PART I

Overview

Taxing energy use in OECD countries

1. Introduction

Energy use is a critical component of modern economies. It is a central ingredient in industrial and commercial production and in consumer consumption. Many forms of energy use, however, also contribute to significant environmental problems, such as climate change and air pollution.

Taxation affects the price, and therefore the use, of various forms of energy. Understanding the structure and level of energy taxes in a country is therefore central to policy discussions regarding energy use. Given the centrality of energy to the economy and the environment, such an understanding is a key reference point for consideration of how policy can best support "green growth" (see OECD, 2011).

This document aims to improve understanding of the relationship between energy use and taxation by illustrating the structure of energy use and taxes on energy consumption in the 34 member countries of the OECD. Specifically, it presents a set of data-rich "maps" for each country, which serve three general objectives:

- to understand the composition of energy use in each country and the carbon dioxide (CO_2) emissions associated with that use;
- to illustrate the structure of energy taxation in each country: the coverage of the various tax bases related to energy consumption; the effective tax rates in energy and carbon terms that apply to different fuels, uses of fuel, and fuel users; and the various tax expenditures that are provided; and
- to establish an analytic foundation for discussion about appropriate tax settings on energy use and for assessment of the tax treatment of different types, uses and users of energy.

The document is structured as follows. Part I – Overview – sets out the policy background to energy taxation and the issues that the maps will help to examine, explains the structure of the maps, outlines the methodology and data sources used, and presents summary results using the data obtained from the maps. Part II – Country profiles – outlines the energy tax system in each country, and presents and discusses the maps of energy use and taxation.

2. Background

2.1. Why countries tax energy

In modern economies, goods and services are often subject to broad-based consumption taxes like value-added or retail sales taxes. A relatively few goods are also subject to specific product and services taxes or excises. Among the products most commonly subject to specific taxes is energy – including fossil fuels like petroleum products, natural gas and coal, as well as secondary energy products like electricity.

There are at least three rationales that countries commonly give for taxing energy:

- Fuels are often taxed in order to internalise in prices some portion of the social cost or externalities that result when private actors burn the fuels, such as the damage caused by emissions of CO_2 and local air pollutants. Using taxes to "price externalities" is referred to as Pigouvian taxation. For externalities that have a global impact, like greenhouse gases, the damage cost may be uniform, while for local air pollutants like those that cause smog, the damage cost will vary from one location to another. Again, marginal damages can differ between stock pollutants (like greenhouse gases) the effect of which is mostly a function of their accumulation, and flow pollutants the effect of which is more closely tied to current emissions. Whether or not a tax on a good that causes external costs is explicitly intended to internalise some of those costs, it will send price signals that implicitly have that effect.
- In some cases, an energy product is taxed simply because it is an essential product the demand for which is relatively inelastic – meaning that an increase in price will cause a relatively small reduction in demand. Such a product can be an attractive tax target because demand and thus government revenue is relatively stable. Consistent with the so-called Ramsey rule of optimal commodity taxation, taxing this type of product does not significantly alter people's preferred consumption patterns. However, like all forms of taxation, energy taxes have significant income and welfare impacts.
- While energy tax revenues are most often directed into general government coffers, in some cases they are earmarked for particular uses, such as where revenues from taxes on road fuel are devoted to maintenance of the highway system.[1] In some cases like this, excise taxes may be viewed as a type of user charge (albeit one based on some measure of average rather than marginal cost).

In practice, governments often tax energy with more than one of these objectives in mind. They will also typically be concerned to meet these objectives while taking into account the role of other environmental policies and minimising negative impacts on the level of economic activity, on particular industries, and on the distribution of income among households. Box 1 discusses in more detail some insights from the optimal tax literature on the use of taxes to internalise external costs.

Regardless of the purpose for which countries tax energy, specific taxes change the relative prices of different forms of energy and thus patterns of energy use, with important economic and environmental consequences. CO_2 emissions from fossil fuel use represent more than 56% of global greenhouse gas (GHG) emissions and more than 73% of total CO_2 emissions. Fossil fuel taxation is therefore a central issue in climate change policy. It also affects net incomes and has important distributional implications. The effect of energy taxes on behaviour is discussed in Box 2.

Box 1. **Optimal commodity taxation to address externalities**

Governments tax energy products for various purposes, such as internalising external costs and raising revenues. Optimal taxation theory discusses how such varying objectives can be met, while minimising the social cost of taxation.

A negative externality or spillover arises where the production or consumption of a good (or service) imposes a cost on a third party. For example, a factory that burns coal creates a negative externality in terms of the pollution emitted. Because the environmental cost of this pollution is borne by society rather

Box 1. **Optimal commodity taxation to address externalities** *(cont.)*

than the factory, the factory will emit more than would be socially optimal. Pigou (1920) showed that the imposition of a tax on coal (or any other polluting activity) could curb emissions by internalising the social cost in the factory owner's production decision.

To fully internalise a negative externality, a "Pigouvian" tax should be imposed at a rate equal to the marginal social cost of the pollution damage, although determining that marginal damage can be difficult. For example, the social cost of carbon has been variously estimated in the range USD 10 to USD 350 per tonne of CO_2 emitted (Yohe *et al.*, 2007). Nonetheless, a Pigouvian tax that is slightly too high or slightly too low, is still likely to provide significant welfare gains compared to the absence of a tax (Heine *et al.*, 2012).

How does the desire to use commodity taxes to raise public revenues affect the level and structure of a Pigouvian tax? The Diamond-Mirrlees (1971) production-efficiency theorem indicates that in a world without externalities (and subject to certain assumptions) taxes should only be imposed on the final consumption of goods and services. The rationale is that "any distortion of production decisions reduces aggregate output, which cannot be wise so long as there is some useful purpose to which that output could be put" (Crawford *et al.*, 2010). The presence of externalities still justifies the imposition of a Pigouvian tax on the intermediate good to correct for the negative externality, but, beyond this, any additional taxation should be imposed on final consumption alone.

There is also some justification for imposing differential tax rates on final consumption which could result in optimal tax rates on polluting goods being greater than the Pigouvian level. Ramsey (1927) showed that in order to raise a given amount of revenue at the lowest cost (in terms of distortions to consumption decisions), higher tax rates should be imposed on goods for which demand is not very sensitive (inelastic) to price increases, with relatively lower tax rates on goods for which demand is more sensitive (elastic) to price increases (the so-called "Ramsey rule"). In the context of taxes on fuel, for which demand tends to be less sensitive to price changes (see Box 2), this implies that taxes on final consumption above Pigouvian levels may be optimal. One weakness, however, in applying this approach is the need for reliable and up-to-date elasticity estimates for all goods. Furthermore, as many inelastic goods (*e.g.* food and energy) may represent a large proportion of consumption by low-income families, implementing the rule may create equity concerns and require off-setting measures.

Optimal commodity tax rates also need to take account of the impact of commodity taxes on the labour market. Commodity taxes push up commodity prices and thereby reduce the consumption value of wages (meaning that fewer goods can be purchased with a given wage). By reducing the reward from working, this tends to discourage labour effort. Assuming leisure cannot be taxed to neutralise incentives, one indirect solution is to tax goods that are complements with leisure more heavily than other goods in order to make leisure less attractive (Corlett and Hague, 1953; Diamond and Mirrlees, 1971; West and Williams, 2007; Crawford *et al.*, 2010). Again, the practical implementation of this kind of differential taxation is difficult given the high administrative cost of establishing and adjusting rates based on accurate data on the complementarity of different goods with leisure, and accurate elasticity estimates. These concerns lead Crawford *et al.* (2010) to conclude that, externality issues aside, there is a strong pragmatic case for uniformity in commodity taxation.

Finally, recent literature has examined the potential for "recycling" the revenue from a Pigouvian tax (like that on fuels) to fund reductions in other distortionary taxes such as those on labour income in order to offset some or all of the efficiency cost of the Pigouvian tax (see, for example, Bovenberg and de Mooij, 1994; Bovenberg and Goulder, 2002; Jacobs and De Mooij, 2012). This includes the question of whether there is potentially a "double dividend" from both reducing environmental harm and reducing the efficiency cost of the tax system as a whole. Much depends on the structure, rates and impacts of the particular taxes being adjusted. Heine *et al.* (2012) note that the literature generally finds that the revenue recycling benefits of reducing labour income taxes are outweighed by the efficiency losses in the labour market due to higher energy prices. They conclude that "the optimal tax is below the marginal external damage, but only moderately so, implying that the Pigouvian tax is still a reasonable, rough approximation".

Box 2. **Are energy taxes an effective policy tool?**

As discussed above, energy is often an attractive tax target because energy demand by consumer and firms is relatively price inelastic – not very sensitive to changing price levels. On the other hand, energy taxes are often used to ensure that the price of energy reflects some of the external costs that energy use imposes on others – harmful emissions, congestion, etc. Used in this way, energy taxes provide a signal aimed at changing behaviour – indirectly encouraging consumers and firms to choose energy-saving or greener products and practices. How does one reconcile these two purposes – does the former imply that energy taxes are not very effective in the latter role of adjusting price signals in order to change behaviour?

Part of the answer is that the key element in achieving the second purpose is to incorporate the external costs of fossil fuel use into fuel prices. How much behaviour changes will depend on how important the activity is to people and what alternatives are available.

A "macro" approach to assessing the degree of behavioural change could be to compare the level (or the trend) of energy taxes in different economies with the energy intensity of the economy (*e.g.*, the share of energy consumption to GDP). Through this kind of analysis, a general indirect relationship can be found. However, energy intensity is a global measure influenced by other factors unrelated to taxation, such as the availability of energy resources and energy-saving technologies, and the stage of economic development in a country (Liddle, 2012). As a result, this kind of comparison can hardly give a precise indication of the efficacy of energy taxes.

The usual measure of the reactivity of demand to price changes is referred to as elasticity. A good's "own-price" elasticity is computed as the percentage change in quantity demanded in response to a one per cent increase in the price of the good (holding constant other factors). OECD (2006), summarises earlier studies which found that the short-run price elasticity of energy as a whole seems to be relatively low, with results in the range between –0.13 and –0.26. This implies that in the short-run, energy practices do not change very much given a change in price. By contrast, studies found considerably higher elasticities in the long run, in the range of –0.37 to –0.46. This implies that if changes persist, and firms and individuals have time to adjust, their behaviour will change. In the case of gasoline, elasticity estimations were even lower (–0.15 to –0.28) for the short term, but higher (–0.51 to –1.07) in the long term. Thus, if road fuel becomes more expensive, people may react by, for example, buying more efficient vehicles or choosing homes closer to where they work. While the level of reactivity differs greatly between products, countries, time spans and income groups (Dahl, 2012), in general long-term elasticities have proven to be considerably higher than shorter ones. With time, firms and consumers adjust and find ways of meeting their needs in a more energy-efficient manner. There is also a literature suggesting that in some cases the elasticity of demand in response to tax changes may be higher than with respect to other price changes (Li *et al.*, 2012; Rivers and Schaufele, 2012).

The reactivity of demand can also be evaluated through "cross-price" elasticities; the percentage change in quantity demanded of an energy-related product in response to a one per cent increase in the price of energy . An example of the importance of cross-price elasticitiy is the evidence of the increase in proportion of the vehicle fleet which uses diesel fuel as a result of more favourable taxation of diesel relative to gasoline and the greater efficiency of diesel engines.

Therefore, energy taxes can have a significant impact in the long run on energy demand and its composition. This implies that environmentally related taxes should be implemented with a long-term view, avoiding set-back due to temporary pressures (*e.g.*, when underlying energy prices increase) and with advance notice of the introduction of the tax and of gradual increases in the tax rate (OECD, 2006).

2.2. Current energy tax challenges

The taxation of energy has gained much attention in recent years. On one hand, combating climate change and addressing air pollution – and the risks they pose to our

economies and overall well-being – calls for economic systems that take into account the environmental impacts of our energy choices. OECD analysis has consistently shown that price signals – as modified through energy taxes or emission trading schemes – are one of the best policy instruments to induce more sustainable patterns of energy use (OECD, 2001, 2006, 2008, 2010a, 2013). On the other hand, after a new wave of fossil fuel price increases, the impact of high energy prices on household budgets and firm competitiveness is a cause of great concern among policy makers. In many countries, the reform of energy taxes and carbon pricing is under lively debate. Tax options take on a particular urgency in an environment where governments are struggling to restore fiscal balance.

An understanding of the role of energy taxes and their relationship to energy use is crucial to a number of broader current policy challenges:

- Politicians, concerned about relieving the adverse impact of high energy prices on low income households at a time of sluggish economic growth, need mechanisms that can address distributional issues without blunting the scarcity and environmental signals sent by energy prices and taxes.
- Similarly, to achieve environmental objectives and move their economies to a green growth path, policy makers need to ensure that appropriate price signals are sent to industry and households regarding energy use, while recognising the need to cushion adjustment impacts.
- In countries adopting (or considering) explicit carbon pricing, the respective role and scope of taxes and emission trading schemes needs to be weighed and carefully designed, recognising the advantages and disadvantages of the two policy tools, with taxes generally having some role given the difficulty of instituting trading for small players.
- Inspired partly by approaches in some Nordic countries, the European Commission has proposed to amend the European Energy Tax Directive[2] by splitting the minimum tax rates – currently based only on the energy content of products – into two components: one based on CO_2 emissions and one based on energy content, and gradually expanding coverage and rates.
- Given commitments to phase out inefficient fossil fuel subsidies, governments need analytic tools to examine the incidence, economic rationale and environmental impacts of fossil fuel preferences within their energy tax systems.

This report is intended to fill an important information gap and to provide a more sound analytic basis on which to address these kinds of policy challenges. To do so, it presents detailed "maps" of energy usage and energy tax structures in the 34 OECD countries. It is recognised that countries have different structures and rates of tax on energy products for a variety of reasons, including differences in revenue-raising needs, environmental goals and policy instruments, resource endowments, and different views about income distribution. In all cases, however, these data-rich illustrations, prepared on a common basis, are a powerful tool for examining and assessing the connections between tax policy and energy use. Why are there relatively high taxes on some energy products and little or no taxes on other energy products? In light of objectives and impacts, are some rates too low? Are other rates too high? It is hoped that the maps will contribute to sound analysis and understanding of these issues, helping policy makers to design effective policies, and increasing public understanding of alternative policy choices and their implications.

3. Structure of the maps, methodology and data sources

The maps show the composition of energy use in each OECD country covered and the effective rate of tax on various segments of energy use. Both energy use and tax rates are shown alternately in terms of energy content and carbon content. Partly inspired by the approach of Sweden's tax expenditure reports, they also depict reported tax expenditures, showing both the actual tax rate and the benchmark rate against which the value of the preference is calculated.

This section provides an overview of the methodology, assumptions, and data sources underlying the maps. Further details on these can be found in Annex A, or, where specific to a particular country, in the relevant country chapter.

3.1. Tax base – energy use

The horizontal axis of each map shows all final use of energy by businesses and individuals, including the net energy used in energy transmission and in the transformation of energy from one form to another (*e.g.*, crude oil to gasoline, coal to electricity). Energy use has been grouped into three broad categories: transport; heating and process use; and electricity. These three areas have been further disaggregated for each country, generally reflecting the particular tax base of that country. The subcategories therefore differ between countries depending on the nature of the fuel, its user, or its use.

Since different types of energy are normally measured and taxed in varying units of volume or mass (*e.g.* litres of gasoline, tonnes of coal, megawatt hours of electricity), all forms of energy are expressed in terms of a common unit (using standard conversion factors). In the first figure for each country, fuel quantities are expressed in terms of energy value (in gigajoules – GJ), reflecting that what all the products have in common is that they are sources of energy. In the second figure for each country, the quantities of the various energy sources are expressed in terms of the carbon emissions associated with their use (in tonnes of CO_2).[3] Since the emissions figures are derived rather than being directly measured, they will differ somewhat from measured emissions reported for such purposes as national greenhouse gas inventories. The re-expression of tax bases in terms of carbon content permits a focus on the structure of taxation with respect to one of the main purposes for which fuel is taxed in many countries – to reflect (at least in part) the social cost of carbon emissions. Consistent with the focus of the publication, only CO_2 emissions associated with fuel combustion are covered; emissions such as those from landfills, fields, livestock, and chemical reactions in industial processes are not included.

Electricity is different from most of the other energy types shown in that it is a *secondary* energy which must be generated by use of some *primary* energy (*e.g.*, coal, natural gas, nuclear power, hydro). The electricity category of the map therefore shows the energy content or carbon emissions of the underlying primary fuel used to generate the electricity domestically rather than of the electricity itself. Thus, even though electricity itself does not give rise to carbon emissions, the maps illustrate the carbon emissions from generating that electricity as well as the efficiency losses incurred in the generation process (due to the fact that, for example, 100 GJ of natural gas may be required to produce 70 GJ of electricity). Depending on the particular tax system, the electricity category may be subdivided by the type of fuel used to generate the electricity, or by the user of the electricity. If the latter, the figures shown represent the particular user's share of the input fuels used to generate electricity.

Data on energy use is taken from the 2009 *Extended World Energy Balances* (IEA, 2011a).

3.2. Tax rates and tax expenditures

On the vertical axis, the maps show the rate of specific taxes and related tax expenditures that apply to energy use. The taxes covered are those such as excises levied directly on a physical measure of energy product consumed. Taxes that apply to a very broad range of goods (such as value added and retail sales taxes) are not included on the basis that since they apply equally to a wide range of goods, they do not change relative prices. On the other hand, where an energy product is subject, for example, to a concessionary rate of VAT, the concession would affect relative prices. Taxes like this, however, that are levied as a percentage of the value of the good (*ad valorum*) rather than as an amount per physical unit of the good are not taken into account because their relationship to fuel volume varies as prices fluctuate.[4] Also excluded are taxes that that may be related to energy use but that are not imposed directly on the energy product (such as vehicle taxes, road user charges or taxes on emissions such as NO_x and SO_x which do not have a fixed relationship to fuel volume. Production taxes, and royalties and other levies on the extraction of energy resources are excluded on the assumption that since they generally apply to internationally traded goods, they have little impact on prices in the domestic market.

Tax rates, which are typically set in monetary units per physical quantity of fuel (*e.g.*, litres, kilograms, kilowatt-hours, etc.) are re-calculated as effective tax rates per gigajoule of energy (in the first map for each country) and per tonne of CO_2 emissions (in the second map). Energy value has been chosen as a neutral basis for comparing tax rates on products that are normally expressed in terms of diverse physical quantities since the thing that these products have in common is their use as a source of energy. This is not meant to endorse a policy of taxing fuels based on their energy content *per se*. By contrast, there is a strong rationale for taxing fuel based on its carbon content as a means of internalising the social cost of the damage caused by CO_2 emissions.

Tax rates are shown in local currency on the left-hand axis of the maps, and in euros on the right-hand axis (converted by reference to the average market exchange rates over the 12 months ending August 2012). The tax rate applying to each fuel is mapped on the graph as a shaded bar across the portion of energy use or carbon emissions (the tax base) to which the particular rate applies. The shaded rectangle beneath this bar is an approximation of the revenue raised by the tax – the rate multiplied by the base.

The maps help to clarify that a common tax rate on different fuels in terms of physical volume will generally not equate to a common tax rate in terms of energy content or carbon emissions. This is because a given volume of different fuels generally has a different energy content and emission characteristics. Box 3 provides more information about how neutrality of tax treatment differs depending on whether tax rates are measured in terms of physical quantities, energy content or carbon content.

Taxes levied on electricity consumption have been mapped as effective taxes on the fuels used to generate the electricity. In cases where a common nominal tax rate is applied to all electricity consumption, the effective tax rate on each underlying energy source (*e.g.*, coal, natural gas, hydro) used to generate the electricity is shown. In cases where different rates of nominal electricity tax apply to consumption in different sectors (*e.g.*, residential, commercial, industrial), for each sector, the effective tax rate shown is that on the "average" basket of fuels used to generate electricity in the country.

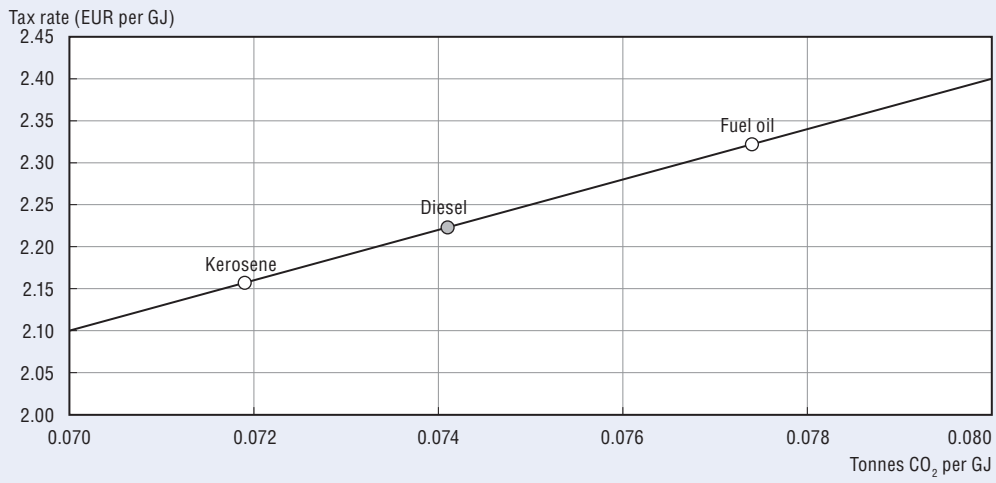
Box 3. **Neutrality in the treatment of different fuels**

A given physical quantity of different fuels generally has a different energy content and different emission characteristics. Therefore, tax rates that are equal in physical terms or in energy terms will not be equal in carbon terms and vice versa. If, for example, one is aiming to use the tax system to send a carbon price signal by internalizing some of the social cost of CO_2 emissions, one would set a tax rate that poses the same cost relative to each tonne of CO_2 emitted. However, achieving a rate that is neutral on a carbon basis will require a higher rate on an energy unit basis on the more carbon-intensive fuels.

This is illustrated in Figure 1 below. The horizontal axis shows the carbon intensity of three fuels in terms of the number of tonnes of CO_2 emitted per gigajoule of energy produced. Relative to its energy value, kerosene is a lower emission fuel than fuel oil. The vertical axis shows effective tax rates in terms of energy content, measured in EUR per GJ.

The sloped line represents a tax rate of EUR 30 per tonne of carbon, which is equivalent to a tax on kerosene at EUR 2.16 per GJ. Because fuel oil is relatively more carbon intensive than kerosene for each unit of energy, that same level of carbon price would require a tax on fuel oil equivalent to EUR 2.32 per GJ. For similar reasons, a uniform tax rate on a carbon basis would require differing tax rates on a physical unit (*e.g.*, per litre or per kilogram) basis.

Figure 1. **Taxation of different fuels at EUR 30 per tonne of CO_2**



Source: OECD calculations based on conversion factors from sources outlined in Annex A (see pp. 244-246).

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Effective carbon tax rates on electricity need to be interpreted carefully when there is a general tax on electricity consumption that applies regardless of the generation source. Essentially, the rate is the answer to the question: *if* the electricity tax were assumed to be a tax on the carbon content in the average unit of electricity, what would the effective rate of that tax (per tonne of CO_2) be? In this case, if carbon energy is a small proportion of the generation mix, the effective tax rate on carbon thus calculated will be very high. A tax on electricity consumption that does not distinguish between electricity from carbon sources and electricity from non-carbon sources cannot send an effective price signal about the use of carbon. Nonetheless, in this report, in order to maintain the same tax coverage for energy and carbon statistics, undifferentiated taxes on electricity consumption are included in the computation of effective tax rates on carbon.[5]

The maps also show tax rebates, credits and other tax expenditures that are reported by the country concerned. Tax expenditure reports typically set out the revenue foregone due to a particular measure. In the maps, the area of the light grey shaded rectangles is an estimation of this revenue loss. In addition, however, the top of this rectangle is the benchmark or "normal" level of tax from which the measure is a departure while the bottom of the rectangle is the net level of tax that applies as a result of the concession. In this respect, the maps are a useful complement to material that focuses on the value of tax expenditures, such as the OECD's *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels* (OECD, 2013). By showing tax expenditures in context, the maps can facilitate discussion about appropriate tax benchmarks for different fuels, uses and users. Information about the international commitment to rationalize fossil fuel subsidies is set out in Box 4.

Box 4. **Tax expenditures for fossil fuels**

Regardless of the basis on which governments apply taxes on energy products, in practice they have often introduced exclusions or preferences to address concerns such as the potentially adverse impacts (real or perceived) of higher energy prices on particular groups of consumers or producers. It is increasingly recognised, however, that such preferences change relative prices in the economy in ways that can have negative environmental impacts.

In the OECD's June 2009 Declaration on Green Growth, 34 countries agreed to "encourage domestic policy reform, with the aim of avoiding or removing environmentally harmful policies that might thwart green growth, such as subsidies: to fossil fuel consumption or production that increase greenhouse gas emissions…" (OECD, 2009). Three months later, G20 leaders committed to "rationalise and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption". They noted that inefficient fossil fuel subsidies "encourage wasteful consumption, distort markets, impede investment in clean energy sources and undermine efforts to deal with climate change" (G20, 2009).

To provide a knowledge-base on which to consider the scope and nature of fossil fuel support policies in member countries, the OECD has compiled an Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels (OECD, 2013). Unlike many developing and emerging countries, few OECD countries provide direct price subsidies for fossil fuels. However, a significant amount of support in these countries is provided through tax expenditures, including reductions in or exemptions from energy taxes. A tax expenditure is generally measured by the amount of tax reduction provided relative to the normal or "benchmark" tax treatment that would otherwise apply. Assuming some degree of neutrality in the benchmark system, tax expenditures measure the size of the relative preference provided within the national economy. Since the "normal" benchmark tax treatment, however, varies so much from country to country, tax expenditures are not readily comparable from one country to another.

A full assessment of a tax expenditure requires broader consideration of the tax system of which it is a part. The maps in this report illustrate the value of the relief given under reported tax expenditures relating to taxes on energy consumption. Importantly, however, they also show the broader context of these measures by showing the actual rate of tax as a result of the tax expenditure, the "normal" level of tax that would otherwise apply (the benchmark rate), and the rates of tax that apply to other products.

Given the economy-wide scale of the maps, they do not show certain small details of tax bases, rates and preferences. For examples, where tax bases are too small to show separately, they may be combined and shown with a weighted average tax rate.

Where multiple energy taxes or tax components apply to the same base, they have been aggregated and mapped together. This ensures that all countries are shown in the same manner and reflects the fact that behaviour is influenced by the overall level of energy taxation, rather than the individual components. However, the level of explicit carbon taxes as part of the aggregated components is indicated where practical within the graphs by a horizontal line within the darker grey shading.

For federal countries, the scale of the maps does not allow the separation of energy consumption by state or province (nor is internationally comparable data available at that scale). However, given the importance of energy taxes at the sub-national level, provincial tax rates are shown for an illustrative group of states or provinces.

In recognition that many countries are effectively pricing carbon emissions for some sectors through emission permit trading, the maps note the interaction of tax systems with the European Union Emission Trading System (EU ETS). An energy category is denoted "[ETS-A]" on the carbon map if it is fully or largely covered by the EU-ETS and "[ETS-P]" if it is only partially covered. The carbon maps also show the average market price for ETS credits for 2010-11 on the vertical axis.

Tax rates are expressed as of 1 April 2012 (unless otherwise indicated). Information on taxes has been taken from the OECD/EEA database on instruments used for environmental policy (*www.oecd.org/env/policies/database*), the European Commission (2012), and country-specific sources. Tax expenditure information is primarily from OECD (2013).

Further information on the methodology can be found in Annex A.

4. Energy use and taxation across OECD countries: Results from the analysis

The country maps presented in the second part of this report provide a number of insights into the taxation of energy use in OECD countries in general and illustrate a number of patterns. This section uses the data presented in the maps to consider patterns across the OECD, before focusing on each of the three broad categories of energy use: transport, heating and process use, and electricity. Finally, given its importance in addressing environmental concerns, the taxation of carbon emissions is considered in more detail.

The country maps make clear, first, that the energy situation across the OECD area is quite diverse – the composition of energy usage in terms of fuels and uses, and the resulting CO_2 emissions, varies substantially from one country to another. The most obvious insight from the maps, however, is that countries differ markedly in the way they tax energy. They differ in the range of products that are taxed, in tax base definitions and in tax rate levels and rebates. Even within individual countries, there are often substantial differences in the way in which different forms, uses and users of energy are taxed, whether they are compared in terms of energy content or CO_2 content. Sometimes the reasons for these differences are apparent, but in many cases, they are not. What is clear is that tax systems often send very different price signals in respect of different fuels and fuel uses.

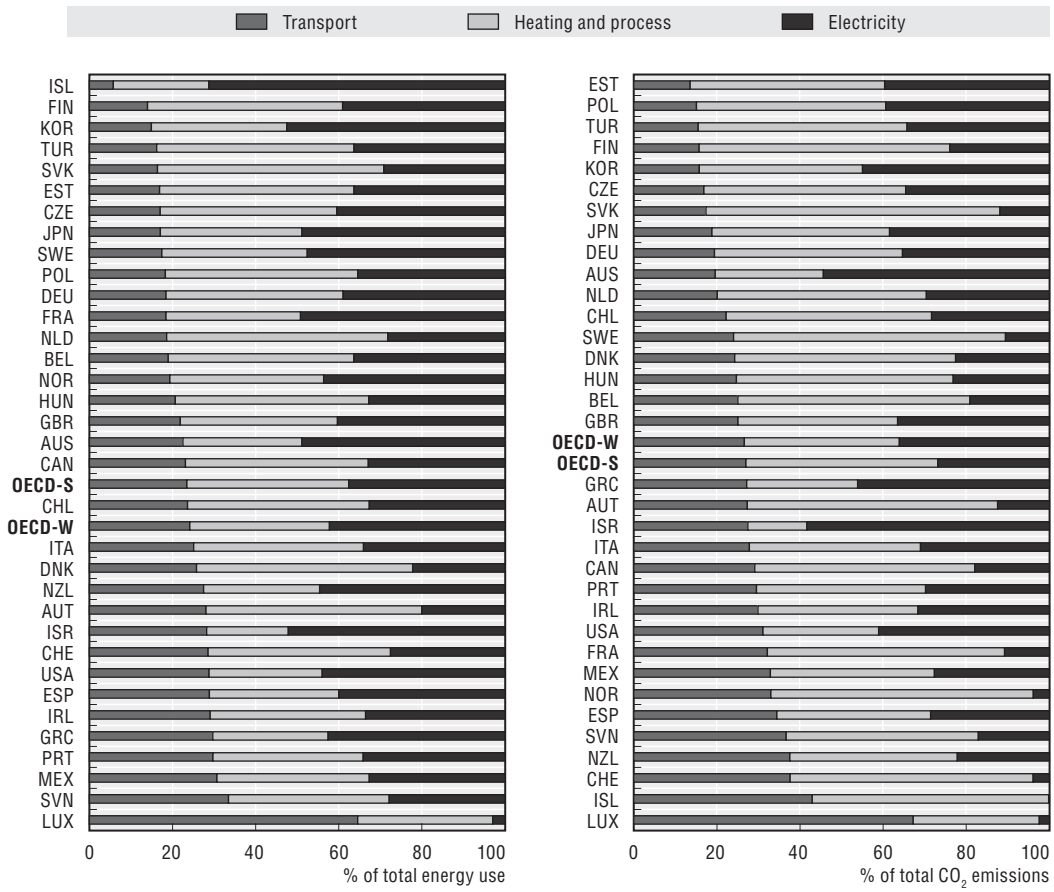
4.1. Taxation of energy in the OECD – general trends

Overall tax base: energy use in the OECD

OECD countries vary significantly in their sources of energy, their uses of energy, and consequently in the CO_2 emissions that result from energy use.

Figure 2 below shows the proportion of energy use (left panel) and CO_2 emissions (right panel) in each of the three main categories of energy use. The transport category varies in size from 6% to 65% of the total energy base, and 14% to 67% of total CO_2 emissions. On a simple average basis across OECD countries, transport accounts for 23% of total energy use and 27% of total CO_2 emissions. In Luxembourg, the unusually high (over 60%) share of energy used for transport purposes arises because of the high volume of motor fuel sales to non-residents.

Figure 2. **Composition of energy use (left) and CO_2 emissions from energy (right) in OECD countries by use**



Source: OECD calculations based on energy use data for 2009 from IEA (2011a).

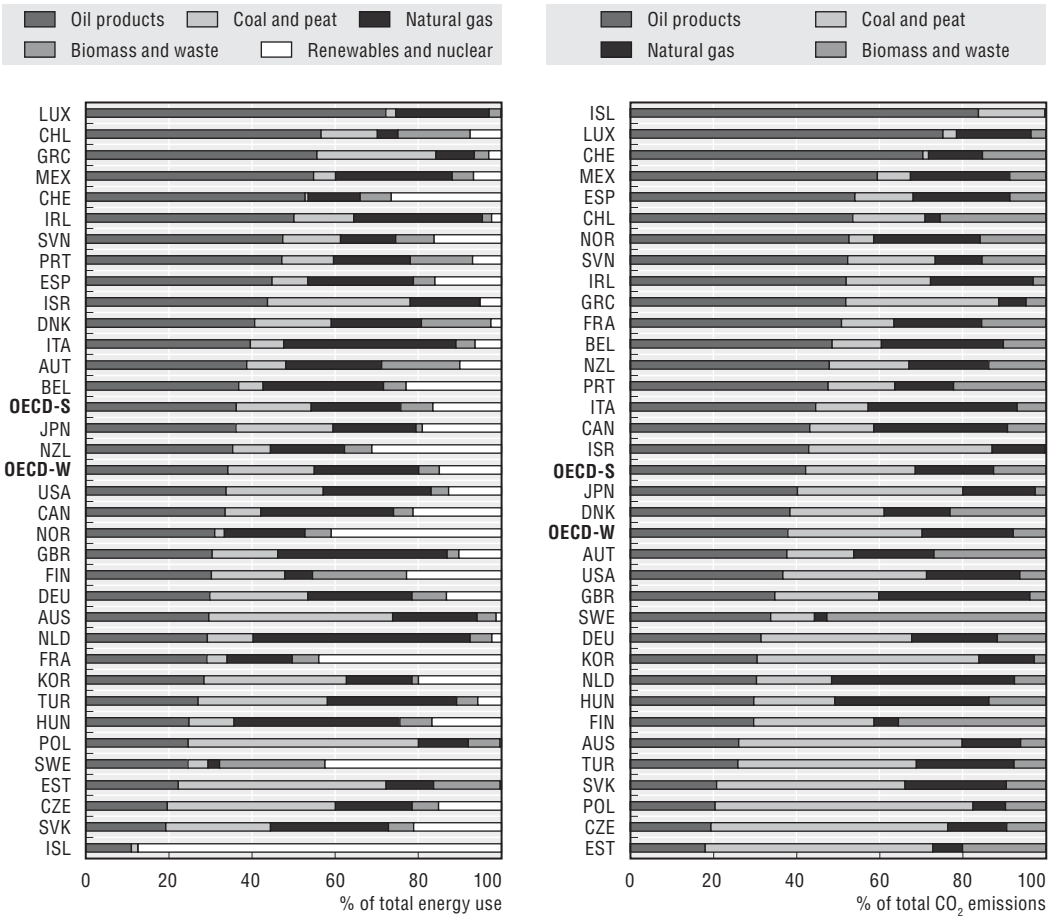
StatLink http://dx.doi.org/10.1787/888932765560

As illustrated, heating and process use varies from 20% to 54% of energy use, and 14% to 71% of CO_2 emissions; the simple averages for all OECD countries are 39% and 46%, respectively. The electricity category varies from 3% to 71% of energy use, and 0% to 58% of CO_2 emissions. The very large share of energy use in the electricity sector that is observed for Iceland (top of left panel) arises because of the importance of electricity-intensive

industries like aluminium smelting. However, since almost all of the electricity comes from renewable sources (hydro and geothermal), it has no appreciable carbon footprint (near bottom of right panel). On a simple average basis across the OECD, electricity makes up 38% of energy use and 27% of CO_2 emissions. The smaller relative size of the electricity category when measured in CO_2 terms is due to the higher proportion of renewables used to generate electricity relative to the small proportions of renewables used in the transport and heat and process categories.

The mix of fuel types also varies substantially across countries. Figure 3 breaks down energy use (left panel) and CO_2 emissions from energy use (right panel) into five major fuel groups. Oil products make up the greatest proportion of total energy usage in OECD countries – 34% (weighted average) and 36% (simple average). However, the proportion ranges from 11% in Iceland to 72% in Luxembourg – again reflecting the unusual characteristics of energy usage in these two countries. Even excluding these two outliers, there is still considerable variation with oil products making up between 19% and 57% of total energy use. Natural gas, coal and peat, and renewable and nuclear energy all account for similar (16%-22%) proportions of total energy use, on a simple average basis, while biomass and waste accounts for just 8% of energy use on this basis. Cross country variation, however, is very wide for each

Figure 3. **Composition of energy use (left) and CO_2 emissions from energy (right) in OECD countries by fuel**



Source: OECD calculations based on energy use data for 2009 from IEA (2011a).

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energy type: natural gas ranges from 0% to 52% of total energy use; coal and peat, from 1% to 55%; renewables and nuclear energy, from 0% to 87%; and biomass and waste, from 0% to 25%. Iceland, unsurprisingly, is the outlier regarding renewables and nuclear energy (at 87%), with the next highest being France at 44%.

The story is very similar regarding CO_2 – there is substantial cross country variation, but with oil products still producing, on average, the greatest proportion of CO_2 emissions. There are two major differences though: renewables and nuclear energy now disappear from the graph – as they produce no CO_2 emissions – and coal tends to contribute a significantly greater share of emissions than natural gas. This is because coal produces greater CO_2 emissions per unit of energy (for example, around 0.095 tonnes per GJ for bituminous coal, depending on the source) than from natural gas (approximately 0.056 tonnes per GJ).

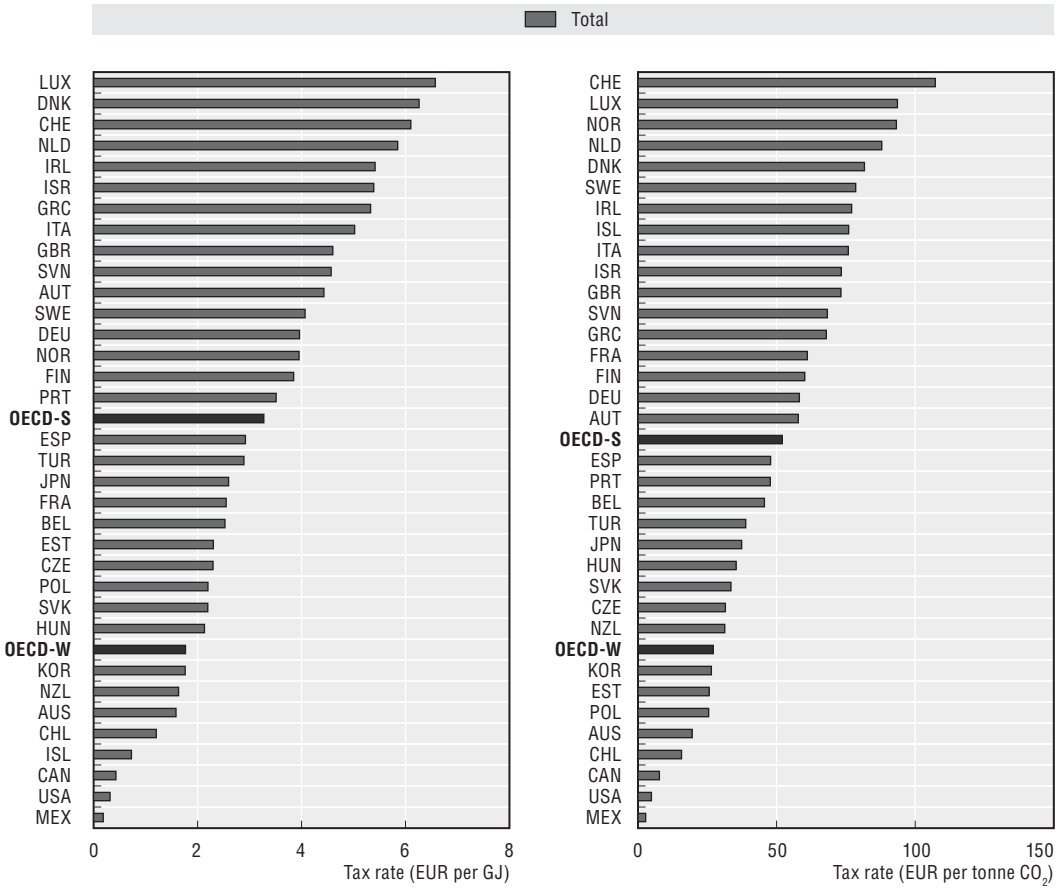
Overall tax rates: effective tax rates on energy in the OECD

At an economy-wide level, there are significant differences in the overall level of energy taxation across the OECD area. Figure 4 sets out for each country the overall average effective tax rate, on a weighted basis, on energy use (left panel) and on CO_2 emissions from energy use (right panel). In energy terms, the simple average rate (OECD-S) is EUR 3.28 per GJ while the weighted average rate (OECD-W) is 1.77 per GJ. The range of country averages, however, is very wide – from EUR 0.18 per GJ in Mexico to EUR 6.58 per GJ in Luxembourg. Luxembourg has the highest rate even though its tax rates on most fuels are not among the highest. This is because Luxembourg has an exceptionally high volume of motor fuel sales which, as in most countries, are taxed at considerably higher rates than other fuel uses. Note that the figures for Mexico do not include the variable component of the *Impuesto Especial sobre Producción y Servicios* on gasoline and diesel which can act as either a tax or a subsidy depending (predominantly) on international gasoline and diesel prices. Note also that for countries that impose energy taxes at both the federal and state/provincial level (notably Canada and the United States), these figures only account for taxes imposed at the federal level. This is the case for all the results presented in this part of the report.

Similarly, there is a wide range of effective tax rates on carbon, when measured on an economy-wide basis, as set out in the right panel of Figure 4. Consistent with the general approach of this report, these figures take into account all specific taxes on energy, whether or not they are explicitly intended to tax carbon. The simple average rate (OECD-S) is EUR 52.04 per tonne of CO_2, while the weighted average (OECD-W) is EUR 27.12 per tonne of CO_2. Again, there is a wide range around these averages: from EUR 2.80 per tonne in Mexico to EUR 107.28 per tonne in Switzerland (which incidentally has an explicit carbon tax).

The highest overall tax rates on carbon tend to be in European countries, which are generally found in the middle and upper parts of the graph. For members of the European Union, energy tax policy is significantly shaped by the 2003 EU Energy Taxation Directive, which sets minimum tax rates for a variety of energy commodities. Box 5 describes the EU Directive in more detail.

Figure 4. **Average effective tax rates on energy (left) and CO_2 from energy (right) in OECD countries**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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Many of those countries with the highest effective tax rates on carbon per Figure 4 are countries with explicit carbon taxes (*e.g.* Denmark, Iceland, Ireland, Norway, Sweden and Switzerland).[6] Explicit carbon taxes generally exist alongside other taxes on energy products, which are sometimes based on the energy content of different fuels. From the maps for these countries in Part II, it can be seen that they tend to tax a broad range of energy products and to have more consistency in rates across different fuels and uses, particularly in the heat and process use category.

Many eastern European and Asian countries tend to have lower effective tax rates on carbon (*e.g.* Czech Republic, Estonia, Hungary, Japan, Korea, Poland, Slovak Republic, Turkey). Australia and the Americas (Canada, Chile, Mexico, United States) have the lowest effective tax rates. The maps for these latter countries (and New Zealand) illustrate that they typically tax fuels used in transport use (though generally at lower rates than the OECD average) and tend not to tax energy in non-transport uses (an exception being at the provincial level in Canada).

What is not evident from the economy-wide tax rates is that tax rates also vary significantly across fuels and fuel uses. Tables 1 and 2 show the simple average for OECD

Box 5. **European Union Energy Taxation Directive**

In October 2003, member states of the European Union (EU) adopted the Energy Taxation Directive 2003/96/EC, which sets out common rules for the taxation of energy products in member states. Twenty-one OECD member countries, as members of the European Union, are thus subject to the Directive: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden and the United Kingdom.

The Directive is intended to reduce distortions of competition, both between member states created by divergent rates of tax on energy products, and between mineral oils and the other energy products. It is also intended to increase incentives to use energy more efficiently. The Directive sets common taxation rules for a range of fuels, including many oil products, coal and natural gas, and for electricity consumption. For each, it sets a minimum level of tax expressed in terms of the volume, weight, or energy content of the fuel. The directive also sets out transitional measures and permitted derogations (both general and country-specific) from the minimum levels, such as exemptions for particular sectors.

The current minimum tax rates under the Directive are set out in the table below.

Fuel		Minimum tax rate (EUR)	Unit	EUR per GJ equivalent[1]	EUR per tonne of CO_2 equivalent[1]
Gasoline	Leaded	421	1 000 litres	12.69	183.07
	Unleaded	359	1 000 litres	10.82	156.11
Gas oil	Propellant use	330	1 000 litres	9.19	123.99
	Heating and process use	21	1 000 litres	0.58	7.89
Kerosene	Propellant use	330	1 000 litres	9.19	129.41
	Process use	21	1 000 litres	0.59	8.24
Heavy fuel oil	Heating	15	1 000 kilograms	0.37	4.82
LPG – propellant use	Propellant use	125	1 000 kilograms	2.64	41.88
	Process use	41	1 000 kilograms	0.87	13.74
	Heating	0	1 000 kilograms	0	0
Natural gas	Propellant use	2.6	1 gigajoule	2.60	46.35
	Process use and non-business heating	0.3	1 gigajoule	0.30	5.35
	Business heating	0.15	1 gigajoule	0.15	2.67
Coal	Non-business heating	0.3	1 gigajoule	0.30	3.17
	Business heating	0.15	1 gigajoule	0.15	1.59
Electricity consumption	Business	0.5	1 megawatt hour	0.14	2.29
	Non-business	1	1 megawatt hour	0.28	4.57

1. Energy content and CO_2 equivalents have been calculated by the OECD Secretariat based on the conversion factors described in Annex A.

The European Commission has proposed a new Energy Taxation Directive which, if approved, would replace the current Directive from 2013 (European Commission, 2011a). The proposed rules aim to promote energy efficiency and consumption of more environmentally friendly products and to avoid distortions of competition in the Single Market. Under the revised directive, taxes on energy would have two components:

- a single minimum rate for CO_2 emissions (EUR 20 per tonne of CO_2) for all sectors that are not part of the EU ETS; and
- minimum rates based on the energy content of the fuel, which will be more uniform across types of fuel.

These components would be combined to produce the overall minimum tax rate at which fuel products would be taxed. Countries would be able to choose to exceed one or both minimum rates, although the same rate would then apply to all fuels used for the same purpose. Transitional periods would apply for certain fuels to allow government and industry to adapt, with full implementation intended from 2023. In addition, certain country-specific transition periods are proposed.

countries of the effective tax rates on energy (Table 1) and CO_2 emissions from energy (Table 2), broken down by major fuel types and fuel use categories. The simple average in a sense reflects the practice of the "typical" OECD country, with all countries considered equally regardless of the volume of their total energy use.

Table 1. **OECD simple average effective tax rates on energy by fuel type and use**

EUR per GJ

		Fuels					
		Oil products	Coal and peat	Natural gas	Biofuels and waste	Renewables (and nuclear)	All fuels
	% of base	34%	21%	25%	5%	15%	100%
Transport use	24%	11.8	0.0	0.6	5.0	0.0	**11.5**
Heating and process use	34%	1.7	0.5	0.7	0.0	0.0	**0.9**
Electricity	42%	0.9	0.7	1.2	0.7	1.1	**0.9**
Total use	100%	**7.9**	**0.8**	**0.8**	**0.8**	**1.0**	**3.3**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a).

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Table 2. **OECD simple average effective tax rates on CO_2 from energy use by fuel type and use**

EUR per tonne CO_2

		Fuels					
		Oil products	Coal and peat	Natural gas	Biofuels and waste	Renewables (and nuclear)	All fuels
	% of base	38%	32%	22%	8%	0%	100%
Transport use	27%	164	0	11	71	0	**161**
Heating and process use	37%	24	5	13	0	0	**12**
Electricity	36%	11	14	14	13	0	**13**
Total use	100%	**110**	**14**	**15**	**31**	**0**	**52**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). The electricity figures exclude three outliers from the calculations – Iceland, Norway and Sweden.

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Focus first on the three macro categories of use in the column at the far left of each table and the corresponding "all fuels" tax rate in the far right column. What is most striking is that on average, transport use bears a very high level of taxation – more than EUR 11.5 per GJ in energy terms and EUR 161 per tonne of CO_2. The rates are well under a tenth of this level with respect to heating and process use and electricity.

The higher tax rates on transport fuel are likely explained by the broader range of policy goals that governments address in this category. While combustion of fossil fuels in all three categories contributes to emissions of CO_2, fuel use in road transport (the biggest subcategory within the transport category) contributes to other externalities such as congestion, traffic accidents and noise. Since these social costs generally vary by location and traffic conditions, time-specific road pricing would generally be a more direct and efficient way of addressing these externalities. In the absence of road pricing, road fuel consumption, which is correlated (though not evenly for different vehicles) with distance travelled, may be a rough proxy for these other external costs.[7] In addition, a number of

countries formally or informally earmark road fuel taxes to fund road infrastructure costs (construction and maintenance), as a kind of loose user charge. The comparatively heavy taxation of fuels for transport use has a strong impact on overall average rates.

There is also a wide variation in the average effective tax rate on the various fuels, seen most clearly from the bottom row of each of Tables 1 and 2, which provides the average tax rate for all uses for each major fuel group, in energy and carbon terms, respectively. Among fossil fuels, oil products are taxed the heaviest; by comparison natural gas and coal are taxed on the order of ten times less, with coal lower than natural gas. In part, this is driven by the high use of oil products in the heavily taxed transport category, but as discussed below, this is not the entire explanation.

In terms of carbon content (Table 2), biofuels and waste are taxed at a relatively higher rate than in energy terms (Table 1). While the effective tax rate on biofuels and waste is only one-eleventh of the tax rate on oil products in energy terms, it is just over a quarter in CO_2 terms. This difference is primarily due to the relatively low carbon intensity of biofuels, the combustion of which produces less CO_2 per GJ of energy than most other fuel types.

As noted, Tables 1 and 2 present the simple average of the effective tax rates in the 34 member countries – in a sense illustrating what the "typical" OECD country does. The effective tax levels on energy and carbon in the OECD area as a whole are even lower, however, if one considers weighted averages which take into account that some of the largest countries in the OECD (*e.g.* the United States, Japan, Canada) tend to have relatively low effective tax rates. This is illustrated in Figure 5, which presents a map of weighted average effective tax rates across the five main fuel categories for the entire OECD area in terms of energy content, and in Figure 6, which presents the same information in terms of carbon content. Given the global nature of the negative externalities created by carbon emissions, this emphasises the particular importance, from a global perspective, of the policy choices made by large energy users.

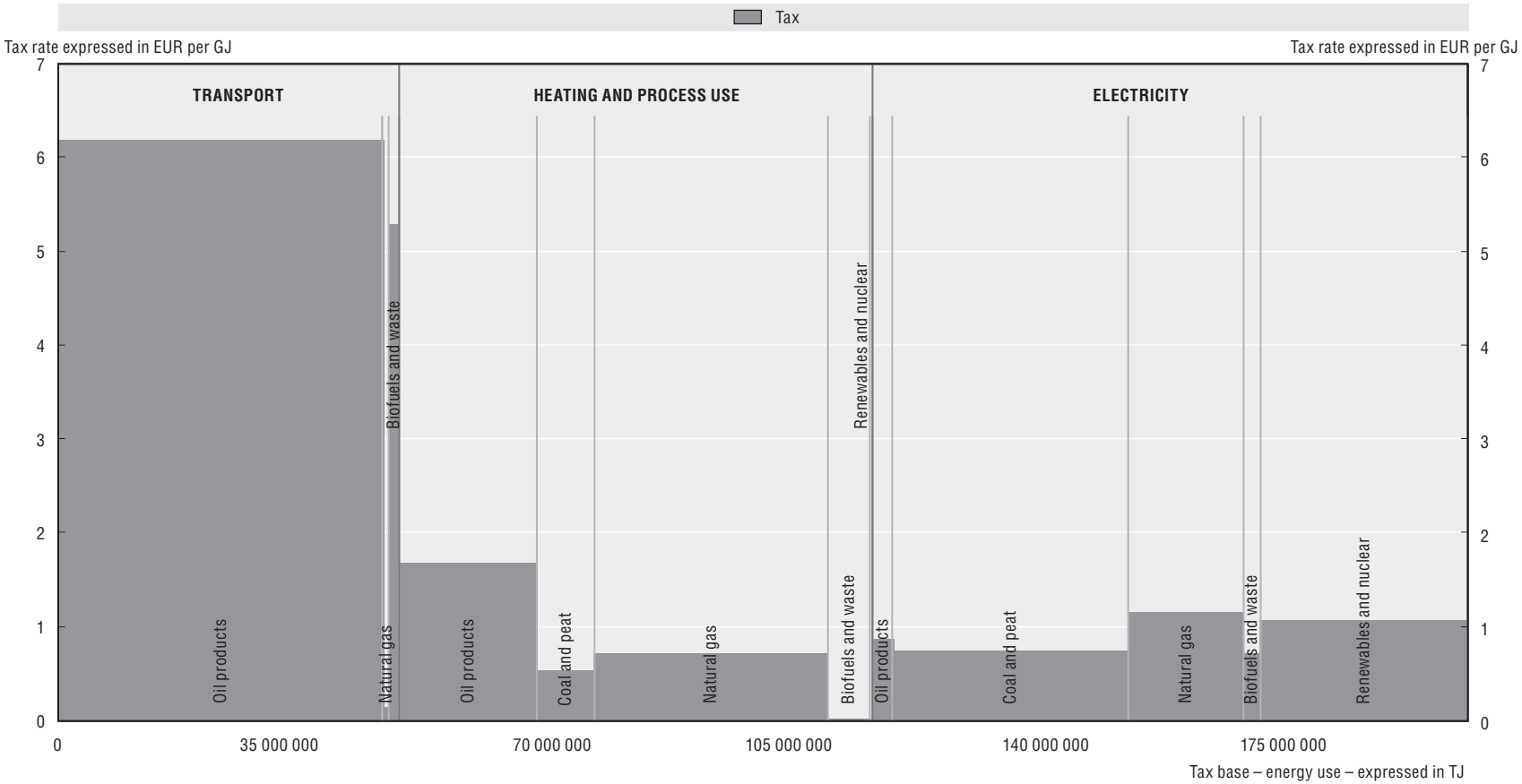
The contrast between the relatively high taxation in the transport category and the relatively low taxation in the heating and process and electricity categories is very evident from both maps. Equally evident in the maps is the variation in tax rates on different fuels within each of the three use categories. For example, the substantial quantity of coal used in electricity generation in the OECD area is taxed, on average, at a lower rate than most other fuel types used to generate electricity, both on an energy and CO_2 basis. Likewise, coal and natural gas used for heating and process purposes are often taxed at lower rates than oil products. Sections 4.2 to 4.4 of this report examine these differences in treatment of fuels sequentially within each of the three broad use categories: transport, heating and process use, and electricity.

4.2. Taxation of energy used in transport

The transport category includes both road transport and other modes such as rail, marine and air. In the average OECD country, transport accounts for 23% of total energy use, and 27% of the CO_2 emissions generated. However, as a result of the substantial tax rates highlighted above, it generates around 85%, on average, of total excise tax revenue from energy products in OECD countries.[8]

As seen above, the transport category is taxed more heavily than other categories. This is true on an OECD-wide basis and within each OECD country, as can be seen from the

Figure 5. **Taxation of energy in the OECD area on an energy content basis**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a).

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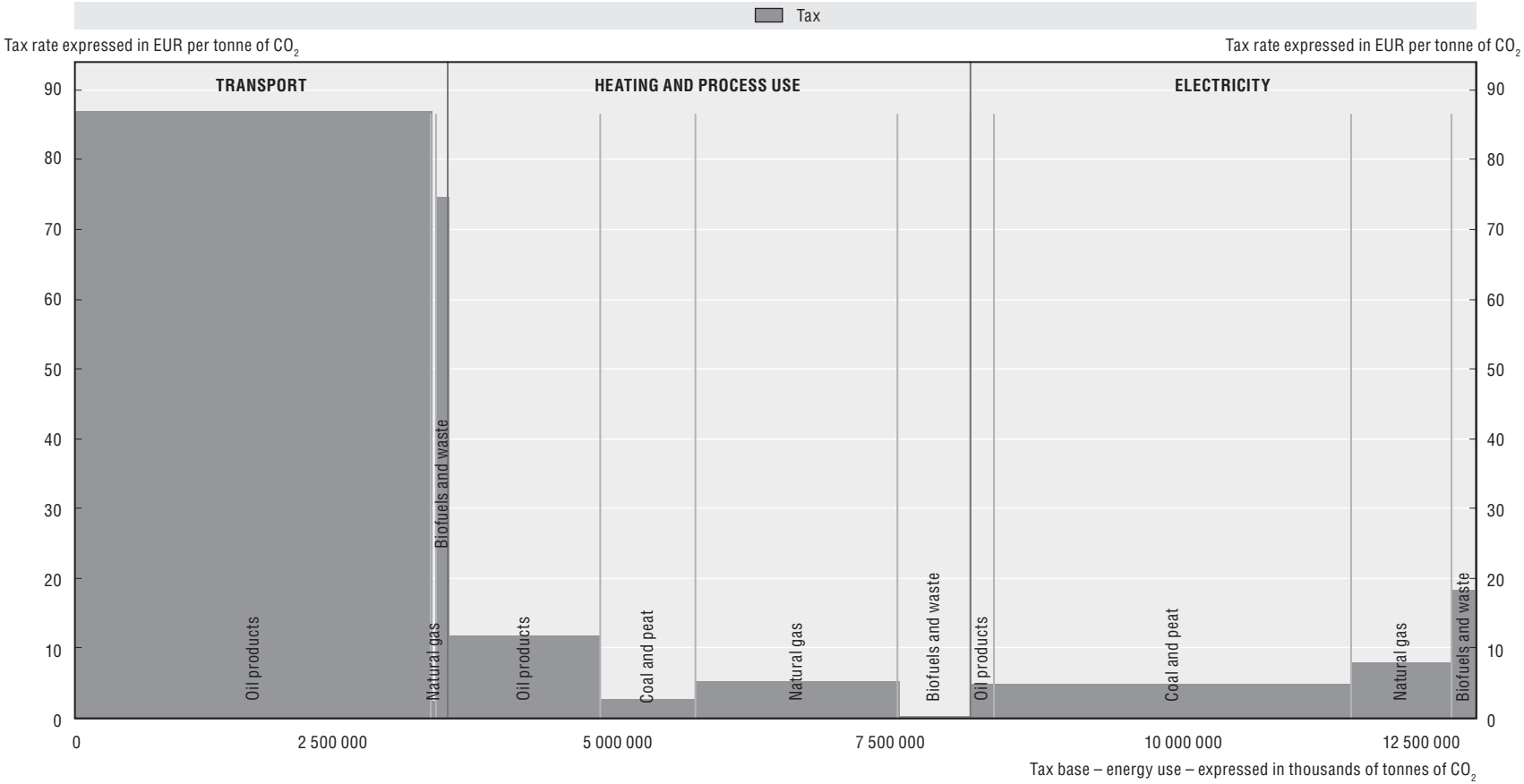
Figure 6. **Taxation of energy in the OECD area on a carbon content basis**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); emissions are based on data for 2009 from IEA (2011a).

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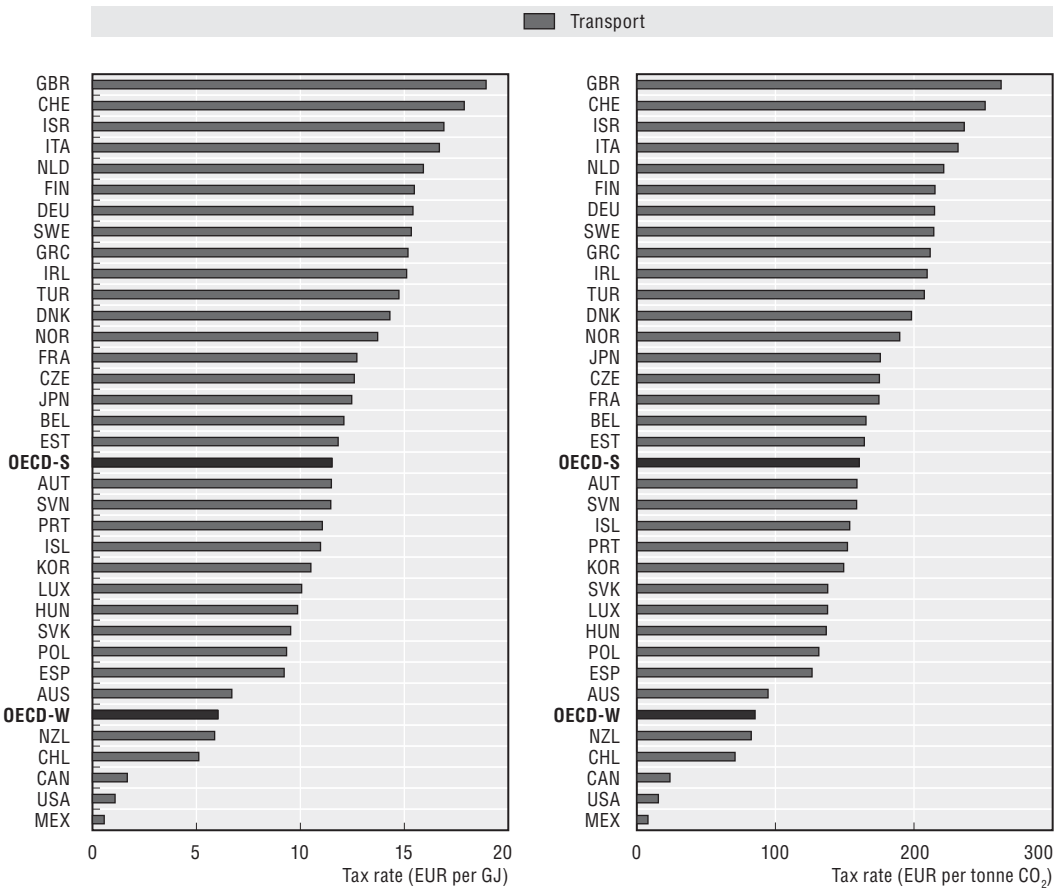
maps in Part II. The variation in the average effective tax rates that apply to transport fuels between countries is illustrated in Figure 7. Effective tax rates on energy (left panel) range from EUR 0.57 per GJ in Mexico to EUR 18.9 per GJ in the United Kingdom. Effective tax rates on carbon range from EUR 8 to EUR 263 per tonne of CO_2, in the same two countries respectively.

Despite these wide variations, Figure 7 shows that the majority of countries impose a substantial tax burden on fuels used in transport, whether measured in terms of energy or CO_2. In terms of energy content, the simple and weighted averages of the country effective tax rates are EUR 11.53 (OECD-S) and EUR 6.05 per GJ (OECD-W), respectively. In carbon terms the simple and weighted averages are EUR 160.53 and EUR 85.40 per tonne of CO_2.

Figure 7. **Effective tax rates on energy (left) and CO_2 (right) in OECD countries: Transport fuel use**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

StatLink http://dx.doi.org/10.1787/888932765655

Effective tax rates on transport fuels also vary considerably within countries, both by fuel use and by fuel type. Tables 3 and 4 present OECD average rates on an energy and CO_2 basis, respectively. Information on the contribution of different fuels to the total size of the respective tax bases is also provided. Some fuels used in small amounts are not presented

in a separate column, though they are included in the calculation of the overall rate for all fuels. Individual country results are set out in Annex B.

Comparing the first and second rows in either table makes clear that road fuel is taxed at much higher rates than fuel used for other modes of transport, in terms of both energy and CO_2 content. This is perhaps explained by the use of taxes on road fuels to internalise social costs specific to road transport (congestion, accidents and noise) or to fund road infrastructure costs.

Table 3. **OECD simple average effective tax rates on energy in transport fuels, by fuel type and use**

EUR per GJ

		Fuels						
		Gasoline	Diesel	LPG	Aviation fuels	Biofuels	Natural gas	All fuels
	% of base	53%	34%	1%	6%	3%	2%	100%
Road use	90%	15.5	10.5	3.4	0.0	5.0	0.7	**12.2**
Non-road use	10%	1.0	4.4	0.3	1.7	0.0	0.3	**2.9**
Total transport use	100%	**15.5**	**10.2**	**3.6**	**1.7**	**5.0**	**0.6**	**11.5**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a).

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Table 4. **OECD simple average effective tax rates on CO_2 from transport fuels, by fuel type and use**

EUR per tonne CO_2

		Fuels						
		Gasoline	Diesel	LPG	Aviation fuels	Biofuels	Natural gas	All fuels
	% of base	52%	36%	1%	6%	3%	1%	100%
Road use	90%	224	142	54	0	71	12	**170**
Non-road use	10%	15	60	4	23	0	5	**40**
Total transport use	100%	**223**	**137**	**56**	**23**	**71**	**11**	**161**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a).

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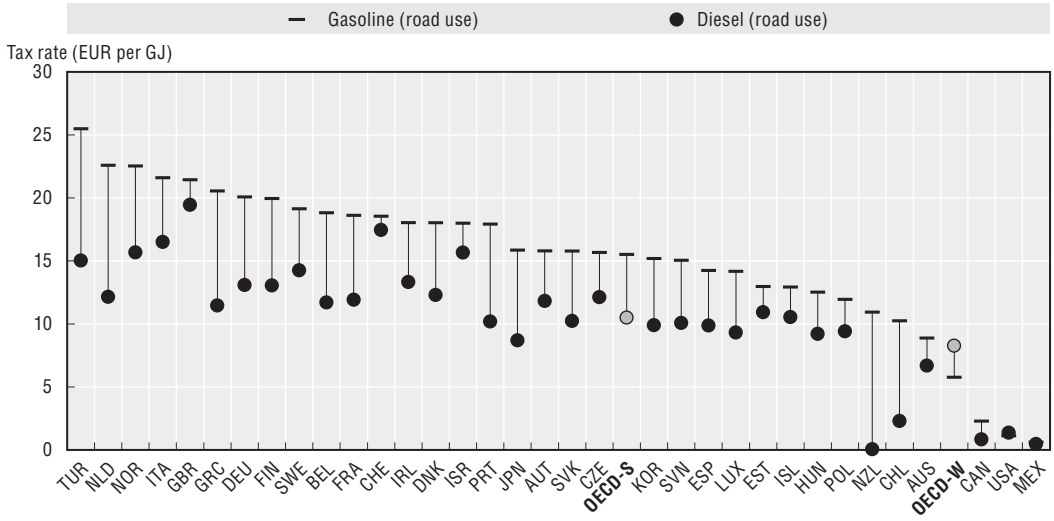
Even within each use category, however, the tables demonstrate a high variance among tax rates on the different fuels, in both energy and carbon terms. In road use, for example, gasoline and diesel face the highest tax rates. By contrast, natural gas, also a fossil fuel, on average is taxed at a very low rate in both energy and carbon terms (in many countries, it is not taxed at all), while LPG on average is taxed at somewhere near one-quarter of the rates on gasoline and diesel. On average, biofuels (mostly ethanol and biodiesel) are taxed at around one-third of the rates applying to gasoline and diesel. The underlying treatment, however, is quite diverse, likely reflecting differing views as to the net carbon impact of biofuels and the role of non-tax policies like mandates requiring a certain percentage of biofuels in the fuel stock. The result is that a few countries tax biofuels at "full" rates, some exempt them, and many tax them at concessionary rates.

The most striking difference from the tables, however, is large difference between the effective tax rates on road gasoline and diesel. Consumers know from experience at the pumps that in most OECD countries diesel is taxed at a lower rate per litre than gasoline. The two fuels, however, have different energy and emission characteristics. A litre of diesel has roughly 10% more combustion energy content than a litre of gasoline. A litre of diesel also produces roughly 18% more CO_2 emissions than a litre of gasoline.[9] (A litre of diesel is also typically associated with higher emissions of local air pollutants, though these are not taken into account in the maps.) As a result, equal treatment of gasoline and diesel on either an energy basis or a carbon basis would require a higher tax rate per litre on diesel than on gasoline. In fact, we observe the opposite: the simple average for all OECD countries of the effective tax rate on diesel is 32% lower than that on gasoline in energy terms and 37% lower in carbon terms.

The same pattern holds on a country by country basis. Figures 8 and 9 show that in all but one country (the United States), diesel is taxed less than gasoline on both a per unit of energy basis and on a per unit of CO_2 basis. In many cases the difference is very substantial.[10]

Figure 8. **Effective tax rates on energy: Gasoline vs. diesel (road use)**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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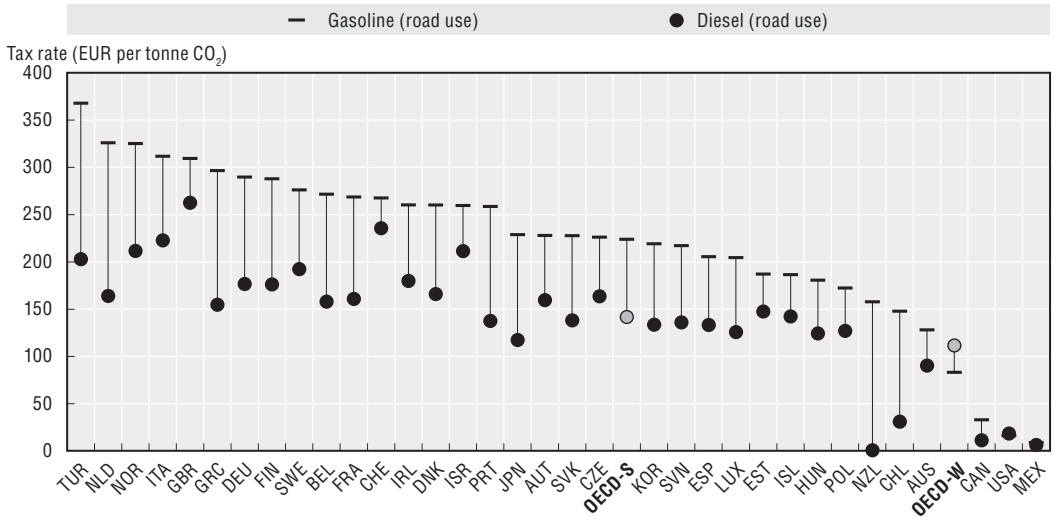
It is sometimes argued that diesel should be taxed at a lower rate per litre than gasoline on the basis that diesel-fuelled cars are more fuel efficient than comparable gasoline-fuelled cars – *i.e.* they can drive more kilometres per litre (both due to the greater energy content of diesel fuel per litre and the greater efficiency of diesel engines in converting fuel energy into motive energy). However, even in the absence of taxes, the increased fuel efficiency of diesel use will be taken into account by consumers in their consumption decisions, tending to increase the demand for diesel over gasoline. This advantage is internalised by the driver and need not be taken into account in fuel taxes. In contrast, the cost of the CO_2 emissions from burning the fuel are not internalised. These emissions (as well as those of certain local air pollutants[11]) – which represent social costs

Figure 9. **Effective tax rates on CO_2: Gasoline vs. diesel (road use)**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

StatLink http://dx.doi.org/10.1787/888932765693

– are higher per litre of diesel than per litre of gasoline, regardless of how far the vehicle travels (an internalised private benefit). Internalising the cost of those emissions through a uniform price on carbon, therefore would imply a higher tax per litre on diesel than on gasoline.

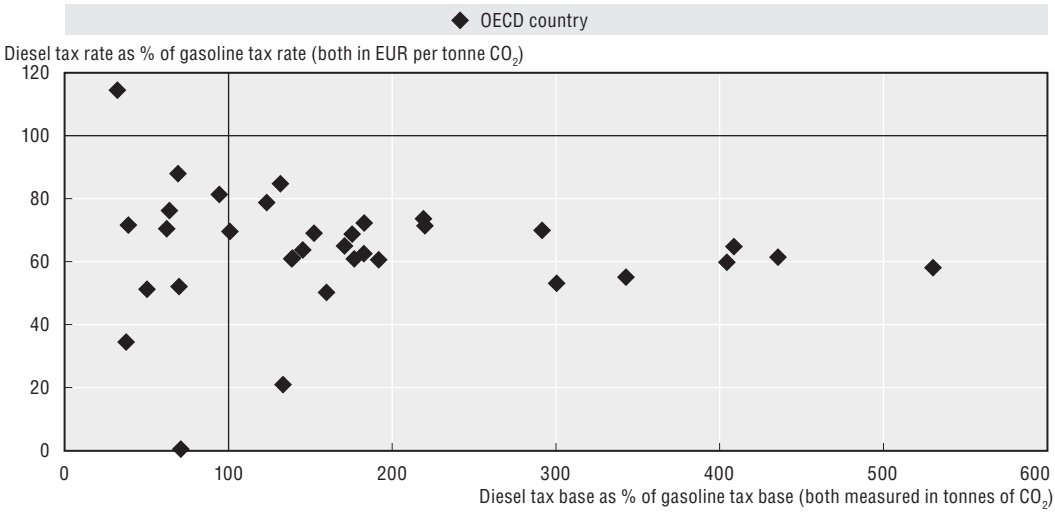
Similar considerations apply to the extent that fuel taxes are intended to internalise externalities related to vehicle use such as congestion and accidents. These costs are likely to be positively correlated with distance travelled. Therefore, since a litre of diesel fuel is generally associated with greater distance travelled, it will generally also be associated with greater congestion and accident costs. This again implies a tax rate per litre that is higher on diesel than on gasoline.

To some extent, the traditionally lower rates on diesel may reflect concerns about industrial competitiveness, given the traditional reliance of commercial and industrial vehicles on diesel fuel. Such competitiveness concerns likely could be addressed in more targeted ways without privileging diesel fuel. Furthermore, even if it was once the case, diesel fuel cannot be regarded as primarily a commercial fuel in many countries today. In recent years the share of diesel-powered passenger cars has increased substantially in many countries, likely at least in part in response to the tax advantage enjoyed by diesel.

There is indeed some correlation between effective tax rates on diesel and the diesel share in the fuel mix. Figure 10 shows on the horizontal axis the size of the diesel tax base in terms of carbon content relative to that of gasoline (for road use only). A number greater than 100% represents a diesel tax base larger than that of gasoline. Similarly, on the vertical axis, the graph shows the effective tax rate on carbon in diesel as a percentage of the effective tax rate on carbon in gasoline, with a number above 100% representing a higher tax rate on diesel than gasoline. With the exception of the United States (in the upper left hand corner), as noted above, all countries have a higher tax rate in carbon terms on gasoline than diesel. It is noteworthy that the large majority of countries are in the lower right quadrant, where there is both a lower effective tax rate on diesel and a higher share

of carbon emissions from diesel than gasoline, with the difference being the most marked in Belgium, France, Luxembourg and Spain, on the right side. While this graph does not show causation or track shares over time, the correlation is not surprising and is consistent with the tax preference for diesel influencing usage patterns.

Figure 10. **Diesel/gasoline (road use) – relative tax rates and bases in carbon terms**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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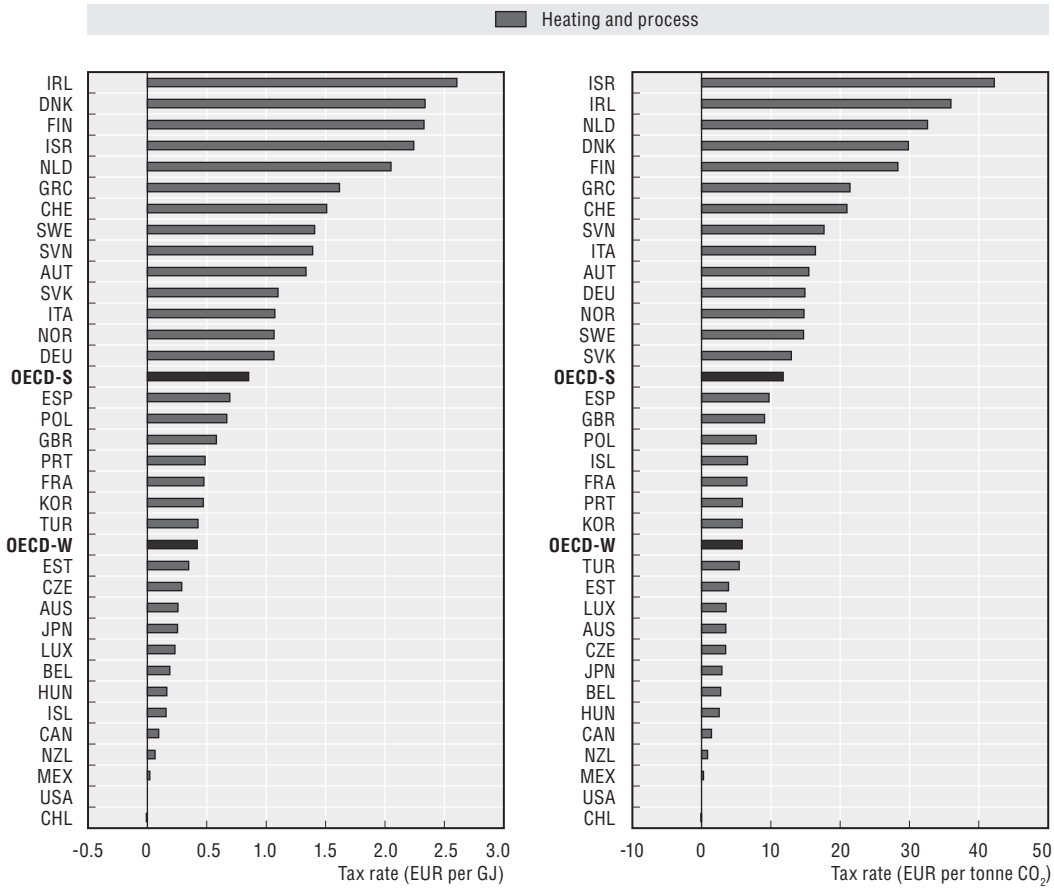
4.3. Taxation of heating and process use of energy

In the average OECD country, the heating and process category represents 39% of total energy use and 46% of the CO_2 emissions from energy use. As with the transport category, there is significant variation in effective tax rates on fuels both between and within countries. However, as highlighted earlier, effective tax rates are much lower than those applying to transport fuels.

Figure 11 illustrates the variation in the total level of taxation on heating and process fuel use across OECD countries in terms of both energy content (left panel) and CO_2 emissions (right panel). Effective tax rates range from EUR 2.61 per GJ in Ireland to being untaxed (at the federal level) in the United States, and to being slightly negative (effectively a subsidy of EUR 0.01 per GJ) in Chile as a result of a petroleum price stabilisation scheme. This scheme effectively imposes a tax when underlying fuel prices are low and a subsidy when they are high. In terms of carbon, effective tax rates range from EUR 42.25 per tonne of CO_2 in Israel, to zero again in the United States and a subsidy of EUR 0.10 per tonne of CO_2 in Chile. Overall, while rates are lower than in the transport category, the degree of variation in rates between countries is greater.

Within countries, effective tax rates also vary substantially by both fuel type and use. Tables 5 and 6 present the simple average for all OECD countries of the effective tax rates on heating and process fuel use broken down by fuel type and fuel use, on an energy and CO_2 basis, respectively. Fuel use is divided into residential and commercial use on one hand, and industrial use and energy transformation (*e.g.,* oil refineries) on the other. Information on the shares of different fuels in the respective tax bases is also provided.

Figure 11. **Effective tax rates on energy (left) and CO_2 (right) in OECD countries: Heating and process fuel use**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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Some fuels used in small amounts are not presented in separate column though they are included in the overall rate for all fuels. Individual country results are again provided in Annex B.

Table 5. **OECD simple average effective tax rates on energy by fuel type and use: Heating and process fuel use**

EUR per GJ

		Fuels						
		Coal	Peat	Natural gas	Diesel	Fuel oil	Other oil products	All fuels
	% of base	12%	0%	49%	12%	3%	14%	100%
Residential and commercial use	41%	0.3	0.1	1.1	3.1	1.9	1.8	**1.2**
Industrial and energy transformation use	59%	0.6	0.1	0.6	3.3	1.3	0.5	**0.8**
Total heating and process use	100%	**0.6**	**0.2**	**0.7**	**3.4**	**1.3**	**0.7**	**0.9**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a).

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Table 6. **OECD simple average effective tax rates on CO_2 by fuel type and use: Heating and process fuel use**

EUR per tonne CO_2

		Fuels						
		Coal	Peat	Natural gas	Diesel	Fuel oil	Other oil products	All fuels
	% of base	18%	0%	39%	12%	3%	14%	100%
Residential and commercial use	38%	3	1	20	42	24	27	**17**
Industrial and energy transformation use	62%	5	1	10	45	17	7	**10**
Total heating and process use	100%	**5**	**2**	**13**	**46**	**17**	**11**	**12**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a).

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In terms of fuels, on average diesel faces the highest effective rate on carbon (Table 5), followed by fuel oil (res fuel) and natural gas, with lower rates applying to coal, peat and other oil products. Coal and sometimes natural gas are not taxed at in a number of countries. Interestingly, diesel faces a relatively similar effective tax rate to that imposed on diesel used for non-road transport. This suggests that countries may tend to make a general distinction between road use diesel and all other uses of diesel. No significant amounts of biofuels, waste or renewables are used for heating and process purposes in OECD countries.

Turning to Table 6, diesel also faces the highest effective tax rate in terms of CO_2 emissions, followed by other oil products, natural gas and fuel oil. Coal and peat face even lower effective tax rates in CO_2 terms than in energy terms as they generate more CO_2 emissions per TJ of energy than the other fuel types. The rationale for these differences is not clear.

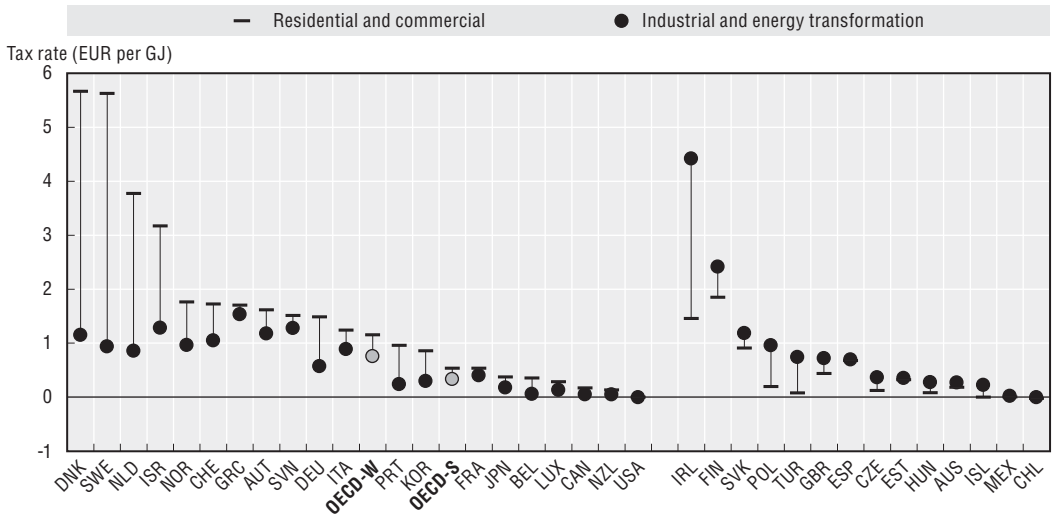
In terms of fuel uses, examination of the first two lines in both tables indicates that fuel used for residential and commercial purposes (mostly space heating) is taxed significantly more in both energy and carbon terms than fuel used in industrial and energy transformation use (mostly for industrial processes). The pattern is also seen for many of the more significant individual fuels: natural gas, fuel oil and other oil products. Diesel is taxed similarly irrespective of its use. On the other hand, coal and peat on average are taxed more highly, in both energy and CO_2 terms, when used in industry and energy transformation than in residential and commercial use (though the use of coal in the latter sector is quite small).

Figures 12 and 13 move down to the national level by presenting the differences in effective tax rates between the two main user groups for all fuels used in heating and process for each OECD country.

In energy terms (Figure 12), 18 countries impose a clearly higher tax on residential and commercial fuel use than on industrial and energy transformation use. In Sweden, Denmark, Italy and Israel the difference is substantial. In contrast, 10 countries impose a clearly higher effective tax rate on industrial use and energy transformation, with one country – Ireland – imposing substantially higher effective rates. Meanwhile, in six countries there is minimal difference between the two fuel use groups.

A similar picture is presented in CO_2 terms (Figure 13). Residential and commercial use is taxed more highly in 16 countries, while industrial use and energy transformation is

Figure 12. **Effective tax rates on energy: Residential and commercial vs. industry and energy transformation use**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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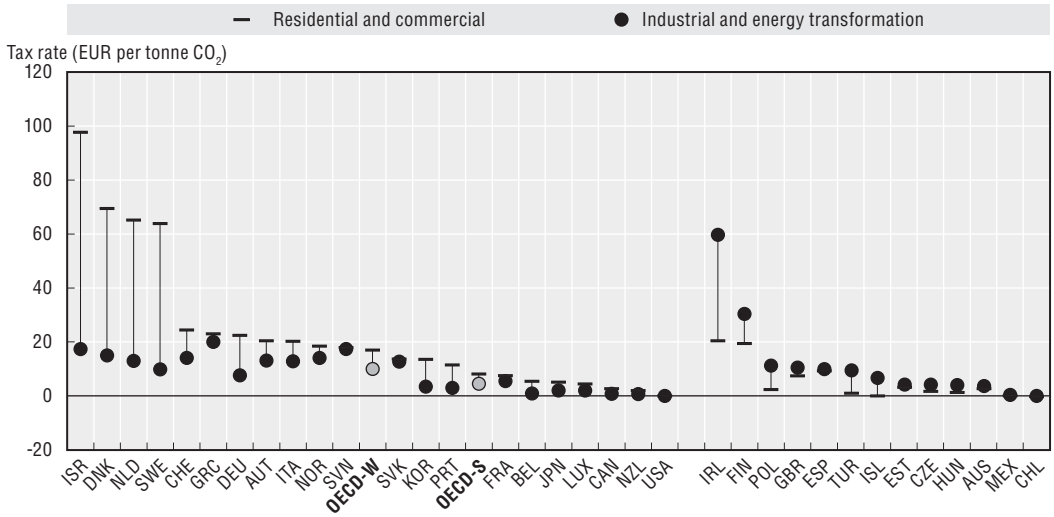
taxed more highly in 11 countries. In the remaining seven countries there is minimal difference between these rates. Among OECD countries, the interquartile range in effective rates for residential and commercial use is from EUR 0.17 per GJ to EUR 1.62 per GJ in energy terms and from EUR 2.36 to EUR 20.43 per tonne of CO_2 in carbon terms. For industrial and energy transformation use, the interquartile range is from EUR 0.23 per GJ and EUR 1.05 per GJ in energy terms and from EUR 2.97 to EUR 13.10 per tonne of CO_2 in carbon terms. The taxation of energy in industry and energy transformation use is thus slightly more variable among countries than the taxation of energy in residential and commercial use

The generally low tax rates in the heating and process category, together with the large variation in rates between different uses, may partly be explained by distributional and competitiveness concerns. For example, countries that impose lower effective tax rates on industrial use may be seeking to address competiveness concerns, particularly in relation to energy-intensive heavy industries that are subject to strong international competition, such as iron and steel, petrochemicals and mineral smelting. On the other hand, in EU countries, the lower rates may to some extent reflect the fact that many large industrial emitters are subject to the EU emission trading system, which sends price signals similar to a carbon tax.

In contrast, countries that impose lower rates on residential fuel use may place greater weight on concerns regarding the ability of low-income families to afford heating fuels, or because of greater need for heating (for example in Sweden, where consumers in the northern part of the country pay a reduced rate on electricity). Meanwhile, countries imposing very low or zero taxes on heating and process fuels in general (*i.e.* the countries on the far right of each part of Figures 12 and 13) may do so due to strong concerns regarding both issues.

Figure 13. **Effective tax rates on CO_2: Residential and commercial vs. industry and energy transformation use**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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While concerns about industrial competitiveness and impacts on low-income households are valid policy concerns, OECD work has underlined that providing relief from environmentally related taxes such as taxes on fuel blunts the price signal (*e.g.* in terms of the cost of carbon emissions) that could otherwise be sent to such sectors. This results in loss of an opportunity to help shift production and consumer decisions toward a lower-carbon path. It is generally preferable to assist such sectors in a way not linked to energy costs, so as to ensure an incentive to change behaviour (OECD, 2006).

4.4. Taxation of energy used to produce electricity

In the average OECD country, fuels used to generate electricity make up 38% of total energy use and 27% of the CO_2 emissions resulting from energy use. Excise taxes can be levied on the fuels used to generate electricity and/or on the consumption of electricity. A number of countries tax both, while many tax only one, or neither (see Table 7). Taxing electricity consumption is more common than taxing the underlying fuels.

Table 7. **Taxation of electricity in OECD countries (number of countries)**

		Consumption	
		Not taxed	Taxed
Production fuels	Not taxed	5	17
	Taxed	2	7
	Rebated	1	2

Source: OECD calculations.

As discussed in Section 3.2, the methodology "looks through" taxes on electricity consumption to calculate the implicit tax rates on the primary energy used to generate electricity. Where countries tax the primary energy used to generate electricity directly, the tax rate for each energy source is calculated. Where a country taxes both fuels used to produce electricity and electricity consumption, both levels of taxation are taken into account in calculating the effective tax rate on each primary energy source.

While taxing electricity consumption is viewed for the purposes of this report as an indirect tax on the fuels used for electricity generation, an electricity tax that does not distinguish between sources of generation sends no price signal favouring high-efficiency or low-carbon sources of generation.

As with the other energy use categories, the maps show that effective tax rates on the fuels used to generate electricity vary considerably across fuel types. Tables 8 and 9 set out the simple average for OECD countries of the effective tax rates in energy and CO_2 terms for different fuels used in electricity generation. These take into account both taxes on fuel used to generate electricity (inputs), and taxes on electricity (the output). Due to the more complicated construction of the effective tax rates on electricity, they must be interpreted carefully.

Since the methodology looks through taxes on electricity consumption to the underlying fuels, a tax on electricity consumption will result in a lower effective tax rate on generation sources that are less efficient in transforming fuel into electricity (since the tax on electricity used is attributed to a greater amount of underlying fuel). This can be seen in Table 8, where natural gas, the most efficient form of fossil fuel generation, faces the highest effective tax rate among fossil fuels in energy terms.[12] A tax on electricity may encourage conservation of electricity generally. However, unlike differential taxation of the fuels used to generate electricity, taxation of electricity consumption itself provides no incentive to favour higher-efficiency generation sources since it effectively ignores energy lost as a result of inefficiencies in the generation process.

Table 8. **OECD simple average effective tax rates on energy by fuel type: Fuels used to generate electricity**

EUR per GJ

		Fuels									
		Coal	Peat	Biofuels	Waste	Natural gas	Oil	Renewables	Hydro	Nuclear	All fuels
	% of base	40%	0%	2%	1%	19%	3%	2%	5%	27%	100%
Electricity	100%	**0.7**	**0.1**	**0.8**	**0.6**	**1.2**	**0.9**	**1.5**	**1.5**	**0.3**	**0.9**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a).

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On the CO_2 side, Table 9 sets out the implicit tax rates on carbon that are calculated by taking into account explicit taxes on carbon fuels and treating taxes on electricity consumption as if they were an indirect tax on the average carbon content of that country's electricity. Where a significant share of electricity is generated from non-carbon sources (*e.g.* renewables and nuclear), the calculated tax burden on the smaller carbon generation

Table 9. **OECD simple average effective tax rates on CO_2 by fuel type: Fuels used to generate electricity**

EUR per tonne CO_2

		Fuels						
		Coal	Peat	Biofuels	Waste	Natural gas	Oil	All fuels
	% of base	71%	0%	3%	2%	20%	5%	100%
Electricity	100%	**14**	**2**	**13**	**12**	**14**	**11**	**13**

Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). The electricity figures exclude three outliers from the calculations: Iceland, Norway and Sweden.

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sources will be quite large. From a policy perspective, this helps illustrate that an undifferentiated tax on electricity regardless of generation source creates no incentive to favour less carbon-intensive sources.

4.5. *Tax rates on carbon – thumbnail profiles*

The full richness of the energy tax picture in each OECD country is set out in the detailed maps in Part II of this report. It can be useful, however, to compress this detailed information into a more compact picture. Using the information underlying the detailed maps, Figure 14 on the next two pages sets out a thumbnail profile of the implicit carbon price signal sent by energy taxes[13] in each of the 34 OECD countries. These sketches take the information on effective tax rates from the maps, and arrange it from the lowest to the highest tax rate.[14] The proportion of the tax base (in tonnes of CO_2) is set out on the horizontal axis, with the corresponding effective tax rate on carbon on the vertical axis. For example, at the 80% mark, the line shows the rate that the 80th percentile of the base is taxed at, and by implication, the rate below which 80% of the carbon emissions in that country are taxed.

Like the summary statistics above, these sketches highlight the wide variance in effective tax rates on carbon both within and across OECD economies. In general, the highest levels on the right side of these profiles represent the tax rates on transportation fuels.

As was emphasised in Box 2, empirical evidence shows that the imposition of energy taxes does affect energy consumption behaviour. Consistent with this, it is interesting to note that a simple scatter plot of OECD countries in Figure 15 shows that countries with a higher average effective tax rates on CO_2 tend to have lower carbon emissions per unit of GDP (*i.e.* have less carbon intensive economies). In this chart, countries with explicit carbon taxes are denoted by a + and others by a dot point. While this correlation does not imply causation, it suggests that there may be a linkage.

Figure 14. **Effective tax rates on carbon in OECD countries: Thumbnail profiles**

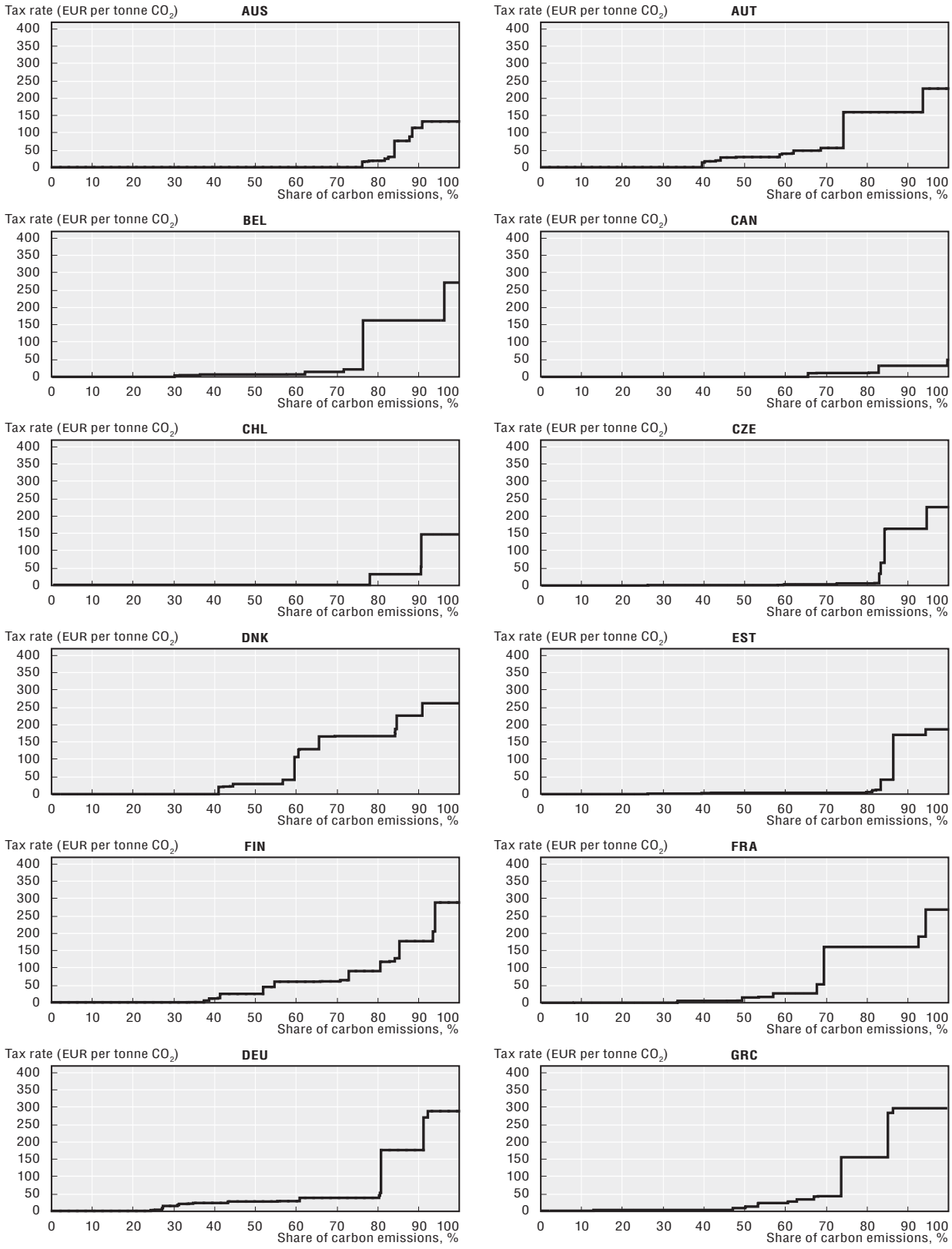


Figure 14. **Effective tax rates on carbon in OECD countries: Thumbnail profiles** *(cont.)*

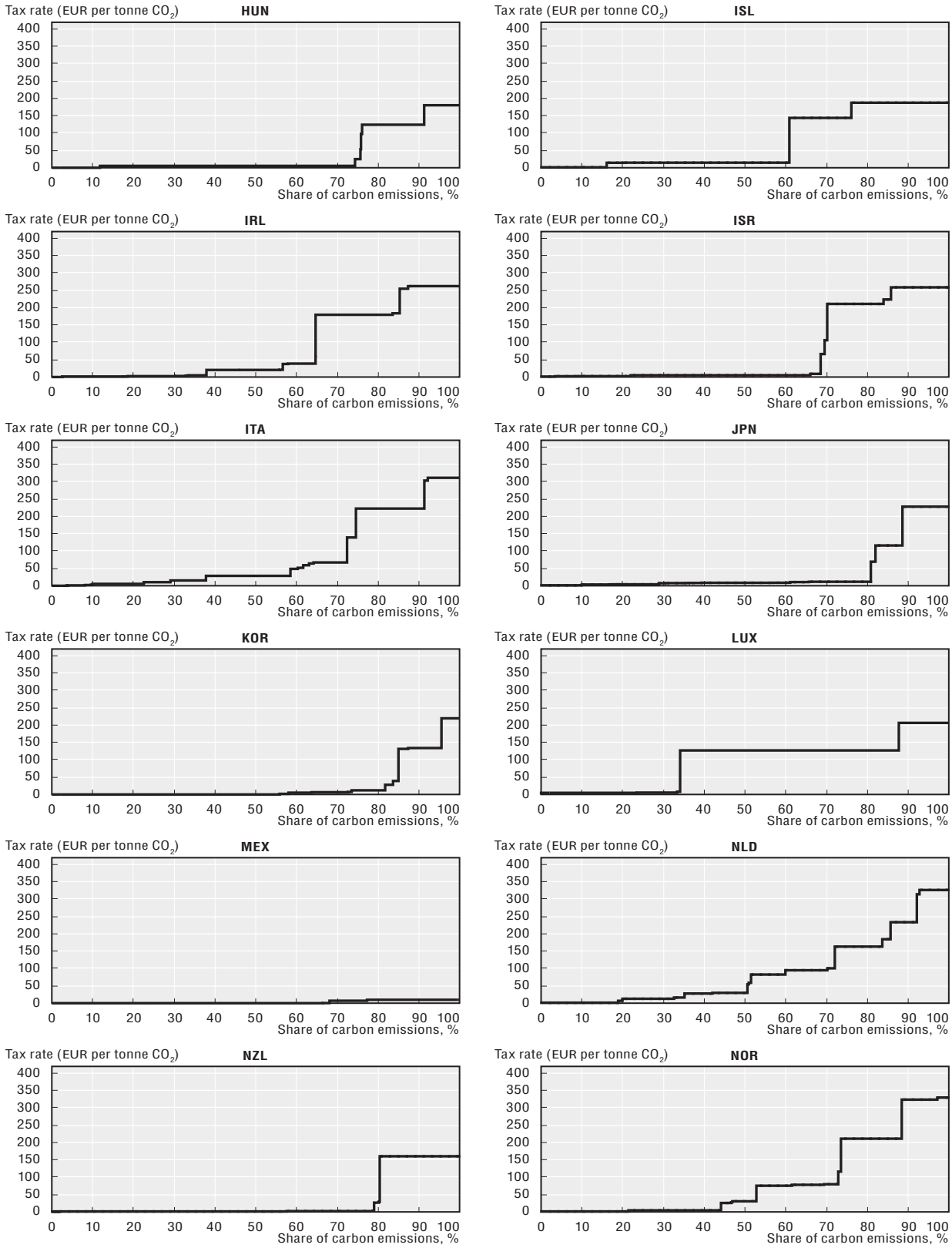
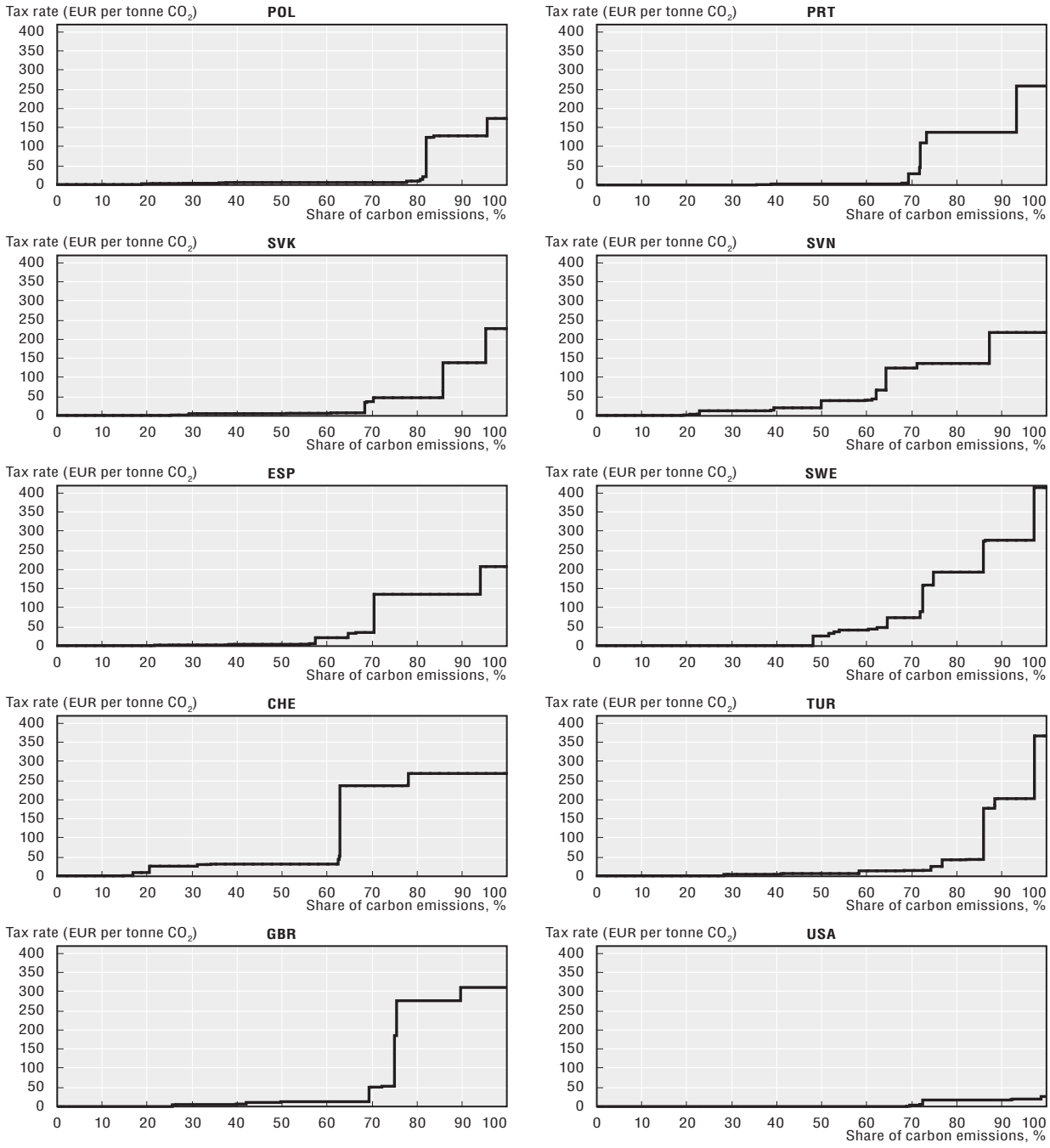


Figure 14. **Effective tax rates on carbon in OECD countries: Thumbnail profiles** *(cont.)*



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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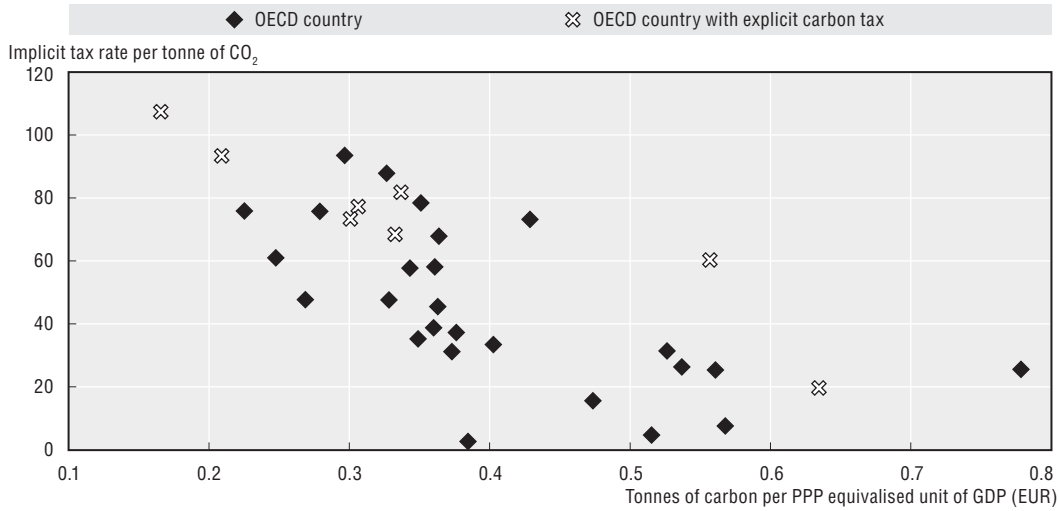
Figure 15. **Average effective tax rates on CO_2 and carbon efficiency in OECD countries**



Source: OECD calculations. Tax rates are as of 1 April 2012 (except 1 July 2012 for AUS); energy use data is for 2009 from IEA (2011a). Figures for CAN and USA include only federal taxes.

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5. Conclusion

Whether or not intended, energy taxes have an important impact on energy use patterns and the environment. Indeed, many current tax systems impose a substantial price on carbon. The profiles of energy taxation set out in this report, however, underline that across countries and within countries there are widely varying effective tax rates on CO_2 emissions – both across fuel types and fuel uses. While in some cases there may be good justifications for variations in effective tax rates on carbon (*e.g.*, where motor fuels are taxed as a proxy for other social costs of vehicle use), in many other cases the reasons are not at all obvious. Furthermore, some rates may not be reflective of the external costs associated with different forms of energy and energy use. This may suggest that many countries have not given great weight in their tax policy design to environmental damage from fuel use, such as that caused by carbon emissions. Many differentials may simply have arisen out of the piecemeal design and introduction of taxes on different energy products over a period of time.

The report notes various situations that suggest a need for reappraisal of tax settings:

- The effective tax rate on diesel for road use in terms of both energy and carbon content is typically lower than the comparable rate on gasoline.
- In both the transport and the heating and process categories, oil products (predominantly gasoline and diesel) tend to be taxed significantly more heavily and more frequently than other energy products, such as natural gas and coal.
- Among heating and process fuels, there is often a very low (or zero) tax rate on coal, despite its significant negative environmental impacts, particularly its greater contribution than other fuels to greenhouse gas emissions and other air pollutants per unit of energy.
- Fuel used in agriculture, fishing and forestry is often exempt from tax, providing no signal with respect to external costs, thereby encouraging over-use.

- In the electricity category, coal, which is widely used, is often taxed at a lower rate than natural gas and biofuels and waste; and taxes on the consumption of electricity provide no signals in terms of the differing environmental impact of the various primary energy sources from which electricity may be generated.

These uneven price signals with respect to different energy products, and low rates and exemptions on some of them, suggest that some of the lowest-cost opportunities to reduce carbon emissions are being foregone. In many countries, a reappraisal may be warranted to explicitly determine whether current energy tax settings are appropriately adapted to their environmental, social and economic goals. The profiles of energy taxation in this report provide policy makers and analysts with a data-rich tool to aid in the review and reappraisal of energy tax systems.

Notes

1. On one hand, earmarking of tax revenue may help increase the public acceptability of environmentally related taxes. As a general principle of fiscal management, however, earmarking of tax revenue is not usually recommended since the revenues that result from a tax are unlikely to match the appropriate spending level for any particular area of public spending on an ongoing basis.
2. The Directive 2003/96/EC sets minimum rates of taxation applicable to energy products when used as motor or heating fuels and to electricity. For more information, see Box 5. For the proposed modification, see European Commission (2011a).
3. The CO_2 emission figures have been derived from fuel use volumes using standard physical conversion factors from the sources set out in Annex A (see pp. 244-246). This is possible since CO_2 emissions are generally fixed for given quantities of particular fuel types (subject to variations in fuel quality) regardless of the particular combustion technology used.
4. The impact of reduced VAT rates and specific *ad valorum* taxes on energy products could be taken into account by considering the average price for the relevant product over a reference period like a year. It was not possible, however, for the purposes of this study to obtain data on all the relevant energy products in all the relevant countries of the OECD.
5. An alternative approach would be to include such taxes only in the computation of effective tax rates expressed in energy terms, but this would result in unequal coverage between the two sets of maps.
6. Other OECD countries with explicit carbon taxes are: Australia (as of July 2012); Canada (British Columbia and Quebec); Finland; Norway; Slovenia; and the United Kingdom.
7. For example, Newberry (2005) and Parry and Small (2005) estimate an optimal level for motor fuel taxes in the UK and the US taking into account a range of externalities. Reviews concerning automobile externalities are also presented in Parry *et al.* (2007) and Ce-Delft (2008).
8. This revenue estimate has been generated from the underlying base and rate data presented in the country maps. Both weighted and unweighted OECD averages are almost identical.
9. Calculated on the basis of conversion factors from the sources in Annex A (see pp. 244-246).
10. The large differential in New Zealand may be explained by the fact that a road user charge, levied per kilometre driven by diesel vehicles, exists in place of a specific excise tax on diesel. Unlike a fuel tax, however, the road user charge does not give any incentive to reduce fuel use per kilometre driven.
11. See: Hausberger *et al.* (2009).
12. Since renewable energy does not have an inherent heat energy value separate from its use to generate electricity, the value of the energy used in generation is considered to be equal to that of the electricity generated – *i.e.* these technologies are essentially considered to be 100% efficient. For this reason, the effective tax rate is highest on renewables.
13. These thumbnail profiles only include explicit taxes and therefore do not reflect the implicit price signal sent by emission trading systems.
14. A similar presentation of effective tax rates on carbon is presented in Vivid Economics (2012).

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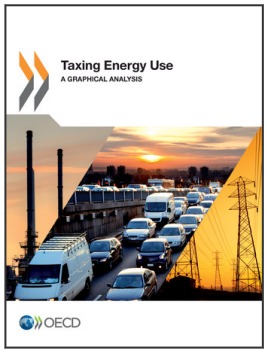

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