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The reform of the European Energy Tax Directive reform: effect on prices

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Abstract:

To address risks related to atmospheric contamination, it is widely accepted the need for policy instruments aimed to reduce emissions. Policy intervention seeks to reduce polluting behaviours by encouraging a more respectful conduct and the use of more efficient technologies. The European Union (EU) counts with two important economic mechanisms for emission control at European level: the Energy Taxation Directive (ETD), an environmental taxation approved in 2003 that affects the price of energy products, and the Emissions Trade System (ETS), a cap and trade system introduced in 2005 that directly affects the CO_2 emission quantity. In 2011, the European Commission (EC) proposed a new version of the ETD. The main aim of the proposal was to increase the effectiveness of the instrument through stronger fiscal pressure on energy products and to coordinate the environmental taxation with the ETS, establishing a comprehensive and consistent CO_2 price signal for sectors not included in the EU-ETS. However, in May 2012 the European Parliament delivered a setback for the EC plans regarding the ETD and the process of updating stopped. The main worry seemed to be the effect of such proposal on competitiveness; in particular the concern regards sectors that would be mostly affected given the intensive use of energy products.The aim of this study is to analyse the effect that the 2011 ETD reform would have on the level of prices, if implemented, particularly in the EU countries where this reform would imply to increase energy taxes. Using data from the World Input Output Database (WIOD) project, the main finding is that the new energy tax regime would have a low impact on prices. Thus, since prices would not be strongly affected by the reform, there will be no drawbacks for competitiveness and distributional implication; but, on the other hand, this result will also imply a low capability of this reform to cause changes in consumption and production towards less environmental pressures.

Resumen:

Para hacer frente a los riesgos relacionados con la contaminación atmosférica, es ampliamente aceptada la necesidad de instrumentos de política encaminados a reducir las emisiones. La intervención tiene por objeto reducir las conductas contaminantes y incentivar una conducta más respetuosa y el uso de tecnologías más eficientes. La Unión Europea cuenta con dos importantes mecanismos económicos para el control de emisiones a escala europea: la directiva sobre los impuestos energéticos, un instrumento de fiscalidad ambiental aprobado en 2003 que afecta el precio de los productos energéticos, y el sistema de comercio de los derechos de emisiones, introducido en 2005, que afecta directamente a la cantidad de emisiones de CO_2. En 2011, la Comisión Europea propuso una nueva versión de la directiva sobre los impuestos energéticos. El objetivo principal de la propuesta es aumentar la eficacia del instrumento a través de una mayor presión fiscal sobre los productos energéticos y de coordinar este instrumento de fiscalidad medioambiental con el sistema de comercio de los derechos de emisiones, para establecer una señal de precio de CO_2 coherente para todos los sectores. Sin embargo, en mayo de 2012 el Parlamento Europeo bloqueó la propuesta de la nueva versión del impuesto, y el proceso de actualización se detuvo. La preocupación principal parecía ser el efecto de dicha propuesta en la competitividad, en particular para los sectores que serían los más afectados dado el uso intensivo de los productos energéticos, como el sector del transporte. El objetivo de este estudio es analizar el efecto que la reforma de la directiva sobre los impuestos energéticos podría tener sobre el nivel de precios, en particular en los países de la Unión Europea donde esta reforma implicaría un aumento de los impuestos energéticos. Utilizando datos del proyecto "World Input-Output Database", la principal conclusión es que el nuevo sistema de impuestos energéticos tendría un impacto muy bajo sobre los precios. Por lo tanto, dado que los precios no serían fuertemente afectados por la reforma, no habrá inconvenientes para la competitividad y implicaciones en términos de distribución, pero, por otro lado, este resultado también implica una baja capacidad de esta reforma para provocar cambios en el consumo y la producción hacia menos presiones ambientales.

JEL classification codes: C67, D57, H23, Q48, Q53.

Keywords: Environmental Tax Price Impact; European Union; World Input-Output Database (WIOD); Multi-Regional Input-Output Price Model.

1. INTRODUCTION

To address risks related to atmospheric contamination, what is widely accepted is the need for policy instruments aimed at reducing emissions. Emission control policies are primarily focused on energy products used by the production system and by end-users, being emissions basically produced through the combustion of these products. Through policy interventions, legislators try to reduce polluting behaviours and to encourage a more respectful conduct and more efficient technologies. There are several tools for emission control, many of which use economic mechanisms to influence the existing patterns of production and consumption. These instruments, generally classified in price-mechanisms and quantity-mechanisms, should minimize abatement costs by creating an incentive to develop alternative technologies or to use alternative energy products. Looking at Europe, although each member state has the legal competency to regulate emissions, also the European Union (EU) takes part in this process. Today there are two important economic mechanisms at European level for emission control: the Emissions Trade System (ETS), a cap and trade system that directly affects the emission quantity, and a system of environmental taxes that affect the price of energy products.

With regard to environmental taxes, the European Energy Taxation Directive (ETD) approved in 2003 (European Council, 2003) governs the current regime of energy taxation. This regulation came from a process started in the early 1990s that was a first attempt to harmonize carbon and energy taxes in the EU (European Commission, 1992, 1995).[1] Given this aim, the current directive fixed minima tax rates on the use of energy products[2] that countries must take into account when enacting their national implementations. Although the legislation clearly reflected environmental concerns, it was also shaped by the need to ensure that the internal market operated correctly.[3] Considering the dependence and intensity in the use of energy products for some industries and the impact of taxation in terms of competitiveness, the 2003 European ETD proposed a complex system of reductions and exemptions that has been denounced as a factor that might reduce the environmental effectiveness of these taxes (Ekins and Speck, 1999). Moreover, in the current directive there are other elements that could suggest the need for a legislative renewal: in particular, the EC (European Commission, 2011a) highlighted the absence of a signal that clearly reflects CO_2 emissions and the energy content of the products, the absence of coordination with the EU-ETS (double burden or loopholes to evade responsibility for emissions are in some cases possible), and the absence of incentives to develop markets for alternative energies.

These reasons explain why the EC proposed a new version of the European ETD in 2011 (European Commission, 2011a). The main aim of the new proposal is to increase the effectiveness of this tool through the implementation of three main changes (see table 1). Firstly, the proposal fixes higher minimum rates in an attempt

[1] See Padilla and Roca (2004) for a detailed description of the regulation process and stages during the 1990s.
[2] The directive fixes minima for mineral oils as well as for coal, gas, and electricity. These products are taxed only if burnt, and are levied with different rates depending on their uses (as motor fuels, for heating, or for industrial use).
[3] In particular, the directive was designed to reduce distortions of competition that had been existing between EU countries as a result of divergent tax rates.

to cause a shift toward less polluting production and consumption patterns. [4] Secondly, existing energy taxes would be split into two components that, taken together, would determine the overall rate at which a product is taxed. One component is based on the energy content -euro per gigajoule (GJ)-. The other component is specifically linked to CO_2 emissions, in order to complement the EU-ETS and establish a comprehensive and consistent CO_2 price signal. Finally, the new text also tries to restructure and simplify the framework of reductions and exemptions, limiting them to the energy taxation based on the energy content of products and removing unjustified subsidies for certain fossil fuels, as diesel and coal.

Table 1. Energy Taxation Directive and Commission reform proposal: main characteristics

<table>
<tr><th colspan="2">Energy Taxation Directive _ETD (2003)</th></tr>
<tr><td>Energy products</td><td>Petrol, gas oil, kerosene, liquefied petroleum gas, natural gas, heavy fuel oil, coal and coke, electricity.</td></tr>
<tr><td>Scope</td><td>Energy products are taxed when used as fuels, for heating, or other industrial uses that imply combustion. They are not under the directive scope when they are used as raw materials, in chemical reductions or in electrolytic or metallurgical processes.</td></tr>
<tr><th colspan="2">Main changes between ETD (2003) and European Commission reform proposal (2011)</th></tr>
<tr><th>2003</th><th>2011</th></tr>
<tr><td>The taxable base for mineral oils is the volume while for coal, gas and electricity is the energy content.</td><td>For each energy product, the tax rate is calculated according to CO_2 emissions content (20€/tone) and energy content (9.6€/GJ if products are used as fuels, 0.15€/GJ if products are used for heating).</td></tr>
<tr><td>Minimum rate are fixed (see Appendix 3, table A).</td><td>Higher minimum rate are proposed (see Appendix 3, table A).</td></tr>
<tr><td>Member States are allowed to differentiate between commercial and non-commercial diesel and provide for a lower rate on commercial diesel.</td><td rowspan="3">It is not allowed any more any exemption or reduction below the minima related to the CO_2 emissions content.</td></tr>
<tr><td>Member States can reduce tax rates if businesses are energy intensive.</td></tr>
<tr><td>Member State can reduce tax rates up to exemption for the agricultural sector.</td></tr>
</table>

Source: own elaboration.

Nonetheless, the Commission's proposal was not supported by the European Parliament and the 2003 directive continues in force: in May 2012 the Parliament delivered a setback for the EC plans and the process of updating stopped. The main worry seemed to be the effect of such proposal on competitiveness caused by the induced increase in prices. In particular the concern regarded sectors that would be mostly affected given the intensive use of energy products.[5] On the other hand, advocates of the reform argued that the impact of the environmental tax reform, for example on diesel prices, has been overestimated since today tax rates in the majority of the EU countries are higher than the new minima proposed.[6] Given these different

[4] The new minimum rates will be introduced in stages until 2018.

[5] See Euractiv (2012).

[6] Astrud Lulling, the Parliament's report lecturer, referred to direct negative social impact from higher prices for coal, natural gas, heating oil and diesel oil. Three major European automobile manufacturer associations (ANFIA for Italy, CCFA for France and VDA for Germany) have issued a joint statement

positions, one might ask whether the 2011 ETD proposal is really an obstacle to the competitiveness of key sectors of the European economy or, conversely, whether blocking this reform might represent a drawback to a process that could bring environmental improvements and that could boost the economy. [7] Environmental taxes, as emission control tools, are largely analysed as the vast literature on the topic shows.[8] Studies go from basic economic analyses on functions of abatement costs to analyses of more complex implications, like the effects of environmental tax on competitiveness and the case of double dividend, or the tax incidence and the effects in terms of social welfare and redistribution. Anyway environmental taxes are instruments directly affecting prices: this is the reason why, before performing all these types of studies, we believe it is appropriate to assess the effect on prices that any implementation or reform of an environmental tax would cause.

So, the aim of this study is to analyse the effect on the level of prices that the 2011 ETD reform would have, if implemented, particularly in the EU countries where this reform would imply an energy tax increase. Two main outcomes of this partial analysis are possible. On the one hand, if prices were not strongly affected by the reform, the proposed change would be ineffective to cause an improvement in consumption and production regarding environmental pressures. On the other hand, if the overall level of prices effectively changed due to the reform, the new taxation could induce a change in consumption pattern and provide incentives to look for more efficient alternatives in production. Although the analysis proposed seems relevant in both scenarios, in the second case further and wider analyses would be needed. In fact, it is realistic to assume that, facing strong price changes, producers and consumers would change their consumption choices and inputs structure, causing in this way new changes in prices. Moreover, if the reform caused a strong increase in prices it would be important to verify its effects in terms of competitiveness and income distribution. Using data from the World Input Output Database (WIOD) project we propose a multiregional price model, which allows us to consider international trade flows within the EU and with the rest of the world. The main finding of this study is that the new energy tax regime would have a really low impact on prices.

The paper is organized as follows. Section 2 proposes a review of the literature, section 3 introduces the methodology, and section 4 describes the database. Finally, results and conclusions are presented in Section 5 and 6, respectively.

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calling on the European Parliament and the Council to disassociate them from the proposed increase in taxation diesel. On the other hand, Algirdas Semeta, commissioner for taxation and customs, seconded the opinion about the overestimation of the impact on diesel prices. Moreover he stressed that diesel use is a major concern for the EC because of the European dependence from import, which causes prices variations stronger that the prices variation the reform would imply. See ANFIA, CCFA, VDA (2011), Euractiv (2012), Greenreport (2012), Reuters (2013).

[7] The EU climate and energy 20-20-20 strategy marks three goals by 2020: a 20% cut in emissions, a 20% improvement in energy efficiency and a 20% share of renewable energies. Blocking the reform could means a hindrance to it because it stopped a taxation shift from labour to pollution and energy use to help create jobs and stimulate growth (the so-called green tax shift).

[8] See Section 2 in this paper.

2. LITERATURE REVIEW

The literature on environmental taxes is extensive, covering a wide range of different issues, moving from theoretical studies, to descriptive approaches, to empirical analyses.[9]

Looking at applied analyses, it is possible to classify them in *ex-ante* and *ex-post* analyses,[10] the most part of literature belonging to the first set. Among the *ex-ante* analyses, on the one hand there are several studies that assess the impact of hypothetical policy options. These analyses are concerned with the implications of such policies in different spheres. Some of them look at the mitigation effects of environmental taxes (see Lin and Li 2011 for a detailed bibliographic review, see also Mongelli et al. 2010); others focus on the main effects in terms of production, competitiveness implications and price changes, and the effects in terms of energy efficiency or technological responses of firms (a complete bibliographic review is proposed by Gerlagh and Lise 2005; see also Boehringer 2002, Han et al. 2004, Dietzenbacher and Vélazquez 2007, Llop 2008, Llop and Pié 2008, Liu et al. 2009, Choi et al. 2010, and Roger 2011). Other studies concentrate on the effects on consumption, on welfare or income distribution changes (as Klinge Jacobsen et al. 2003, Padilla and Roca 2004, Bae and Shortle 2005, Tiezzi 2005, Wier et al. 2005, Cornwell and Creedy 1996, Creedy and Sleeman 2006, Kerkhof et al. 2008, Martini 2009, Galinato and Yoder 2009). Finally there are analyses concerned with the interaction between environmental taxes and other distortionary taxes, the double dividend hypothesis, and other macroeconomic implications (as, among others, Goulder 1995, Sinko 1996, Heutel 2012).

On the other hand, there are few works that focus on law proposals. Both Manne and Richels (1993) and Barker et al. (1993) analyse the effect of the 1992 European Commission proposal to reform energy taxation applying general equilibrium analyses. The fist study tries to verify if it is efficient to put together different targets- to lower CO_2 emissions and to reach energy conservation- as the reform would do enlarging energy taxation to nuclear and hydroelectric projects. The second study is focused on the environmental and efficiency goals that the reform would imply, as well as its macroeconomic implications in terms of growth. Nguyen (2008) applies an input-output price model to verify the impact on prices of the contemporary Vietnamese Government's proposal to increase taxes on electricity, using data referred to 2000. He finds no important effects of the proposed tax change.

The following analysis falls into this research line, since the aim is to analyse the effects that the 2011 ETD reform would have if implemented. In particular, we propose a multiregional price model in order to take into account all the interrelations among all the EU countries and between EU and the rest of the world. As it is known, general equilibrium models are able to offer a more complete description of the effect of energy taxes, and they are often used due to their explanatory capacity and due to

[9] Some theoretical studies are, amongst others, Aldy et al. (2008), Aldy et al. (2009), Andersen (2009), Ekins (2009), Fullerton et al. (2010), Jacobs and van der Ploeg (2010), Clarke (2010) and Weisbach (2011). For studies that propose a description of current or past experiences that countries have implemented, see for instance, Ekins (1999), Bosquet (2000), Hasselknippe and Christiansen (2003), Stavins (2003), Vehmas (2005), Cauter and Meensel (2009), or Ekins and Speck (2011).

[10] See Baranzini and Carattini (2012) for a bibliographic revision of ex-post analyses on environmental taxes.

their formal and theoretical strength. However, sometimes researchers or policymakers are interested in analysing the direct effect of a policy, that is the induced price variation. In such cases the analysis can be interpreted as a short-run analysis of a first impact of policy changes on prices before producers were able to change their input combinations or before the government was able to re-distribute through other policy changes. But this kind of analysis turns out to be adequate if results do not show great variations in prices: in this case it is realistic to assume no important changes in producers' and consumers' choices, and adding simplifying assumptions could alter results without adding any useful information. On the other hand, if results revealed significant variations in prices, deeper analyses (such as general equilibrium models) would be needed.

3. METHOD

The method used has three main steps. First, it is necessary to work out what is the additional tax per unit of product that each sector would face if the reform proposal will be implemented. Second, the analysis moves toward an input-output price model that permits to verify what is the impact of this additional taxation on the overall level of prices of the economy. Finally, two price indices are calculated to offer a synthetic measure of the effects of the reform.

To work out the additional tax per unit of product that the new environmental taxation would imply, it is necessary to know, for every sector, what is the consumption of the different energy products per unit of output, and what is the additional taxation on every energy product.

It is possible to compute a vector $\mathbf{t}$ of the additional tax per unit of product as:[11]

$$\mathbf{t} = (\mathbf{D} \otimes \mathbf{R})\mathbf{i} \qquad [1]$$

D is a matrix of energy use coefficients, $\mathbf{R}$ is a matrix of tax rates variations, **i** is a column vector of appropriate dimension. In particular, **D** is obtained considering a matrix **E** of energy flows from energy-producing sectors to all sectors and considering the output **x** produced by each sector:

$$\mathbf{D} = \mathbf{E}\hat{\mathbf{x}}^{-1} \qquad [2]$$

The second step is a simulation of the effect of the new minima rates on prices through an input-output price model. [12] The use of the input-output framework to detect the effect on prices of changes in the environmental regulation is mainly due to its capability to take into account the interconnections among different sectors of the economy.

[11] Matrices are indicated by bold, upright capital letters; vectors by bold, upright lower case letters; and scalars by italicized lower case letters. Vectors are columns by definition, so that row vectors are obtained by transposition, indicated by a prime. A circumflex indicates a diagonal matrix with the elements of any vector on its diagonal and all other entries equal to zero. The notation **i** is used to represent a column vector of 1's of appropriate dimensions.

[12] This price model is called *cost-push input output price model* (Oosterhaven 1996 and Dietzenbacher,1997). It is generally used to measure the impact on prices throughout the economy of a change in the cost of primary inputs in one or more sectors. However, this price model can also be applied to analyze the impact of new costs.

The input-output price model uses the information contained in the inter-industry delivery matrix to express a production model characterized by homogeneous sectors, constant returns to scale, fixed inputs proportions and constant prices for each sector (Miller and Blair, 2009). The *j-th* column of an input-output table expressed in monetary terms reveals the information of the total value of the *j-th* industrial output and the total production costs:

$$p_j x_j = \sum_{i=1}^{n} p_i z_{ij} + v_j \quad [3]$$

Where p_j is the price of *j-th* sector's product, x_{ij} is the total *j-th* sector's output, z_{ij} is the input that the *j-th* sector needs from the *i-th* sector, and v_j is the value added for *j*. In matrix terms:

$$\mathbf{p'x} = \mathbf{p'Z} + \mathbf{v'} \quad [4]$$

Substituting $\mathbf{Z} = \mathbf{Ax}$, and post-multiplying by $\hat{\mathbf{x}}^{-1}$ it is possible to obtain:

$$\mathbf{p'} = \mathbf{p'A} + \mathbf{v_c'} \quad [5]$$

$\mathbf{v_c'}$ is a vector containing value added per unit of output for every sector, $\mathbf{A}$ is the input coefficient matrix. The right-hand side of the last expression is the cost of inputs per unit of output. The right-hand side of the expression is the prices vector: each price is indexed, equal to 1.

It is finally possible to express the input–output price model as:

$$\mathbf{p'} = \mathbf{v_c'}(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{v_c'L} \quad [6]$$

$\mathbf{L}$ is the Leontief matrix that captures both direct and indirect effects of changes in value added and it expresses the technical structure of the production process.

Then, a new price vector is considered, where prices are affected by the new additional cost per unit value of output $\mathbf{t}$ defined by expression (3):

$$\tilde{\mathbf{p}}' = \tilde{\mathbf{p}}'\mathbf{A} + \mathbf{v_c'} + \mathbf{t'} \quad [7]$$

$$\tilde{\mathbf{p}}' = (\mathbf{v_c'} + \mathbf{t'})(\mathbf{I} - \mathbf{A})^{-1} = (\mathbf{v_c'} + \mathbf{t'})\mathbf{L} \quad [8]$$

Therefore, the increase in prices is given by the difference between the new prices vector and the old one:[13]

$$\tilde{\mathbf{p}}' - \mathbf{p}' = (\mathbf{v_c'} + \mathbf{t'})\mathbf{L} - (\mathbf{v_c'})\mathbf{L} = (\mathbf{t'})\mathbf{L} \quad [9]$$

Finally two indices are computed. A first index considers the quantities of the goods produced by the industrial sectors that are consumed by households, and it weights the price variation vector obtained through the input-output price model with these quantities. This permits a synthetic measure of the price change considering the composition of the basket of goods that characterizes households' consumption. Defining p_i as the initial price of the good i, q_i as the quantity of the good i consumed

[13] Using data from a standard input-output table in monetary terms, all initial prices will be equal to one: all goods are measured in "Leontief units" that is the amount can be bought with one monetary unit.

by households and $\tilde{p}_i$ as the new price after the proposal implementation, the index is defined as:

$$PI_L^I = \frac{\sum_{i=1}^{n} \tilde{p}_i q_i}{\sum_{i=1}^{n} p_i q_i} \qquad [10]$$

Anyway, the price variation vector obtained through the input-output price model considers that the increased taxation would affect the inputs used for the production of the goods, while it does not take into account that the proposed taxation would also affect the price of energy products directly consumed by households. This is the reason why a second index is computed. In this second index non-energy products and energy products are considered separately; while for the non-energy products the new prices used in the index is the price computed through the input-output price model, for the energy products we consider the increased in price for the new tax rates directly applied to them as well as the increase in price due to the effect of the tax on the input used to produce them. In this second case the index is defined as:

$$PI_L^T = \frac{\sum_{i=1}^{n} \tilde{p}_i q_i + \sum_{e=1}^{p} t_e q_e}{\sum_{i=1}^{n} p_i q_i} \qquad [11]$$

Being e each energy product, q_e the quantity of each energy product consumed by households and t_e the tax variation of each energy product applied to households' consumption. The comparison between the two measurements allows to verify the different effect of the reform, considering only the part that falls on industrial production or considering also the part that falls directly on households.

4. DATABASE

4.1 DATABASE DESCRIPTION

The following section is devoted to the description of the three main databases used for the analysis: multi-regional input output (MRIO) tables, energy use tables and information on current and proposed tax rates. The MRIO tables used are the world input output tables, described in section 4.1.1., made available by the WIOD project. Also for energy use tables, described in section 4.1.2., the main sources used are the environmental accounts belonging to WIOD. When necessary, additional information is taken from energy balances of the International Energy Agency (IEA), and from the WIOD socio-economic accounts. Finally, the last section (4.1.3.) describes the documents that contain information about the existing taxes on energy products in European countries, and the new rates proposed by the European Commission.

4.1.1. MRIO tables

The MRIO tables used have been made available by the WIOD project since April 2012 (WIOD, 2012a).[14] In particular, for MRIO tables, the study considers the information contained in the world input-output tables and international supply and use tables (WIOT-ISUT). These data, available for the years 1995-2009, refer to 27 European counties, 13 other major countries in the world and all the remaining regions aggregated in a single “rest of the world” region.[15] Among the different tables contained in the WIOT-ISUT series,[16] the world input output table at current prices for the year 2008 is used. It is a symmetrical table “industry by industry”, offering a desegregation of about 35 sectors for each country.[17] This industry-type table is estimated under the assumption of “fixed product sales structure”, that states that each product has its own specific sales structure, irrespective of the industry where it is produced. Data are expressed in monetary terms (millions of dollars).

4.1.2. Energy use tables

For energy use tables, data used are the EA made available by WIOD. This satellite accounts have the same scope as MRIO tables: same period (1995-2009), country coverage (27 European counties, 13 other major countries in the world and the remaining “rest of the world” region) and sector breakdown (35 sectors). The WIOD EA consist of energy accounts, emissions accounts, material extraction, land use and water use. The main tables used are, among the energy accounts,[18] the tables “Emission relevant energy use” for the year 2008 (WIOD, 2012b). Data include energy flows in physical terms (terajoules, TJ), related to 26 energy products,[19] derived from the gross energy use but excluding the non-energy use and the inputs for transformation into energy products.

When necessary, data are integrated and transformed using additional information from IEA extended world energy balances, from IEA series on world energy prices, and from the database Odyssee, as described in details in section 4.2.

[14] The WIOD database consists of four main time series: world input-output tables and international supply and use tables (WIOT-ISUT); national input-output tables and national supply and use tables (NIOT-NSUT); socio-economic accounts (SEA); environmental accounts (EA).

[15] See Appendix 1 for the complete list of countries.

[16] The full set of the WIOT-ISUT tables contains international supply and use tables at current and previous year prices, with use split into domestic and import by country (35 industries by 59 products), world input output tables at current and previous year prices (35 industries by 35 industries), and interregional input output tables for 6 regions (35 industries by 35 industries). The used classification is the “National Classification of Economic Activities” (NACE) Rev 1.1 (Eurostat 2002), for industries, and “Classification of Product by Activities” (CPA) (Eurostat 2008), for products.

[17] See Appendix 2 for the complete list of sectors.

[18] Two time series constitute the energy accounts: “Gross energy use” and “Emission relevant energy use”. The second series is developed as a bridge between gross energy use and emissions, and it does not include the use of energy products that are not burnt, nor fuels transformed in other fuels.

[19] The 26 energy products are further classified in six groups as following: coal (hard coal and derivatives, lignite and derivatives, coke), crude and feedstock (crude oil and feedstock), petroleum products (diesel oil for road transport, motor gasoline, jet fuel, light fuel oil, heavy fuel oil, naphtha, other petroleum products), gases (natural gas, derived gas), renewables and wastes (industrial and municipal waste, bio-gasoline including hydrated ethanol, bio-diesel, bio-gas, other combustible renewables), electricity and heat (electricity, heat, nuclear, hydroelectric, geothermal, solar, wind power, other sources).

4.1.3. Energy taxation

As regards energy taxation, it is necessary to know, on the one hand, what the present regime applied in the European countries is, and, on the other hand, what changes the implementation of the Commission proposal (European Commission, 2011a) would cause.

Regarding the current environmental taxation regime, two sources of information are used. The first one is the European Commission's "Taxes in Europe" database (TEDB), an on-line information tool that provides, for each member state, a document describing the main taxes in force for all energy products, detailing also exemptions, reductions and special regimes (European Commission, 2011c). Moreover, the European Commission provides a document (European Commission, 2013) that actualizes to 2013 the tax regimes implemented in the European countries for the main energy products.

The main document that describes the new regime is the 2011 European Commission's proposal (European Commission, 2011a) that amends the Council Directive (European Council, 2003) regulating the Community framework for the taxation of energy products and electricity.

4.2 DATABASE TRANSFORMATION

The necessary database transformations regard the energy use table selection and transformations and the compilation of a matrix of tax variation for different energy products, sectors and countries.

For the energy use table, firstly it is necessary to select data depending on what energy products are taxed through the ETD and what products are available in WIOD EA. Two main differences exist between ETD and WIOD regarding energy products classification. The ETD regime distinguishes between products used as motor fuel and products used for heating,[20] but this distinction does not exist in WIOD data; moreover, there is no a strict correspondence between WIOD and ETD product classifications used. For these reasons some transformations are applied, using the IEA energy balances as additional information when necessary.[21] Appendix 3 describes in detail all the transformations applied. The nine uses of energy products finally analysed are gasoline (motor fuel), diesel (motor fuel), LFO, LPG (motor fuel), LPG (heating), natural gas (heating), HFO (heating), coal and coke (heating), and electricity.

As regards tax variation, a matrix containing the variation in rates is filled in, considering in column the nine energy products analysed, and in row 35 sectors for 41 countries. The variation is assumed to be equal to zero for all the non-European countries. Moreover, as for European countries, when the new minima proposed is lower than the present rate no change in taxation is assumed.[22] The tax

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[20] The same tax rates are applied to heating use and to industrial use of energy products. For simplicity in the text we refer to heating use, although data refer to both categories.

[21] The reason for using IEA data is that the WIOD EA has been compiled mainly using IEA data.

[22] This seems to be a realistic assumption: if a country is already charging rates higher than the current minima proposed, there would be no reason for the proposal to cause a decrease in present rates.

rates variation comes from the novelties contained in the proposal. First, the reform would cause an increase in the tax rates in force at present when the minima rates fixed are higher than the present rates. Appendix 4, table A, compares the current minima rates established by the European Council (2003) and the minima rates proposed by the European Commission (2011a).The second main goal of the reform is to create a price signal coherent with the ETS: this implies particular treatments for some sectors that result in different tax rate variations as follows. The main change introduced is to split the tax into two components, the component related to emissions and the component related to the energy content (Appendix 4, table B shows the new tax rates split into two components). For sectors already belonging to ETS, they are exempted from the component related to CO_2 emissions. Appendix 4, table C lists the sectors covered by the ETS. Moreover, for two of these sectors (sectors "Electricity, gas and water supply" and "Air transport") also an exemption for the energy content component is applied, so that the tax variation is equal to zero.[23] On the other hand, the increase in taxation is greater for some sectors because the reform tries to reduce favored treatments. In particular, the tax variation would be higher for agriculture, because of the elimination of previous exemptions for the energy tax component related to emissions. Moreover, the reform also eliminates the favored treatment for the commercial use of diesel: its enforcement would therefore cause a greater tax variation for the sector "inland transport".[24] Table 2 summarizes new rates applied to specific sectors.

Table 2. New minima rates applied to specific sectors

WIOD code	WIOD sector	New minima applied (for all energy product)
AtB	Agriculture, Hunting, Forestry and Fishing	Component related to CO^2 emissions
21t22	Pulp, Paper, Paper , Printing and Publishing	Component related to energy content
23	Coke, Refined Petroleum and Nuclear Fuel	Component related to energy content
27t28	Basic Metals and Fabricated Metal	Component related to energy content
E	Electricity, Gas and Water Supply	Zero
60	Inland Transport	Component related to CO^2 emissions (only for gas oil)
61	Water Transport	Zero
62	Air Transport	Zero

Source: own elaboration.

Anyway, this assumption could be changed in order to see what happens if countries decided to lower the fiscal pressure at the minimum level required by the directive.

[23] Electricity is exempted because the most of products used by this sector are transformed in electricity. Air and water transport are exempted because they are regulated by international agreements.

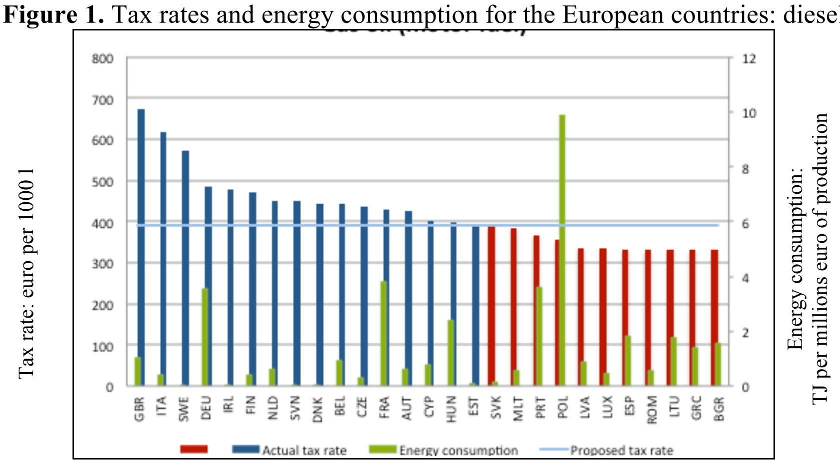
[24] The commercial use of energy products is defined by the current directive (European Council, 2003) as the use for "the carriage of goods and the carriage of passengers". In particular, countries that are currently applying this reduction are Belgium Hungary, Italy, Spain, Slovenia.

5. EMPIRICAL ANALYSIS

The following section illustrates the empirical analysis, for the 27 European countries, carried out using 2008 data.[25] First, we look at data highlighting which may be the possible outcome of the analysis. Then we describe the results of the simulation that tries to reproduce the variation in prices the reform would cause if applied. Finally we propose a synthetic measurement of the expected variation in price, calculating for each country two different price indices as described in section 3.

Looking at the current level of taxation, the product used as motor fuel that could be particularly affected by the reform is diesel. Figure 1 shows, for each country, the current level of taxation, the tax rate proposed by the reform and the intensity of energy consumption[26]: it shows that the actual tax rate applied to diesel is lower than the minimum proposed by the Commission for 11 European countries. Among them, the countries that use more intensively such product are Poland and Portugal, followed by Bulgaria, Lithuania and Spain, suggesting that these countries could be particularly affected by the increased rates on diesel.

Figure 1. Tax rates and energy consumption for the European countries: diesel



Source: own elaboration.

As regards the energy products used as heating or for industrial use, the most part of the European countries are currently applying rates that are lower than the rates proposed by the reform for LPG, natural gas, HFO, coal and coke (see figure 2). Moreover, countries that use intensively these products are France (LPG, coal and coke), Germany (HFO, coal and coke), Poland (coal and coke), Romania (natural gas), Spain (natural gas, HFO), UK (LPG, natural gas).

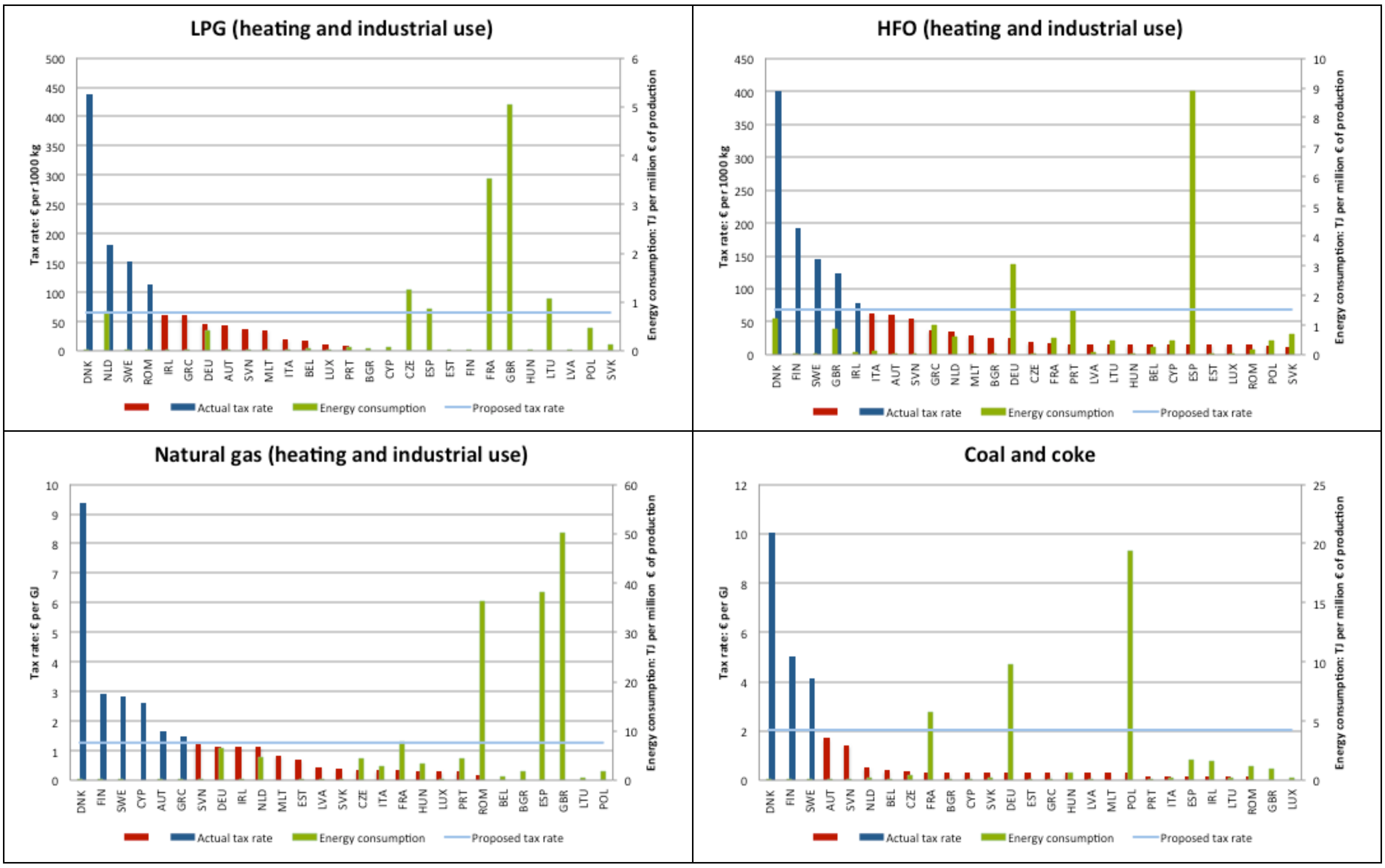
[25] The year 2008 has been chosen for two main reasons. First, it is one of the last years available in data. Second, for 2008 we dispose of data on energy use, referred to Italy, desegregated depending on the purpose of the energy products use. This permits a check of the transformations applied to the WIOD EA.

[26] Data used for this and the following graphs refer only to industrial consumption. Moreover, consumption of energy products used to produce electricity is excluded because it is not taxed.

In contrast, for gasoline, LPG used as motor fuel and electricity, countries are already applying rates that are generally higher than the minimum rates proposed by the reform[27], so that the reform would not actually cause an increase in taxation.

Although the descriptive analysis already highlights what changes proposed by the reform could have an impact on prices, it is not able to quantify this impact: the final effect on product prices depends also on the relative weight of energy product costs on prices. The aim of the simulation is to estimate this final effect, and the analysis reveals that such reform would cause a relevant price growth.

Figure 2. Tax rates and energy consumption for the European countries: LPG, HFO, Natural gas, Coal and Coke



Source: own elaboration.

For the majority of energy products, in particular gasoline, LPG, LFO, HFO and electricity, the reform would leave prices almost unchanged. For gasoline and electricity, as stressed also through the descriptive analysis (see appendix 5), the main reason is that generally countries are charging rates that are already higher than the minimum rates proposed under the ETD reform, so that the reform would not actually cause an increase in taxation. As regards LPG, LFO and HFO, the analysis reveals that the quantity embodied in the production of goods is not relevant enough to affect prices significantly. The two countries that use most intensively LPG are France and UK. In France, the 36% of LPG used by industries is used by the sector “Chemicals”, while in UK the three sectors mainly using LPG are “Food” (11%), “Chemicals” (19%) and “Construction” (20%). Anyway the price variation of these sectors never

[27] Appendix 5 shows the descriptive analysis of current taxation and energy consumption for the remaining energy products.

exceeds the 0.5%. As regards LFO, generally the main sectors using it is the "agricultural" sector, but also in this case the price variation never exceed the 1%. Finally, as regards HFO, this energy product is basically used by the sector "Water transport", that is a sector exempted by the ETD (and it would remain exempted also if the reform were applied) because it is regulated through international agreements.[28]

Table 3. Effect of the proposed minima tax rates on price (percentage variation)

Sector	Country	Direct price variation (energy product and relative weight*)	Total price variation
Mining and Quarrying	CZE	2.53 (Coal Coke: 2.48)	2.63
	DEU	1.64 (Coal Coke: 1.62)	1.70
	ROM	1.63 (Coal Coke: 1.28)	1.91
	SVK	1.57 (Coal Coke: 1.31)	1.64
Chemicals	BGR	1.24 (Natural gas: 0.76)	1.54
	ROM	1.93 (Natural gas: 1.69)	2.20
Other Non-Metallic Mineral	BGR	1.69 (Natural gas: 0.80)	2.23
	CYP	0.79 (HFO: 0.44)	1.05
	EST	2.61 (Coal Coke: 2.47)	2.81
	LTU	1.75 (Coal Coke: 1.37)	1.86
	LUX	1.22 (Coal Coke: 0.63)	1.46
	LVA	1.10 (Coal Coke: 0.67)|	1.29
	POL	1.11 (Coal Coke: 0.62)|	1.37
	SVK	0.80 (Coal Coke: 0.52)|	1.03
Inland Transport	BEL	1.05 (Diesel: 1.04)	1.24
	BGR	3.17 (Diesel: 2.64)	3.37
	GRC	1.32 (Diesel: 1.32)	1.35
	POL	1.01 (Diesel: 0.95)	1.17
	PRT	1.48 (Diesel: 1.47)	1.69

Source: own elaboration.
*Indicated in parenthesis are the energy products mainly responsible for the variation in price with the price change that depends on that product.

Looking at the other energy products considered (diesel, natural gas, coal and coke) the main result is that few sectors in few countries would see an increase in prices greater than 1%. In particular, the sectors mainly affected would be "Mining and quarrying", "Chemicals", "Other non-metallic Mineral", and "Inland transport". The main change that would influence "Mining and quarrying" and "Other non-metallic Mineral" is the increased tax rate on coal and coke (in particular for Bulgaria, Czech Republic, Cyprus, Estonia, Germany, Latvia, Lithuania, Luxembourg, Poland, Romania and Slovakia); anyway the price growth never exceeds the 2%, except for "Mining and quarrying" in Czech Republic 2.63%), and "Other non-metallic Mineral" in Estonia (2.81%). Although Poland and France use intensively this product, for these countries the main sectors involved would be "Metals and fabricated metals" and "Electricity", and both sectors are partially or totally exempted because they belong to the ETS mechanism. For natural gas, the main sector affected would be the "Chemicals" sector, in Bulgaria and Romania, but also in this case the price increase is lower than 3%.[29] Finally, the increase in diesel taxation would basically regard "inland transport", but only in few countries (Belgium, Bulgaria, Greece, Poland,

[28] For Spain, that is the country that uses more intensively HFO, the 23% of the industrial use of this product is consumed by "Water transport" sector, the 34% by "Electricity" sector. Both sectors are totally exempted, and this explains why there is no increase in prices.

[29] For Spain and UK-the countries that most intensively use natural gas, the price increase for "Chemicals" would be, respectively, 0.33% and 0.60%. In these countries the most affected sectors would be "Other non-metallic Mineral" for Spain and "Agriculture" for UK, but less than 1%.

Portugal) the price increase would be greater than 1% and only in Bulgaria greater than 2 (3.37%).

Table 3 summarizes the main results described so far; appendix 6 shows more in detail the results of the analysis for those sectors where the total price variation is greater than 0.5%.

Appendix 7 finally shows the two indices computed for all the European counties. Table 6 shows the indices for the three countries less affected (Finland, Denmark Sweden) and for the three countries most affected (Latvia, Poland, Bulgaria). Not surprisingly, as regards the first price index- that considers only the variation in price due to the effect of the new taxation on the industrial inputs- the effect of the reform considering the representative household consumption basket is low for all the countries, ranging from 1.0002 to 1.0048. A more interesting result regards the second index, which shows that the effect on prices would be low even if the direct taxation on energy products directly consumed by households is taken into account. This result reinforces the conclusions of the previous analysis.

Table 4. Price indices for the three countries less affected and for the three countries most affected

	Country	Price index for industrial products	(%)	Price index for industrial and energy products	(%)
Less affected	Finland	1.000191642	0.02%	1.000199649	0.02%
	Denmark	1.000246243	0.02%	1.000246254	0.02%
	Sweden	1.000271131	0.03%	1.000271151	0.03%
Most affected	Latvia	1.002308748	0.23%	1.004300924	0.43%
	Poland	1.002493846	0.25%	1.006279417	0.63%
	Bulgaria	1.004772549	0.48%	1.007364162	0.74%
EU-27	**Mean**	**1.001171256**		**1.002328513**	

Source: own elaboration.

6. FINAL REMARKS

The work is focused on European Energy Taxation Directive (ETD), the environmental taxation applied to energy products used by industrial sectors and by households. In 2011, the European Commission proposes a new version of the ETD (European Commission, 2011a). The aim of the new proposal is to promote energy efficiency and the consumption of more environmentally friendly products. The target is also to coordinate the environmental taxation with the Emission Trading Mechanism (ETS), the other economic mechanism introduced by the Community in 2005, to establish a comprehensive and consistent CO_2 price signal beyond the EU ETS.[30]

The aim of this work is to analyse the effect that the ETD reform would have if implemented, in particular on the level of prices in the European countries. The framework chosen is the input output analysis, a useful instrument because it can take into account not only the direct effect of changes in the taxation rates, but also the

[30] It is interesting to consider that there is also a current debate, at European level (European Commission 2012), on the functioning of the ETS mechanism. Due to the economic downturn and the consequent decrease in consumption, the ETS market is setting CO_2 prices far below the expected values, providing in this way too low incentives to reduces emissions.

indirect effect caused by increases in the price of inputs.[31] The main finding is that the new energy tax regime will not have a strong impact on prices, affecting only few sectors in few countries with a price variation that would exceed the 2.5% only in three cases[32]. Since prices are not strongly affected by the reform, there will be no a significant problem for competitiveness and the effect on distribution would also be very low. On the other hand this will imply a low capability of this reform to change consumption and production in order to reduce environmental pressures. This result is due to the fact that, although the reform tries to strengthen the environmental protection, the new minimum tax rates proposed are often lower than the current taxation in force in the most of the Member States. Moreover, some important exemption that would continue to be in force (in particular for the sectors “Electricity” and “Water transport”) does not create an incentive for these energy-intensive sectors to change their energy input structure. From the analysis is therefore evident the difficulty, at European level, to reform the environmental fiscal measures as part of the climate change policy: since any fiscal decision affecting all European countries requires unanimity, even a proposal that would have very low economic and social impact –as the analysis reveals- can be easily blocked.

The result suggests further possible analyses. One possible extension could be to analyse the effects of energy taxation on the basis of different policy scenarios: for example, considering today's important problems in economic recovery it is realistic to assume that the European countries that are applying a tax system harder than the minimum rates required by the Community may decide to reduce the tax burden. A second possible extension could focus on the “inland transport” sector. The proposal was blocked by the Parliament due to worries related to the effect of the increased taxation in terms of competition, and actually the reform would lead to a price increase for the transport sector. However, the analysis reveals that the price increase would be slight. Furthermore, the reform aims at influencing the pattern of production and consumption, also through a change in prices. It would be interesting to include in the analysis the possibility of substitution among production inputs and see what change in prices (and therefore what level of taxation) creates an incentive to use alternative fuels or to change the consumption pattern.

[31] However it must be remembered that the analysis does not take into account the possible effects of the reform on technology and input structure.
[32] “Mining and quarrying” in Czech Republic (2.63%),“Other non-metallic Mineral” in Estonia (2.81%), and “Inland transport” in Bulgaria (3.37%).

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Appendices

Appendix 1. Counties considered

European Countries	Denmark	Ireland	Poland	UK	Indonesia	Taiwan
	Estonia	Italy	Portugal	**Non-European Countries**	India	United States
Austria	Finland	Latvia	Romania		Japan	Rest of the World
Belgium	France	Lithuania	Slovak Republic	Australia	Korea	
Bulgaria	Germany	Luxemburg	Slovenia	Brazil	Mexico	
Cyprus	Greece	Malta	Spain	Canada	Russia	
Czech Republic	Hungary	Netherland	Sweden	China	Turkey	

Source: own elaboration.

Appendix 2. Sectors considered

Sector number	WIOD code	Sector
1	AtB	Agriculture, Hunting, Forestry and Fishing
2	C	Mining and Quarrying
3	15t16	Food, Beverages and Tobacco
4	17t18	Textiles and Textile Products
5	19	Leather, Leather and Footwear
6	20	Wood and Products of Wood and Cork
7	21t22	Pulp, Paper, Paper , Printing and Publishing
8	23	Coke, Refined Petroleum and Nuclear Fuel
9	24	Chemicals and Chemical Products
10	25	Rubber and Plastics
11	26	Other Non-Metallic Mineral
12	27t28	Basic Metals and Fabricated Metal
13	29	Machinery, Nec
14	30t33	Electrical and Optical Equipment
15	34t35	Transport Equipment
16	36t37	Manufacturing, Nec; Recycling
17	E	Electricity, Gas and Water Supply
18	F	Construction
19	50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
20	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
21	52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
22	H	Hotels and Restaurants
23	60	Inland Transport
24	61	Water Transport
25	62	Air Transport
26	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
27	64	Post and Telecommunications
28	J	Financial Intermediation
29	70	Real Estate Activities
30	71t74	Renting of M&Eq and Other Business Activities
31	L	Public Admin and Defence; Compulsory Social Security
32	M	Education
33	N	Health and Social Work
34	O	Other Community, Social and Personal Services
35	P	Private Households with Employed Persons

Source: own elaboration.

Appendix 3. Energy table transformations applied

Table A) Main transformations applied

Products
The main products that are taxed through the ETD are: petrol used as motor fuel; gas oil, kerosene, liquefied petroleum gas (LPG) and natural gas used as motor fuel as well as for heating; heavy fuel oil (HFO) and coal and coke used for heating; finally electricity. Biofuels are currently taxed but an option of fully exemption exists, and they would remain exempt under the reform. Nuclear fuels are not energy products for the purposes of the directive. For some of these products a correspondence exists between the ETD classification and the classification used in the WIOD database.
Product selection
Three uses - kerosene used as motor fuel, kerosene used for industrial use and heating, and natural gas used as motor fuel -are excluded from the analysis for the following reasons. As regards kerosene, it is used as motor fuel basically by the aviation sector that is exempted from the energy component of the tax for competitiveness reasons and is exempted from the CO2 component of taxation because it is an ETS sector. As regards kerosene used as heating, when consumption is relevant, households rather than economic sectors basically use it. Finally, as regards natural gas used as motor fuel, it is not considered in the analysis because the IEA considers the amount consumed in most countries (except for Bulgaria, France, Germany, Italy, Sweden) as irrelevant, assigning to data (IEA, 2012a) a value equal to zero.
LPG
As regards LPG, two transformations are needed. Since in WIOD LPG is classified in the category “Other petroleum products” along with other nine energy products (the products classified in the “Other petroeum products” category are LPG, bitumen, ethane, lubricants, non-specified oil products, other kerosene, paraffin waxes, petroleum coke, refinery gas, white spirit.), it is necessary to desegregate the WIOD category into the different components. This is done using IEA energy balances information that have been used for computing the WIOD category “other petroleum products” (IEA, 2012a). Then, it is necessary to distinguish between LPG used as motor fuel and LPG used for heating. Also in this case the additional information used comes from IEA energy balances: in IEA data (IEA, 2012a) there is a final consumption flow named “road” that records fuels used in road vehicles. For LPG, as for gas oil and petrol, this flow has been split and allocated to all NACE sectors and private consumption in WIOD. Following the same procedure, explained in Genty et al. (2012), it is possible to desegregate, for each WIOD sector, the share of LPG classified in IEA as “road”, and consider this component as LPG used as motor fuel, while the remaining share of LPG is considered as used for heating. This transformation requires additional information from IEA prices (IEA, 2012b) and from the database Odyssee (Odyssee Mure, 2012).
Coal and coke
The different WIOD products “coal” and “coke” are aggregated in a single product as in the ETD. Table 2 summarizes the correspondences between ETD and WIOD products and the transformation needed.
Conversion factors
It is necessary to convert WIOD energy data in units coherent with the ETD: in the ETD rates on different products are expressed in euro related to different volumetric measures. In particular: rates on petrol, gas oil and kerosene are expressed in euro per 1000 litres, rates on LPG are expressed in euro per 1000 kilograms, rates on natural gas, coal and coke are expressed in euro per gigajoule. On the other hand, WIOD energy use tables are expressed in their energy content (TJ). They have indeed to be conveniently transformed with the ETD.[33] Table 2 shows the conversion factors used for each energy product.

Source: own elaboration.

[33] The European Commission makes available conversion factors for each energy product (documentation ancillary to the Commission proposal (European Commission 2011a) available at: http://ec.europa.eu/taxation_customs/resources/documents/taxation/presentation_energy_en.pdf)

Table B) Correspondence between ETD and WIOD energy products classification

ETD product	WIOD product	Transformation
Petrol (motor fuel)	Gasoline	None
Gas oil (motor fuel)	Diesel	None
Gas oil (heating)	Light fuel oil-LFO	None
Kerosene (motor fuel)	Jetfuel	Excluded
Kerosene (heating)	Other kerosene	Excluded
LPG (motor fuel)	Other petroleum products	Desegregated
LPG (heating)	Other petroleum products	Desegregated
Natural gas (motor fuel)	Natural gas	None
Natural gas (heating)	Natural gas	Excluded
Heavy fuel oil-HFO (heating)	Heavy fuel oil-HFO	None
Coal and coke	Coal	Aggregated
Coal and coke	Coke	Aggregated
Electricity	Electricity	None

Source: own elaboration.

Table C) Conversion factors

WIOD Energy Product	WIOD Units	ETD Units	Net Calorific Value (NCV, GJ/1000 kg) Density (D, Kg/m^3) Conversion factor (CF, GJ/1000 kg)	Transformation from WIOD to ETD Units
Gasoline (motor fuel)	TJ	1000 kg	CF=NCV= 32.8	Data in 1000 kg=TJ x 1000/32.8
Diesel (motor fuel)	TJ	1000 l	NCV =42.3; D=832; CF=NCV x D/1000=35.2	Data in 1000 l=TJ x 1000/35.2
LFO (heating)	TJ	1000 l	NCV=42.3; D =832; CF=NCV x D/1000=35.2	Data in 1000 l=TJ x 1000/35.2
LPG (motor fuel)	TJ	1000 kg	CF=NCV (GJ/1000 kg)= 46	Data in 1000 kg=TJ x 1000/46
LPG (heating)	TJ	1000 kg	CF=NCV (GJ/1000 kg)= 46	Data in 1000 kg=TJ x 1000/46
Natural gas (heating)	TJ	GJ		Data in GJ=TJ x 1000
HFO (heating)	TJ	1000 kg	CF=NCV (GJ/1000 kg)= 40	Data in 1000 kg=TJ x 1000/40
Coal-coke (heating)	TJ	GJ		Data in GJ=TJ x 1000
Electricity	TJ	MWh	CF=NCV (GJ/MWh)= 3.6	Data in MWh= TJ x 1000/3.6

Source: own elaboration.

Appendix 4. Actual and proposed environmental tax regimes

Table A) Comparison between the current minima rates established by the European Council (2003) and the minima rates proposed by the Commission (EC, 2011)

Motor fuels	Current minima	Minima proposed in ETD reform
Petrol (€ per 1000 l)	359	360
Gas oil (€ per 1000 l)	330	390
Kerosene (€ per 1000 l)	330	392
LPG (€ per 1000 kg)	125	500
Natural gas (€ per GJ)	2.6	10.7
Heating fuels and motor fuels for industrial use		
Gas oil (€ per 1000 l)	21	57.37
Heavy fuel oil (€ per 1000 kg)	15	67.84
Kerosene (€ per 1000 l)	0	56.27
LPG (€ per 1000 kg)	0	64.86
Natural gas (€ per GJ)	0.15	1.27
Coal and coke (€ per GJ)	0.15	2.04
Electricity *(€ per MWh)*	0.5	0.54

Source: European Commission, 2011a.

Table B) New minima rates split in two components

Motor fuels	Component related to energy content (9.6 € per GJ)	Component related to CO_2 emissions (20 € per tonne)	Minima proposed in the ETD reform
	(a)	(b)	(a)+(b)
Petrol (€ per 1000 l)	314	46	360
Gas oil (€ per 1000 l)	337.9	52.1	390
LPG (€ per 1000 kg)	442	58	500
Heating fuels and motor fuels for industrial use	**(9.6 € per GJ)**	**(20 € per tonne)**	
	(a)	**(b)**	**(a)+(b)**
Gas oil (€ per 1000 l)	5.28	52.1	57.37
Heavy fuel oil (€ per 1000 kg)	6	61.84	67.84
LPG (€ per 1000 kg)	6.9	58	64.86
Natural gas (€ per GJ)	0.15	1.12	1.27
Coal and coke (€ per GJ)	0.15	1.89	2.04

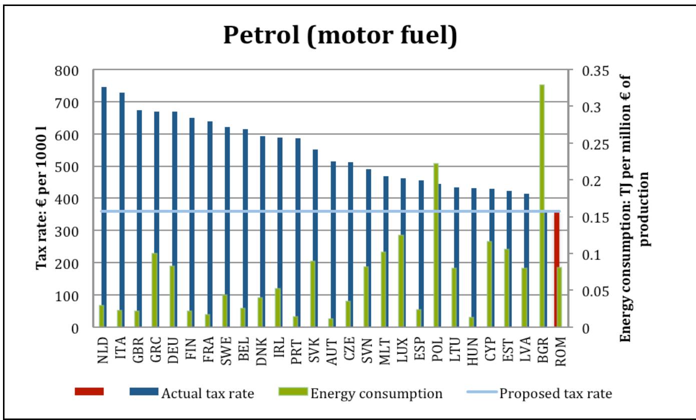
Source: European Commission, 2011a.

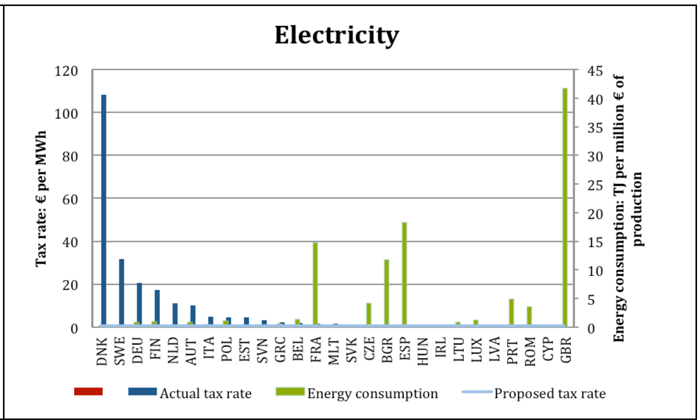
Table C) Sectors subject to the ETS

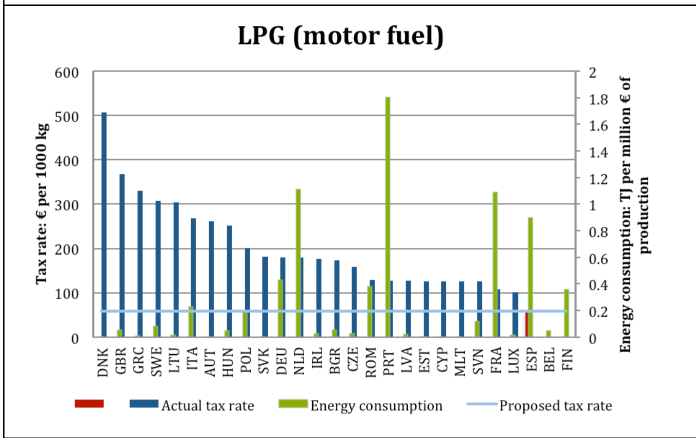
Activities (European Parliament and Council, 2003)	WIOD sector
Energy activities	
Combustion installations with a rated thermal input exceeding 20 MW (except hazardous or municipal waste installations)	Electricity, Gas and Water Supply
Mineral oil refineries	Coke, Refined Petroleum and Nuclear Fuel
Coke ovens	
Production and processing of ferrous metals	Basic Metals and Fabricated Metal
Metal ore (including sulphide ore) roasting or sintering installations	
Installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2,5 tonnes per hour	
Mineral industry	
Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or lime in rotary kilns with a production capacity exceeding 50 tonnes per day or in other furnaces with a production capacity exceeding 50 tonnes per day	
Installations for the manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day	
Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, and/or with a kiln capacity exceeding 4 m3 and with a setting density per kiln exceeding 300 kg/m3	
Other activities	Pulp, Paper, Paper , Printing and Publishing
Industrial plants for the production of	
(a) pulp from timber or other fibrous materials	
(b) paper and board with a production capacity exceeding 20 tonnes per day	
Aviation[*]	Air Transport
Flights which depart from or arrive in an aerodrome situated in the territory of a Member State to which the Treaty applies.	

[*] European Parliament and Council, 2008.
Source: own elaboration.

Appendix 5. Tax rates and energy consumption for the European countries: Petrol (motor fuel), LPG (motor fuel), electricity







Source: own elaboration.

Appendix 6. Simulations results

Effect of increased rates on prices (percentage variations)

Country	Sector	Gasoline	Diesel	LFO	LPG motor	LPG heating	Natgas	HFO	CoalCoke	Electr	Tot
BEL	Agriculture, Hunting, Forestry and Fishing	0.00	0.07	0.42	0.00	0.00	0.12	0.05	0.01	0.00	0.68
BEL	Mining and Quarrying	0.00	0.05	0.02	0.00	0.00	0.07	0.03	0.45	0.04	0.68
BEL	Other Non-Metallic Mineral	0.00	0.07	0.01	0.00	0.00	0.39	0.16	0.17	0.02	0.83
BEL	Inland Transport	0.00	1.19	0.02	0.00	0.00	0.02	0.00	0.00	0.01	1.24
BGR	Mining and Quarrying	0.00	0.17	0.01	0.08	0.01	0.13	0.02	0.13	0.00	0.55
BGR	Food, Beverages and Tobacco	0.00	0.15	0.03	0.13	0.04	0.26	0.05	0.05	0.00	0.72
BGR	Textiles and Textile Products	0.00	0.12	0.01	0.31	0.01	0.18	0.02	0.03	0.00	0.69
BGR	Leather, Leather and Footwear	0.00	0.15	0.02	0.32	0.02	0.20	0.03	0.04	0.00	0.79
BGR	Wood and Products of Wood and Cork	0.00	0.23	0.02	0.17	0.02	0.15	0.03	0.03	0.00	0.66
BGR	Chemicals and Chemical Products	0.00	0.10	0.02	0.03	0.01	0.88	0.01	0.50	0.00	1.54
BGR	Rubber and Plastics	0.00	0.11	0.00	0.13	0.01	0.21	0.01	0.06	0.00	0.55
BGR	Other Non-Metallic Mineral	0.00	0.22	0.02	0.09	0.04	0.97	0.03	0.86	0.00	2.23
BGR	Manufacturing, Nec; Recycling	0.00	0.18	0.01	0.18	0.01	0.12	0.01	0.02	0.00	0.53
BGR	Construction	0.00	0.15	0.02	0.12	0.01	0.14	0.01	0.09	0.00	0.54
BGR	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	0.00	0.19	0.04	0.20	0.01	0.07	0.02	0.02	0.00	0.54
BGR	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	0.00	0.28	0.02	0.21	0.02	0.10	0.01	0.02	0.00	0.65
BGR	Hotels and Restaurants	0.00	0.10	0.01	0.29	0.01	0.07	0.01	0.02	0.00	0.52
BGR	Inland Transport	0.00	2.76	0.04	0.03	0.00	0.53	0.00	0.01	0.00	3.37
BGR	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.00	0.85	0.02	0.04	0.00	0.09	0.01	0.03	0.00	1.04
BGR	Post and Telecommunications	0.00	0.43	0.01	0.03	0.00	0.05	0.01	0.01	0.00	0.54
BGR	Education	0.00	0.07	0.01	0.36	0.00	0.05	0.00	0.01	0.00	0.51
BGR	Health and Social Work	0.00	0.08	0.01	0.31	0.01	0.09	0.01	0.03	0.00	0.53
BGR	Other Community, Social and Personal Services	0.00	0.12	0.02	0.28	0.01	0.07	0.01	0.02	0.00	0.52
CYP	Other Non-Metallic Mineral	0.00	0.00	0.00	0.00	0.01	0.02	0.56	0.43	0.03	1.05
CZE	Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.06	0.01	2.55	0.00	2.63
CZE	Chemicals and Chemical Products	0.00	0.01	0.00	0.00	0.07	0.19	0.05	0.68	0.00	0.99
CZE	Other Non-Metallic Mineral	0.00	0.01	0.00	0.01	0.00	0.53	0.03	0.42	0.00	0.99
DEU	Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.02	0.00	1.67	0.00	1.70
ESP	Chemicals and Chemical Products	0.00	0.08	0.00	0.00	0.04	0.40	0.04	0.03	0.00	0.60
ESP	Other Non-Metallic Mineral	0.00	0.13	0.00	0.00	0.01	0.58	0.05	0.05	0.00	0.82
EST	Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.15	0.02	0.56	0.00	0.74
EST	Other Non-Metallic Mineral	0.00	0.01	0.00	0.00	0.00	0.16	0.02	2.63	0.00	2.81
FRA	Other Non-Metallic Mineral	0.00	0.00	0.00	0.00	0.01	0.30	0.10	0.14	0.00	0.55
GBR	Agriculture, Hunting, Forestry and	0.00	0.00	0.00	0.00	0.02	0.86	0.07	0.01	0.00	0.96

	Fishing										
GBR	Mining and Quarrying	0.00	0.00	0.00	0.00	0.01	0.45	0.00	0.19	0.01	0.66
GBR	Other Non-Metallic Mineral	0.00	0.00	0.00	0.00	0.03	0.50	0.00	0.39	0.03	0.96
GRC	Other Non-Metallic Mineral	0.00	0.04	0.00	0.00	0.00	0.02	0.13	0.56	0.00	0.74
GRC	Inland Transport	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.35
HUN	Other Non-Metallic Mineral	0.00	0.04	0.00	0.00	0.01	0.41	0.01	0.33	0.00	0.80
HUN	Inland Transport	0.00	0.79	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.83
IRL	Other Non-Metallic Mineral	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.55	0.00	0.60
LTU	Other Non-Metallic Mineral	0.00	0.07	0.00	0.00	0.00	0.32	0.03	1.42	0.00	1.86
LTU	Inland Transport	0.00	0.69	0.00	0.00	0.00	0.06	0.00	0.01	0.00	0.77
LUX	Agriculture, Hunting, Forestry and Fishing	0.00	0.33	0.34	0.00	0.00	0.04	0.00	0.01	0.00	0.73
LUX	Other Non-Metallic Mineral	0.00	0.13	0.00	0.00	0.00	0.58	0.01	0.73	0.00	1.46
LUX	Manufacturing, Nec; Recycling	0.00	0.19	0.00	0.00	0.00	0.35	0.00	0.03	0.00	0.58
LUX	Inland Transport	0.00	0.76	0.02	0.00	0.00	0.01	0.00	0.01	0.00	0.80
LVA	Agriculture, Hunting, Forestry and Fishing	0.00	0.13	0.41	0.01	0.01	0.05	0.00	0.02	0.00	0.62
LVA	Other Non-Metallic Mineral	0.00	0.07	0.04	0.01	0.06	0.34	0.01	0.75	0.00	1.29
LVA	Inland Transport	0.00	0.64	0.17	0.00	0.00	0.02	0.00	0.01	0.00	0.85
POL	Agriculture, Hunting, Forestry and Fishing	0.00	0.04	0.00	0.00	0.06	0.04	0.01	0.39	0.00	0.55
POL	Mining and Quarrying	0.00	0.05	0.00	0.00	0.02	0.14	0.00	0.61	0.00	0.81
POL	Chemicals and Chemical Products	0.00	0.05	0.00	0.00	0.01	0.11	0.02	0.55	0.00	0.75
POL	Other Non-Metallic Mineral	0.00	0.07	0.00	0.00	0.02	0.52	0.04	0.72	0.00	1.37
POL	Inland Transport	0.00	1.04	0.00	0.00	0.01	0.09	0.00	0.03	0.00	1.17
POL	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	0.00	0.46	0.00	0.00	0.01	0.07	0.00	0.04	0.00	0.59
PRT	Textiles and Textile Products	0.00	0.11	0.00	0.00	0.01	0.28	0.16	0.00	0.00	0.57
PRT	Other Non-Metallic Mineral	0.00	0.12	0.00	0.00	0.02	0.52	0.05	0.09	0.00	0.80
PRT	Inland Transport	0.00	1.66	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.69
ROM	Mining and Quarrying	0.00	0.05	0.00	0.00	0.00	0.38	0.02	1.46	0.00	1.91
ROM	Chemicals and Chemical Products	0.00	0.04	0.00	0.00	0.00	1.83	0.01	0.31	0.00	2.20
ROM	Other Non-Metallic Mineral	0.00	0.05	0.00	0.00	0.00	0.37	0.02	0.30	0.00	0.74
ROM	Inland Transport	0.00	0.47	0.00	0.00	0.00	0.05	0.00	0.02	0.00	0.54
SVK	Mining and Quarrying	0.00	0.01	0.00	0.00	0.00	0.29	0.00	1.34	0.00	1.64
SVK	Other Non-Metallic Mineral	0.00	0.01	0.00	0.00	0.00	0.37	0.00	0.65	0.00	1.03
SVK	Inland Transport	0.00	0.06	0.00	0.00	0.00	0.45	0.00	0.02	0.00	0.53
SVN	Inland Transport	0.00	0.88	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.89

Appendix 7. Simulations results

Country	Price index for industrial products	(%)	Price index for industrial and energy products	(%)
FIN	1.000191642	0.02%	1.000199649	0.02%
DNK	1.000246254	0.02%	1.000246254	0.02%
SWE	1.000271151	0.03%	1.000271151	0.03%
NLD	1.000328581	0.03%	1.000331024	0.03%
AUT	1.000345735	0.03%	1.00037069	0.04%
DEU	1.000371321	0.04%	1.000482325	0.05%
FRA	1.000506277	0.05%	1.001384409	0.14%
IRL	1.000526684	0.05%	1.001062337	0.11%
MLT	1.000608247	0.06%	1.000821155	0.08%
SVN	1.000611426	0.06%	1.000718979	0.07%
ITA	1.00063525	0.06%	1.000891293	0.09%
CYP	1.000770331	0.08%	1.000770331	0.08%
GBR	1.000777287	0.08%	1.002436817	0.24%
EST	1.00080239	0.08%	1.001079858	0.11%
GRC	1.000860575	0.09%	1.00088301	0.09%
BEL	1.001004259	0.10%	1.002998774	0.30%
SVK	1.001346562	0.13%	1.002872899	0.29%
HUN	1.001372916	0.14%	1.004313247	0.43%
PRT	1.001444297	0.14%	1.002117053	0.21%
CZE	1.001474333	0.15%	1.003134872	0.31%
ESP	1.001492193	0.15%	1.002984423	0.30%
LUX	1.001739114	0.17%	1.0059848	0.60%
ROM	1.002050953	0.21%	1.004056876	0.41%
LTU	1.00227098	0.23%	1.004513111	0.45%
LVA	1.002308748	0.23%	1.004300924	0.43%
POL	1.002493846	0.25%	1.006279417	0.63%
BGR	1.004772549	0.48%	1.007364162	0.74%
Mean	1.001171256	0.02%	1.002328513	0.02%
Min	1.000191642	0.02%	1.000199649	0.02%
Max	1.004772549	0.03%	1.007364162	0.03%