Chapter 1

Taxing energy use: Introduction, scope and methodology

Effective tax rates on energy use translate statutory excise and carbon tax rates into rates per tonne of CO_2 and per GJ. For the Taxing Energy Use publications and database, effective tax rates on energy use are calculated for 42 OECD and G20 economies, distinguishing the main economic sectors and fuels used. This chapter describes the motivation and scope for the measurement and analysis of effective tax rates on energy use and carbon emissions from energy use. It also provides an overview of the methodology used and the data feeding into the calculation of effective tax rates. Some methodological refinements introduced for the second vintage of the Taxing Energy Use database are outlined, too.

The OECD collects data on specific taxes on energy use in all OECD countries and selected partner economies, and processes them to allow for systematic comparison of patterns of the taxation of energy use across countries. This report extracts the main insights from the second vintage of the database, which presents effective tax rates on energy use for 2015. The first *Taxing Energy Use* (TEU) vintage, with tax data for 2012, was discussed in *Taxing Energy Use*: *A Graphical Analysis* (OECD, 2013) and *Taxing Energy Use 2015: OECD and Selected Partner Economies* (OECD, 2015a). The first vintage is also the source of raw tax data used to construct *Effective Carbon Rates* (ECR, OECD, 2016), which discusses the state of carbon pricing, including specific taxes on energy use and emissions trading systems.

This report, which accompanies country notes that are published online, discusses the main insights from the TEU update. After discussing methodological refinements to the database in this chapter, Chapter 2 considers the landscape of taxes on energy use in 2015 and the main changes between 2012 and 2015. More specifically, Chapter 2 discusses carbon and other taxes on energy use by fuel, in different sectors, and highlights some differences between country groups. The report focusses on messages relating to the update, repeating only briefly discussions of motivation, scope and limitations that are discussed at greater length in previous TEU reports (OECD, 2013; OECD, 2015a).

The database of taxes on energy use covers OECD countries (34 in the first vintage, 35 in the second with the accession of Latvia in 2016) and 7 partner economies, namely Argentina, Brazil, China, India, Indonesia, Russia, and South Africa. Data on tax rates are for 2015, and these are combined with the most recent available data on energy use by fuel and sector, which are data obtained from the *Extended World Energy Balances* from the International Energy Agency pertaining to 2014 (IEA, 2016a). With its disaggregation of tax rates to the level of sectors and fuels, the TEU database is the most detailed and up-to-date database on energy taxation available.

The approach taken in TEU is to collect statutory rates by fuel and by sector, and to translate these into rates per unit of energy (EUR/GJ) and per unit of CO_2 emissions from energy use (EUR/tCO_2). The resulting rates are called effective tax rates. Taxes included are *specific* taxes on energy use, which in practice means mainly excise taxes and carbon taxes. Broadly applicable taxes, e.g. VAT or sales taxes, are not included, as the objective is to chart taxes that change the price of each type of energy use relative to the price of other expenditure items.

Specific taxes on energy use are the relevant ones to consider from an environmental pricing point of view, since these are the taxes that alter the relative prices of energy use and that can in principle be used to reflect marginal environmental damages. Some countries have introduced specific taxes on carbon with the explicit objective of mitigating carbon emissions, and some refer to environmental objectives to motivate relatively high excise taxes on energy use. Existing excise taxes are not always, and not even usually, primarily introduced for environmental purposes. As will be seen, this often results in poor alignment of taxes with environmental costs. Nevertheless, these taxes are specific to energy use, a form of consumption with environmentally relevant outcomes, so that the taxes are environmentally-related even if the policy intention behind their introduction is not.

The TEU database expresses tax rates on energy use in EUR/GJ and EUR/tCO_2. Taxes included are specific taxes on energy use (excise and carbon taxes). For fuels, the statutory base usually is volumetric, and conversion to GJ and CO_2 is straightforward given knowledge of the fuel type. For electricity as an energy carrier, taxes are either levied on generation fuels (input fuels) or on electricity use (kWh).

The tax rates from the database are summarised in energy tax profiles. These are available per country and for selected country groupings, and show tax rates across all fuels in six economic sectors: road transport, domestic off-road transport, industry, agriculture and fishing, residential and commercial, and electricity. On a country level, these energy tax profiles are available online only (in country notes); this report restricts discussion to energy tax profiles for country groups (see Chapter 2).

The first section of this chapter is a brief overview of the methodology used and the data feeding into the calculation of effective tax rates, and of how to read the energy tax profiles. More in-depth discussions are available in *Taxing Energy Use: A Graphical Analysis* (OECD, 2013) and *Taxing Energy Use 2015: OECD and Selected Partner Economies* (OECD, 2015a). The second section of this chapter explains some methodological refinements introduced for the second TEU vintage.

Structure of the energy tax profiles, methodology and data sources

The taxes included in the database are specific taxes on energy use, whether rates are quoted per-unit or as a percentage of the sales price (*ad valorem* taxes). To calculate effective tax rates on energy use, statutory tax rates are linked to energy use of a country, sourced from the IEA *Extended World Energy Balances*. The current (second) vintage links tax rates for 2015 to energy use for 2014 (the most recent available for use in the database for this companion document, IEA, 2016a). The first vintage linked 2012 tax rates to 2009 energy use.[1] For each country in the TEU Database, the energy tax profiles show the effective tax rates on different fuels in six economic sectors: road, off-road transport, industry, agriculture and fishing, the residential and commercial sector, and electricity.

The horizontal axis of the energy tax profiles plots a country's final energy use, including the net energy used in energy transport and the transformation of energy from one form into another (e.g. by refineries, from crude oil to diesel). Within each of the six economic sectors, fuel use is disaggregated in a way that reflects fuel use in a particular country. For example, if a country predominantly uses coal to generate electricity, the category showing the effective tax rate on coal will dominate the electricity sector, while all oil products are grouped together into a single category. Conversely, if a country primarily uses different oil products, fuel oil, diesel and LPG are shown separately.

Electricity and heat are different from the other types of energy use shown in the energy profiles, in that they are secondary energy products, produced using primary fuels as inputs. The basis for the calculation of effective tax rates, and the energy use and carbon emissions shown in the energy tax profiles, are the fuels used to produce electricity and heat (as opposed to the electricity and heat output generated from these fuels).

All energy use in each country is converted into common units of energy (GJ) and carbon emissions (tonnes of CO_2) using the standard conversion factors of the IPCC. Groupings of fuel types (e.g. oil and oil products, coal and coal gases) keep with the definitions of the documentation of the *Extended World Energy Balances* (IEA, 2016a). Energy tax profiles excluding carbon emissions from biomass from the horizontal axis are available online but are not discussed in this report.

The vertical axis of the energy tax profiles measures effective tax rates on energy use applicable at 1 April 2015. Taxes included are those which alter the relative prices of energy use, based on the principle that specific taxes can alter relative prices to reflect marginal environmental damages from using energy.

Carbon taxes, which typically set a tax rate on energy based on its carbon content, but which are often expressed per physical unit of energy for practical purposes are included, but the database also includes other specific taxes on energy use (primarily excise taxes), the rates of which are typically quoted per physical unit of energy. The tax rates employed in the analysis are obtained from country-specific sources, as detailed in the country notes accompanying the energy tax profiles, available online.

In Argentina, Indonesia and India, excise taxes are quoted as a percentage of the sales price, and these are translated into per-unit taxes using price information to allow for their inclusion into the database. Country-specific sources are listed in the country notes accompanying the database.

The database includes reduced tax rates that apply to specific fuels or uses. For example, where a country refunds all or part of an energy tax to specific industrial or agricultural users, this reduced rate is taken into account in the calculation of effective tax rates. In some cases, governments report these reduced rates as a tax expenditure, i.e. as a deviation from the "standard" tax rate. Where governments report such tax expenditures, the reduced rate is shown (in a lighter colour) in relation to the "benchmark" level of tax from which the reduced rate is considered a departure by the government in question. A key source of data on tax expenditures is the OECD *Inventory of Fossil Fuel Subsidies* (OECD, 2018, forthcoming) and the database associated with it. The latest data on tax expenditures reported by government available at the time of writing has been included in this vintage of the database, namely for 2014 (OECD, 2015b).

Carbon taxes and other taxes on energy use levied at subnational level are not included in the calculation of effective tax rates. Where important, energy taxes levied at the subnational level are indicated in a country's energy tax profile, for an illustrative group of states or provinces.

As explained in the next section of this chapter, taxes on electricity output are not included when ETRs are expressed in currency per tCO_2. When taxes on electricity output are included, i.e. when ETRs are expressed in currency per GJ, the taxes on electricity output are shown as though they applied directly to the fuels used to generate electricity (see *Taxing Energy Use: A Graphical Analysis*, OECD, 2013, for more detail).

Taxes which apply to a very broad range of goods, such as value added and retail sales taxes, are not included in the database, given that they generally do not change the relative prices of energy use. However, concessionary VAT or sales tax rates change relative prices, so should be accounted for in principle. However, data limitations currently prevent their inclusion on a comparable basis across the 42 countries covered. OECD (2015a) gauges the extent to which VAT rate differentiation takes place across OECD and G20 countries, and the OECD *Inventory of Fossil Fuel Subsidies* (OECD 2018, forthcoming) provides an estimate of the extent of revenue foregone from reduced VAT rates on energy products.

Useful comparison of taxes on energy use across countries requires that these taxes are added to a producer price of energy which broadly aligns with production costs. While this is a reasonable approximation of the situation in most of the countries under study, some countries apply price support measures which keep producer prices below production cost. Support measures for fossil fuels are not accounted for here, but a comprehensive estimate of revenue foregone and an in-depth discussion of their impacts can be found in the OECD *Inventory of Fossil Fuel Subsidies* and its Companion (OECD, 2018 forthcoming).

Methodological refinements

The methodological approach taken and the data sources used remain consistent across the two vintages of the TEU database, but some adjustments have been made to how the data is aggregated and presented. These changes are introduced to refine the estimates of the effective tax rates calculated, in particular in the industry sector, and to increase the comparability of the TEU data with the *Effective Carbon Rates* (OECD, 2016).

The adjustments concern the treatment of taxes on electricity output for the calculation of effective tax rates per tonne of CO_2, the grouping of energy use into economic sectors, the treatment of energy use and carbon emissions from the auto-generation of electricity in the industry sector, the presentation of carbon emissions from the combustion of biomass, and the treatment of carbon taxes in countries which also participate in an emissions trading system.

Taxes on electricity use

Taxes on electricity consumption, usually quoted per kWh, are a specific tax on energy use that alters the relative price of consuming electricity. These taxes are included in the TEU database, and were included in the calculation of effective tax rates in previous TEU publications (OECD, 2013 and 2015a), also when these effective tax rates were expressed per tonne of CO_2. This is no longer the case.

The effective tax rates on energy use continue to include price signals from taxes on electricity output when they are expressed in terms of their energy content, e.g. in EUR per GJ. When expressed in terms of carbon content, taxes on electricity output are no longer included.

Taxes on electricity output are independent of the fuel mix used to generate electricity and of the efficiency of generation. Taxes on electricity do induce users to become more electricity-efficient, but they do not send a direct price signal to discourage carbon-intensive generation. However, since effective tax rates per tonne of CO_2 are mainly interpreted as carbon taxes, and these are dominantly interpreted in the context of climate change mitigation policy instrument (CO_2 is not a neutral *numéraire*) it is better to exclude electricity output taxes from them.

Including taxes on electricity output would be appropriate if the carbon intensity of the electricity generation mix was essentially fixed. However, in fact, the carbon intensity of power generation is generally quite sensitive to carbon price signals. In the short term, the existence and magnitude of carbon taxes may, for instance, determine whether coal or gas-fired units are dispatched to meet demand (IEA, 2016b).

The result of excluding taxes on electricity output from effective tax rates expressed in currency per tCO_2 is that these rates are significantly lower in the electricity sector than those shown in earlier TEU publications and in *Effective Carbon Rates*. For ease of reference, the energy tax profiles published online are presented both including and excluding taxes on electricity output.

With respect to the coverage of (specific) taxes on electricity use, the database includes "compulsory, unrequited payments", in line with the OECD definition of the term (OECD, 2001). For comparison, this is a considerably more narrow definition than the one introduced in Regulation (EU) 2016/1952 on "European statistics on natural gas and electricity prices and repealing Directive 2008/92/EC" (European Commission, 2016). The latter defines a category "taxes, fees, levies and charges" which includes value added tax;

taxes, fees, levies or charges relating to the promotion of renewable energy sources, energy efficiency and CHP generation; those relating to capacity payments, energy security and generation adequacy and other required services; air quality and emissions charges; those relating to the nuclear sector; and finally all other taxes, fees, levies and charges.

These taxes, fees, levies and charges are part of the price of electricity use, and this part has been growing strongly in the European Union in recent years. Evidence presented in European Commission (2016) shows that the share of the taxes and levies component in household retail prices increased from 28% in 2008 to 38% in 2015. This increase is the consequence mainly of rising levies for renewable energy and combined heat and power. This component does not fall under the OECD definition of taxes, and is not included in the TEU database. Irrespective of views of the merit of precise classifications of electricity price components, this example highlights that the *tax* information in the TEU database does not capture all *price* movements, *in casu* it does not include costs related to renewable investment, also if these are part of retail prices.

Sector classification

The energy tax profiles shown in the previous TEU publications showed energy use for three broad sectors: transport, heating and process use, and electricity. Starting with this vintage, energy use is shown for six sectors: road, off-road transport, industry, agriculture and fishing, residential and commercial and electricity. These six sectors map to the three sectors previously used as shown in Table 1.1.

Table 1.1. **Sector classification of energy use**

3-sector classification	6-sector classification	Energy use grouped in these sectors
Transport	Road	All energy used in road transport
	Off-road	All energy used in off-road transport (incl. pipeline transport, rail, domestic aviation and maritime transport)
Heating & process use	Industry	All energy used in industrial processes, in heating (incl. inside industrial installations) and in the transformation of energy from one form into another (e.g. in refineries). Starting with the second vintage of the TEU database, this sector also includes emissions from the autogeneration of electricity (section 22.3).
	Commercial & residential	All energy used for commercial and residential heating
	Agriculture & fisheries	Energy used in agriculture, fisheries and forestry. Energy used in on-road transport in this sector is included in the road transport sector.
Electricity	Electricity	All fuels used to generate electricity in main generation (rather than the amount of electricity generated from each fuel). Fuels from autogeneration of electricity in industry are included with the industry sector.

The more detailed classification allows for a more precise picture of the taxation, particularly in the industry, the commercial and residential sector, and agriculture and fisheries sectors. The separation of fuels used in the road and off-road sectors allows appreciation of the different tax rates applying across the different fuels and uses in the broader transport sector. In addition, the grouping into six economic sectors is consistent with that of the *Effective Carbon Rates* report (OECD, 2016).

Energy use and emissions from the auto-generation of electricity

Electricity and heat can be produced as a main activity (main generation), or by (mostly) industrial or energy transformation users that also produce electricity on-site (auto-generation). The first vintage of the TEU database included auto-generation of electricity along with main generation.

However, for the calculation of *Effective Carbon Rates*, it was recognised that the accounting of emissions under emissions trading systems takes place at the facility level, so that when an industrial installation auto-generates heat or electricity, the emissions from that activity will be included with the emissions of the industrial sector. Emissions from auto-generated electricity accordingly were classified in the industrial sector. The same approach is now taken for the TEU database. As before, the data assumes that auto-generated electricity is taxed at the same rates as the electricity from main generation, which affects industry average rates. However, given that the shares of energy use and emissions from auto-generated electricity are relatively small in most countries, the resulting change in effective tax rates is minor.

Energy use and carbon emissions from biomass

Previous TEU publications did not explicitly differentiate the emissions from the combustion of biomass from other emissions from fuel combustion. However, in countries with a substantial proportion of biomass use, the energy tax profiles displayed biomass separately. In addition, effective tax rates on biofuels and waste were compared separately across countries.

In order to accommodate different approaches to accounting for the CO_2 emissions from biomass combustion, specifically those that treat biomass as carbon neutral on a life cycle basis, an additional energy tax profile (on a CO_2-basis) is published that excludes carbon emissions from the combustion of biomass, for all 42 countries. For most countries, the profiles with biomass combustion emissions "in" and "out" are very similar, but the differences are larger for, e.g. Brazil, Sweden and Switzerland. To avoid confusion, this report does not include this new tax profile, but it is published in the country notes online. Consistent with earlier publications, the effective tax rates shown in this report are calculated including carbon emissions from biomass.

Interactions between carbon taxes and emissions trading systems

Some countries that participate in or operate an emissions trading system refund carbon tax payments to the firms that are subject to these systems. Such interactions were noted in previous TEU publications and were sometimes taken into account by calculating a reduced effective tax rate on emissions in some industrial sectors.

The assumptions taken around the interactions between carbon taxes and emissions trading systems have now been refined using detailed information collected for the estimation of *Effective Carbon Rates* (OECD, 2016). Carbon taxes were fully, partially or not removed for the shares of energy use or emissions that are estimated as covered by an emissions trading system, in line with country approaches. Table 1.2 provides an overview of the adjustments made to carbon taxes where there is an emissions trading system.

Table 1.2. **Adjustments to carbon taxes made in sectors and fuels covered by ETS**

Jurisdiction	Treatment of carbon tax when ETS applies
Denmark	Fully removed
Finland	Not removed
France	Not removed
Ireland	Fully removed
Iceland	Not removed
Japan	Not removed
Latvia	Fully removed
Norway	Partially removed
Portugal	Fully removed
Slovenia	Not removed
Sweden	Fully removed
Switzerland	Fully removed
United Kingdom	Not removed

References

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Notes

1. Linking rates to use in an earlier year is obviously not ideal, but delays in the availability of energy use data and avoiding excessive lags in reporting tax data impose this choice. Internal analysis on the first vintage has revealed that the error from combining different years is small enough for it not to influence the type of insights discussed in this report. Future versions of the database will also combine tax and base data for the same year.