available.

Note that the methodology described in this annex is limited by the level of detail of EUROSTAT's energy balances, and the ambiguities of the definitions of the ETD categories (e.g. definition of motor and heating fuels, definition of metallurgical processes, etc.) and the processes listed in JRC-IDEES (e.g. electric mechanical processes in the wood and wood products industry), which are open to interpretation.

Table 1: Industrial sectors considered in the analysis

Industry	Description
Iron and steel	NACE Rev. 2 Groups 24.1, 24.2 and 24.3; and NACE Rev. 2 Classes 24.51 and 24.52[16] C241: Manufacture of basic iron and steel and of ferroalloys C242: Manufacture of tubes, pipes, hollow profiles and related fittings, of steel C2451: Casting of iron C2452: Casting of steel
Chemical and petrochemical	NACE Rev. 2 Divisions 20 and 21 C201: Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms C202: Manufacture of pesticides and other agrochemical products C203: Manufacture of paints, varnishes and similar coatings, printing ink and mastics C204: Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations C205: Manufacture of other chemical products C206: Manufacture of man-made fibres C21: Manufacture of basic pharmaceutical products and pharmaceutical preparations
Non-ferrous metals	NACE Rev. 2 Group 24.4; and NACE Rev. 2 Classes 24.53 and 24.54 C244: Manufacture of basic precious and other non-ferrous metals C2453: Casting of light metals C2454: Casting of other non-ferrous metals
Non-metallic minerals	NACE Rev. 2 Division 23 C231: Manufacture of glass and glass products C232: Manufacture of refractory products C233: Manufacture of clay building materials C234: Manufacture of other porcelain and ceramic products C235: Manufacture of cement, lime and plaster C236: Manufacture of articles of concrete, cement and plaster C237: Cutting, shaping and finishing of stone C239: Manufacture of abrasive products and non-metallic mineral products n.e.c.
Transport equipment	NACE Rev. 2 Divisions 29 and 30 C29: Manufacture of motor vehicles, trailers and semi-trailers C30: Manufacture of other transport equipment
Machinery	NACE Rev. 2 Divisions 25, 26, 27 and 28 C25: Manufacture of fabricated metal products, except machinery and equipment C26: Manufacture of computer, electronic and optical products C27: Manufacture of electrical equipment C28: Manufacture of machinery and equipment n.e.c.
Mining and quarrying	NACE Rev. 2 Divisions 07 (excluding 07.21: mining of uranium and thorium ores) and 08 (excluding 08.92: extraction of peat), NACE Rev. 2 Group 09.9 B07: Mining of metal ores B08: Other mining and quarrying B099: Support activities for other mining and quarrying
Food, beverages and tobacco	NACE Rev. 2 Divisions 10, 11 and 12 C10: Manufacture of food products C11: Manufacture of beverages C12: Manufacture of tobacco products
Paper, pulp and printing	NACE Rev. 2 Divisions 17 and 18 C171: Manufacture of pulp, paper and paperboard C172: Manufacture of articles of paper and paperboard C18: Printing and reproduction of recorded media
Textile and leather	NACE Rev. 2 Divisions 13, 14 and 15 C13: Manufacture of textiles C14: Manufacture of wearing apparel

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[16] In the calculations the energy used in coke ovens and blast furnaces is attributed to the iron and steel industry, although they are considered part of the energy sector in EUROSTAT energy balances. The latter is done to better represent energy flows in the energy statistics, but the raison d'être of coke ovens and blast furnaces is to produce coke and pig iron, not to produce manufactured gases.

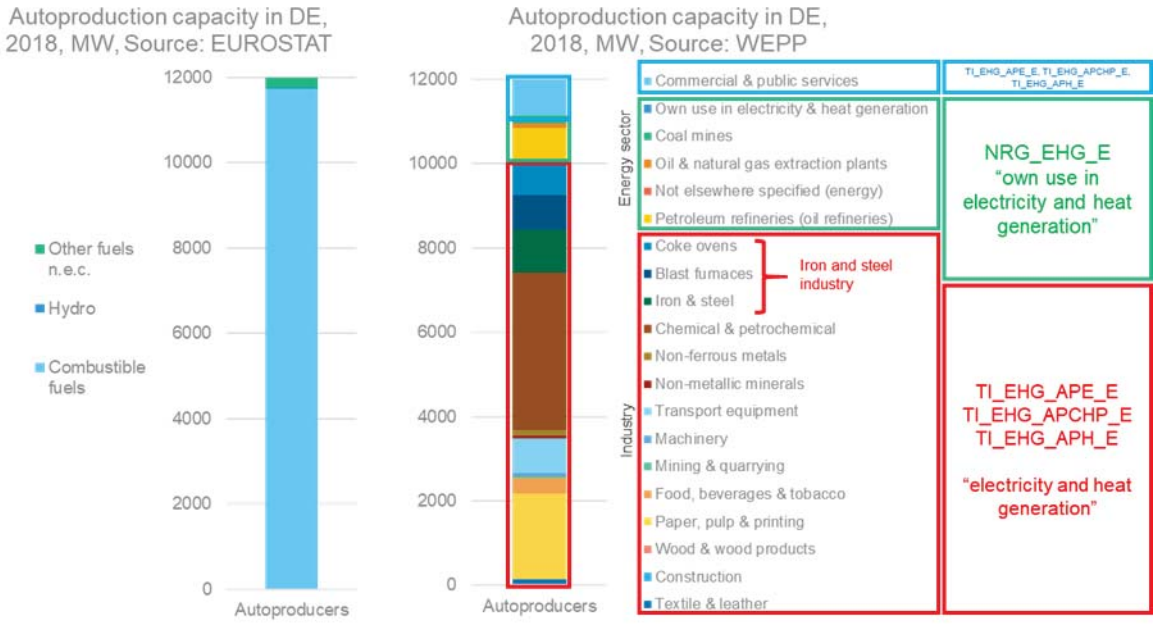
Industry	Description
	C15: Manufacture of leather and related products
Construction	NACE Rev. 2 Division 41, 42 and 43 F41: Construction of buildings F42: Civil engineering F43: Specialised construction activities
Wood and wood products	NACE Rev. 2 Division 16 C161: Sawmilling and planing of wood C162: Manufacture of products of wood, cork, straw and plaiting materials

Source: JRC, 2020

2.1 Disaggregation of the autoproduction blocks in the energy balances

The transformation inputs reported in EUROSTAT's energy balances for the autoproduction of "electricity and heat generation" (items TI_EHG_APE_E, TI_EHG_APCHP_E, and TI_EHG_APH_E in the energy balances) and the "own use in electricity and heat generation" (item NRG_EHG_E) are broken down by industry according to the installed capacities reported by S&P Global Platts "World Electric Power Plant Database" (WEPP) (S&P Global Platts, 2019)[17]. Autoproducers related to coke ovens and blast furnaces are considered part of the iron and steel industry.

Figure 1. Disaggregation of the autoproduction capacity



Source: JRC, 2020

To this purpose, the business types used in WEPP are matched with the sectors included in the energy balances of EUROSTAT, considering only the capacities of industrial autoproducers (see Table 2) to estimate the additional energy inputs not included as final energy consumption or non-energy use. The correspondences between WEPP and EUROSTAT are further refined depending on whether WEPP reports the power plants as CHP or not, as autoproducers or utilities, the fuel types used, or the owning company.

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[17] Similarly to coke ovens and blast furnaces, EUROSTAT considers the energy inputs necessary for the autoproduction of electricity and heat in the transformation and own use blocks of the energy balances, in order to better represent the energy flows in the statistics. However, the energy bills (and the corresponding taxes) of industrial autoproducers are paid by the industry they belong to, and therefore the energy consumed by industrial autoproducers is allocated to the corresponding sector.

Table 2. Correspondences between WEPP business types and EUROSTAT sectors

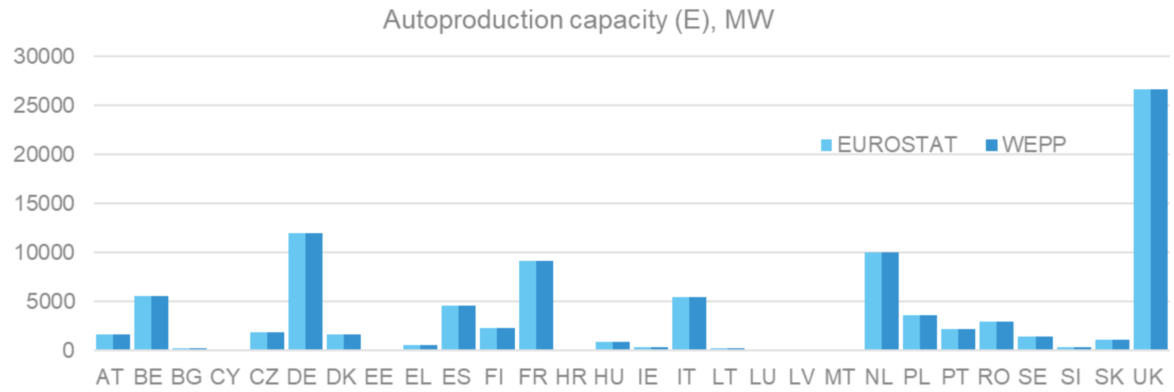
WEPP's business type	EUROSTAT sector
Commercial: Agriculture	Commercial & public services
Commercial: Leisure/recreation centres & swimming pools	Commercial & public services
Commercial: Greenhouse	Commercial & public services
Commercial: Hospitals & nursing homes	Commercial & public services
Commercial: Hotels & resorts	Commercial & public services
Commercial: Laundry & dry cleaning	Commercial & public services
Commercial: Media/publishing/book vendor	Commercial & public services
Commercial: Misc	Commercial & public services
Commercial: Misc commercial/industrial autoproducers	Commercial & public services
Commercial: Misc services	Commercial & public services
Commercial: Retailing	Commercial & public services
Commercial: Sugar Mill or Plant	Commercial & public services
Commercial: Trade/holding/diversified/conglomerate	Commercial & public services
Energy: DSM & energy services (ESCO)	Own use in electricity & heat generation
Energy exchanges	Own use in electricity & heat generation
Energy: Operating services company (non-utility)	Own use in electricity & heat generation
Energy: PUC/regulatory body	Own use in electricity & heat generation
Energy: Trading/brokers/marketers (electric power and/or gas)	Own use in electricity & heat generation
Fuels: Coal	**Coke ovens** Coal mines Patent fuel plants BKB & PB plants Coal liquefaction plants
Fuels: Gas	Oil & natural gas extraction plants Gas works
Fuels: Gas and oil	Oil & natural gas extraction plants
Fuels: Gas and/or oil	Oil & natural gas extraction plants
Fuels: Other	Nuclear industry Liquefaction & regasification plants (LNG) Gasification plants for biogas Gas-to-liquids (GTL) plants Charcoal production plants
Fuels: Petroleum refinery	Petroleum refineries (oil refineries)
Fuels: ZZ (unspecified)	Not elsewhere specified (energy)
Fuels: Uranium mining & milling	**Mining & quarrying**
Govt: National	Commercial & public services
Govt: Regional (local/municipal/state)	Commercial & public services
Govt: Regional (County/District)	Commercial & public services
Govt: Regional (Local/Municipal)	Commercial & public services
Govt: Regional (State)	Commercial & public services
Mfg: Cement	**Non-metallic minerals**
Mfg: Chemicals & fertilzers	**Chemical & petrochemical**
Mfg: Equipment/Misc	**Machinery** **Transport equipment**
Mfg: Food products	**Food, beverages & tobacco**
Mfg: Metals & mining & smelters	**Iron & steel** **Blast furnaces** **Non-ferrous metals** **Mining & quarrying**
Mfg: Pulp & paper & forest products	**Paper, pulp & printing**

WEPP's business type	**EUROSTAT sector**
	Wood & wood products
Mfg: Textiles & clothing	**Textile & leather**
Mfg: ZZ/Unspecified	**Construction** **Not elsewhere specified (industry)**
Services: University/academic/library/laboratory	Commercial & public services
Services: Architect/Engineer/Constructor	Commercial & public services
Services: Association	Commercial & public services
Services: Association (Electric)	Commercial & public services
Trade groups and other types of membership organizations	Commercial & public services
Trade groups and other types of membership organizations	Commercial & public services
Trade groups and other types of membership organizations	Commercial & public services
Services: Association (Trade)	Commercial & public services
Services: Consulting	Commercial & public services
Services: Environmental	Commercial & public services
Services: Banking/finance/accounting/insurance	Commercial & public services
Services: Banking & finance (Banking)	Commercial & public services
Services: Banking & finance (Insurance)	Commercial & public services
Merchant transmission companies	Commercial & public services
Services: Waste to energy companies/plants	Commercial & public services
Trade groups and other types of membership organizations	Commercial & public services
Services: Private power project development	Commercial & public services
Services: Power plant services	Commercial & public services
Services: Real Estate	Commercial & public services
Services: Railroad/shipping/ports/airports	Commercial & public services
Services: Telecommunications and information technology	Commercial & public services
Util Other: Gas	Own use in electricity & heat generation
Util Other: Heating (Steam)	Own use in electricity & heat generation
Util Other: Telecommunications	Commercial & public services
Util Other: Water and wastewater	Commercial & public services
Elec Util & Comb: Cooperative ownership (US=Rural Elec Coops)	Own use in electricity & heat generation
District heating and/or cooling utility	Commercial & public services
Elec Util & Comb: Government ownership	Commercial & public services
Elec Util & Comb: Government ownership (County)	Commercial & public services
Elec Util & Comb: Government ownership (Irrigation District)	Commercial & public services
Elec Util & Comb: Government ownership (Local/Municipal)	Commercial & public services
Elec Util & Comb: Government ownership (Federal/Provincial)	Commercial & public services
Elec Util & Comb: Government ownership (Public Power/Public Utility District)	Commercial & public services
Elec Util & Comb: Government ownership (Regional)	Commercial & public services
Elec Util & Comb: Government ownership (State)	Commercial & public services
Elec Util & Comb: Holding	Commercial & public services
Elec Util & Comb: Investor/private ownership (IOU)	Commercial & public services
Elec Util & Comb: Operating service company (regulated utility)	Commercial & public services

Source: JRC, 2020
In bold: industrial sectors

The result of this process allows matching fairly well the amount of autoproduction capacity reported by EUROSTAT for each EU MS (Figure 2).

Figure 2. Comparison of the autoproduction capacity in EUROSTAT and WEPP

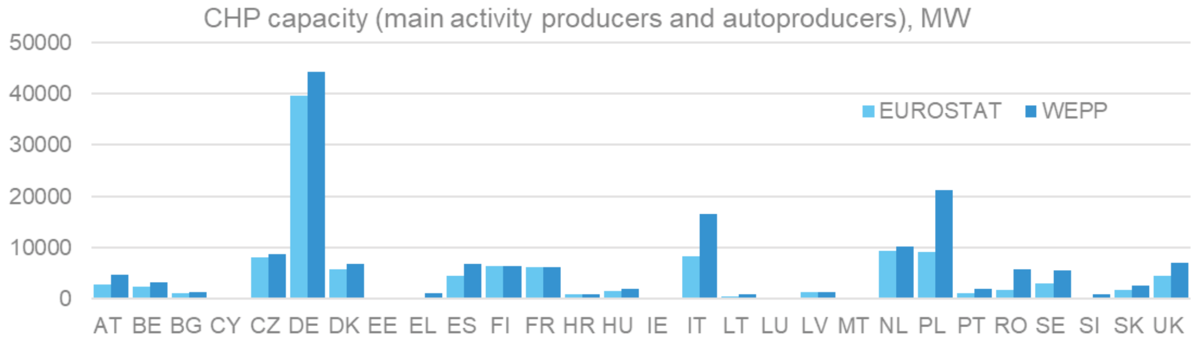


Source: JRC, 2020

However, the following caveats need to be taken into account:

- The disaggregation of the energy balances by industry should be based on activity-based indicators, but there are no data on the utilisation rates of these autproduction facilities. The resulting capacity-based disaggregation of the energy balances is therefore only a plausible approximation built upon the available information.
- There are mismatches between the operational status of autoproducers in WEPP and EUROSTAT. While EUROSTAT reports 69 GW of autoproduction capacity, only 61 GW were operational according to WEPP. If that were taken into account, the disaggregation of the autoproduction would yield different results, especially in some industries where the amount of energy used for autoproduction represents a noticeable share of the total energy use (e.g. pulp, paper and printing, 12% on average for the EU).
- CHP data do not match in some countries (WEPP reports higher capacities in some countries, notably PL, IT, DE, RO, SE) (Figure 3). The calculations are based on WEPP's data.
- There are no data on the capacities of autoproducers of heat only, thus it is assumed that the capacity of autoproduction of heat follows the same distribution as the CHP capacity.

Figure 3. Comparison of the CHP capacity in EUROSTAT and WEPP.



Source: JRC, 2020

2.2 Disaggregation of non-energy use by industry

Energy products are used as feedstocks for different purposes (Table 3). The consumption of energy for non-energy uses accounts for a significant share of the total energy use in the industry (between 4% and 55% depending on the MS, 28% on average for the EU) but it is not disaggregated by industry in EUROSTAT's energy balances. The disaggregation by industrial sector has been done according to the "memo items" available from the IEA's Extended World Energy Balances (International Energy Agency, 2020).

Table 3. Possible non-energy uses of energy carriers (non-exhaustive)

Energy carrier	**Purpose**
Gas/diesel oil	Ammonia, petrochemicals
LPG	Petrochemicals
Naphtha	Ethylene, petrochemicals
Lubricants, solvents, paraffin waxes, greases	All industrial sectors
Oil products	Ammonia
Coke, coal	Titanium dioxide, carbide, aluminium, ferroalloys
Coke	Lead, zinc, food and beverages
Natural gas	Ammonia, methanol, carbon black, nitric acid, petrochemicals, hydrogen
Bitumen	Construction
Refinery gas	Petrochemicals
Petroleum coke	Carbide production

Source: JRC, 2020, adapted from Annex 8A.2, Table 2.12, in (Eggleston et al., 2006).

3.3 Estimation of the total energy use by industry

Once all the blocks of the energy balances are fully disaggregated it is possible to estimate the total amount of energy used by each industrial sector. This is done by subtracting the feedbacks from coke ovens[18], blast furnaces[19], and power plants[20] from the total amount of energy inputs[21]. Only the inputs from external sources are considered to be taxable. The feedbacks of energy carriers that are produced internally are considered exempt from additional taxation.

Figure 4 and Figure 5 illustrate this approach with the examples of the energy balances of the German iron and steel and chemical and petrochemical industries in 2018.

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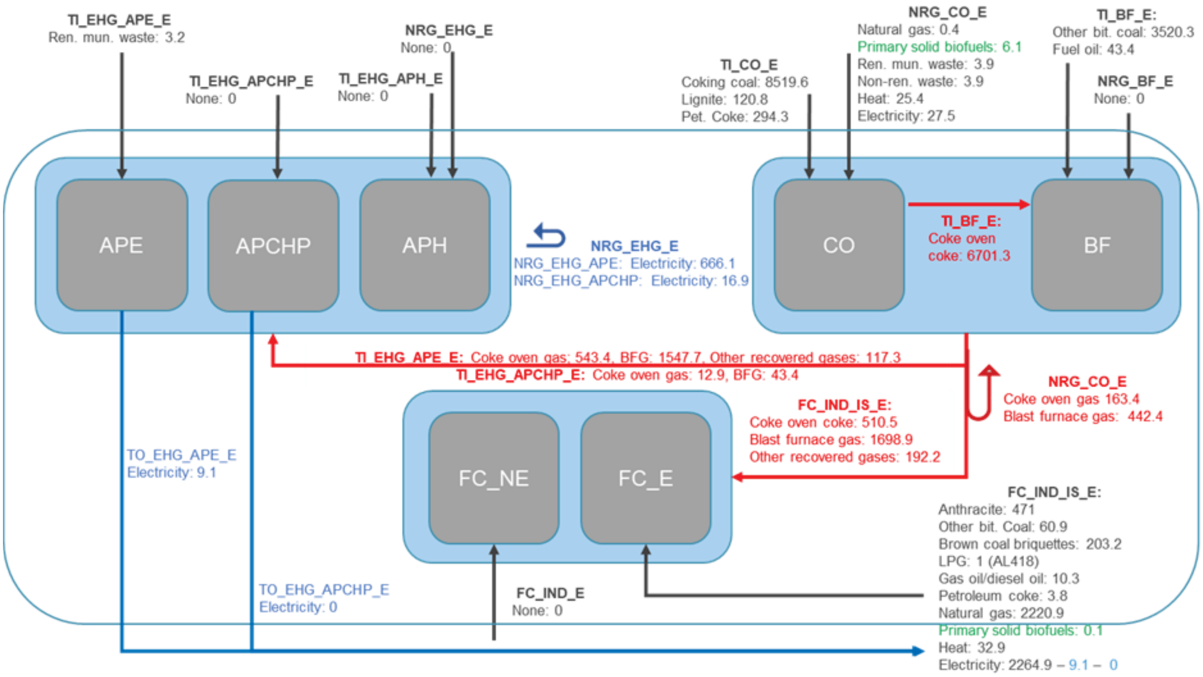
[18] Columns "coke oven coke", "coal tar" and "coke oven gas" in the final energy consumption block.

[19] Columns "blast furnace gas" and "other recovered gases" in the final energy consumption block.

[20] Column "electricity" from autoproducers of electricity and heat.

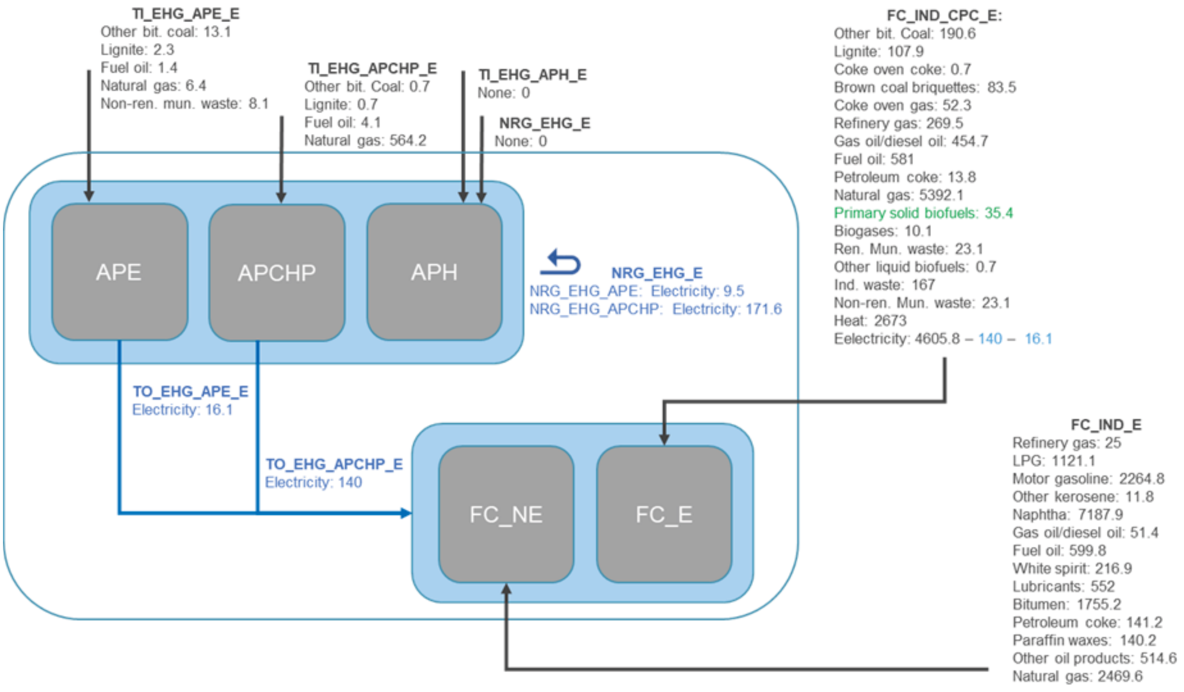
[21] Rows TI_EHG_APE_E, TI_EHG_APCHP_E, TI_EHG_APH_E (transformation inputs for the autoproduction of electricity, CHP, and heat); TI_CO_E (transformation inputs into coke ovens), TI_BF_E (transformation inputs into blast furnaces), NRG_EHG_E (own consumption of autoproducers), FC_IND_NE (non-energy use in industry), and FC_IND_E (final energy consumption in industry) in the energy balances.

Figure 4. Energy balance of the German iron and steel industry in 2018



Source: JRC, 2020 with data from EUROSTAT

Figure 5. Energy balance of the German chemical and petrochemical industry in 2018



Source: JRC, 2020 with data from EUROSTAT

All figures in ktoe.Colour legend:
Inputs from external sources: taxes may be applied on these items only
Feedbacks of coke oven coke, coal tar, and coke oven gas from coke ovens: produced internally, not taxed
Feedbacks of blast furnace gas and other recovered gases from blast furnaces produced internally, not taxed
Feedbacks of electricity from autoproducers of electricity and CHP: produced internally, not taxed
Wood and wood products, peat not taxed according to article 2 ETD

2.4 *Breakdown of the total energy use by industry*

The total energy used by each industry is split into in/out of scope categories according to the shares resulting from assigning the processes included in the detailed energy balances of JRC-IDEES 2015 to the categories considered in the ETD. The shares calculated in this process are assumed to be valid for 2018.

The assignations and the shares are corrected with more detailed information at facility level whenever available (only in the cases of the chemical and petrochemical (Boulamanti and Moya, 2017); pulp, paper and printing (Moya and Pavel, 2018); and iron and steel industries (Pardo et al., 2012)). The assignations also take into account relevant rulings of the Court of Justice of the European Union (CJEUC) interpreting article 2 of the ETD (see Table 4).

According to the ETD some energy carriers and processes can be considered out of scope:

- **Chemical reduction**: in the calculations part of the energy used for the production of hydrogen, ammonia and methanol in the chemical and petrochemical industry, and the inputs to blast furnaces would fall under this category.
- **Electrolysis**: the use of electricity for the production of chlorine in the chemical and petrochemical industry and for the smelting of aluminium in the non-ferrous metals industry.
- **Metallurgical processes** in the iron and steel and the non-ferrous metal industries. This includes shaping processes (such as casting, forging, rolling, extrusion, machining, cutting, or bending), heat treatments (annealing, tempering, or quenching), and surface treatments (plating, shot peening or thermal spraying). Therefore, the “products finishing”, “thermal foundries” and “thermal and electric connections” processes listed in JRC-IDEES are considered as metallurgical processes.
- **Mineralogical processes**. This category includes all processes in the non-metallic minerals industries (as specified in article 2 of the ETD), as well as the production of lime within the pulp, paper and printing industry.
- **Other dual uses** would include the consumption of energy products used as process feedstocks.
- **Wood and wood products**: this is the consumption of products CN-4401 and CN-4402[22], as stipulated in article 2.4.a of the ETD, which is estimated as the consumption of “primary solid biofuels” and charcoal, which are used as proxy due to the lack of better data. The actual amount of wood and wood products would be a fraction of this value.
- **Peat**: according to article 2.3 of the ETD, the amounts of “peat” and “peat products” recorded in the energy balances.
- **Electricity**: when it accounts for 50% of the cost of a product, but this is not estimated due to lack of data.
- **Uses other than motor or heating fuels**: these would include diverse processes (such as lighting or cooling). Electricity is considered as a motor fuel when it can be replaced by another energy product.

Any other uses not explicitly included in the above list have been considered by default within the scope of the ETD.

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[22] Combined nomenclature codes, Commission Regulation (EC) No 2031/2001 of 6 August 2001, amending Annex I to Council Regulation (EEC) No 2658/87 on the tariff and statistical nomenclature and on the Common Customs Tariff

The following tables (Table 6 to Table 17) summarise how the processes used in JRC-IDEES are considered to be in/out of scope of the ETD.

Table 4. CJEUC rulings interpreting article 2 of the ETD.

Ruling	Summary
CJEUC-606/13, OKG AB, ECLI:EU:C:2015	The case concerns the taxation of thermal power of nuclear reactors. The scope of the ETD, defined by Art.2, does not include the thermal power of a nuclear reactor, hence it cannot be considered an "energy product". The definition of "electricity" in Art.2.2, defined by CN code 22716, means that the thermal power of a nuclear reactor does not come within the definition of "electricity".
CJEUC-517/07, Afton Chemical Limited, ECLI:EU:C:2008	The case concerns whether fuel additives which are themselves not designed to power vehicles (they are cleaning agents, solvents, demulsifiers, etc.) should be taxed under the ETD. The court case itself states that the wording is unclear and imprecise. The ruling shows that any additive to a fuel should be taxed to the same extent as the motor fuel (Art.2.3).
CJEUC-43/13 and C-44/13, Kronos Titan GmbH, ECLI:EU:C:2014	The case concerns how the equivalent taxes for energy products that are not directly specified in the ETD should be determined (should they be taxed as heating fuels or motor fuels based on its use or its closest energy product listed in the ETD). In this case, a producer of titanium dioxide powder needs a temperature of 1 650 degrees to produce the chemical reaction desired. To do so, they burn toluene spraying into an oxygen stream. Another manufacturer of surface coatings burns white spirit for a thermal treatment process. The court rules that the equivalent rate of taxation, is first determined based on its use as either as a heating fuel or motor fuel (in both cases above they are heating fuels), before identifying for which of the motor or heating fuels in Annex I is closest to it
CJEUC-426/12, X, ECLI:EU:C:2014	The case concerns a sugar producer who argues that the use of coal as a fuel in the lime kiln, and the use of the resulting CO_2 to produce lime-kiln gas (indispensable for the purification of raw juice) and the subsequent absorption of CO_2 into earth form (sold as fertiliser to the agricultural sector), corresponds to dual-use under Art.2.4.b, and should be exempt under the ETD. A product has "dual use" under Art.2.4.b when it is used both as heating fuel and for purposes other than as motor fuel and heating fuel. In the case of sugar production, the gas which is needed for purification can only be obtained by using coal (due to impurities), so coal can be considered both as a heating fuel and as a raw material (to produce CO_2). The court ruled that in this case, using coal as the heating fuel and then using the generated CO_2 from the combustion within the same production process does constitute "dual use". However, the use of gas as a residue that is then recycled to produce chemical fertiliser (which is then used as a primary material in a separate manufacturing process) does not constitute "dual use". From the ruling: "… there may be dual use of an energy product burned in a manufacturing process where … that process cannot be completed without a substance that can be generated only by the combustion of that energy product".
CJEUC-529/14, YARA Brunsbüttel GmbH, ECLI:EU:C:2015	This case concerns an ammonia producer, who uses natural gas in a superheater mixed with the "poor" waste gases of the ammonia production. The heat used fulfilled multiple functions: heating and drying of vapour; chemical decomposition of waste gas; evacuation of waste gases. The producer argues that the natural gas should be considered "dual use" (and thus exempt under the ETD), as it is partly used as a heating fuel (steam for the ammonia production) but also in the waste-gas treatment (decomposition of waste-gas). An expert stated that the ammonia production could take place without the natural gas (sufficient heat from the waste gases) and that its purpose was to evacuate waste-gases (to be in agreement with environmental regulations). The court ruled that it does not constitute dual use, for two reasons: i. First, the production process could be completed without the natural gas. ii. Even if it could not be, vapour is not a substance that can be generated only using natural gas (does this mean that any steam production is automatically in scope?). It is implicit in both the sugar and ammonia case "that the energy product could only benefit from the 'dual use' exception to the extent that it had been physically transformed and contributed in that altered state to the production process".
CJEUC-465/15, Hüttenwerke Krupp Mannesmann	The case concerns a steel producer, who argues that the electricity used to power turbo blowers which compress air that is then injected into the blast furnace to trigger the reduction of iron ore should be exempt under Art.2.4.b ("electricity used principally for

Ruling	Summary
GmbH, ECLI:EU:C:2017	the purposes of chemical reduction”). The court rules that this is not the case. It argues that if the turbo blowers were operated with diesel instead of electricity, the diesel would not be exempt from the ETD (it would not fall under the “dual use” concept), since it would solely be a motor fuel. As the ETD aims to tax energy products and electricity to the same extent when they are interchangeable, it means that in this case the electricity is also not exempt. “If, however, the turbo blower had operated not with electricity, but rather by using an energy product such as diesel, the latter would not fall within the concept of ‘dual use’ of Art.2.4.b, since the use of the energy product concerned would only serve to produce a driving force, which would therefore correspond to use as a fuel”.

Source: JRC, 2020

Specific assumptions for the chemical and petrochemical industry

In the case of the chemical and petrochemical industry, additional data at facility level (Boulamanti and Moya, 2017) have been used to determine how much of the energy consumed in each of the main production processes is in scope of the ETD, or used for chemical reduction or electrolysis.

Table 5 shows the 45 main processes used in the chemical industry across the EU (Boulamanti and Moya, 2017). The processes are split into three types: “electrolysis”, “redox”, and “other”. In a “redox” reaction the oxidation states of the atoms change (oxidation: increment of the oxidation state, reduction: decrease of the oxidation state), while they do not in “other” reactions. The shares of thermal and electric energy necessary for each process are assigned to “electrolysis”, “reduction” (when at least one of the elements of the main product is reduced and the others do not change their oxidation state), or “in scope” (when the elements of the main product are only oxidized, reduced and oxidized, or do not change at all).

The breakdown of the energy uses in the chemical and petrochemical industry at national level is shown in Table 6. These values result from the data for each process (Table 5) with the available information at facility level (Boulamanti and Moya, 2017). They are used when there is not a straightforward allocation of processes from JRC-IDEES to the ETD categories (processes “steam processing”, “generic electric processes”, and “high enthalpy processing”, which appear under different ETD categories in Table 7).

The dataset provides a snapshot of the chemical and petrochemical industry in 2013 that accounts for a share of its final energy consumption in that year. For that reason it has been assumed that the uncovered share of final energy consumption is considered in scope by default since the same structure cannot be extrapolated to the whole industry. The resulting distribution of the energy uses is then applied to the 2018 energy balances of the chemical and petrochemical industry. It is also assumed that the database includes all the production capacity of chlorine, the only product that requires electrolysis, in 2018.

Table 5. Types of production processes in the chemical and petrochemical industry

Process	Product	Reaction(s)	Type	Electricity share			Thermal energy share		
				Elec.	C. red.	I. S.	Elec.	C. red.	I. S.
Ammoxidation (Sohio process)	Propylene	C_6H_{14} (-2.33,+1) → 2 $\mathbf{C_3H_6}$ (-2,+1) + H_2 (0)	Redox	0	0	100	0	0	100
	Acrylonitrile	C_3H_6 (-2,+1) + NH_3 (-3,+1) + 1.5 O_2 (0) → $\mathbf{C_3H_3N}$ (-2,+1,+3) + 3 H_2O (+1,-2)							
Chloralkali diaphragm cell	Chlorine		Electrolysis	100	0	0	0	0	100
Chloralkali membrane cell	Chlorine		Electrolysis	100	0	0	0	0	100
Chloralkali mercury cell	Chlorine		Electrolysis	100	0	0	0	0	100
Cyclohexane KA oxidation	Adipic acid	$C_6H_{10}O$ (-1.33,+1,-2) + $C_6H_{12}O$ (-1.67,+1,-2) + x HNO_3 (+1,+5,-2) → 2 $\mathbf{C_6H_{10}O_4}$ (-0.33,+1,-2) + y N_2O (+1,-2) + z H_2O (+1,-2)	Redox	0	0	100	0	0	100
Direct chlorination	Ethylene dichloride	C_2H_4 (-2,+1) +Cl_2 (0) → $\mathbf{C_2H_4Cl_2}$ (-1,+1,-1)	Redox	0	0	100	0	0	100
Direct oxidation	Ethylene oxide	C_2H_4 (-2,+1) + 0.5 O_2 (0) → $\mathbf{C_2H_4O}$ (-1,+1,-2)	Redox	0	0	100	0	0	100
EDC cracking	Vinyl chloride monomer	C_2H_4Cl (-1,+1,-1) → $\mathbf{C_2H_3Cl}$ (-1,+1,-1) + HCl (+1,-1)	Other	0	0	100	0	0	100
Emulsion polymerisation	PVC-e	n C_2H_3Cl (-1,+1,-1) → $\mathbf{(C_2H_3Cl)_n}$ (-1,+1,-1)	Other	0	0	100	0	0	100
ETB dehydrogenation	Styrene	C_8H_{10} (-1.25,+1) → $\mathbf{C_8H_8}$ (-1,+1) + H_2 (0)	Redox	0	0	100	0	0	100
Fluid catalytic cracking	Propylene	C_6H_{14} (-2.33,+1) → 2 $\mathbf{C_3H_6}$ (-2,+1) + H_2 (0)	Redox	0	0	100	0	0	100
Friedel crafts	Ethylbenzene	C_6H_6 (-1,+1) + C_2H_4 (-2,+1) → $\mathbf{C_6H_5CH_2CH_3}$ (-0.83,+1,-2,+1,-3,+1)	Redox	0	0	100	0	0	100
Furnace black	Carbon black	C_xH_y (-y/x,+1) + z O_2 (0) → x $\mathbf{C}$ (0) + H_2O (+1,-2)	Redox	0	0	100	0	0	100
Heavy oil partial oxidation	Methanol	C_xH_y (-y/x,+1) + z O_2 (0) → x $\mathbf{CH_4O}$ (-2,+1,-2) + z H_2O (+1,-2)	Redox	0	0	100	0	0	100
Heavy residue based ammonia	Hydrogen	C_xH_y (-y/x,+1) + 0.5x O_2 (0) → 0.5y $\mathbf{H_2}$ (0) + x CO (+2,-2)	Redox	0	26.8	73.2	0	93	7
		C (0) + H_2O (+1,-2) → $\mathbf{H_2}$ (0) + CO (+2,-2)							
		C (0) + 0.5 O_2 (0) → $\mathbf{CO}$ (+2,-2)							
	Ammonia	N_3 (0) + 3 H_2 (0) → 2 $\mathbf{NH_3}$ (-3,+1)							
Hydration	Monoethylene glycol	C_2H_40 (-1,+1,-2) + H_2O (+1,-2) → $\mathbf{C_2H_6O_2}$ (-1,+1,-2)	Other	0	0	100	0	0	100
Naphtha based - benzene	Benzene	C_6H_{14} (-2.33,+1) → $\mathbf{C_6H_6}$ (-1,+1) + 4 H_2 (0)	Redox	0	0	100	0	0	100
Naphtha based - only benzene	Benzene	C_6H_{14} (-2.33,+1) → $\mathbf{C_6H_6}$ (-1,+1) + 4 H_2 (0)	Redox	0	0	100	0	0	100
Naphtha based - toluene	Toluene	7 C_6H_{14} (-2.33,+1) → 6 $\mathbf{C_7H_8}$ (1.14,+1) + 25 H_2 (0)	Redox	0	0	100	0	0	100
Naphtha based - xylenes	Xylenes	6 C_6H_{14} (-2.33,+1) → 3 $\mathbf{C_8H_{10}}$ (-1.25,+1) + 13 H_2 (0)	Redox	0	0	100	0	0	100
Naphtha reforming	Hydrogen	Steam cracking	Redox	0	0	100	0	0	100
Natural gas based ammonia	Nitrogen, hydrogen	CH_4 (-4,+1) + H_2O (+1,-2) → 3 $\mathbf{H_2}$ (0) + CO (+2,-2)	Redox	0	37.7	62.3	0	67.7	32.3
		CO (+2,-2) + H_2O (+1,-2) → $\mathbf{H_2}$ (0) + CO_2 (+4,-2)							
		CH_4 (-4,+1) + air (0) →2 $\mathbf{N_2}$ (0) + CO (+2,-2) + 2 H_2 (0)							
	Ammonia	N_3 (0) + 3 H_2 (0) → 2 $\mathbf{NH_3}$ (-3,+1)							
Ostwald: dual pressure	Nitric acid	NH_3 (-3,+1) + 5 O_2 (0) → 4 $\mathbf{NO}$ (+2,-2) + 6 H_2O (+1,-2)	Redox	0	0	100	0	0	100
		2 NO (+2,-2) + O_2 (0) → 2 $\mathbf{NO_2}$ (+4,-2)							
		3 NO_2 (+4,-2) + H_2O (+1,-2) → 2 $\mathbf{HNO_3}$ (+1,+5,-2) + NO (+2,-2)							
Ostwald: single pressure	Nitric acid	NH_3 (-3,+1) + 5 O_2 (0) → 4 $\mathbf{NO}$ (+2,-2) + 6 H_2O (+1,-2)	Redox	0	0	100	0	0	100
		2 NO (+2,-2) + O_2 (0) → 2 $\mathbf{NO_2}$ (+4,-2)							
		3 NO_2 (+4,-2) + H_2O (+1,-2) → 2 $\mathbf{HNO_3}$ (+1,+5,-2) + NO (+2,-2)							

Process	Product	Reaction(s)	Type	Electricity share			Thermal energy share		
				Elec.	C. red.	I. S.	Elec.	C. red.	I. S.
Oxychlorination	Ethylene dichloride	2 C_2H_4 (-2,+1) + 4 HCl (+1,-1) + O_2 (0) → $\mathbf{C_2H_4Cl_2}$ (-1,+1,-1) + H_2O (+1,-2)	Redox	0	100	0	0	100	0
Partial oxidation	Hydrogen	Heavy oil partial oxidation	Redox	0	0	100	0	0	100
Phenol KA oxidation	Adipic acid	2 C_6H_6O (-0.67,+1,-2) + 4 H_2O (+1,-2) + O_2 (0) → 2 $\mathbf{C_6H_{10}O_4}$ (-0.33,+1,-2)	Redox	0	0	100	0	0	100
PVC - mechanical recycling	PVC recycled		Other	0	0	100	0	0	100
Pygas based - benzene	Benzene	C_6H_{14} (-2.33,+1) → $\mathbf{C_6H_6}$ (-1,+1) + 4 H_2 (0)	Redox	0	0	100	0	0	100
Pygas based - only benzene	Benzene	C_6H_{14} (-2.33,+1) → $\mathbf{C_6H_6}$ (-1,+1) + 4 H_2 (0)	Redox	0	0	100	0	0	100
Pygas based - toluene	Toluene	7 C_6H_{14} (-2.33,+1) → 6 $\mathbf{C_7H_8}$ (1.14,+1) + 25 H_2 (0)	Redox	0	0	100	0	0	100
Pygas based - xylenes	Xylenes	6 C_6H_{14} (-2.33,+1) → 3 $\mathbf{C_8H_{10}}$ (-1.25,+1) + 13 H_2 (0)	Redox	0	0	100	0	0	100
Solvay	Soda ash	2 $Na_3H(CO_3)_2$ (+1,+1,+4,-2) → 3 $\mathbf{Na_2CO_3}$ (+1,+4,-2) +H_2O (+1,-2) + CO_2 (+4,-2)	Other	0	0	100	0	0	100
	Soda ash	NaCl (+1,-1) + $CaCO_3$ (+2,+4,-2) → $\mathbf{Na_2CO_3}$ (+1,+4,-2) + $CaCl_2$ (+2,-1)	Other	0	0	100	0	0	100
Steam cracking ethane-based	Ethylene	C_2H_6 (-3,+1) → $\mathbf{C_2H_4}$ (-2,+1) + H_2 (0)	Redox	0	0	100	0	0	100
Steam cracking gas oil-based	Ethylene	2 $C_nH_{(2n+2)}$ (-(2n+2)/n,+1) → n $\mathbf{C_2H_4}$ (-2,+1) + 2 H_2 (0)	Redox	0	0	100	0	0	100
Steam cracking naphtha-based	Butadiene	2 C_6H_{14} (-2.33,+1) → 3 $\mathbf{C_4H_6}$ (-1.5,+1) + 5 H_2 (0)	Redox	0	0	100	0	0	100
Steam cracking naphtha-based	Butenes	2 C_6H_{14} (-2.33,+1) → 3 $\mathbf{C_4H_8}$ (-2,+1)) + 2 H_2 (0)	Redox	0	0	100	0	0	100
Steam cracking naphtha-based	Ethylene	C_6H_{14} (-2.33,+1) → 3 $\mathbf{C_2H_4}$ (-2,+1) + H_2 (0)	Redox	0	0	100	0	0	100
Steam cracking naphtha-based	Propylene	C_6H_{14} (-2.33,+1) → 2 $\mathbf{C_3H_6}$ (-2,+1) + H_2 (0)	Redox	0	0	100	0	0	100
Steam reforming	Hydrogen	CH_4 (-4,+1) + H_2O (+1,-2) → 3 $\mathbf{H_2}$ (0) + CO (+2,-2)	Redox	00	100	0	0	100	0
		CO (+2,-2) + H_2O (+1,-2) → $\mathbf{H_2}$ (0) + CO_2 (+4,-2)							
		CH_4 (-4,+1) + air (0) → 2 $\mathbf{H_2}$ (0) + CO (+2,-2) + 2 N_2 (0)							
Steam reforming - methanol	Hydrogen	CH_4 (-4,+1) + H_2O (+1,-2) → 3 $\mathbf{H_2}$ (0) + CO (+2,-2)	Redox	0	22.6	77.4	0	12.5	87.5
		CO (+2,-2) + H_2O (+1,-2) → $\mathbf{H_2}$ (0) + CO_2 (+4,-2)							
		CH_4 (-4,+1) + air (0) → 2 $\mathbf{H_2}$ (0) + CO (+2,-2) + 2 N_2 (0)							
	Methanol	CO (+2,-2) + 2 H_2 (0) → $\mathbf{CH_4O}$ (-2,+1,-2)							
		CO_2 (+4,-2) + 3 H_2 (0) → $\mathbf{CH_4O}$ (-2,+1,-2) + H_2O (+1,-2)							
		CH_4 (-4,+1) + 0.5 O_2 (0) → $\mathbf{CH_4O}$ (-2,+1,-2) + 2 H_2 (0) + CO (+2,-2)							
Suspension polymerisation	PVC-S	n C_2H_3Cl (-1,+1,-1) → $\mathbf{(C_2H_3Cl)_n}$ (-1,+1,-1)	Other	0	0	100	0	0	100
Urea synthesis	Ammonia	See ammonia processes	Other	0	0	100	0	0	100
	Urea	NH_3 (-3,+1) + CO_2 (+4,-2) → $\mathbf{CH_4N_2O}$ (+4,+1,-3,-2) + H_2O (+1,-2)							

Source: JRC, 2020

1: Main product in bold
2: Colour code: red = oxidation, green = reduction, blue = oxidation and reduction
3: Numbers within brackets show the oxidation states
4: Elec.: electrolysis
5: C. red.: chemical reduction
6: I. S.: in scope

Table 6. Breakdown of the energy uses in the chemical and petrochemical industry from (Boulamanti and Moya, 2017)

Country	FEC[1] (2013, ktoe)		FEC coverage[3]	"In scope" by default	Electricity shares[4]			Thermal energy shares[4]		
	EUROSTAT	Database[2]			Electrolysis	Chemical reduction	In scope	Electrolysis	Chemical reduction.	In scope
AT	995	111.1	11.2%	88.8%	3%	3%	93%	0%	8%	92%
BE	4201	1792.7	42.7%	57.3%	11%	3%	86%	0%	7%	93%
BG	781	408.0	52.3%	47.7%	0%	1%	99%	0%	8%	92%
CY	3	0.0	1.2%	98.8%	0%	0%	100%	0%	0%	0%
CZ	1039	349.6	33.7%	66.3%	12%	0%	88%	0%	0%	100%
DE	14232	6200.4	43.6%	56.4%	18%	3%	79%	0%	6%	94%
DK	268	0.6	0.2%	99.8%	0%	0%	100%	0%	0%	100%
EE	75	26.6	35.7%	64.3%	0%	2%	98%	0%	32%	68%
EL	111	30.4	27.3%	72.7%	8%	1%	90%	0%	25%	75%
ES	4075	1080.0	26.5%	73.5%	21%	5%	74%	0%	2%	98%
FI	1055	78.8	7.5%	92.5%	6%	1%	93%	0%	0%	100%
FR	4753	2271.1	47.8%	52.2%	15%	2%	82%	0%	7%	93%
HR	137	119.7	87.2%	12.8%	0%	4%	96%	0%	40%	60%
HU	1048	435.9	41.6%	58.4%	21%	1%	79%	0%	6%	94%
IE	228	3.9	1.7%	98.3%	1%	0%	99%	0%	0%	100%
IT	4137	1155.0	27.9%	72.1%	2%	2%	95%	0%	5%	95%
LT	362	71.5	19.7%	80.3%	0%	0%	100%	0%	15%	85%
LU	70	0.1	0.2%	99.8%	0%	0%	100%	0%	0%	100%
LV	25	0.0	0.1%	99.9%	0%	0%	100%	0%	0%	100%
MT	3	0.0	0.4%	99.6%	0%	0%	100%	0%	0%	0%
NL	7232	2584.7	35.7%	64.3%	14%	4%	81%	0%	7%	93%
PL	2790	1137.9	40.8%	59.2%	4%	0%	96%	0%	15%	85%
PT	495	62.4	12.6%	87.4%	11%	1%	88%	0%	1%	99%
RO	1645	716.8	43.6%	56.4%	32%	2%	66%	0%	17%	83%
SE	536	524.9	97.9%	2.1%	8%	3%	89%	0%	4%	96%
SI	150	4.1	2.7%	97.3%	5%	0%	95%	0%	0%	100%
SK	295	113.1	38.3%	61.7%	17%	0%	83%	0%	22%	78%
EU	50742	14003	38.0%	62.0%	13%	3%	84%	0%	7%	93%

Source: JRC. 2020

1: FEC: final energy consumption
2: Source: (Boulamanti and Moya, 2017)
3: Ratio Database / EUROSTAT. Low values in the "FEC coverage" column correspond to countries where the chemical and petrochemical industry is fairly small.
4: These shares are used to allocate the JRC-IDEES processes "steam processing", "generic electric processes", and "high enthalpy processing" to ETD categories in Table 7.

Table 7. Chemical and petrochemical processes

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat	Lighting	Production of hydrogen, ammonia, and methanol		Production of chlorine		Feedstocks	Wood and wood products
Low enthalpy heat	Process cooling (based on natural gas, steam or electricity)	Steam processing[1]					Peat
Air compressors		Generic electric processes[1]					
Motor drives							
Fans and pumps							
Steam processing[1]							
Thermal and electric furnaces							
Generic electric processes[1]							
High enthalpy heat processing							

Source: JRC. 2020

1: This corresponds to the share not covered in (Boulamanti and Moya, 2017) that cannot be identified explicitly as out of scope, according to Table 5.

Table 8. Pulp, paper and printing.

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat	Lighting				Lime production[1]	Feedstocks	Wood and wood products
Low enthalpy heat	Wood preparation and grinding						Peat
Air compressors	Stock preparation (electricity)						
Motor drives	Paper machine (electricity)						
Fans and pumps	Electric pulping						
Thermal pulping	Cleaning						
Stock preparation (thermal energy)	Product finishing						
Paper machine (thermal energy)							

Source: JRC, 2020

1: From (Moya and Pavel, 2018)

Table 9. Iron and steel

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat	Lighting	Blast furnaces and basic oxygen furnaces	Sinter and pellet making			Feedstocks	Wood and wood products
Low enthalpy heat			Furnaces, refining and rolling				Peat
Air compressors			Products finishing				
Motor drives			Electric arc				
Fans and pumps							

Source: JRC. 2020

Table 10. Non-metallic minerals

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat					All processes (article 2 of the ETD)	Feedstocks	Wood and wood products
							Peat

Source: JRC, 2020

Table 11. Non-ferrous metals

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat	Lighting		Alumina refining	Aluminium smelting		Feedstocks	Wood and wood products
Low enthalpy heat			Aluminium processing and finishing				Peat
Air compressors			Metal production, processing and finishing				
Motor drives							
Fans and pumps							
High enthalpy heat							

Source: JRC. 2020

Table 12. Food, beverages and tobacco

In scope	Out of scope						
	Uses other than motor or heating fuel	Chemical reduction	Metallurgical processes	Electrolysis	Mineralogical processes	Other dual uses	Excluded energy carriers
Autoproduction of electricity and heat	Lighting					Feedstocks	Wood and wood products
Low enthalpy heat	Cooling						Peat
Air compressors	Electric machinery						
Motor drives							
Fans and pumps							
Direct heat							
Process heat							
Steam processing							
Drying processes							

Source: JRC, 2020

Table13. Machinery equipment

In scope	Out of scope						
	Uses other than motor or heating fuel	Chemical reduction	Metallurgical processes	Electrolysis	Mineralogical processes	Other dual uses	Excluded energy carriers
Autoproduction of electricity and heat	Lighting		Products finishing			Feedstocks	Wood and wood products
Low enthalpy heat	General machinery		Thermal foundries				Peat
Air compressors			Thermal and electric connection				
Motor drives							
Fans and pumps							
Heat treatment							
Steam processing							

Source: JRC, 2020

Table 14. Textiles and leather

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat	Lighting					Feedstocks	Wood and wood products
Low enthalpy heat	Product finishing						Peat
Air compressors	Electric machinery						
Motor drives							
Fans and pumps							
Pre-treatment with steam							
Wet processing with steam							
Drying processes							

Source: JRC, 2020

Table 15. Transport equipment

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat	Lighting		Thermal foundries			Feedstocks	Wood and wood products
Low enthalpy heat	Product finishing		Thermal and electric connection				Peat
Air compressors	General machinery						
Motor drives							
Fans and pumps							
Heat treatment							
Steam processing							

Source: JRC, 2020

Table 16. Wood and wood products

In scope	Out of scope						
	Uses other than motor or heating fuel	**Chemical reduction**	**Metallurgical processes**	**Electrolysis**	**Mineralogical processes**	**Other dual uses**	**Excluded energy carriers**
Autoproduction of electricity and heat	Lighting					Feedstocks	Wood and wood products
Low enthalpy heat	Products finishing						Peat
Air compressors	Electric mechanical processes						
Motor drives							
Fans and pumps							
Specific processes with steam							
Drying processes							

Source: JRC, 2020

3. *Results*

The analysis of the results shows that the chemical and petrochemical industry accounts for one third of the total energy used by the EU industry (Table 17) 123517 ktoe out of 361020 ktoe). The chemical and petrochemical sector is followed by the iron and steel industry (which uses 18.93% of the energy, 66122 ktoe), the pulp, paper and printing industry (9.8 %, 35247 ktoe)), the non-metallic minerals account (10.29.5 %, 34187 ktoe), the food, beverages and tobacco industry (7.8 %, 28239 ktoe), construction (5.7 %, 20634), and the machinery industry (5.0%, 17957 ktoe). These seven industries account for 90.3 % of total industrial energy use. The remaining industries use less than 3% each.

Most of the energy products, 60.7% (219004 ktoe), are used for energy purposes within the industries. Again the chemical and petrochemical sector explains the largest share (22%, 48193 ktoe). The non-metallic minerals, the pulp, paper and printing, and the food, beverages, and tobacco account for similar shares (15.3% - 33563 ktoe, 13.9% - 30483 ktoe, and 12.4% - 27069 ktoe respectively), followed by the iron and steel industry (9.1%, 19911 ktoe), and the machinery industry (7.9%, 17320 ktoe).

Non-energy use of energy products accounts for 23.4% of the total energy use in the EU, 84534 ktoe. Most of the non-energy use takes place also in the chemical and petrochemical sector (84.9%, 71754 ktoe) and the construction industry (13.6%, 11502 ktoe).

Finally, about 3.2% (11620 ktoe) of the total energy use is needed for the autoproduction of electricity and heat. Approximately 40.7 % (4727 ktoe) of this energy is used by autoproducers within the pulp, paper and printing industry, followed by the chemical and petrochemical sector (30.7%, 3570 ktoe), and the food, beverage and tobacco (9.8 %, 1134 ktoe).

In terms of out of scope categories, one third of the total energy use (33.2%, 120010 ktoe) is considered to have a dual use, especially in the chemical and petrochemical industry (59.8% of the energy excluded, 71754 ktoe), and the iron and steel industry (29.6%, 35523 ktoe).

Mineralogical processes require about 9.3 % of the total energy use, 33719 ktoe. Almost all the energy used in mineralogical processes is consumed in the non-metallic minerals sector (96.6 %, 32579 ktoe), and the rest in the pulp, paper and printing (3.4 %, 1140 ktoe).

Energy used for metallurgical processes account for 8.7% of the total energy use, 31341 ktoe. Most of the energy for metallurgical processes is used by the iron and steel (59.1%, 18513 ktoe), the non-ferrous metals (23.5%, 7375 ktoe), the machinery (14.4%, 4508 ktoe), and the transport industries (3%, 945 ktoe).

About 7.2 % (25908 ktoe) of the total energy use is for uses other than motor or heating fuel, especially in the food, beverages and tobacco (22.3 %, 5776 ktoe), pulp, paper and printing (18.0 %, 4652 ktoe), machinery (15.9 %, 4117 ktoe), and chemical and petrochemical industry (15.4 %, 3990 ktoe).

Wood and wood products represent 6.3 % of the total energy use, 22568 ktoe. They are mostly used in the pulp, paper and printing industry (66.8 %, 15083 ktoe) and the wood and wood products industry (22.0 %, 4976 ktoe).

The energy used for chemical reduction accounts only for 3.3 % of the total energy use, 11971 ktoe. 86.7 % of the energy use in reduction processes is used by the iron and steel industry (10380 ktoe), while the rest (13.3 %, 1591 ktoe) is used in the chemical and petrochemical sector.

Electrolysis requires 0.4% of total energy use (1437 ktoe of electricity) and it is used only in the non-ferrous metals industry (92.7 %, 1333 ktoe), and the chemical industry (7.3 %, 104 ktoe).

Finally, peat represents only 0.05% of the total energy use, 174 ktoe, mostly in the pulp, paper and printing industry (94.2%, 164 ktoe) and in a very few MS.

The results are also provided per group of energy product (described in Table 18), defined in agreement with TAXUD). The categories most used by all the EU industries are “natural gas” (Table 19), 27.9 % of the total energy use), 100680 ktoe), “not taxed” products (21.5 %, 77516 ktoe), electricity (20 %, 72094 ktoe), coal (15.6 %, 56202 ktoe). The “out of scope” group accounts for 6.3% to total energy use, 22749 ktoe. The other groups are used in much smaller amounts. Most of the “not taxed” products (52437 ktoe), gasoline (2684 ktoe), kerosene (233 ktoe), and LPG (11377 ktoe) have a non-energy use.

The aggregate results per industry for each MS are shown in Table 20 to Table 31.

Table 17. Overview of the EU results per industry

		Chemical & petrochemical	Iron & Steel	Paper, pulp & printing	Non-metallic minerals	Food, beverages & tobacco	Machinery	Non-ferrous metals	Construction	Wood & wood products	Transport equipment	Mining & quarrying	Textile & leather	EU
Net inputs	**Energy use**	**51763**	**66076**	**35210**	**33853**	**28203**	**17677**	**10029**	**9131**	**8524**	**7744**	**4277**	**3999**	**276486**
	Autoproducers E	187	40	376	14	33	91	45	19	0	15	88	1	909
	Autoproducers CHP	3353	230	4258	276	1065	251	68	97	1	149	393	354	10495
	Autoproducers H	29	33	93	1	37	15	1	1	1	2	3	1	217
	Coke ovens	0	35482	0	0	0	0	0	0	0	0	0	0	35482
	Blast furnaces	0	10380	0	0	0	0	0	0	0	0	0	0	10380
	Final energy consumption	48193	19911	30483	33563	27069	17320	9915	9014	8522	7578	3794	3643	219004
	Non-energy use	**71754**	**47**	**36**	**334**	**36**	**280**	**444**	**11502**	**20**	**23**	**35**	**23**	**84534**
	Total energy use	**123517**	**66122**	**35247**	**34187**	**28239**	**17957**	**10473**	**20634**	**8544**	**7767**	**4311**	**4022**	**361020**
Out of scope	**Out of scope**	**77732**	**64510**	**21075**	**33897**	**6751**	**9048**	**9194**	**14179**	**5258**	**3195**	**1370**	**918**	**247128**
	Chemical reduction	1591	10380	0	0	0	0	0	0	0	0	0	0	11971
	Electrolysis	104	0	0	0	0	0	1333	0	0	0	0	0	1437
	Metallurgical processes	0	18513	0	0	0	4508	7375	0	0	945	0	0	31341
	Minerological processes	0	0	1140	32579	0	0	0	0	0	0	0	0	33719
	Dual use	71754	35523	36	334	36	280	444	11502	20	23	35	23	120010
	Wood and wood products	290	14	15083	983	938	143	2	59	4976	13	47	20	22568
	Peat	3	0	164	1	1	0	0	0	6	0	0	0	174
	Uses other than motor or heating fuel	3990	80	4652	0	5776	4117	40	2618	256	2215	1288	875	25908
In scope	**Uses as motor or heating fuel**	**45785**	**1613**	**14172**	**291**	**21488**	**8909**	**1279**	**6454**	**3286**	**4572**	**2941**	**3104**	**113892**
	Final energy consumption	42271	1310	11876	0	20419	8594	1164	6353	3286	4406	2458	2748	104885
	Autoproducers E	186	40	118	14	23	89	45	6	0	15	88	1	625
	Autoproducers CHP	3300	230	2147	276	1023	219	68	95	0	149	393	354	8253
	Autoproducers H	29	33	30	1	22	8	1	0	0	2	3	1	130
	Ratio (in scope / total energy use)	**37.1%**	**2.4%**	**40.2%**	**0.9%**	**76.1%**	**49.6%**	**12.2%**	**31.3%**	**38.5%**	**58.9%**	**68.2%**	**77.2%**	**31.5%**

Source: JRC, 2020

Table 18. Groups of energy products

Energy products used in EUROSTAT's energy balances	Group of energy products	Products listed in article 2 of the ETD	
		CN code	Description
Anthracite	Coal	2701	Coal; briquettes, ovoids and similar solid fuels manufactured from coal
Coking coal			
Other bituminous coal			
Sub-bituminous coal			
Lignite		2702	Lignite, whether or not agglomerated, excluding jet
Patent fuel		2704	Coke and semi-coke of coal, of lignite or of peat, whether or not agglomerated; retort carbon
Coke oven coke			
Gas coke			
Coal tar		2706	Tar distilled from coal, from lignite or from peat, and other mineral tars, whether or not dehydrated or partially distilled, including reconstituted tars
Brown coal briquettes		2701	Coal; briquettes, ovoids and similar solid fuels manufactured from coal
Gas works gas	Natural gas [1]	2705	Coal gas, water gas, producer gas and similar gases, other than petroleum gases and other gaseous hydrocarbons
Coke oven gas			
Blast furnace gas			
Other recovered gases			
Peat	Out of scope [2]	2703	Peat (including peat litter), whether or not agglomerated
Peat products			
Oil shale and oil sands	Coal	2714	Bitumen and asphalt, natural; bituminous or oil-shale and tar sands; asphaltites and asphaltic rocks
Crude oil	Not taxed	2709	Petroleum oils and oils obtained from bituminous minerals, crude
Natural gas liquids			
Refinery feedstocks			
Additives and oxygenates (excluding biofuel portion)	Additives	3811 3817 3824	Anti-knock preparations, oxidation inhibitors, gum inhibitors, viscosity improvers, anticorrosive preparations and other prepared additives, for mineral oils (including gasoline) or for other liquids used for the same purposes as mineral oils Mixed alkylbenzenes and mixed alkylnaphthalenes, other than those of heading 2707 or 2902 Prepared binders for foundry moulds or cores; chemical products and preparations of the chemical or allied industries (including those consisting of mixtures of natural products), not elsewhere specified or included
Other hydrocarbons	Not taxed	2901 2902 2905 11 00 2707 [5]	Acyclic hydrocarbons Cyclic hydrocarbons Methanol (Methyl Alcohol) Oils and other products of the distillation of high temperature coal tar; similar products in which the weight of the aromatic constituents exceeds that of the nonaromatic constituents
Refinery gas	Natural gas[1]	2711	Petroleum gases and other gaseous hydrocarbons
Ethane			

Energy products used in EUROSTAT's energy balances	**Group of energy products**	**Products listed in article 2 of the ETD**	
		CN code	**Description**
Liquefied petroleum gases			
Motor gasoline (excluding biofuel portion)	Gasoline	2710	Petroleum oils and oils obtained from bituminous minerals, other than crude; preparations not elsewhere specified or included, containing by weight 70 % or more of petroleum oils or of oils obtained from bituminous minerals, these oils being the basic constituents of the preparations; waste oils
Aviation gasoline			
Gasoline-type jet fuel			
Kerosene-type jet fuel (excluding biofuel portion)	Kerosene		
Other kerosene			
Naphtha [3]	Not taxed		
Gas oil and diesel oil (excluding biofuel portion)	Diesel		
Fuel oil	Heavy fuel		
White spirit and special boiling point industrial spirits	Not taxed		
Lubricants		3403	Lubricating preparations (including cutting-oil preparations, bolt or nut release preparations, anti-rust or anti-corrosion preparations and mould- release preparations, based on lubricants) and preparations of a kind used for the oil or grease treatment of textile materials, leather, furskins or other materials, but excluding preparations containing, as basic constituents, 70 % or more by weight of petroleum oils or of oils obtained from bituminous minerals
Bitumen		2715	Bituminous mixtures based on natural asphalt, on natural bitumen, on petroleum bitumen, on mineral tar or on mineral tar pitch (for example, bituminous mastics, cutbacks)
Petroleum coke		2713 2708	Petroleum coke, petroleum bitumen and other residues of petroleum oils or of oils obtained from bituminous minerals Pitch and pitch coke, obtained from coal tar or from other mineral tars
Paraffin waxes		2712	Petroleum jelly; paraffin wax, microcrystalline petroleum wax, slack wax, ozokerite, lignite wax, peat wax, other mineral waxes, and similar products obtained by synthesis or by other processes, whether or not coloured
Other oil products		3824 90 99	Other
Natural gas	Natural gas	2711	Petroleum gases and other gaseous hydrocarbons
Hydro	Not taxed [4]	2716	Electricity
Tide, wave, ocean			

Energy products used in EUROSTAT's energy balances	Group of energy products	Products listed in article 2 of the ETD	
		CN code	**Description**
Wind			
Solar photovoltaic			
Solar thermal			
Geothermal			
Primary solid biofuels	Out of scope [2]	4401	Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms; wood in chips or particles; sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms
Charcoal		4402	Wood charcoal (including shell or nut charcoal), whether or not agglomerated
Biogases	Natural gas [1]		
Renewable municipal waste	Not taxed		
Pure biogasoline	Gasoline	1507 1508 1509 1510 1511 1512 1513 1514 1515 1516 1517 1518	Soya-bean oil and its fractions, whether or not refined, but not chemically modified Ground-nut oil and its fractions, whether or not refined, but not chemically modified Olive oil and its fractions, whether or not refined, but not chemically modified Other oils and their fractions, obtained solely from olives, whether or not refined, but not chemically modified, including blends of these oils or fractions with oils or fractions of heading 1509 Palm oil and its fractions, whether or not refined, but not chemically modified Sunflower-seed, safflower or cotton-seed oil and fractions thereof, whether or not refined, but not chemically modified Coconut (copra), palm kernel or babassu oil and fractions thereof, whether or not refined, but not chemically modified Rape, colza or mustard oil and fractions thereof, whether or not refined, but not chemically modified Other fixed vegetable fats and oils (including jojoba oil) and their fractions, whether or not refined, but not chemically modified Animal or vegetable fats and oils and their fractions, partly or wholly hydrogenated, inter-esterified, re-esterified or elaidinised, whether or not refined, but not further prepared Margarine; edible mixtures or preparations of animal or vegetable fats or oils or of fractions of different fats or oils of this Chapter, other than edible fats or oils or their fractions of heading Animal or vegetable fats and oils and their fractions, boiled, oxidised, dehydrated, sulphurised, blown, polymerised by heat in vacuum or in inert gas or otherwise chemically modified, excluding those of heading 1516; inedible mixtures or preparations of animal or vegetable fats or oils or of fractions of different fats or oils of this chapter, not elsewhere specified or included
Blended biogasoline			
Pure biodiesels	Diesel		
Blended biodiesels			
Pure bio jet kerosene	Kerosene		
Blended bio jet kerosene			
Other liquid biofuels	Diesel		
Ambient heat (heat pumps)	Not taxed		
Industrial waste (non-renewable)	Not taxed		

Energy products used in EUROSTAT's energy balances	**Group of energy products**	**Products listed in article 2 of the ETD**	
		CN code	**Description**
Non-renewable municipal waste	Not taxed		
Nuclear heat	Not taxed[4]		
Heat	Not taxed		
Electricity	Electricity	2716	Electricity

Source: JRC, 2020

1: products that can replace natural gas.
2: out of scope according to article 2 of the ETD.
3: normally used as a feedstock.
4: electricity or heat that only appears in the supply blocks of the energy balances.
5: this group includes hydrogen.

Table 19: Overview of the EU results for all industries per group of energy products

		Total	Coal	Gasoline	Kerosene	Diesel	Heavy fuel	Additives	LPG	Natural gas	Electricity	Out of scope	Not taxed
Net inputs	**Energy use**	**276486**	**56202**	**252**	**94**	**8899**	**3572**	**0**	**2510**	**85035**	**72094**	**22749**	**25079**
	Autoproducers E	909	67	0	0	4	29	0	0	244	0	284	280
	Autoproducers CHP	10495	225	0	0	22	591	0	3	6889	0	2247	517
	Autoproducers H	217	48	0	0	0	1	0	4	66	0	88	9
	Coke ovens	35482	34807	0	0	0	0	0	0	128	130	6	410
	Blast furnaces	10380	10086	0	0	1	43	0	0	99	122	0	29
	Final energy consumption	219004	10968	252	94	8871	2907	0	2502	77609	71842	20123	23835
	Non-energy use	**84534**	**0**	**2684**	**233**	**1183**	**975**	**0**	**11377**	**15645**	**0**	**0**	**52437**
	Total energy use	**361020**	**56202**	**2936**	**327**	**10083**	**4546**	**0**	**13887**	**100680**	**72094**	**22749**	**77516**
Out of scope	**Out of scope**	**247128**	**51520**	**2737**	**265**	**4063**	**2177**	**0**	**12446**	**51928**	**34147**	**22742**	**65103**
	Chemical reduction	11971	10225	3	0	20	78	0	19	799	526	0	302
	Electrolysis	1437	0	0	0	0	0	0	0	0	1437	0	0
	Metallurgical processes	31341	1637	6	2	327	280	0	473	12341	15435	0	840
	Minerological processes	33719	3977	1	9	513	453	0	221	13408	6092	0	9044
	Dual use	120010	34807	2684	233	1184	975	0	11377	15773	130	0	52847
	Wood and wood products	22568	0	0	0	0	0	0	0	0	0	22568	0
	Peat	174	0	0	0	0	0	0	0	0	0	174	0
	Uses other than motor or heating fuel	25908	874	43	21	2019	391	0	356	9607	10527	0	2070
In scope	**Uses as motor or heating fuel**	**113892**	**4682**	**200**	**62**	**6020**	**2369**	**0**	**1441**	**48752**	**37947**	**6**	**12413**
	Final energy consumption	104885	4342	199	62	5993	1748	0	1434	41552	37947	0	11607
	Autoproducers E	625	67	0	0	4	29	0	0	244	0	0	280
	Autoproducers CHP	8253	225	0	0	22	591	0	3	6889	0	6	517
	Autoproducers H	130	48	0	0	0	1	0	4	66	0	0	9
	Ratio (in scope / total energy use)	**32%**	**8%**	**7%**	**19%**	**60%**	**52%**	**0%**	**10%**	**48%**	**53%**	**0%**	**16%**

Source: JRC, 2020

Table 20. Results for the chemical and petrochemical industry

	Chemical & petrochemical	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	1172	4181	871	7	1100	15129	340	33	292	3762	1096	3971	155	1144	267	3851	417	46	30	4	7157	3425	636	1522	508	152	494	51763
	Autoproducers E	28	0	0	0	0	31	0	0	0	116	0	9	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	187
	Autoproducers CHP	116	34	40	0	82	570	39	0	171	416	0	121	0	3	0	604	8	0	4	0	196	562	264	94	9	0	22	3353
	Autoproducers H	1	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1	0	0	0	7	12	0	0	0	0	0	29
	Final energy consumption	1028	4147	831	7	1018	14528	301	33	122	3230	1096	3833	155	1141	267	3245	408	46	27	4	6953	2851	372	1428	499	152	472	48193
	Non-energy use	1288	7194	226	0	1800	17474	1	0	730	3612	1163	9670	363	1996	0	5444	934	0	1	0	12538	3785	483	392	1700	11	950	71754
petrochemical	**Total energy use**	2460	11375	1097	7	2900	32603	341	33	1023	7374	2258	13641	518	3140	267	9296	1350	46	31	4	19694	7210	1119	1914	2207	164	1444	123517
Out of scope	**Out of scope**	1485	7686	313	1	1894	19077	47	8	752	3934	1267	10208	392	2141	31	5807	1009	5	7	0	13379	4266	523	646	1769	43	1042	77732
	Chemical reduction	37	129	41	0	2	337	0	4	14	32	1	106	10	39	0	58	36	0	0	0	304	245	2	136	6	0	51	1591
	Electrolysis	1	4	0	0	2	50	0	0	0	3	2	22	0	4	0	3	0	0	0	0	4	1	1	2	3	0	1	104
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	1288	7194	226	0	1800	17474	1	0	730	3612	1163	9670	363	1996	0	5444	934	0	1	0	12538	3785	483	392	1700	11	950	71754
	Wood and wood products	76	14	7	0	0	35	13	0	0	5	6	67	0	1	0	3	11	0	4	0	0	3	4	4	19	18	0	290
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3
	Uses other than motor or heating fuel	84	345	39	1	90	1180	33	4	7	281	96	343	19	100	31	299	29	5	2	0	532	232	33	113	38	13	40	3990
In scope	**Uses as motor or heating fuel**	975	3690	784	6	1005	13527	294	25	270	3440	991	3433	126	1000	235	3489	342	40	25	4	6316	2944	596	1268	439	121	402	45785
	Final energy consumption	867	3666	745	6	924	12925	255	25	100	2908	991	3295	126	997	235	2884	333	40	21	4	6112	2369	332	1174	436	121	380	42271
	Autoproducers E	28	0	0	0	0	31	0	0	0	116	0	9	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	186
	Autoproducers CHP	80	23	40	0	82	570	39	0	171	416	0	121	0	3	0	604	8	0	4	0	196	562	264	94	3	0	22	3300
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1	0	0	0	7	12	0	0	0	0	0	29
petrochemical	**Ratio (in scope / total energy use)**	40%	32%	71%	81%	35%	41%	86%	75%	26%	47%	44%	25%	24%	32%	88%	38%	25%	88%	79%	89%	32%	41%	53%	66%	20%	74%	28%	37%

Source: JRC, 2020

Table 21. Results for the construction industry

	Construction	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	318	205	66	10	275	1652	176	53	153	1226	409	1909	103	311	6	359	44	30	32	3	698	195	152	334	338	39	39	9131
	Autoproducers E	0	0	0	0	1	0	0	0	0	10	0	2	0	2	0	1	0	0	0	0	2	0	0	0	0	0	0	19
	Autoproducers CHP	1	0	0	0	82	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	3	0	0	0	0	0	6	97
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Final energy consumption	316	204	66	10	192	1651	176	53	153	1216	409	1901	103	309	6	358	44	30	32	3	693	195	152	333	338	39	33	9014
	Non-energy use	494	303	155	35	496	1846	189	54	105	894	149	2521	79	126	196	1084	162	17	63	5	102	1294	180	329	451	52	122	11502
n	**Total energy use**	812	507	221	45	771	3497	364	107	258	2120	558	4430	182	437	202	1443	206	47	95	8	800	1489	331	662	789	91	161	20634
Out of scope	**Out of scope**	592	372	186	38	549	2260	238	67	168	1236	247	3026	98	233	199	1330	185	34	71	6	240	1382	229	402	585	69	137	14179
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	494	303	155	35	496	1846	189	54	105	894	149	2521	79	126	196	1084	162	17	63	5	102	1294	180	329	451	52	122	11502
	Wood and wood products	6	0	0	0	3	0	0	0	0	24	0	6	0	4	0	2	2	0	2	0	4	1	0	2	0	2	0	59
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uses other than motor or heating fuel	92	69	31	3	50	414	50	12	62	318	97	499	19	103	3	243	21	17	6	1	134	88	49	72	134	15	15	2618
In scope	**Uses as motor or heating fuel**	220	136	35	8	221	1237	126	40	90	884	312	1404	84	204	3	114	21	13	24	2	560	107	102	260	204	22	24	6454
	Final energy consumption	219	135	35	8	139	1236	126	40	90	883	312	1401	84	202	3	114	21	13	24	2	555	107	102	260	204	22	18	6353
	Autoproducers E	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	6
	Autoproducers CHP	1	0	0	0	82	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	6	95
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n	**Ratio (in scope / total energy use)**	27%	27%	16%	17%	29%	35%	35%	38%	35%	42%	56%	32%	46%	47%	1%	8%	10%	27%	25%	25%	70%	7%	31%	39%	26%	24%	15%	31%

Source: JRC, 2020

Table 22. Results for the food, beverages and tobacco industry

	Food, beverages & tobacco	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	Energy use	528	1618	251	40	574	5253	600	56	462	2589	426	5157	199	663	521	2847	193	22	83	6	2247	2259	493	539	347	79	150	28203
	Autoproducers E	6	7	0	0	0	0	0	0	0	9	0	1	0	0	0	1	0	0	0	0	6	2	1	0	0	0	0	33
	Autoproducers CHP	0	40	0	0	1	93	1	0	3	503	0	88	1	1	43	69	0	0	0	0	145	6	65	1	0	0	3	1065
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	12	0	0	1	0	0	0	37
	Final energy consumption	522	1571	251	40	573	5160	599	56	459	2077	425	5046	198	661	478	2777	193	22	83	6	2084	2251	427	537	347	79	147	27069
	Non-energy use	2	1	0	0	0	5	1	0	0	25	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	36
ages & tobacco	Total energy use	530	1619	251	40	574	5258	601	56	462	2614	426	5157	199	663	521	2847	193	22	83	6	2247	2260	493	540	347	79	150	28239
Out of scope	Out of scope	133	363	95	9	106	1140	155	17	182	732	93	1218	53	207	140	649	54	10	29	4	342	541	129	144	146	21	39	6751
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	2	1	0	0	0	5	1	0	0	25	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	36
	Wood and wood products	8	59	25	2	3	40	0	0	105	222	8	200	6	61	24	37	12	0	11	0	0	30	33	26	23	2	2	938
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Uses other than motor or heating fuel	122	303	71	7	103	1095	154	17	77	484	86	1017	47	147	116	611	42	10	19	4	342	511	96	117	123	19	37	5776
In scope	Uses as motor or heating fuel	398	1256	156	32	467	4118	446	39	280	1882	333	3940	146	455	381	2198	138	12	54	2	1905	1719	364	396	201	59	111	21488
	Final energy consumption	391	1210	155	32	466	4025	446	39	277	1389	332	3874	145	454	337	2129	138	12	54	2	1742	1710	298	394	201	59	108	20419
	Autoproducers E	6	7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6	2	1	0	0	0	0	23
	Autoproducers CHP	0	40	0	0	1	93	1	0	3	493	0	57	1	1	43	69	0	0	0	0	145	6	65	1	0	0	3	1023
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	12	0	0	1	0	0	0	22
ages & tobacco	Ratio (in scope / total energy use)	75%	78%	62%	79%	81%	78%	74%	70%	61%	72%	78%	76%	73%	69%	73%	77%	72%	54%	65%	34%	85%	76%	74%	73%	58%	74%	74%	76%

Source: JRC, 2020

Table 23. Results for the iron and steel industry

	Iron & Steel	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	Energy use	2498	3116	126	0	3089	17829	90	194	130	3942	1726	6791	24	1179	163	5043	0	284	1	0	3436	10677	193	816	2000	145	2583	66076
	Autoproducers E	2	0	0	0	0	3	0	0	0	2	0	1	0	0	0	0	0	0	0	0	30	0	0	1	0	0	0	40
	Autoproducers CHP	0	28	0	0	5	0	0	0	0	0	0	0	0	0	163	1	0	0	0	0	4	10	0	0	0	0	19	230
	Autoproducers H	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	33
	Coke ovens	1224	1106	0	0	2378	9002	0	194	0	1407	840	3141	0	984	0	1709	0	0	0	0	1870	9088	0	0	1037	0	1502	35482
	Blast furnaces	618	1093	0	0	199	3564	0	0	0	567	262	1777	0	42	0	256	0	0	0	0	1055	215	0	0	252	0	479	10380
	Final energy consumption	654	889	126	0	507	5260	90	0	130	1966	623	1871	24	152	0	3077	0	284	1	0	477	1333	193	815	711	145	582	19911
	Non-energy use	3	3	1	0	1	0	1	0	0	14	0	5	0	0	0	0	0	14	0	0	0	2	1	1	0	1	0	47
	Total energy use	2501	3118	127	0	3090	17829	91	194	130	3956	1726	6797	24	1179	163	5043	0	298	1	0	3436	10680	194	817	2000	146	2583	66122
Out of scope	Out of scope	2455	3033	121	0	3041	17471	87	194	122	3846	1693	6647	23	1166	0	4850	0	283	1	0	3361	10554	182	769	1960	141	2511	64510
	Chemical reduction	618	1093	0	0	199	3564	0	0	0	567	262	1777	0	42	0	256	0	0	0	0	1055	215	0	0	252	0	479	10380
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	607	828	120	0	461	4883	86	0	122	1852	588	1713	23	138	0	2874	0	268	1	0	433	1244	180	766	669	140	519	18513
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	1227	1109	1	0	2379	8996	1	194	0	1421	840	3147	0	984	0	1709	0	14	0	0	1870	9090	1	1	1037	1	1502	35523
	Wood and wood products	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	14
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uses other than motor or heating fuel	3	4	0	0	3	22	0	0	0	6	2	9	0	1	0	10	0	1	0	0	3	5	1	3	3	0	4	80
In scope	Uses as motor or heating fuel	47	86	6	0	49	357	4	0	8	110	34	150	1	13	163	193	0	15	0	0	76	126	12	48	40	6	72	1613
	Final energy consumption	45	58	6	0	43	354	4	0	8	108	34	149	1	13	0	193	0	15	0	0	42	83	12	46	40	5	53	1310
	Autoproducers E	2	0	0	0	0	3	0	0	0	2	0	1	0	0	0	0	0	0	0	0	30	0	0	1	0	0	0	40
	Autoproducers CHP	0	28	0	0	5	0	0	0	0	0	0	0	0	0	163	1	0	0	0	0	4	10	0	0	0	0	19	230
	Autoproducers H	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	33
	Ratio (in scope / total energy use)	2%	3%	5%	0%	2%	2%	4%	0%	6%	3%	2%	2%	2%	1%	100%	4%	0%	5%	4%	0%	2%	1%	6%	6%	2%	4%	3%	2%

Source: JRC, 2020

Table 24. Results for the machinery industry

	Machinery	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	**586**	**336**	**136**	**3**	**694**	**5272**	**213**	**38**	**66**	**918**	**322**	**1877**	**70**	**465**	**330**	**3512**	**32**	**11**	**18**	**10**	**528**	**801**	**179**	**427**	**339**	**210**	**284**	**17677**
	Autoproducers E	0	42	0	0	1	7	0	0	0	1	0	7	0	18	1	0	0	0	0	0	13	0	0	1	0	0	0	91
	Autoproducers CHP	1	8	0	0	1	29	1	0	1	33	0	21	1	2	3	49	0	0	0	0	55	0	40	0	0	0	5	251
	Autoproducers H	0	0	0	0	7	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
	Final energy consumption	585	286	136	3	685	5236	212	38	64	883	322	1841	69	445	326	3462	32	11	18	10	460	801	139	426	339	210	279	17320
	Non-energy use	**9**	**1**	**5**	**0**	**2**	**1**	**4**	**0**	**0**	**24**	**0**	**0**	**6**	**1**	**13**	**202**	**0**	**0**	**0**	**0**	**0**	**7**	**2**	**2**	**0**	**0**	**0**	**280**
	Total energy use	**595**	**337**	**141**	**3**	**696**	**5272**	**217**	**38**	**66**	**942**	**322**	**1877**	**76**	**466**	**343**	**3714**	**32**	**11**	**18**	**10**	**528**	**809**	**181**	**430**	**339**	**210**	**284**	**17957**
Out of scope	**Out of scope**	**328**	**81**	**86**	**2**	**352**	**2504**	**113**	**16**	**15**	**427**	**128**	**1096**	**34**	**258**	**159**	**1953**	**21**	**5**	**9**	**7**	**223**	**432**	**72**	**246**	**185**	**121**	**177**	**9048**
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	136	33	33	1	153	1489	46	9	12	242	71	476	12	51	81	986	6	0	2	3	126	183	33	106	85	50	83	4508
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	9	1	5	0	2	1	4	0	0	24	0	0	6	1	13	202	0	0	0	0	0	7	2	2	0	0	0	280
	Wood and wood products	8	7	0	0	3	53	15	1	0	1	1	27	0	3	0	3	1	0	3	0	0	1	0	6	0	3	5	143
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uses other than motor or heating fuel	175	40	47	1	194	963	48	6	3	160	55	593	15	202	65	762	14	5	3	4	97	240	37	132	99	68	89	4117
In scope	**Uses as motor or heating fuel**	**267**	**256**	**55**	**1**	**344**	**2768**	**104**	**23**	**51**	**515**	**195**	**781**	**42**	**208**	**184**	**1761**	**11**	**6**	**9**	**4**	**305**	**377**	**109**	**183**	**154**	**89**	**108**	**8909**
	Final energy consumption	267	212	55	1	335	2742	103	23	50	481	195	768	42	188	180	1712	11	6	9	4	237	377	69	183	154	89	102	8594
	Autoproducers E	0	42	0	0	1	7	0	0	0	0	0	7	0	18	1	0	0	0	0	0	13	0	0	0	0	0	0	89
	Autoproducers CHP	0	3	0	0	1	19	1	0	1	33	0	5	1	2	3	49	0	0	0	0	55	0	40	0	0	0	5	219
	Autoproducers H	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	Ratio (in scope / total energy use)	**45%**	**76%**	**39%**	**39%**	**49%**	**52%**	**48%**	**59%**	**77%**	**55%**	**60%**	**42%**	**56%**	**45%**	**54%**	**47%**	**35%**	**52%**	**49%**	**35%**	**58%**	**47%**	**60%**	**43%**	**45%**	**42%**	**38%**	**50%**

Source: JRC, 2020

Table 25 . Results for the mining and quarrying industry

	Mining & quarrying	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	**359**	**52**	**126**	**6**	**337**	**535**	**85**	**10**	**115**	**453**	**164**	**403**	**15**	**35**	**113**	**120**	**6**	**1**	**8**	**1**	**127**	**460**	**71**	**39**	**544**	**23**	**68**	**4277**
	Autoproducers E	0	0	0	0	0	64	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88
	Autoproducers CHP	0	0	0	0	256	117	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	8	393
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	3
	Final energy consumption	359	52	126	6	81	354	85	10	115	452	164	379	15	35	113	120	6	1	8	1	127	448	71	39	544	23	59	3794
	Non-energy use	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**2**	**4**	**19**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**1**	**1**	**0**	**0**	**0**	**35**
ıarrying	**Total energy use**	**359**	**52**	**127**	**6**	**337**	**535**	**87**	**10**	**117**	**457**	**183**	**403**	**15**	**35**	**113**	**120**	**6**	**1**	**8**	**1**	**127**	**466**	**72**	**39**	**544**	**23**	**68**	**4311**
Out of scope	**Out of scope**	**106**	**18**	**60**	**2**	**22**	**94**	**50**	**2**	**49**	**124**	**59**	**102**	**3**	**12**	**63**	**82**	**3**	**1**	**2**	**1**	**25**	**208**	**24**	**11**	**216**	**9**	**27**	**1370**
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	0	0	1	0	0	0	2	0	2	4	19	0	0	0	0	0	0	0	0	0	0	6	1	1	0	0	0	35
	Wood and wood products	0	0	0	0	0	7	33	0	0	0	1	3	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	47
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uses other than motor or heating fuel	106	18	59	2	21	87	15	2	47	120	39	99	3	12	63	82	3	1	1	1	25	202	23	8	216	9	27	1288
In scope	**Uses as motor or heating fuel**	**253**	**35**	**67**	**5**	**315**	**441**	**37**	**8**	**68**	**333**	**124**	**301**	**13**	**23**	**50**	**38**	**3**	**1**	**6**	**1**	**102**	**258**	**48**	**29**	**328**	**14**	**41**	**2941**
	Final energy consumption	253	35	67	5	59	260	37	8	68	333	124	277	13	23	50	38	3	1	6	1	102	246	48	29	328	14	32	2458
	Autoproducers E	0	0	0	0	0	64	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88
	Autoproducers CHP	0	0	0	0	256	117	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	8	393
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	3
ıarrying	**Ratio (in scope / total energy use)**	**70%**	**66%**	**53%**	**75%**	**94%**	**82%**	**43%**	**77%**	**58%**	**73%**	**68%**	**75%**	**81%**	**66%**	**45%**	**32%**	**46%**	**42%**	**75%**	**60%**	**81%**	**55%**	**67%**	**73%**	**60%**	**59%**	**60%**	**68%**

Source: JRC, 2020

Table 26. Results for the non-ferrous metals industry

	Non-ferrous metals	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	234	326	179	0	93	2341	0	1	714	1297	262	1161	20	127	502	709	0	0	0	0	293	520	31	470	331	165	253	10029
	Autoproducers E	0	0	0	0	0	0	0	0	0	1	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
	Autoproducers CHP	0	4	2	0	0	27	0	0	8	9	0	15	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	68
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Final energy consumption	234	322	177	0	93	2314	0	1	706	1288	262	1101	20	127	502	706	0	0	0	0	293	520	31	470	331	165	253	9915
	Non-energy use	1	0	0	0	1	140	1	0	0	123	0	23	0	0	0	0	0	0	0	0	1	1	0	69	0	28	56	444
s metals	**Total energy use**	235	326	180	0	94	2481	1	1	714	1420	262	1184	20	127	502	709	0	0	0	0	294	520	31	538	331	194	309	10473
Out of scope	**Out of scope**	231	312	175	0	93	2208	1	1	577	1181	255	960	19	105	349	690	0	0	0	0	288	510	31	470	324	190	227	9194
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	357	0	0	105	145	0	325	0	0	0	0	0	0	0	0	49	0	0	89	109	54	100	1333
	Metallurgical processes	228	311	174	0	91	1708	0	1	471	911	254	610	19	105	348	689	0	0	0	0	237	508	31	312	215	107	46	7375
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	1	0	0	0	1	140	1	0	0	123	0	23	0	0	0	0	0	0	0	0	1	1	0	69	0	28	56	444
	Wood and wood products	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uses other than motor or heating fuel	0	1	0	0	0	3	0	0	1	2	0	2	0	0	1	1	0	0	0	0	0	1	0	1	0	0	25	40
In scope	**Uses as motor or heating fuel**	4	14	5	0	1	273	0	0	137	239	7	225	0	22	153	19	0	0	0	0	7	11	1	68	7	4	82	1279
	Final energy consumption	4	11	3	0	1	246	0	0	129	230	7	164	0	22	153	16	0	0	0	0	7	11	1	68	7	4	82	1164
	Autoproducers E	0	0	0	0	0	0	0	0	0	1	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
	Autoproducers CHP	0	4	2	0	0	27	0	0	8	9	0	15	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	68
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
s metals	**Ratio (in scope / total energy use)**	2%	4%	3%	100%	1%	11%	0%	2%	19%	17%	3%	19%	1%	17%	31%	3%	0%	0%	0%	0%	2%	2%	2%	13%	2%	2%	27%	12%

Source: JRC, 2020

Table 27. Results for the non-metallic minerals industry

	Non-metallic minerals	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	929	1390	572	153	1171	6890	491	110	650	4166	314	3857	375	575	453	4319	155	144	170	0	625	3107	1106	1129	384	205	413	33853
	Autoproducers E	0	13	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
	Autoproducers CHP	0	0	0	0	0	3	0	0	0	187	0	1	0	0	0	28	0	0	0	0	6	0	50	0	0	0	0	276
	Autoproducers H	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Final energy consumption	929	1376	572	153	1171	6886	491	109	650	3979	314	3855	375	575	453	4291	155	144	170	0	619	3107	1056	1129	384	205	413	33563
	Non-energy use	2	1	23	0	1	6	2	0	1	5	0	33	11	52	0	0	6	0	0	0	0	24	1	141	0	6	18	334
ic minerals	**Total energy use**	931	1390	595	153	1172	6896	493	110	651	4171	314	3890	386	628	453	4319	161	144	170	0	625	3132	1107	1270	384	211	431	34187
Out of scope	**Out of scope**	931	1377	595	153	1172	6892	493	109	651	3984	314	3888	386	628	453	4291	161	144	170	0	619	3131	1057	1270	384	211	431	33897
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	874	1239	569	151	1170	6744	489	109	646	3750	309	3719	372	556	451	4159	143	139	165	0	619	3102	979	1127	384	205	413	32579
	Dual use	2	1	23	0	1	6	2	0	1	5	0	33	11	52	0	0	6	0	0	0	0	24	1	141	0	6	18	334
	Wood and wood products	55	138	3	2	2	142	2	0	4	229	5	136	4	20	2	133	11	5	5	0	0	5	77	2	0	0	0	983
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
	Uses other than motor or heating fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
In scope	**Uses as motor or heating fuel**	0	13	0	0	0	3	0	1	0	187	0	1	0	0	0	28	0	0	0	0	6	0	50	0	0	0	0	291
	Final energy consumption	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Autoproducers E	0	13	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
	Autoproducers CHP	0	0	0	0	0	3	0	0	0	187	0	1	0	0	0	28	0	0	0	0	6	0	50	0	0	0	0	276
	Autoproducers H	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ic minerals	**Ratio (in scope / total energy use)**	0%	1%	0%	0%	0%	0%	0%	1%	0%	4%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%	0%	5%	0%	0%	0%	0%	1%

Source: JRC, 2020

Table 28. Results for the paper, pulp, and printing industry

	Paper, pulp & printing	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	2072	727	218	2	682	6068	68	77	54	2081	6850	2291	68	228	28	2307	52	6	6	2	616	1853	1845	197	6003	186	619	35210
	Autoproducers E	82	5	0	0	0	72	0	0	0	24	120	53	0	0	0	0	0	0	0	0	3	0	16	0	0	0	0	376
	Autoproducers CHP	206	54	18	0	96	615	1	0	0	932	412	139	0	0	0	360	0	1	0	0	44	111	568	49	486	11	153	4258
	Autoproducers H	5	0	5	0	14	0	0	0	0	0	22	24	0	0	0	0	0	0	0	0	0	4	0	8	0	0	10	93
	Final energy consumption	1780	668	195	2	571	5382	68	77	54	1125	6296	2075	68	228	28	1947	52	5	5	2	568	1739	1261	140	5517	175	456	30483
	Non-energy use	1	1	0	0	0	0	1	0	0	12	0	0	0	0	0	0	0	0	0	0	16	0	5	0	0	0	0	36
& printing	**Total energy use**	2074	728	219	2	682	6068	69	77	54	2092	6850	2291	69	228	28	2307	52	6	6	2	632	1854	1850	197	6003	186	619	35247
Out of scope	**Out of scope**	1201	454	154	1	469	2356	34	45	27	889	5262	1065	25	92	15	591	35	1	3	1	218	1253	1295	111	4896	75	504	21075
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	41	20	8	0	50	36	0	14	0	23	344	50	0	0	0	0	0	0	0	0	0	148	55	0	333	0	18	1140
	Dual use	1	1	0	0	0	0	1	0	0	12	0	0	0	0	0	0	0	0	0	0	16	0	5	0	0	0	0	36
	Wood and wood products	916	340	136	0	364	811	10	5	3	709	4285	622	2	22	0	0	19	0	0	0	1	941	1180	55	4169	19	473	15083
	Peat	0	0	0	0	0	0	0	0	0	0	163	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	164
	Uses other than motor or heating fuel	242	93	10	1	55	1509	23	26	24	146	470	393	22	70	15	591	17	1	2	1	202	163	55	55	394	56	13	4652
In scope	**Uses as motor or heating fuel**	873	274	64	1	213	3712	35	33	27	1203	1589	1226	44	136	13	1716	17	5	3	1	413	600	555	86	1107	110	115	14172
	Final energy consumption	771	258	60	1	202	3309	35	32	27	394	1537	1065	44	136	13	1356	17	4	3	1	366	564	288	83	1107	107	96	11876
	Autoproducers E	35	5	0	0	0	3	0	0	0	10	10	51	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	118
	Autoproducers CHP	63	10	4	0	4	400	0	0	0	799	32	104	0	0	0	360	0	1	0	0	43	34	267	3	0	3	19	2147
	Autoproducers H	4	0	0	0	7	0	0	0	0	0	9	7	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	30
& printing	**Ratio (in scope / total energy use)**	42%	38%	29%	41%	31%	61%	51%	42%	50%	57%	23%	54%	64%	60%	45%	74%	33%	80%	54%	44%	65%	32%	30%	44%	18%	59%	19%	40%

Source: JRC, 2020

Table 29. Results for the textile and leather industry

	Textile & leather	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	EU
Net inputs	**Energy use**	63	189	66	0	126	487	17	9	101	365	23	320	24	43	15	1147	34	36	8	3	136	99	452	148	21	18	46	3999
	Autoproducers E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Autoproducers CHP	0	0	0	0	0	30	0	0	2	69	0	5	0	0	0	21	0	0	0	0	24	37	144	0	0	0	22	354
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Final energy consumption	63	189	66	0	126	457	17	9	99	296	23	315	24	43	15	1127	34	36	8	3	112	63	308	148	21	18	24	3643
	Non-energy use	1	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	23
ather	**Total energy use**	64	190	66	0	126	487	17	9	101	384	23	320	24	43	15	1147	34	36	8	3	136	99	453	150	21	18	46	4022
Out of scope	**Out of scope**	18	63	22	0	36	97	7	4	34	104	5	66	8	11	5	256	9	2	1	2	22	16	76	33	10	5	6	918
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	1	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	23
	Wood and wood products	0	0	2	0	0	2	1	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	9	1	0	0	0	20
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uses other than motor or heating fuel	17	62	20	0	36	96	6	4	34	81	5	66	7	11	5	256	9	2	1	2	22	16	66	29	10	4	5	875
In scope	**Uses as motor or heating fuel**	46	127	44	0	90	389	10	5	67	281	18	254	17	31	10	891	25	33	7	1	114	84	377	117	11	14	41	3104
	Final energy consumption	45	127	44	0	89	360	10	5	65	212	18	249	17	31	10	871	25	33	6	1	90	47	233	117	11	14	18	2748
	Autoproducers E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Autoproducers CHP	0	0	0	0	0	30	0	0	2	69	0	5	0	0	0	21	0	0	0	0	24	37	144	0	0	0	22	354
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ather	**Ratio (in scope / total energy use)**	72%	67%	67%	29%	71%	80%	60%	57%	67%	73%	79%	79%	68%	73%	66%	78%	72%	93%	82%	27%	84%	84%	83%	78%	52%	75%	88%	77%

Source: JRC, 2020

Table 30. Results for the transport equipment industry

	Transport equipment	**AT**	**BE**	**BG**	**CY**	**CZ**	**DE**	**DK**	**EE**	**EL**	**ES**	**FI**	**FR**	**HR**	**HU**	**IE**	**IT**	**LT**	**LU**	**LV**	**MT**	**NL**	**PL**	**PT**	**RO**	**SE**	**SI**	**SK**	**EU**
Net inputs	**Energy use**	**148**	**125**	**19**	**0**	**484**	**2996**	**14**	**12**	**22**	**595**	**60**	**1113**	**13**	**241**	**27**	**426**	**5**	**2**	**8**	**2**	**122**	**469**	**79**	**298**	**214**	**34**	**217**	**7744**
	Autoproducers E	0	3	0	0	0	1	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
	Autoproducers CHP	1	0	0	0	0	101	0	0	0	0	0	24	0	0	0	23	0	0	0	0	0	2	0	0	0	0	0	149
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	Final energy consumption	148	122	19	0	484	2895	14	12	22	595	60	1077	13	241	27	403	5	2	8	2	122	467	79	298	214	34	217	7578
	Non-energy use	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**14**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**3**	**0**	**0**	**0**	**23**
quipment	**Total energy use**	**149**	**125**	**19**	**0**	**484**	**2996**	**15**	**12**	**22**	**610**	**60**	**1113**	**13**	**241**	**27**	**426**	**5**	**2**	**8**	**2**	**122**	**471**	**81**	**300**	**214**	**34**	**217**	**7767**
Out of scope	**Out of scope**	**67**	**69**	**7**	**0**	**208**	**1044**	**6**	**6**	**9**	**292**	**12**	**481**	**5**	**139**	**15**	**144**	**2**	**1**	**3**	**1**	**52**	**210**	**38**	**138**	**113**	**18**	**117**	**3195**
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	21	15	3	0	38	336	2	1	2	96	7	162	2	33	1	37	1	0	1	0	19	63	12	28	24	5	34	945
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	0	0	0	0	0	0	1	0	0	14	0	0	0	0	0	0	0	0	0	0	0	2	2	3	0	0	0	23
	Wood and wood products	1	0	0	0	0	5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
	Peat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uses other than motor or heating fuel	44	53	4	0	169	703	3	5	7	181	5	314	3	105	13	107	2	0	2	1	33	145	23	108	89	13	83	2215
In scope	**Uses as motor or heating fuel**	**82**	**56**	**12**	**0**	**276**	**1952**	**9**	**6**	**13**	**318**	**48**	**633**	**8**	**102**	**12**	**282**	**3**	**1**	**5**	**1**	**70**	**261**	**43**	**162**	**101**	**16**	**100**	**4572**
	Final energy consumption	82	53	12	0	276	1851	9	6	13	318	48	596	8	102	12	259	3	1	5	1	70	259	43	162	101	16	100	4406
	Autoproducers E	0	3	0	0	0	1	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
	Autoproducers CHP	1	0	0	0	0	101	0	0	0	0	0	24	0	0	0	23	0	0	0	0	0	2	0	0	0	0	0	149
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
quipment	**Ratio (in scope / total energy use)**	**55%**	**45%**	**63%**	**48%**	**57%**	**65%**	**62%**	**48%**	**59%**	**52%**	**80%**	**57%**	**62%**	**42%**	**46%**	**66%**	**53%**	**64%**	**64%**	**42%**	**57%**	**55%**	**54%**	**54%**	**47%**	**48%**	**46%**	**59%**

Source: JRC, 2020

Table 31. Results for the wood and wood products industry

	Wood & wood products	**AT**	**BE**	**BG**	**CY**	**CZ**	**DE**	**DK**	**EE**	**EL**	**ES**	**FI**	**FR**	**HR**	**HU**	**IE**	**IT**	**LT**	**LU**	**LV**	**MT**	**NL**	**PL**	**PT**	**RO**	**SE**	**SI**	**SK**	**EU**
Net inputs	**Energy use**	**640**	**233**	**71**	**1**	**217**	**1802**	**114**	**67**	**38**	**497**	**573**	**671**	**76**	**124**	**174**	**488**	**90**	**13**	**486**	**0**	**42**	**1034**	**36**	**344**	**589**	**52**	**53**	**8524**
	Autoproducers E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Autoproducers CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Final energy consumption	640	233	71	1	217	1802	114	67	38	497	573	671	76	122	174	488	90	13	486	0	42	1034	36	344	589	52	53	8522
	Non-energy use	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**6**	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**20**
od products	**Total energy use**	**641**	**233**	**71**	**1**	**217**	**1802**	**114**	**67**	**38**	**505**	**573**	**671**	**76**	**124**	**174**	**488**	**91**	**13**	**492**	**0**	**42**	**1035**	**38**	**344**	**589**	**52**	**53**	**8544**
Out of scope	**Out of scope**	**349**	**182**	**46**	**0**	**142**	**1220**	**91**	**10**	**17**	**337**	**230**	**410**	**23**	**76**	**133**	**236**	**47**	**11**	**320**	**0**	**32**	**655**	**33**	**180**	**413**	**33**	**30**	**5258**
	Chemical reduction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Electrolysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Metallurgical processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minerological processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Dual use	1	0	1	0	0	0	0	0	0	9	0	0	0	0	0	0	1	0	6	0	0	1	2	0	0	0	0	20
	Wood and wood products	324	181	43	0	140	1199	89	6	15	321	214	378	13	70	129	167	40	11	311	0	31	639	31	167	397	32	29	4976
	Peat	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	Uses other than motor or heating fuel	25	1	2	0	2	21	1	4	2	7	11	33	10	6	3	69	6	0	3	0	1	16	1	13	16	2	1	256
In scope	**Uses as motor or heating fuel**	**292**	**51**	**25**	**0**	**75**	**581**	**23**	**56**	**21**	**169**	**343**	**260**	**53**	**48**	**42**	**252**	**44**	**3**	**172**	**0**	**10**	**380**	**5**	**164**	**176**	**18**	**23**	**3286**
	Final energy consumption	292	51	25	0	75	581	23	56	21	169	343	260	53	48	42	252	44	3	172	0	10	380	5	164	176	18	23	3286
	Autoproducers E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Autoproducers CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Autoproducers H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
od products	**Ratio (in scope / total energy use)**	**45%**	**22%**	**35%**	**71%**	**35%**	**32%**	**20%**	**84%**	**55%**	**33%**	**60%**	**39%**	**69%**	**39%**	**24%**	**52%**	**49%**	**20%**	**35%**	**0%**	**23%**	**37%**	**12%**	**48%**	**30%**	**36%**	**43%**	**38%**

Source: JRC, 2020

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