THE ITALIAN CLIMATE CHANGE THINK TANK

ENERGY TAXATION IN THE TRANSITION TO THE ELECTRIC CAR

REPORT
OCTOBER 2024

Edited by Massimiliano Bienati

With the contributions of Francesca Andreolli, Gabriele Cassetti and Michele Governatori and the coordination of Matteo Leonardi

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Executive summary

The **progressive electrification of the circulating car fleet** brings with it two relevant consequences. On the one hand, the **reduction of emissions** from passenger road mobility, thanks to the use of electricity from an energy mix with an increasing share of renewable sources. On the other hand, the **reduction of final energy consumption** due to its greater efficiency compared to traditional cars. This reduction is further amplified over time by a projected decline in car usage, driven by alternative mobility policies.

The decrease in energy consumption also leads to a decrease in fiscal revenue compared to current collection levels.

With the aim of providing a better understanding of the **fiscal implications of the energy transition to electric vehicles**, this report aims to:

1. Quantify **the evolution of revenue from the fiscal and parafiscal components of energy carriers for road mobility** (gasoline, diesel, LPG, electric) within a dynamic scenario of electric mobility expansion consistent with 2030 NECP forecasts and the Italian long-term strategy for greenhouse gas emission reduction.
2. Describe the current **fiscal and parafiscal structures of energy carriers for car mobility**, quantifying the impact per energy unit (€/kWh), per km travelled (€/km) and per unit of CO_2 emissions (€/tCO_2).
3. Provide options for **designing fiscal energy policies aimed at maintaining revenue neutrality without introducing contradictions to climate policies**, as well as avoiding undue burdens on consumers during the transition to electric mobility.

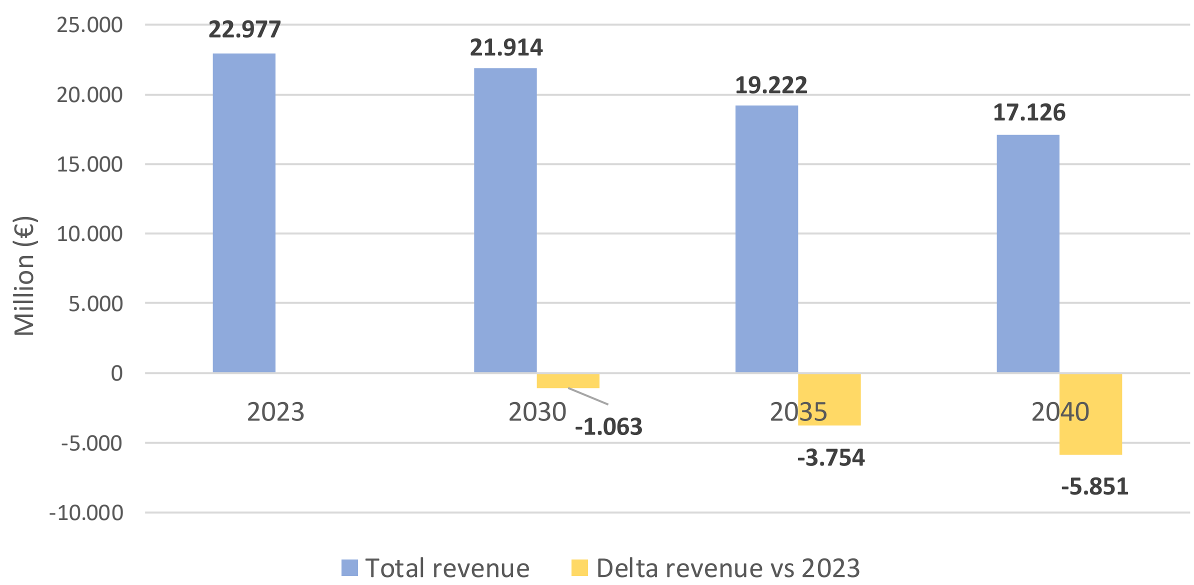
All analyses were carried out using average value of the cost components that make up electricity tariffs and fuel prices, with reference to the year 2023. For electric charging costs, only the pay-per-use tariff levels were considered. **The analyses refer solely to private road mobility (cars).**

1. Evolution of fiscal and parafiscal revenue

Given the current taxation structure applied to energy carriers used in private road mobility:

- **A.** A **2030 evolutionary scenario** aligned with the NECP target of **4.3 million BEVs on the road**, along with the introduction of the **ETS2** mechanism on transport fuels, **estimates a fiscal revenue reduction of €1.06 billion compared to 2023.**
- **B. In the medium-term**, with a forecast scenario of 11 million circulating electric vehicles, **the gap is projected to be around €3.75 billion by 2035.**
- **C. In the long-term**, as the electrification of the fleet progresses significantly, and considering the higher energy efficiency of electric vehicles, **the reduction in revenue is expected to be €5.85 billion by 2040**.

Evolution of the scenario of total fiscal and parafiscal revenue from energy consumption in private car mobility for the period 2023-2040 and changes compared to 2023 (M€)



The variations in revenue over this period are determined by three key and interrelated variables: *i)* the **adoption of electric vehicles and their higher energy efficiency** compared to combustion engine vehicles; *ii)* the **progressive reduction of the circulating vehicle fleet**; and *iii)* **the extension of the ETS mechanism to transport** (ETS2), set to enter into force in 2027.

The introduction of ETS2 allows for a progressive compensation of the revenue loss expected from the other two identified variables. **By 2030, the contribution of ETS2**

is estimated to generate an additional fiscal revenue of approximately €3.2 bn, which will increase to €5.5 bn by 2035 and €6.8 bn by 2040. **The impact of ETS2 on fuel prices** by 2030 is estimated to result in an increase of **less than 10%** compared to average pump prices in 2023.

2. Fiscal and parafiscal structures for mobility energy carriers

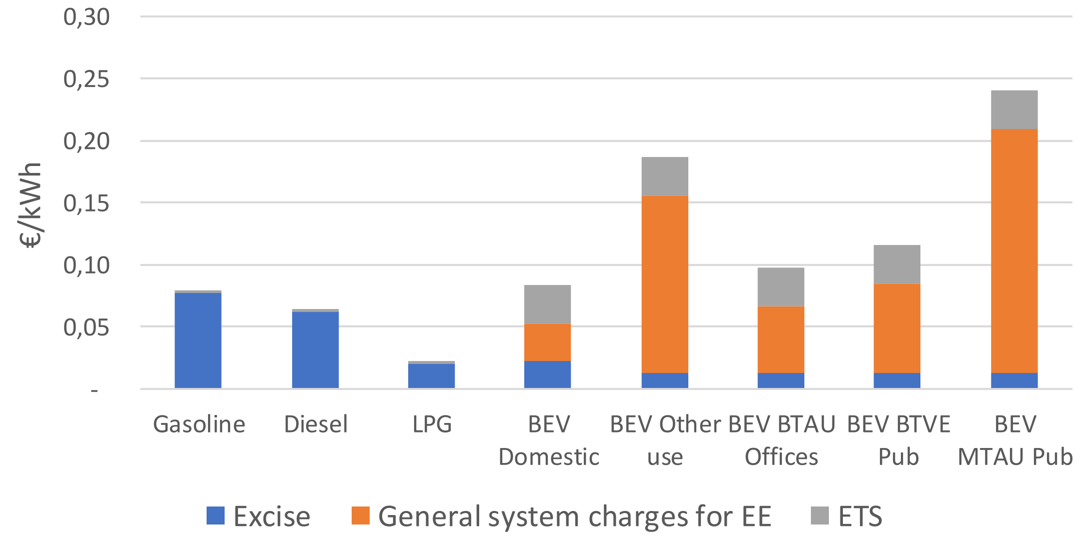
The analysis of the fiscal and parafiscal components that contribute to determining the final energy carrier tariff in the car transport sector leads to the following findings:

A. **Impact per unit of energy (€/kWh)**

Per unit of kWh of energy consumed, the comparative analysis of taxation and parafiscal charges on different energy carriers shows the **tax burden on electric vehicle charging is consistently higher than that applied to fossil fuels**.

In all the cases analysed, the higher taxation for electric charging is largely due to the **weight of the parafiscal component of the general system charges**[1] in the charging tariff. **This component is particularly relevant** in the case of charging by users of the *Other Uses* electric tariffs, which typically apply to shared electricity meters, such as those used in condominiums or private garages, as well as from **public medium voltage or ultra-fast public charging infrastructures**. For the latter, the taxation is up to three times higher than the excise taxes applied to gasoline.

Impact of excise, general system charges and ETS (1,2) on refuelling and electric vehicle charging



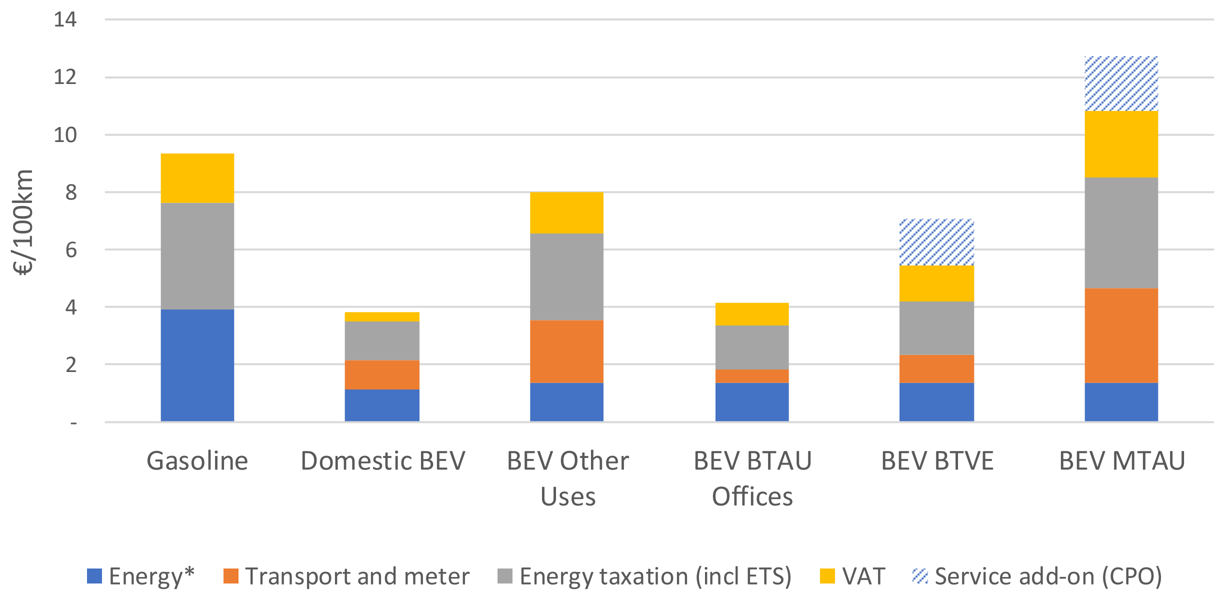
[1] These charges refer to parafiscal components designed to cover general interest expenses (see Introduction for further details)

B. Impact per km travelled

Despite the burden of fiscal and parafiscal components per kWh of energy consumed, **electric cars remain the most cost-effective option for the same distance travelled.** Due to its **greater energy efficiency**, the cost of driving 100 km with an electric car, when charged at home or at the office, is up to 2.5 times lower than driving the same distance with a gasoline-powered car, and up to 1.5 times lower if charging is done at low voltage public charging stations.

In terms of **average annual expenditure**, for 10,000 km of driving and assuming a **typical mix of charging methods, the savings from driving electric amount to approximately €340/year**.

Refuelling cost per 100 km for comparable B-SUV models, gasoline or electric, across different charging options (€/100 km)



** Value expressed net of estimated ETS cost included in energy tax shares.*

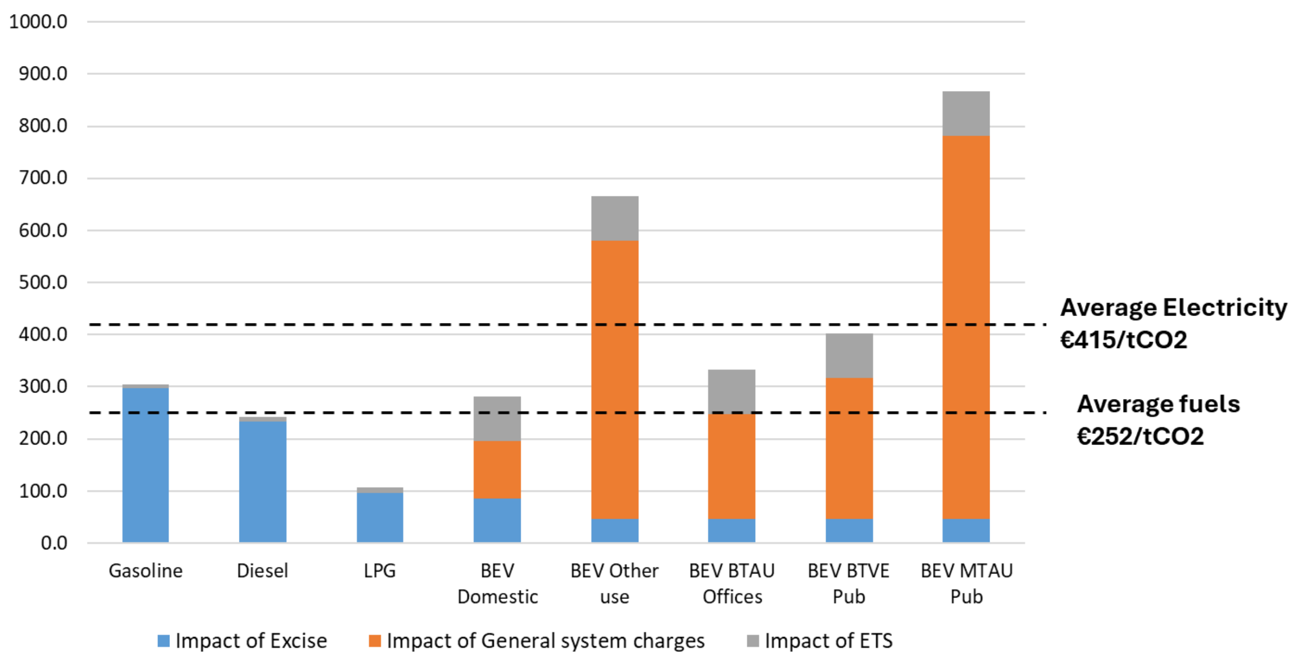
C. Impact on emissions (€/tCO2)

From an energy systems integration perspective, the **misalignment** of fiscal and parafiscal components across various energy carriers for mobility - both in terms of energy units and CO2 emissions - is **contradictory to the goals of environmental energy policies. This discrepancy results in an undue burden on final consumers**, who end up paying higher fiscal and parafiscal components per unit of CO2 emitted, **precisely when they choose low-impact technology.**

Considering the emissions of the current electricity consumption mix, **electric vehicle charging is subject to an average total fiscal and parafiscal burden equivalent to a cost of €415/tCO2, compared to an average of €252/tCO2 for fuels.** For medium voltage charging, this burden rises to €870/tCO2.

These figures may seem contradictory, given that these costs are driven by mechanisms designed to incentivise **renewable energy sources in the electricity system. Today these mechanisms support the achievement of decarbonisation targets in the transport sector**, which, in contrast has seen no emission reduction over the last 20 years.

Weight of excise taxes, general system charges and ETS vs. CO2 emissions of different energy carriers (€/tCO2)*



** Average values reported refer to weighted average on consumption*

These differences contradict the **polluter pays principle**, given that even with the current electricity mix, **the emissions from an electric car are up to 66% lower than those of a combustion car**: 41 gCO2/km for a B-segment electric vehicle, compared to 122 gCO2/km for a gasoline-equivalent hybrid one. Additionally, since electric vehicles do not rely on combustion, they eliminate **local pollutant emissions such as NOx and PM2.5, further reducing their environmental impact.**

3. Energy and environmental fiscal policies aimed at maintaining revenue parity without introducing contradictions to climate policies

A. Given the evidence presented above, recovering lost tax revenue **through an additional tax burden on the electric carrier is not feasible** because:

- The current **fiscal and parafiscal burden on the electric carrier** is already **higher than that applied to fossil fuels**, contradicting **energy-environmental tax principles, climate policies and consumer interests**.
- **Upward changes to this taxation** would introduce an element contrary to the policy objectives outlined by the NECP, delaying its implementation.
- Since a significant share of electric vehicle charging occurs at home, **any increase in taxation for the electric carrier would impact all the consumption of these users.**
- If applied to public electric charging stations, an **increase in taxation would result in an obstacle to the infrastructural development of new electric mobility**.
- In terms of CO2 emissions, increasing the current taxation applied to the electric carrier would be **equivalent to an additional environmentally harmful subsidy** granted to fossil fuel consumption, in contradiction with the commitment of the Italian government to eliminate existing subsidies.

B. **The current tax gap between diesel and gasoline** is identified by the Ministry of Environment and Energy Security as an **Environmentally Harmful Subsidy** (EHS) leading to an annual **tax revenue shortfall of 3.4 billion euros** (based on 2021 data).

The amount of revenue that could be recovered by acting on this EHS would provide sufficient resources to maintain revenue neutrality until at least 2035. **This policy option appears to be the most consistent with the electrification goals of mobility introduced by the NECP**.

A review of the EHS policy framework for energy is seen as a necessary approach with respect to:

- **Commitments made by Italy in the G7** since 2017 (Italian Presidency) and subsequently confirmed in each official Communiqué;

- **Commitments made by the government under Law No. 111 of August 9, 2023, known as the fiscal delegation law,** which provides for a **reform of energy taxation aimed at eliminating subsidies on energy products**, considering the environmental impact of each product with the goal of contributing to the gradual reduction of greenhouse gas emissions and air pollution;

- **Commitments made by the government in the context of the European Council for the new Mission 7 of the National Recovery and Resilience Plan (NRRP) introduced by the Repower EU Chapter for Italy**, which include measures to reduce EHS by at least **€2 billion by 2026 and at least €3.5 billion by 2030**;

- **Establishment of the new directive on energy taxation currently being discussed at EU level** whose proposal, already endorsed by the European Parliament and the Council, introduces a unified taxation system for energy carriers based on their **energy content and environmental performances**, as well as providing for higher taxation on fossil fuels compared to electricity.

C. Based on the analyses presented in this report, **the fiscal and parafiscal charges applied to medium voltage public charging methods** is disproportionate compared to other types of charging, making this option very costly for consumers.

The general system charges in electricity tariffs are mainly related to the need to recover resources to support electricity generation from renewable sources.

In this regard, it is a priority to **intervene so that the impact of these charges does not hinder the deployment of public charging infrastructure and electric vehicles**. This can be achieved by reducing charging costs through discount mechanisms on the tariff components that most affect the determination of tariffs, **or by promoting the installation and use of these infrastructures**.

D. **In the medium/long-term**, once the transition to electric mobility in private transport can be considered consolidated and the decarbonisation of the electric system is complete, it will be appropriate to **consider compensatory interventions for the loss of revenue. These could involve fiscal mechanisms targeting vehicles**, or policies taxing ownership and mileage of vehicles, **as mentioned in the introduction of this paper**.

Foreword

*Edited by Andrea Zatti**

The European Union's climate policy aims to achieve net-zero emissions by 2050. The transport sector plays a particularly important role in reaching this goal, accounting for about 25 percent of total emissions and, unlike other sectors, having experienced a growing trend in emissions over the past thirty years.

In the medium to long-term perspective, sectoral policies are strongly focused on the electrification of road transport, with the aim of covering the entire vehicle fleet by 2050. This development raises a number of issues, both technical-environmental (efficiency and reliability of vehicles, net effects in terms of emissions and other externalities, availability of raw materials and impacts on waste generation, etc.) and economic-fiscal (effects on the structure of the value chain, dependence on foreign supplies of raw materials, tax burden on different types of power supply, evolution of fiscal revenues related to transport, etc.).

Within this complex framework, ECCO's report explores two specific, interrelated aspects. On the one hand, it provides a comparative analysis of the energy-environmental taxation burden on private road passenger mobility, distinguishing between fuel and electricity and, therefore, between internal combustion engine vehicles and electric vehicles. The goal, in this case, is to assess the consistency of this structure with the principles of environmental taxation (internalisation of externalities) and, concurrently, with the objectives of the gradual spread of electric technology.

On the other hand, it provides an estimate of the expected changes in fiscal and parafiscal revenue under a scenario of reduced fossil fuel consumption and increased electricity consumption, driven by the progressive shift to electric mobility[2]. This is a highly relevant evaluation given the considerable weight that fuel excise taxes currently have on tax revenues, and which opens the door to different evolving scenarios regarding the fiscal gap and possible alternative solutions to address it. [3]

Preliminarily, it can be observed that the theoretical framework for vehicle traffic taxation is based on the internalisation of external costs, aimed at introducing a price

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[2] The issue is well summarised in a recent International Transport Forum report, "*The shift to electric vehicles (ECs) and continuing improvements in the fuel efficiency of internal combustion engine (ICE) vehicles will drastically diminish revenue from fuel taxes, requiring a fundamental change to taxation in the transport sector*." ITF (2023), *Decarbonisation and the Pricing of Road Transport: Summary and Conclusions,* ITF Roundtable Reports, No 191, OECD Publishing, Paris, p. 6.

[3] The same study reports an estimate for the United Kingdom for which a 4 percentage point increase in VAT rates or a 5 percent increase in the average personal income tax rate would be needed to offset the drop in revenue due to the electric transition of the fleet (ITF, 2023, op. cit., p. 11).

disincentive/signal for businesses and consumers that reflects the external cost they generate.

At present, fuel taxation, along with vehicle taxation, represents the main instrument impacting private transport, forming a levy that burdens both ownership and use[4] . In some cases, the application of tariffs/fees for access/use of specific territorial contexts (road pricing, area pricing, parking fees, etc.) also helps to capture, at least in part, the strong spatiotemporal concentration of some of the externalities related to transport (congestion, space occupation, noise, local pollutants).

There are several studies and analyses dedicated to this topic at the international and European level, with two key references: the European Commission's Handbook on External Costs in Transport[5] and the International Monetary Fund's monitoring of fossil fuel subsidies[6]. Both highlight that, at present, the fiscal levies on passenger transport remain well below the externalities generated. For example, in the European Commission's Handbook, it is calculated that external costs[7] in the European Union are more than double the total tax revenue generated by cars, while the IMF study reveals that even in a country with high fuel taxes such as Italy, there is still room for a more complete internalisation of external costs, especially in the diesel-powered sector.

Looking at the specific case of electric cars[8] , the structure of fiscal levies should consider several aspects and objectives, including forward-looking ones such as:

- the lower external costs generated compared to traditional vehicles, particularly those related to combustion, and thus to emissions, both greenhouse gases and local pollutants, that impact public health;
- the need to ensure, in the short-term, a favourable, or at least non-hostile, treatment that incentivises, in line with the objectives set at local and national levels, the widespread adoption of this technological solution, also making it possible to exploit learning economies;

[4] It was noted in this regard that (p. 360): "*the excise in part acts as a crude approximation to a road user charge*" and again (p. 363): "*The excise tax has some correlation with a road user charge and pollution. It is a crude way to internalise road user costs, and has a negligible correlation with congestion external costs*," (Freebairn J., 2022, *Economic Problems with Subsidies for Electric Vehicles,* Economic Papers, Vol. 41, NO 4, December 2022, 360-368).

[5] EC, 2020, *Handbook on the external costs of transport*, European Commission, Directorate-General for Mobility and Transport https://data.europa.eu/doi/10.2832/51388.

[6] Simon B., Liu A., Parry I., Vernon N., 2023. *IMF Fossil Fuel Subsidies Data: 2023 Update*, Working paper, IMF, Washington, DC, https://www.imf.org/en/Publications/WP/Issues/2023/08/22/IMF-Fossil-Fuel-Subsidies-Data-2023-Update-537281.

[7] Among which those to infrastructure are not considered.

[8] In the Report, reference is made only to the usage phase, not considering either that of vehicle construction or final disposal. This is somewhat equivalent to assuming that the externalities generated at these levels are already internalised through other means (process and product standards, taxes on the use of raw materials, ETS, taxes on energy consumption, taxes on final disposal, etc.).

- the medium to long-term need, corresponding to the phase where the spread of electric cars will become predominant, to still maintain a marginal disincentive to the use of these vehicles in order to limit the rebound effects in terms of distance travelled and the externalities related to them (congestion, accidents, certain types of emissions, infrastructure costs);
- the need to ensure, again in the medium to long-term perspective, that electric vehicles also contribute to covering the costs of transportation infrastructure and, more generally, the public expenditures presently covered by automobile taxation.[9]

This is a complex perspective which cannot be fully addressed in this brief note. However, it is possible to outline some key steps in an evolutionary approach that seeks to integrate all the aforementioned elements.

In the short and medium-term, it is reasonable that the fiscal burden per kilometre travelled should be lower for electric cars compared to gasoline and, especially, diesel cars, due to the reduced pollution costs they generate and the fact that climate change related costs are already internalised through the tradeable permit system that operates upstream for electricity generation (e.g. ETS)[10]. This incentivising approach can be further strengthened through measures that reduce taxes on the purchase and ownership of electric vehicles, thereby supporting the learning process and cost reduction of this emerging technology. [11]

The current situation, as outlined in ECCO's report, does not seem to be consistent with this approach, especially for charging from so-called Other Uses' and public medium voltage charging for which the high impact of system charges results in a fiscal and parafiscal burden per kilometre that is similar to or even higher than that of internal combustion engines. **This consideration is confirmed when referring to the**

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[9] The latter two aspects are highlighted well by the International Transport Forum: "*If EV use remained untaxed, these vehicles' lower marginal cost per kilometre compared to ICE vehicles could significantly increase their average travel distances. This would exacerbate congestion and undermine sustainable urban mobility policies. Not taxing EV use would also raise an equity issue, as their owners would make little or no contribution to road infrastructure costs*" (ITF, 2023, op. cit., p. 6).

[10] If we take as reference what is reconstructed in the ITF report (2023, op. cit.), it can be seen that the marginal external cost (excluding infrastructure) of electric cars:

- is very close to that of other cars under conditions of high congestion (both urban and rural);
- is about half that of an efficient diesel car and 2/3 that of an efficient gasoline car in urban areas in uncongested situations;
- is about 1/5 that of an efficient diesel car and 1/4 that of an efficient gasoline car in rural areas in uncongested situations.

If infrastructure costs were also considered, the differences would be reduced, since this component is the same regardless of power supply, but still remain significant, especially in suburban areas.

[11] As the OECD points out, "*The first objective is to steer toward electrification of the vehicle fleet through the vehicle purchase taxation system, in coordination with the EU-wide intensity regulation, accompanied by significant investment in charging infrastructure for electric vehicles (EVs),*" OECD, 2021, *An Action Plan for Environmental Fiscal reform in Italy*, https://www.mase.gov.it/sites/default/files/archivio/allegati/sviluppo_sostenibile/OECD-ECDGREFORM-Italy_project_Environmental_fiscal_reform_Italy_An_action_plan_22-09-21.pdf , p. 23.

unitary fiscal burden on CO2 emissions, as it is significantly higher for electric power sources, reaching values up to 3.5 times greater when comparing public electric charging to diesel.

This situation leaves ample room for corrective interventions, which could involve both an increase in the fiscal burden on traditional engines, particularly diesel and LPG, and a reduction in general system charges, particularly those affecting condominium and public charging. For example, a gradual (even if partial) narrowing of the excise tax gap between gasoline and diesel would be sufficient to offset, in the medium-term (up to 2035), the reduction of taxes on electric charging, without generating further demands on general taxation.

In a medium to long-term scenario, where fossil fuel consumption begins to decline significantly, it will be necessary to develop a tax system increasingly based on distance travelled, which, if the technology allows, could eventually differentiate the unitary tax based on location and time of travel[12] . This phase must also fully involve electric cars[13], which have become a significant part of the vehicle fleet, both to address external costs not related to combustion and to compensate for the loss of revenue that would otherwise need to be covered by other sources.

Some states have already begun taking initial steps in this direction, while also trying to find the right balance between different phases to avoid undermining the goal of transitioning to electric vehicles (see Box 1).

At the same time, and in coordination with the two previous points, a gradual phase-out of incentives for electric vehicles should be envisioned. Indeed, the increasing cost competitiveness of this technology will make it increasingly accessible, freeing up resources to stimulate the decarbonisation of the more difficult segments of the vehicle fleet (such as buses and trucks) and to ensure wider coverage of charging points. The timing of this phase should be determined based on the actual market penetration rate, avoiding, as international cases show, starting it too early.

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[12] However, the latter assumption faces significant problems in terms of both technological, legal and administrative burdens (see ITF 2023, *op. cit*. and Borjesson M, Asplund D., Hamilton C., 2023, *Optimal kilometre tax for electric vehicles,* Transport Policy, 134, pp. 52-64).

[13] Always keeping in mind that "*Internal combustion engines should face higher total road-user charges to address their larger climate pollution and noise impact*" (ITF, 2023, op. cit., p. 35).

Box 1

Cases of ad hoc taxation of electric cars per km driven

In New Zealand, cars not subject to fuel taxation will be expected to pay a kilometre rate based on the values recorded by the odometer, paid annually along with the ownership tax. Originally scheduled to come into effect in 2021, this has been delayed until 2024 (ITF, 2023, op. cit.).

Some American states (Oregon, Utah, Virginia) apply an ownership surcharge to electric vehicles and other types of vehicles that do not pay or pay reduced fuel excise taxes. In these states, owners can alternatively opt to pay a kilometric rate based on data recorded by special devices installed in vehicles. These systems are seen as a stepping stone toward a medium to long-term goal of kilometre-based taxation across the entire circulating fleet (ITF, 2023, op. cit.).

Four Australian states (New South Wales, Victoria, South Australia and Western Australia) have adopted official acts aimed at introducing a kilometric tax on electric vehicles. Of these, only the state of Victoria has introduced the tax, while the other three have postponed its implementation until 2027 to avoid disincentivising the short-term deployment of electric cars.

In the case of the State of Victoria, a levy of 2.5 Australian cents per kilometre is applied for electric cars (2 for hybrids): a value estimated to be well below what cars currently pay on average (4.4 cents) in fuel excise taxes (Freebairn, 2022, *op.cit.*). The tax is calculated based on the values recorded by the odometer and is paid annually alongside the ownership tax.

Two additional considerations emerge from the wealth of information provided in the report.

The first consideration is related to the net budgetary effects and the concerns that the widespread adoption of electric cars could lead to gaps that are difficult to bridge. However, the data shows that these concerns should not be overstated, especially if adequate and timely accompanying measures are put in place. In the short and medium-term, the lower revenues under current policies estimated by the report (€1.1 billion by 2030; €3.8 billion by 2035) can, in the first instance, be offset by a (partial) reform of Environmentally Harmful Subsidies.

In the long-term, as electric vehicles are expected to become more dominant, it will be essential to introduce alternative forms of taxation on vehicles. This includes the possibility of combining, in a two-part system, taxation on vehicle ownership and kilometres travelled.

The second consideration emphasises the importance of viewing the vehicular sector within the broader context of people's mobility and environmental and social sustainability. Indeed, the analysis conducted in the report is based on reference scenarios from the NECP and the Decarbonisation Strategy, where the electrification of the fleet is accompanied by a 25 percent reduction in the circulating fleet by 2040 and 40 percent by 2050. This would mark a significant shift from the past 70 years, which, on the one hand, requires substantial intervention policies on other non-technological components (urban planning, collective transport, soft mobility, people's habits) and, on the other hand, would lead to additional significant social and environmental benefits (less congestion, less pollution, increased physical activity, etc.).

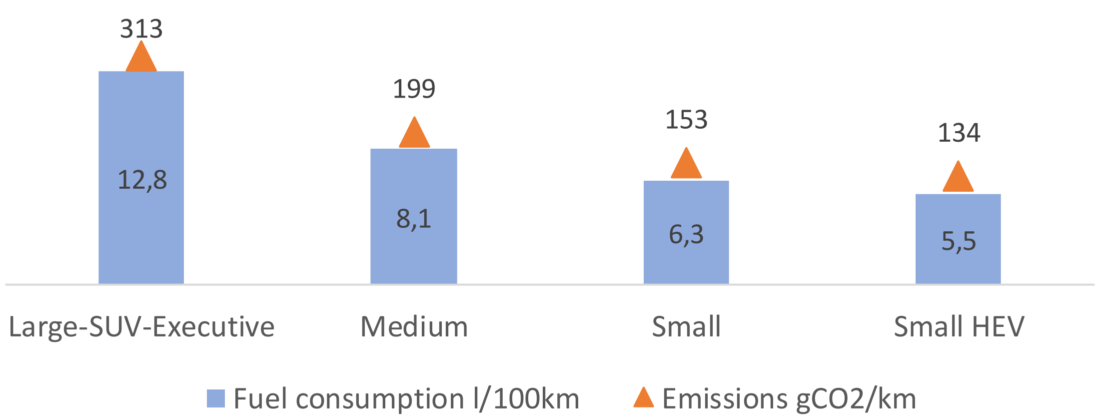
Without considering these broader systemic aspects, the mere calculation of costs and revenues for the state, while important, risks being partial and, in some respects, misleading.

** Professor of European Public Finance and Public Policy and Environment at the Department of Political and Social Sciences, University of Pavia.*

Introduction

Filling up with gasoline or diesel at a fuel station and plugging an electric car into a charging station have different energy and environmental implications. In the first case, fuel is used by a car with an average energy efficiency that varies, depending on the model, between 0.45 and 1.2 kWh/km[14] (or, if preferred with average consumption between 4.8 and 12.8 litres per 100 km) generating tailpipe emissions ranging from 130 gCO2/km for a hybrid utility vehicle (HEV) to over 310 gCO2/km for the most powerful SUVs. [15]

Figure 1 – Real average fuel consumption and emissions of gasoline vehicles in the car fleet circulating in Italy in 2021



Source: ISPRA/Copert data processing

In the second case, electricity is used by an electric car with an energy efficiency ranging from 0.14 to 0.24 kWh/km,[16] 3 to 5 times higher than an equivalent traditional combustion engine vehicle, with zero tailpipe emissions, both of greenhouse gases and other pollutants (see Box 2).

Box 2

Under the regulation on CO2 emission standards for vehicles (EU Regulation 852/2023), emissions from pure electric vehicles are considered to be zero. However, this does not mean they are zero in an absolute sense, given, for example, the emissions associated with

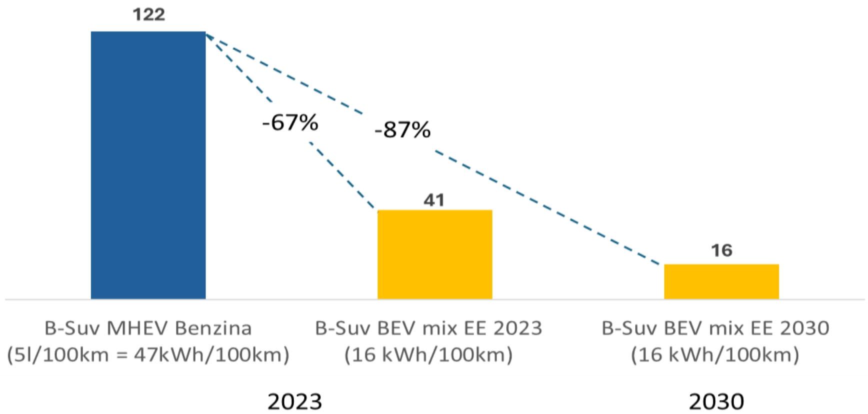
[14] Throughout the document, when comparing different forms of energy, such as fuels and electricity, kWh is adopted as the reference unit of energy. The energy conversion factors used for fuels are: Gasoline = 9.3645 kWh/l; Diesel 9.9736 kWh/l; LPG = 7.2264 kWh/l (Source of conversion factors: Energy balance guide (Eu Commission 2019))

[15] Data compiled from ISPRA/Copert database for the circulating fleet in The database of average emission factors for the circulating fleet in Italy (isprambiente.it)Italy as of 2021 - .

[16] Energy consumption of full electric vehicles cheatsheet - EV Database (ev-database.org)

the electricity generation mix[17]. Even so, emissions from electric vehicles are already 66% lower than those from a combustion engine car. As the share of renewable energy increases according to the scenario projected by the NECP, this reduction will reach 87 percent by 2030. Over time, the difference will approach a 100% reduction, meaning electric vehicles will have zero actual emissions, while emissions for combustion engine vehicles will remain largely unchanged.

Specific emissions of a gasoline-powered B-SUV MHEV compared to the emissions of the equivalent B-SUV BEV using electricity from the national energy mix in 2023 and 2030 (values expressed in gCO2/km)



** Two vehicles of the same B-SUV model in two configurations were used for comparison: Mild Hybrid gasoline (MHEV) and full electric (BEV). Average fuel consumption used for the calculation is as declared by the manufacturer in the vehicle data sheet under the WLTP approval cycle. For 2023 national energy mix emissions, the average electric consumption of year 202 was used as a proxy (Source: Ispra); for year 2030, the mix emissions are those predicted by PNIEC 2023.*

The climate benefits, and more generally the environmental benefits, of using electric vectors in private mobility[18] are not always adequately reflected in a corresponding fiscal advantage for consumers. Regarding electric vehicle charging tariffs, in addition to the energy costs (*Energy* components) and distribution costs (transport components and meter management), excise taxes and, significantly, the cost of **general system charges** are also applied. These charges refer to parafiscal components designed to cover general interest expenses, which can significantly impact the cost differences compared to internal combustion engine vehicles.

[17] For a comprehensive comparative assessment of WTW life-cycle impacts for greenhouse gas emissions of different vehicle types and different energy mixes globally, see: A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars (theicct.org).

[18] Electric vehicles: a smart choice for the environment - European Environment Agency (europa.eu); Health and environmental benefits related to electric vehicle introduction in EU countries - ScienceDirect; The Environmental Benefits of Electric Vehicles as a Function of Renewable Energy (harvard.edu)

Another relevant cost component, similar to a fiscal charge, concerns the impact of emission allowances under the European Emission Trading System (EU-ETS) on electricity production from fossil sources and, consequently, on the energy costs paid by consumers.

The **general system charges** are divided into two macro-categories: $\boldsymbol{A_{Sos}}$ **charges**, related to the support of renewable energy and cogeneration, as well as subsidies for energy-intensive businesses; and $\boldsymbol{A_{Rim}}$ **charges**, or remaining general charges, intended to cover expenses for public interest activities, including decommissioning of nuclear power, system research and tariff protection measures for consumers in difficulty, etc. [19].

As for the A_{Sos} component, which represents the largest share of general system charges, in 2021[20] the economic requirement was 10.6 billion euros, mainly covering incentives for renewable energy sources introduced by the *Conto Energia*[21]. The impact of these charges on electricity bills is expected to decrease significantly from 2032, the deadline for exiting from the existing incentive mechanisms.

In this context, the analyses proposed in this report are divided into two parts.

Part I proposes a comparative analysis of the burden of energy-environmental taxation on energy consumption in private road passenger mobility, distinguishing between fuels and electricity and, therefore, between taxation for fuelling internal combustion engine vehicles and for charging electric vehicles.

Based on this data and considering the energy consumption of the circulating vehicle fleet, **Part II** estimates the expected changes in fiscal and parafiscal revenue under a scenario of reduced fossil fuel consumption and increased electricity consumption associated with the gradual shift to electric mobility.

The **purpose of the analysis** is twofold. On the one hand, to verify the consistency with the principles of environmental taxation of the current structure of fiscal taxation applied to energy consumption for private mobility and the possible interventions to support the spread of electric technologies. On the other, to highlight the potential fiscal revenue differential that could progressively emerge with the spread of electric vehicles, in order to assess the opportunity to identify corrective measures in line with the priorities of the transition.

[19] Arera: General system charges and additional components; The general charges of the electricity system (camera.it);

[20] *GSE_Report_Activity_2021.pdf; Reporting on the use of resources allocated to contain the effects of price increases in the electricity and natural gas sectors - Arera

[21] Chamber.it - Documents - Topics of Parliamentary Activity

Methodological note

The analyses developed in this report consider the different forms of fiscal and parafiscal taxation applied to energy consumption for fuel and electricity related to the use of passenger vehicles for private mobility (cars). A brief description of the approach used is provided below. For detailed information on the analysis methodology, see the Annex to the methodological note.

Comparative analyses of fiscal and parafiscal taxation

The comparison of the fiscal and parafiscal burdens on electric vehicle charging, including full electric vehicles (BEVs) and plug-in hybrids (PHEVs), compared to refuelling for endothermic vehicles, was conducted based on the average values of cost components that make up electric tariffs and fuel prices for the year 2023. The final electricity tariff prices were considered only for the pay-per-use scenarios.

The impact of emission allowances under the European Emission Trading System (ETS1 and ETS2)[22], typically incorporated into the price of energy, was separated and considered as a component of fiscal taxation.

As for electric charging, among the numerous options for charging plug-in vehicles, this model considers a configuration of five different charging methods that best represent current offerings, namely:

- Domestic users, meaning the use of the same household electricity tariff (hereinafter referred to as BEV Domestic).
- Private low voltage users for Other Uses, typical of apartment buildings or private garages (BEV Other Uses).
- Public low voltage charging stations with BTVE tariff[23] (BEV BTVE Pub).
- Private low voltage charging stations for company recharging with BTAU tariff (BEV BTAU Offices).
- Public medium voltage charging stations with MTAU tariff (BEV MTAU Pub).

Scenario assessments

For the scenario assessments aimed at estimating the variations in fiscal revenue associated with reduced fuel consumption and the gradual electrification of mobility, a calculator was set up to process the total average consumption of fuel and electricity, considering the composition of the current and projected circulating fleet of vehicles, the average energy efficiency of the vehicles and the average annual distance travelled.

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[22] EU Emissions Trading System (EU ETS) - European Commission (europa.eu)

[23] Only the BTVE tariff was considered because it is the most widely used given the current average utilisation rates of about 2 percent

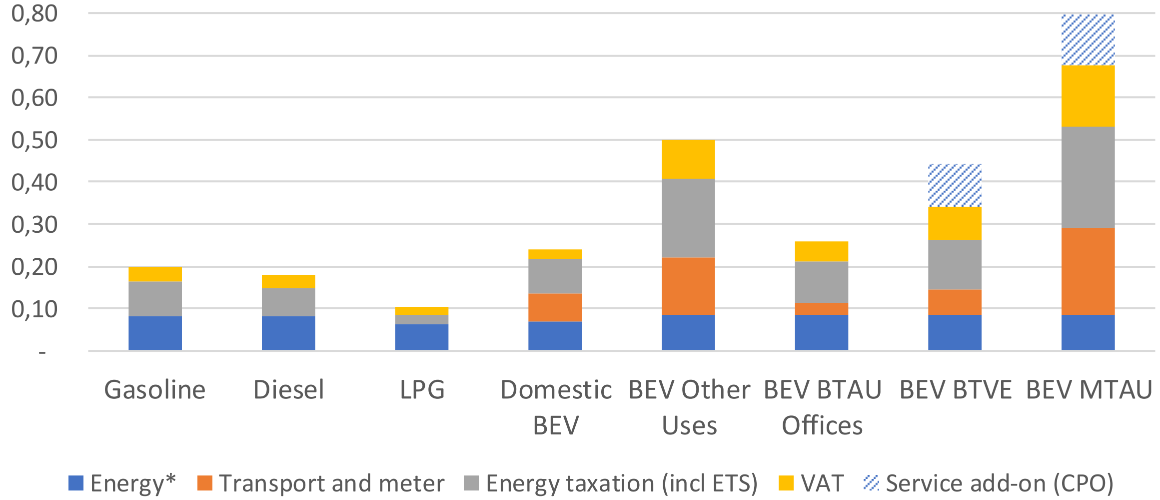
PART I - Comparative analysis of energy taxation in refuelling and electric charging costs

Analysis with equal energy consumption

As of today, charging one kWh of electricity into an electric vehicle's battery is more expensive than refuelling one kWh using any fossil fuel (corresponding to 0.107 litres if it were gasoline, 0.100 litres if it were diesel, 0.138 litres if it were LPG). This difference is not so much due to a different net energy cost between the two options, but rather the various components that define the final price of both recharging and fuelling. In fact, given the current allocation method of tariff components for electricity, electric charging is burdened by substantial costs for transportation and meter management, as well as fiscal and parafiscal charges.

In the configuration adopted for the analysis, based on average prices for the year 2023 (see Methodological Note and related Annex), the cost of refuelling with gasoline is around €0.2/kWh, compared to €0.18/kWh for diesel (-10%compared to gasoline) and €0.10/kWh for LPG (-48%).

Figure 2 - Refuelling cost for traditional cars and charging cost for plug-in electric vehicles per unit of energy (€/kWh)

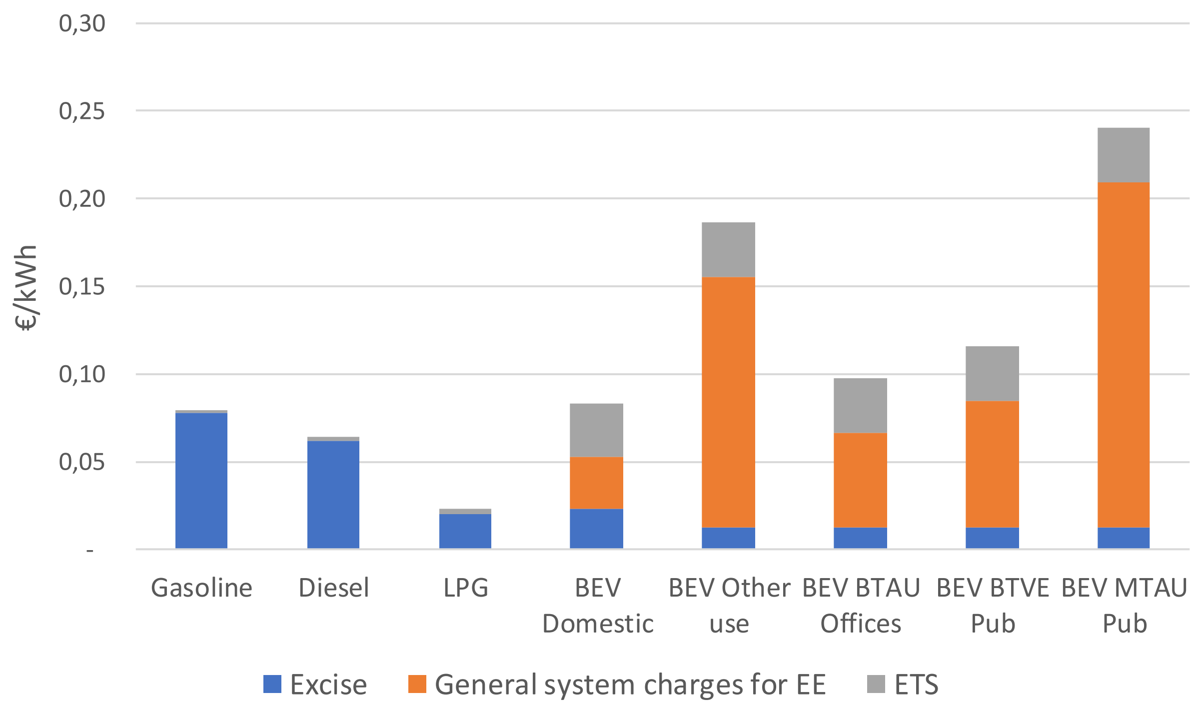


** Value expressed net of estimated ETS cost included in energy tax shares.*

Conversely, for all electric charging options, the costs per kWh are higher. For domestic users, the cost is 0.24 €/kWh (+20% compared to gasoline), which rises to 0.5 €/kWh (+150%) in the case of other use utilities. For low voltage office use charging, the cost is €0.26/kWh (+30% compared to gasoline), slightly higher than that for domestic charging, partly due to the VAT applied (22%, compared to 10% for domestic recharges). For public low voltage BTVE charging, the cost is about €0.44/kWh (+122% compared to gasoline) and €0.80/kWh (+202%) for medium voltage MTAU charging.

Focusing only on the impact of the fiscal and parafiscal components that form the final price of different energy carriers, the comparison for the same amount of energy consumed highlights that the tax burden is always higher in cases of electric charging than in refuelling.

Figure 3 - Impact of excise duties, general system charges and ETS components on refuelling and electric vehicle recharging



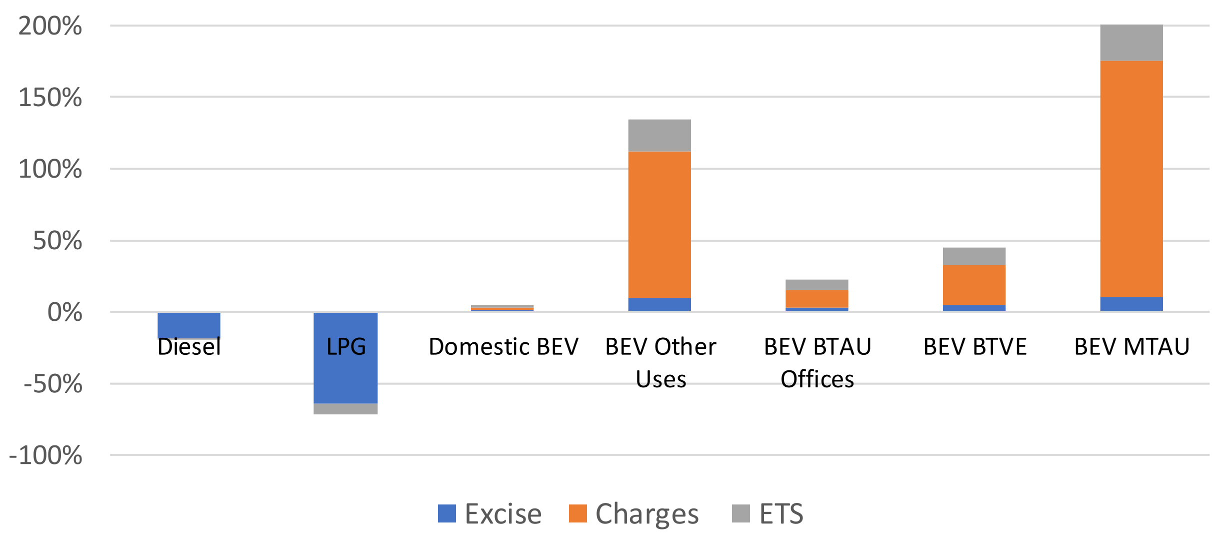
Looking at the weight of the components in differential terms compared to gasoline refuelling, there appears to be a clear fiscal advantage for diesel and LPG, and a disadvantage for all forms of charging. Specifically, for diesel and LPG, the overall fiscal advantage is -20% and -71%, respectively, due to the lower excise duties applied to these two fuels. [24]

For domestic charging, the fiscal burden is only slightly higher than gasoline, +5%, which becomes +30% when compared to diesel (and +265% compared to LPG). For Other Uses utilities, the tax differential is+ 134 percent higher (+191% vs. diesel, + 718% vs. LPG); for office-use BTAU charging, the differential is +22% (+52% vs. diesel, +327%

[24] The difference in taxation between these fuels expressed in €/l is -15% for diesel fuel (to which an excise tax of €0.617/l is applied versus €0.728/l for gasoline) and -78% for LPG (to which a reduced excise tax of €0.14/l is applied). The difference in the two comparisons is due to the transformation of the energy content of the unit volume of fuels into kWh.

vs. LPG); for public low voltage BTVE charging, it is 45% (+81% vs diesel, +407% vs LPG) and for medium voltage MTAU charging, it reaches 202% (+275% vs diesel, +954% vs LPG).

Figure 4 - Percentage difference of fiscal and parafiscal components affecting the refuelling and charging of vehicles compared to gasoline refuelling (% difference calculated on values in €/kWh)



In all cases, the higher taxation on electric charging is linked to the weight of the general system charges, while the impact of the excise duty component is minimal.

Looking at the impact of the taxation applied to different energy carriers in terms of specific CO2 emissions[25], it appears that electric vehicle charging incurs the equivalent of an average (consumption-weighted) carbon tax that is over 160 € higher than refuelling: €415/tCO2 for charging compared to €252 /tCO2 for fuels.

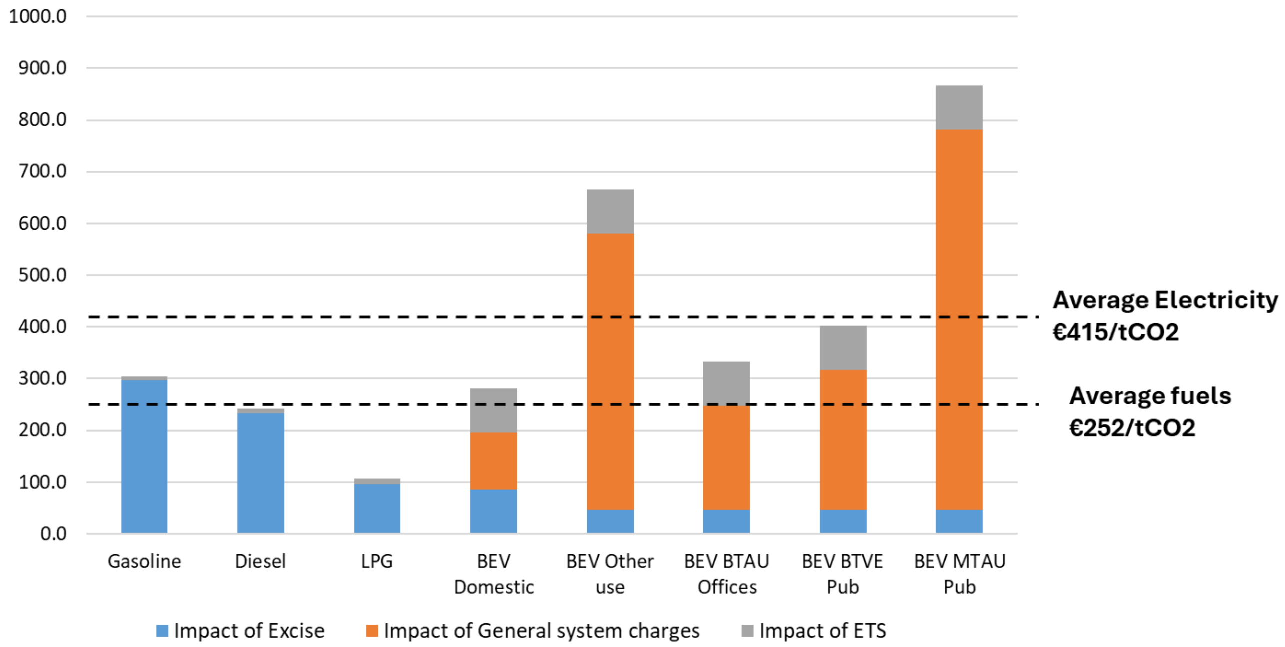
In detail, by type of energy carrier, the taxation applied to charging from domestic users reflects a value comparable to that of gasoline, still significantly higher than that of diesel and LPG. In other cases of electric charging, the impact of taxation in relation

[25] For the calculation, the average emission coefficient of the 2021 national electricity generation mix published by Ispra Efficiency and decarbonization indicators in Italy and in the biggest European Countries (isprambiente.gov.it) was applied. Considering also the contribution of renewable energy sources, the coefficient is 268 gCO2/kWh, which is essentially equivalent to the average value found for gasoline and diesel (264 gCO2/kWh).

The average electric emission coefficient of the mix appears to be declining progressively since 1990, when it was 709 gCO2/kWh. For the year 2022, Ispra reports a higher coefficient (308 gCO2/kWh), due to the effects of the Russian war in Ukraine that required the maximization of electricity production in coal-fired power plants under the National Natural Gas Consumption Containment Plan. For the coming years, partly due to the expected growth in installed electric renewable capacity, it is expected that this value will resume its rapid decline. For this reason, the year 2021 was chosen as the reference for the analysis.

to emissions is far greater than that found for all fossil fuels, with a peak of nearly €900/tCO2 for charging at medium voltage.

Figure 5 - Comparison of taxation for excise duties, general system charges and ETS versus CO2 emissions of different energy carriers (€/tCO2)*



** Average values reported refer to weighted average based on consumption*

Analysis with equal distances travelled

The analysis of taxation based on equal distances travelled (€/km) allows for the inclusion of vehicle energy efficiency in the calculation of refuelling costs for different energy carriers.

Despite the higher fiscal and parafiscal imposition per unit of energy consumed on electric charging compared to fossil fuel refuelling, the greater efficiency of electric vehicles offers a consistent advantage in terms of usage over traditional vehicles powered by fossil fuels.

Below is an analysis of costs, and of the impact of fiscal imposition for a real case[26] of two comparable B-SUV segment vehicles: one electric (BEV) and the other mild-hybrid gasoline (MHEV). According to the data from the manufacturer's technical sheets, the BEV version consumes 16 kWh of energy to travel 100 km, while the

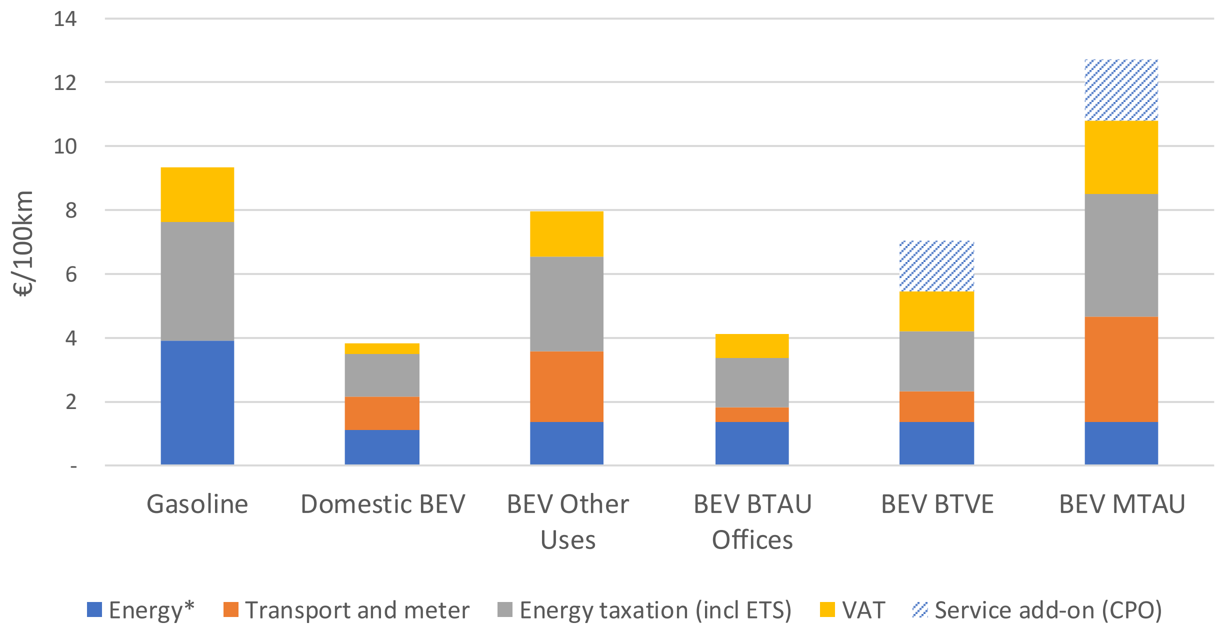
[26] The case involves two cars of the same model from the same manufacturer in the two different configurations BEV and MHEV. Manufacturer-reported consumption data collected according to the Worldwide Harmonised Light Vehicle Test Procedure standard are used in the analysis (Source: manufacturer's website).

gasoline MHEV model consumes 5 litres of fuel, equivalent to 46.8 kWh of energy, or about 3 times the consumption of the full-electric version.

In the average cost configuration of 2023 assumed for the analysis (see Methodological Note and accompanying Annex), the average expenditure for travelling 100 km with the gasoline MHEV model is €9.7/100km, compared to a value ranging between €3.8/100km and €12.7/100km for the BEV version, depending on whether charging is done domestically or from a public medium voltage MTAU charging station.

Specifically, the greater energy efficiency of the electric vehicle allows the user to save €5.5 if charged domestically, €5.2 if charged from office-use charging stations, and €2.3 if charged from public low voltage BTVE charging stations.

Figure 6 – Refuelling cost to travel 100 km with comparable B-SUV segment vehicles (gasoline or electric) for different charging options (€/100 km)

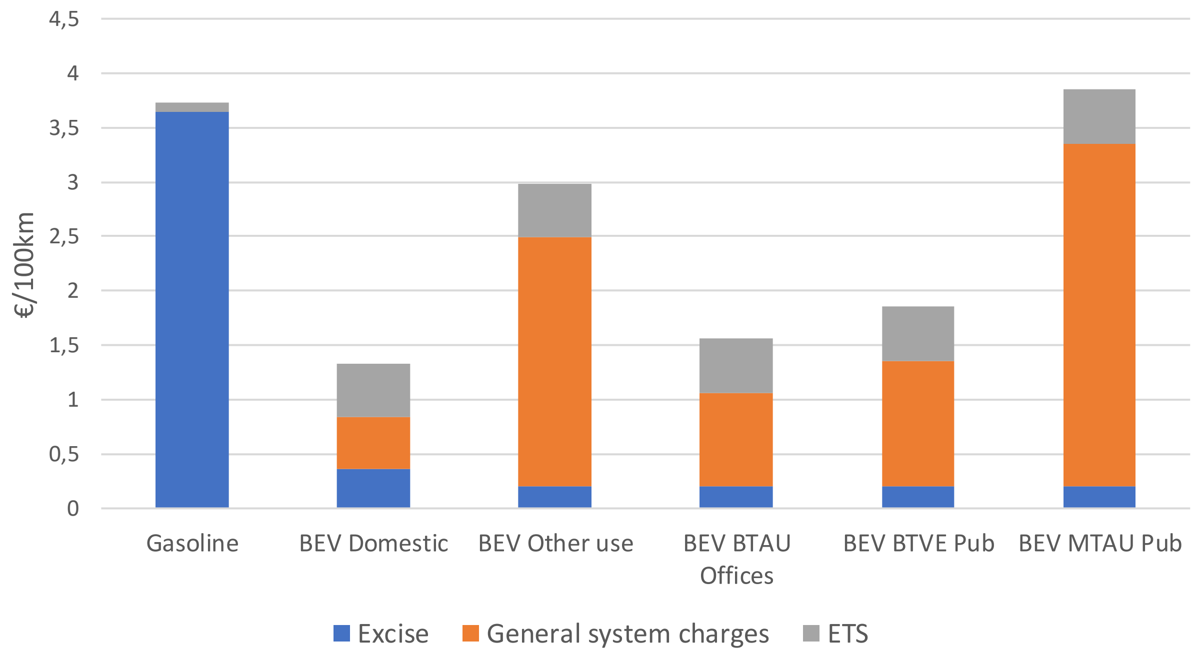


** Value expressed net of estimated ETS cost included in energy tax shares.*

The advantage in charging costs due to the electric vehicle's greater efficiency is significantly reduced when charging for Other Uses (€1.3 savings) and is nullified when using medium voltage charging with an MTAU tariff, for which the average cost for travelling 100 km is €3.4 higher than for a gasoline vehicle.

This can be attributed to the weight of the general system charges, as shown when looking at the breakdown of individual components applied to the different recharging options compared to gasoline refuelling.

Figure 7 - Breakdown of the impacts of fiscal and parafiscal taxation on the cost of refuelling to travel 100 km with comparable B-SUV segment vehicles (gasoline or electric) for different charging options (€/100 km).



In terms of average annual expenditure, assuming 10,000 km/year of driving for both vehicles and a predominant charging mix for the BEV vehicle, the cost of driving the gasoline MHEV model is €896/year versus €559/year for the BEV version, resulting in net savings of €337 annually for full-electric vehicle drivers. [27]

Concluding remarks

The analysis conducted based on energy consumption units (€/kWh) shows a taxation system applied to energy carriers for private road mobility that penalises electric charging compared to fossil fuels. This penalisation is evident in both direct comparisons of cost components and when considering specific CO2 emissions for the different carriers.

[27] For the BEV model, an average distribution of recharging modes referring to the circulating fleet was considered: 55% Domestic, 15% Other Uses; 8% Office BTAU; 15% BTVE; 7% MTAU (see Methodological Note and Annex 1). Adopting a distribution of recharging modes with a greater weight of domestic and office recharging (60% Domestic, 20% Offices, 15% BTVE, 5% MTAU), the savings becomes 414 €/year.

In all cases, it is clear that the higher taxation €/kWh on electric charging is primarily due to the weight of the parafiscal component of the general system charges, while excise duties have a marginal impact. This is due to the current method of allocating cost components, where the power charge (cost based on the power available at the charging point) has the greatest impact, particularly when utilisation rates are very low and the power supplied is very high, while excise duties are allocated at a fixed value per kWh consumed.

Charging from domestic and business users already faces a taxation comparable to that applied to gasoline, significantly higher than for diesel and LPG, with notable excise duty discounts in place. For charging from utility accounts for Other Uses, typical of private meters in locations other than residences or condominium spaces, as well as from public infrastructure, the level of taxation is considerably higher, especially for medium voltage infrastructure, like Ultra-fast chargers.

These are essential to ensure that electric vehicle users have the security of charging quickly during long-distance travel, reducing **range anxiety**- the fear that a vehicle's range will not be sufficient to reach the destination, a factor that is still perceived as one of the key barriers to the adoption of electric cars in private mobility.[28]

The analysis conducted of equal distances travelled (€/100km) reveals how the greater energy efficiency of electric vehicles still provides savings for electric vehicle drivers, especially when charged for domestic and business accounts. However, the advantage decreases for charging done by users for other uses or public at low voltage and is nullified in the case of medium voltage charging. Therefore, the excessive weight of the general system charges leads to the applied tariffs being disadvantageous even compared to gasoline.

General system charges are primarily associated with the recognition of incentives for the development of electricity generation from renewable sources and for energy efficiency. In this context, it seems contradictory that their significant impact could become a barrier to the spread of efficient vehicles powered by renewable electricity.

This contradiction is even more apparent when looking at the impact of these components in relation to the specific CO2 emission coefficients of the different energy carriers, or the equivalent of a carbon tax. In terms of cost per ton of CO2 emitted (€/tCO2), the taxation applied to electric charging is disproportionate to fossil fuel refuelling and up to three times higher than gasoline in the case of medium voltage charging.

[28] EY index: 70% of Italians are willing to buy an electric or hybrid vehicle

The availability of shared and public charging infrastructure with favourable rates can encourage the purchase of electric vehicles. Under market conditions, the cost of charging from these installations is expected to decrease over time due to the expansion of renewable energy production, impacting the cost of the energy component. Additionally, in the case of public charging, increasing the utilisation factor of the infrastructure, combined with a higher penetration of electric vehicles in the circulating fleet, should lead to a reduced weight of system charges, as well as the extra service costs applied by operators, thanks to competitive dynamics.

However, in the short and medium-term, the opportunity should be considered to intervene in order to reduce charging costs through mechanisms that discount the weight of the tariff components that have the greatest impact on determining rates, or by encouraging the installation and use of these charging options.

In practical terms, in a typical scenario[29], for every million electric vehicles the cost of removing 100 percent of the general system charges from charging tariffs for all users is approximately 125 M€. This is 27 times lower than the lost tax revenue resulting from the different tax treatment between gasoline and diesel, which amounts to 3.378 billion euros - a value reported in the latest edition of the Catalogue of Environmentally Harmful Subsidies (EHS) and Environmentally Beneficial Subsidies (EBS) published by the Ministry of Environment and Energy Transition, Fifth Edition 2022)[30]. Regarding this difference, the same catalogue reports that:

> *[...] In Italy, the excise duty applied to diesel for road transport is lower than that of gasoline, and this cannot be justified in environmental terms, especially in light of the revision of the EU directive on the taxation of energy products and electricity, which adjusts the weight of taxation. Instead of being based on volume, as is the case in most instances today, it is based on the energy content and "environmental performance" of fuels and electricity, taxing energy products that result in higher CO2 emissions in the atmosphere more heavily*

Intervening with a reform of EHS, beginning with the excise duty differential between diesel and other fossil fuels, to reduce the burden of general system charges by shifting their cost to fossil fuel energy taxation, is part of the framework for interpreting the polluter pays principle as a reference for the correct reform of energy-environmental taxation.

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[29] This situation considers an average annual distance travelled of 10,000 km, with average vehicle energy efficiency: diesel cars = 6.3 l/100 km (as per average circulating fleet 2021); BEV cars = 15.8 kWh/100km. Distribution charging mode of BEV users: 55% domestic, 15% other use, 8% Office use; 15% Public BTVE; 7% Public MTAU

[30] Catalogue of environmentally harmful subsidies and environmentally favourable subsidies | Ministry of Environment and Energy Security (mase.gov.uk)

In this regard, it should also be noted that reducing, if not eliminating, EHS is one of the pivotal reforms included in the new Mission 7 of the NRRP in relation to Repower EU's planned investment and reform for Italy.[31]

[31] RepowerEU (camera.it)

PART II – Variation in fiscal and parafiscal revenues from energy consumption in the transition to the electric car

The gradual penetration of electric cars in the circulating fleet and the simultaneous reduction in internal combustion engine vehicles implies a downward shift in tax revenue from fossil fuel consumption and an upward shift in tax and parafiscal revenue from electric consumption. However, despite the higher taxation per unit of energy consumed applied to electric charging compared to fossil fuel refuelling, the overall balance remains negative due to the greater energy efficiency of electric vehicles, which allows more kilometres to be travelled with less energy consumed.

Building on the information provided in the previous chapter about the differences in fiscal and parafiscal taxation between electric charging and fuel refueling, quantifying the gradual change in revenue over time provides useful information for legislators in planning corrective interventions within a framework of energy-environmental taxation that aligns with the transition.

In this regard, in the following a scenario analysis will be presented of the variation in fiscal and parafiscal revenues for energy consumption in private road mobility, in relation to the electrification prospects of the circulating car fleet between 2023-2040.

Scenario assessments are based on fixed 2023 average prices.

Scenario assumptions

For the scenario analysis, changes in the composition of the car fleet were based on the NECP 2023 forecasts for 2030 (4.3 million electric vehicles, BEVs; 2.3 million plug-in hybrid vehicles, PHEVs). For subsequent periods, potential developments in the electric vehicle market were considered within the context of existing European legislation[32]. Assumptions were also made regarding the changes in the energy and emission efficiency of the vehicle fleet, in line with historical trends of fleet renewal.

The scenario also considers a gradual reduction in the number of vehicles in the circulating fleet, following a trajectory compatible with the goal of having 24 million full electric vehicles by 2050, as outlined in Italy's long-term strategy on the reduction of greenhouse gas emissions approved in 2021[33].

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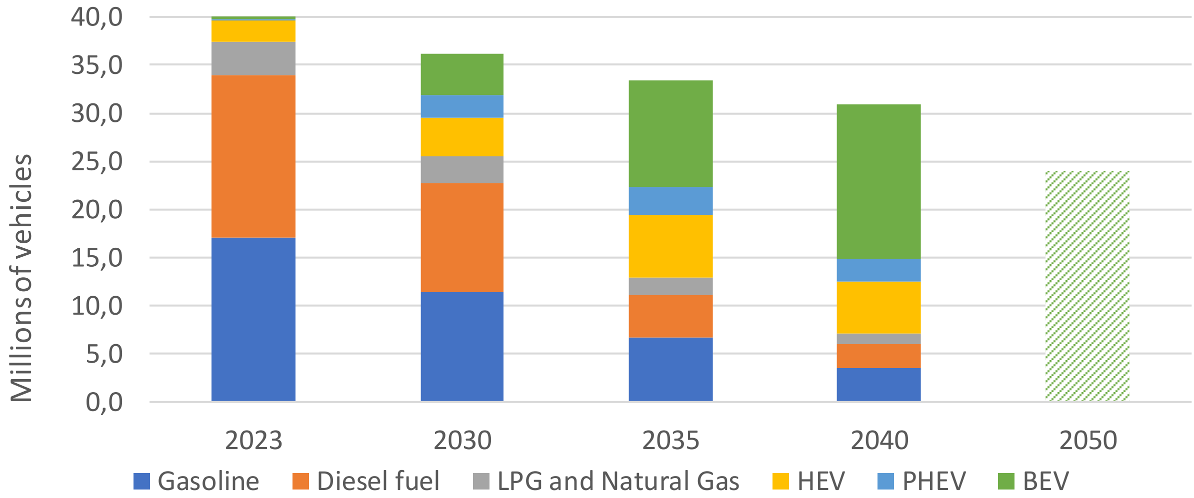
[32] New EU Regulation 2023/851 on reducing Co2 emissions from motor vehicles (camera.co.uk)

[33] NLTS - National Long-Term Strategy | Ministry of Environment and Energy Security (mase.gov.it)

Figure 8 - Changes in the composition of the national vehicle fleet adopted as a reference scenario for the analysis of changes in tax revenues from refuelling and electric charging (millions of vehicles)



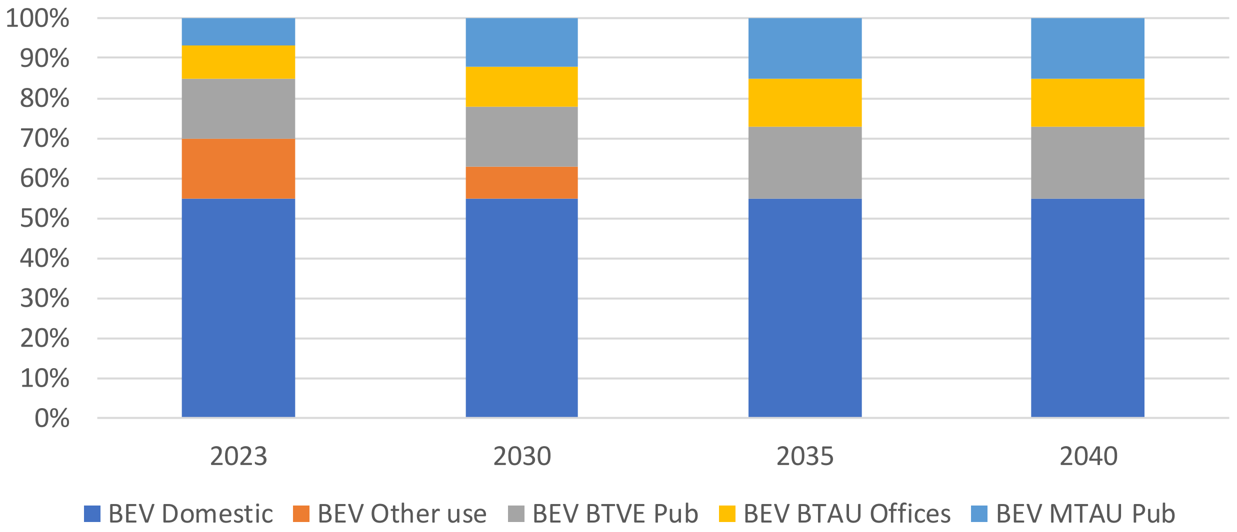
For the average vehicle consumption in the circulating fleet, the scenario uses the 2021 average efficiency (see Methodological Note and related Annex) for standard vehicle models and the types of energy carriers used (gasoline, diesel, LPG, electric). For subsequent periods, correction coefficients compatible with the historical efficiency increases recorded for combustion engine vehicles[34] and the predicted technological progress for electric vehicles are applied.

Regarding charging options for plug-in electric vehicles, the model assumes that domestic charging will prevail in a context of rapidly decreasing charging from utility accounts for Other Uses (replaced by tariffs similar to domestic charging rates), a growing use of charging options from office-use utilities, and from low voltage (BTVE) and medium voltage (MTAU) public charging infrastructure.

For public charging points, an increase in utilisation rates over time due to growth in the circulating fleet was also considered, bringing the average to 6 percent.

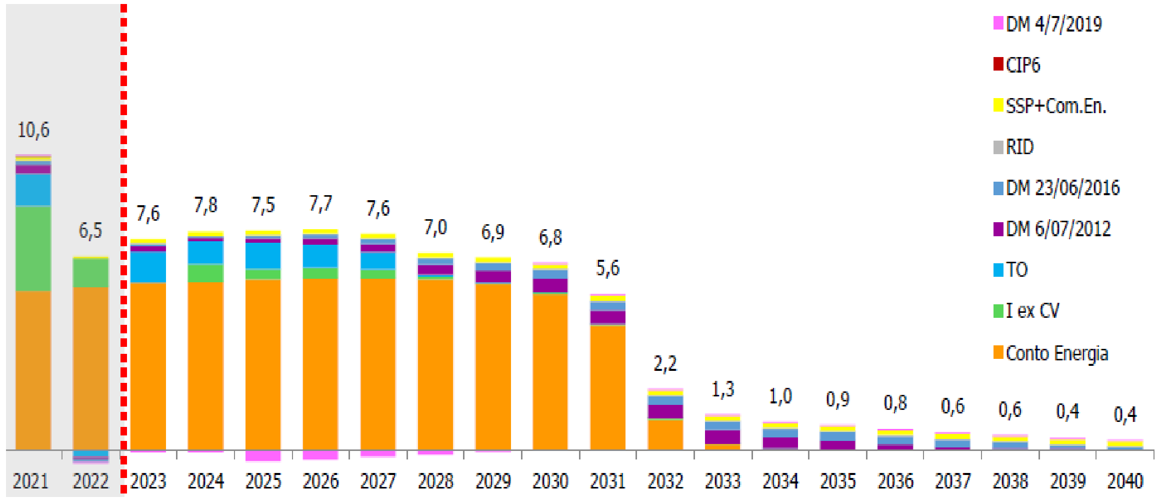
[34] CO2 emissions from new passenger cars in Europe: Car manufacturers' performance in 2021 - International Council on Clean Transportation (theicct.org)

Figure 9 - Configuration of the typical charging options adopted for electric vehicles in the scenario



Regarding the impact of general system charges, the scenario considers decreasing variations based on the projected reductions in requirements for the A_{Sos} component, as reported by the GSE in the latest 2023 update[35]. Assumptions on the introduction of new types of incentives (e.g., for Energy Communities) are also considered for this component. On average, starting from 2032, the scenario considers an overall reduction in charges (A_{Sos} and A_{Rim}) of 60 percent compared to 2023, which in turn contributes to lower charging costs.

Figure 10 - GSE scenario of evolution of economic requirement for Asos charges



Source: GSE 2024

[35] Semiannual report Energy and climate in Italy 12/02/2024.

For the assessment on the impact of revenue from CO2 emission allowances in the ETS market (see ETS1) for electricity (see Methodological Note and related Annex), the analysis assumes a progressive increase in price by 2030 and 2035, based on the main international trend scenarios[36], applied to the specific emissions of the national production mix. For the latter, an evolution by 2030 is assumed in line with NECP forecasts (72% renewable production; specific emissions mix 101.0 gCO2/kWh)[37] and by 2035 with forecasts of the ECCO-Artelys scenario[38] (99% renewable production, specific emissions mix 4 gCO2/kWh). Beyond 2035, the analysis assumes a fully decarbonised energy mix, within which the ETS1 market has no impact.

Regarding the potential revenue from the extension of the ETS market to fuels, known as the ETS2 mechanism, expected to be implemented by 2027[39], the analysis anticipates an evolution in the price of emission allowances in line with the most optimistic scenario developed by the Potsdam Institute for Climate Impact Research, anticipating the implementation of effective energy efficiency policies. [40]

Table 1 - Scenario prices for emission allowances under ETS assumed for analysis

€/tCO2	2023*	2030	2035	2040
	85,3	150	200	n/a
ETS2	0	71	150	270

** Average value recorded by EU ETS Auctions (eex.com)*

Note, that with the increase in ETS2 prices for the considered scenario, the expected short and medium-term impact on final fuel prices is relatively small.

Table 2 - Estimated increase in consumer fuel prices determined by the price of ETS2 emission allowances assumed for analysis (€/l)

€/l	2030	2035	2040
Gasoline	0,173 (+9%)	0,367 (+20%)	0,661 (+35%)
Diesel	0,187 (+10%)	0,395 (+22%)	0,712 (+40%)

[36] Global Carbon Market Outlook 2024 | BloombergNEF (bnef.com); EU ETS Market Outlook 1H 2024: Prices Valley Before Rally | BloombergNEF (bnef.com); EU carbon prices to triple by 2035, analysts predict, publishing among first ETS Phase 5 forecasts " Carbon Pulse (carbon-pulse.com)

[37] PNIEC_2023.pdf (mase.gov.uk)

[38] The scenario envisions electricity generation with a 72 percent share of renewables by 2030 and substantially decarbonised generation by 2035. Development-of-a-transition-pathway-towards-a-close-to-net-zero-electricity-sector-in-Italy-by-2035_19June.pdf (eccoclimate.org)

[39] eur-lex.europa.eu/legal-content/IT/TXT/PDF/?uri=CELEX:02003L0087-20230605

[40] Carbon prices on the rise? Shedding light on the emerging EU ETS2 SSRN, 2024

Differential analyses of fiscal and parafiscal revenue from fuel and electric charging

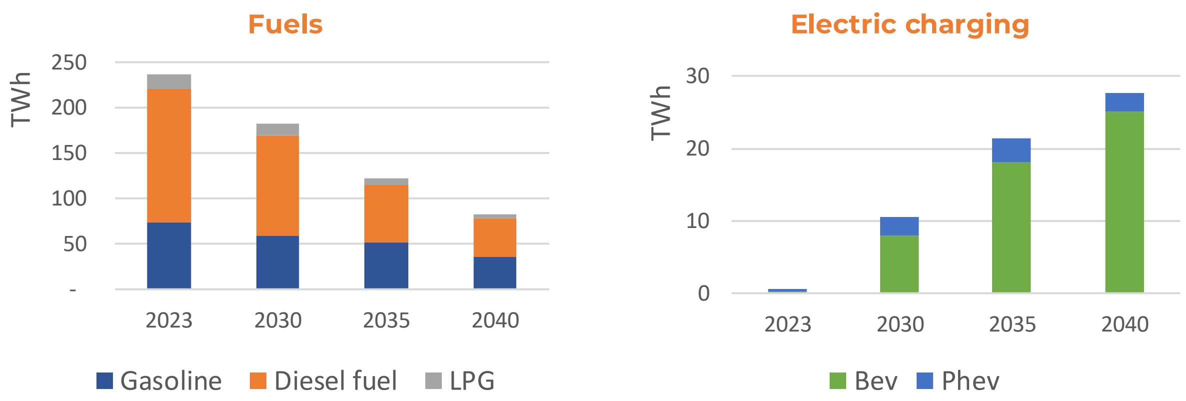
Under the scenario assumptions considered, referring to the period between 2023 and 2040, the variations in consumption and fiscal and parafiscal revenue are summarised in the table below.

Table 3 - Scenario evolution of consumption and fiscal and parafiscal revenue 2023-2040

		2023	2030	2035	2040
Gasoline	*Consumption (Ml)*	7.945	6.237	5.591	3.837
	Consumption (GWh)	74.404	58.404	52.353	35.933
	Excise (M€)	5.787	4.543	4.072	2 .795
	ETS2	-	1.381	2.053	2.536
	VAT (M€)	2.673	2.098	1.880	1.291
Diesel	*Consumption Liters*	14.632	11.161	6.209	4.161
	Consumption (GWh)	145.929	111.319	61.925	41.500
	Excise (M€)	9.034	6.891	3.833	2.569
	ETS2	-	1.168	2.213	2.734
	VAT (M€)	4.729	3.607	2.007	1.345
LPG	*Consumption Liters*	2.324	1.820	1.111	788
	Consumption (GWh)	16.791	13.151	8.032	5.695
	Excise (M€)	342	268	164	116
	ETS2	-	679	1.286	1.588
	VAT (M€)	314	246	150	106
BEV	*Consumption (GWh)*	300	7.872	18.123	25.043
	Charges (M€)	24	206	360	497
	Excise (M€)	5	143	328	454
	ETS1	9		14	
	VAT (M€)	15	340	707	976
PHEV	*Consumption (GWh)*	310	2.654	3.288	2.685
	Charges (M€)	17	56	49	38
	Excise (M€)	5	38	39	30
	ETS1	10	40	3	-
	VAT (M€)	13			51

In detail, fuel consumption decreases from approximately 24.9 billion litres in 2023 (equivalent to 237 TWh-eq), to 19.2 billion litres in 2030 (183 TWh-eq), to 12.9 billion in 2035 (122.3 TWh), to 8.8 billion litres in 2040 (83 TWh-eq), and eventually to zero in the time horizon to 2050. On the other hand, there is an increase in electricity consumption over the same period, from 0.61 TWh in 2023 to 10.5 TWh in 2030, to 21.4 TWh in 2035, to 27.7 TWh in 2040, a value between 7-8 percent of the forecasted demand according to Terna scenarios[41]. By 2050, estimates indicate an electricity consumption of approximately 37.5 TWh for the fully electrified fleet.

Figure 11 - Scenario trends in fuel and electricity consumption 2023-2040 (TWh)*

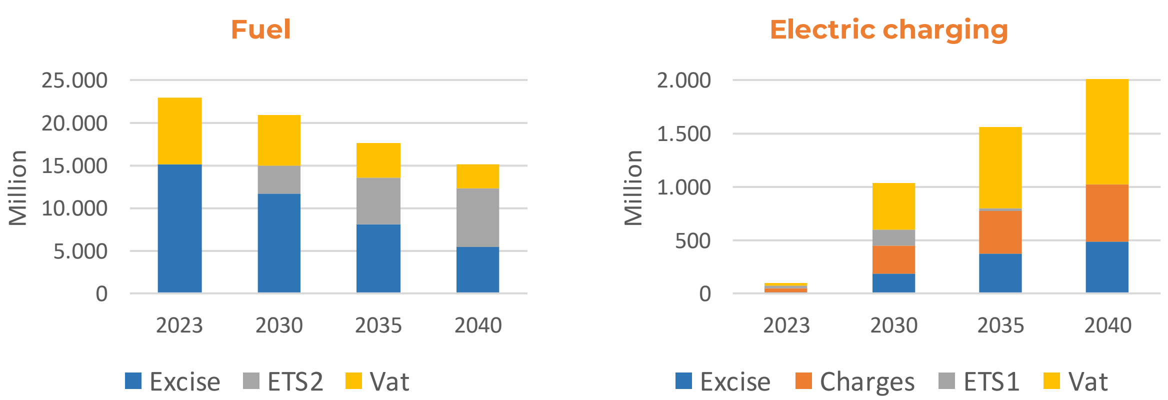


** For comparative purposes note that the scales of the two diagrams have an order of magnitude difference.*

Given this trend, tax revenues from fuel consumption (excise duties, ETS2, and VAT) decrease from 22.9 bn euros in 2023, to 20.8 bn in 2030, to 17.6 bn in 2035, and 15.1 bn in 2040.

For electric charging, the revenue derived from electricity consumption for general system charges (assuming a 60 percent reduction from the 2023 value starting in 2032, as per the Methodological Note and the related Annex), excise duties, ETS1 and VAT, increases from €100 million in 2023 to €2 billion in 2040.

Figure 12 - Scenario evolution of fiscal and parafiscal revenue from fuel and electricity 2023-2040 (M€)*

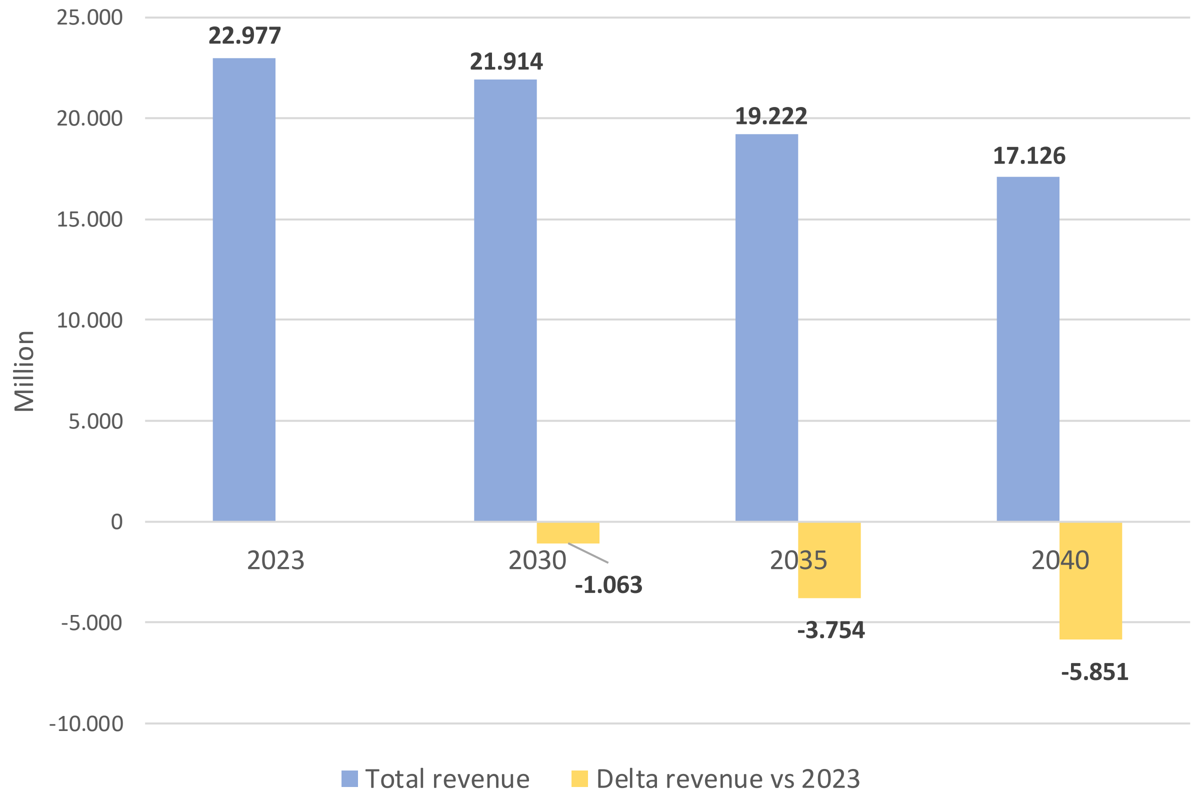


[41] Document_Description_Scenarios_2022_8da74044f6ee28d.pdf (terna.co.uk)

** For comparative purposes note that the scales of the two diagrams have an order of magnitude difference.*

Overall, the expected revenue from total energy consumption in 2030 is about €21.9 bn, or about €1.1 bn less than in 2023; in 2035 the revenue becomes €19.2 bn (-€3.75 bn compared to 2023) and in 2040 it is about €17.1 bn (-€5.85 bn compared to 2023).

Figure 13 - 2023-2040 scenario evolution of total fiscal and parafiscal revenue from energy consumption and variations compared to 2023



Details of the various contributions to this trend and the formation of the differential fiscal and parafiscal revenues show that the revenue generated by the introduction of the carbon tax on fuels, as foreseen by ETS2, is particularly relevant as it significantly limits revenue reduction.

In particular, in the scenario with increasing ETS emission allowance prices, and considering the prolonged fuel consumption due to the gradual replacement of combustion engine vehicles in the fleet, the contribution to ETS2 revenue is projected to be approximately 3.3 bn in 2030, 5.5 bn in 2035, and just under 6.9 bn in 2040. Considering this additional revenue, the expected price increase on fuels remains relatively small (see Table 2)

Table 4 - Details of contributions of individual revenue components in the 2023-2040 scenario and final differences compared to 2023 (M€)

		2023	2030	2035	2040
Fuel refuelling	Excise	15.163	11.702	8.069	5.480
	Vat	7.715	5.951	4.037	2.742
	Subtotal (no ETS2)	**22.878**	**17.652**	**12.106**	**8.222**
	ETS2 incidence	*0*	*3.228*	*5.551*	*6.858*
	TOTAL Fuels	**22.878**	**20.881**	**17.658**	**15.080**
Electric charging	*Excise*	10	180	367	484
	Charges	41	262	408	535
	ETS	19	158	17	0
	Vat	29	432	772	1.027
	TOTAL Charging	99	1.033	1.565	2.046
	TOTAL REVENUE	**22.977**	**21.914**	**19.222**	**17.126**
	TOTAL REVENUE (no ETS2)	*22.977*	*18.685*	*13.671*	*10.267*
	DELTA REVENUE vs. 2023		**-1.063**	**-3.754**	**-5.851**
	DELTA REVENUE vs. 2023 (no ETS2)		*-4.291*	*-9.306*	*-12.709*

In the scenario where electric vehicle penetration in the fleet is accompanied by the complete elimination of the burden of general system charges on electric charging, the time progression of the revenue differential is only slightly accelerated: 1.4 bn in 2030; 4.2 bn in 2035; and 6.5 bn in 2040.

Concluding remarks

In the scenario for electric vehicle penetration in the circulating fleet, which aligns in the short-term with the NECP and in the long-term with the National Decarbonisation Strategy for 2050, the differential analysis of expected fiscal and parafiscal revenues from energy consumption indicates a gradual decrease until 2040.

This dynamic is mainly related to the extension of the ETS market to the transport sector, the so-called ETS2, which introduces a carbon tax on fuels aimed at reducing consumption, and consequently emissions, with a view to decarbonisation. In this regard, it should be noted that in the scenario of increasing ETS2 prices, which assumes the implementation of energy efficiency policies that accelerate the shift of transport and building consumption to electric, the expected impact in the short to medium-term on final fuel prices is relatively small.

By 2030, with 4.3 million electric vehicles in the circulating fleet and without changing the current fiscal and parafiscal structure for fuels and electric charging, the change in revenue compared to 2023 is expected to be around 1.1 billion euros. By taking action to eliminate all general system charges on electric charging, the revenue reduction by 2030 would amount to approximately 1.4 billion euros.

In both cases, this is a situation that can be easily managed by intervening with a **reform of Environmentally Harmful Subsidies** to equalise the excise duties on diesel with those on gasoline, whose estimated annual cost, according to the Ministry of Environment and Energy Security, is 3.378 billion euros each year. [42]

The effect of an expanded reform, intervening on the current EHS in place for all fossil fuel uses in transport, would recover over 6 billion euros (out of a total of 8.8 bn€ of EHS in the energy sector).

In this regard, it is worth noting that reducing Environmentally Harmful Subsidies is one of the pivotal reforms included in the new Mission 7 of the NRRP in relation to **Repower EU's planned investment and reform for Italy**[43] , which indicates a target of at least 2 billion in EHS reduction by 2026 and 3.5 billion by 2030. [44]

An energy tax reform aimed at eliminating subsidies on energy products, taking into account the environmental impact of each product and with the goal of contributing to the progressive reduction of greenhouse gas emissions and air pollution, is also foreseen under **Law No. 111 of August 9, 2023, the tax delegation law.** In particular, Art. 12(1)(c) provides for the opportunity for *the reorganisation and revision of excise duty exemptions on energy products and electricity, as well as the gradual elimination or adjustment, in compliance with the provisions of the European Union concerning compulsory excise tax exemptions, of some of the concessions, categorised as environmentally harmful subsidies, which are particularly impactful on the environment*.

The potential revenue recovery of an extended EHS reform would also help mitigate the reduction in revenue in the medium-term, estimated to be between 3.8 and 4.2 billion euros by 2035, depending on the scenario assumptions considered. In the long-term, with the progressive and significant advancement of fleet electrification and a reduction in the number of circulating vehicles, the estimated reduction in revenue

[42] Catalogue of environmentally harmful subsidies and environmentally favourable subsidies | Ministry of Environment and Energy Security, Fifth Edition 2022 (mase.gov.uk)

[43] RepowerEU (camera.it)

[44] *COM2023_0765_IT_ALL1.pdf (parlamento.it)

increases in a range between €5.9 and €6.5 bn to 2040, which remains manageable within the framework of reorganisation of the current EHS regulations.

In a later timeframe, once the transition to electric vehicles in private mobility can be consolidated, aided by the effects of the new EU regulation on CO2 emission standards for cars[45] , it will be necessary to consider compensatory interventions to offset the loss of revenue through fiscal mechanisms aimed at the vehicles themselves, or through policies associated with vehicle ownership and distance travelled, as indicated in the introduction to this paper.

[45] Regulation - 2023/851 (europa.eu)

Annex to the methodological note

The following annex provides additional information on the assumptions made for the analysis, both regarding the comparison of fiscal and parafiscal taxation applied to fuel refueling and electric vehicle charging, as well as the scenario assessments of revenue differentials associated with changes in energy consumption during the transition of the vehicle fleet to electric cars.

Components of fiscal and parafiscal tax components for comparative analysis

For the comparative assessments of the weight of taxation applied to the fuelling of internal combustion engine vehicles compared to plug-in electric vehicles (comprising 100% electric vehicles and plug-in hybrids), an analytical model was set up based on the average values of the cost components that make up the price of fuel and electricity, with reference to the year 2023. For electric charging tariffs, only the average levels of pay-for-use tariff prices were considered, without considering any subscriptions.

In the comparative analyses of the fiscal cost applied to the fuelling of traditional vehicles with fossil fuels and the charging of electric vehicles with electricity, the energy content of the different energy carriers under investigation was converted to the same unit of measurement, the kWh.[46]

Components for electric charging

Regarding electric vehicle charging, among the many options available, the model considers a configuration of five different charging modes that best represent current and prospective offerings.

- Domestic users (using the same tariff as at home);
- Private users with low voltage for Other Uses (condominiums or garages with a dedicated POD (point of delivery);
- Public low voltage charging stations with the BTVE tariff[47];
- Private charging stations (office use) for business charging in low voltage with the BTAU tariff;
- Public medium voltage public charging stations with the MTAU tariff.

[46] Energy conversion factors adopted: gasoline = 9.3645 kWh/l; diesel 9.9736 kWh/l; LPG = 7.2264 kWh/l. Source of conversion factors: energy balance guide (Eu Commission 2019)

[47] Only the BTVE tariff was considered because it is the most widely used given the current average utilisation rates of about 2 percent

For each charging mode, the different cost components were defined in accordance with the current regulations provided by the Italian Regulatory Authority for Energy Networks and Environment (ARERA)[48]. Specifically:

- For domestic and other use charging, the various tariff components were defined in accordance with Resolution 297/2023/R/com of 28 June 2023[49] . For domestic users, the typical scenario of an average household with an electric car and a consumption of 3.6 MWh/year was considered; for other uses, an average mixed vehicle/other auxiliary load consumption of 1.7 MWh/year was considered.
- For charging from private stations in businesses (office use), both in low voltage (LV) and medium voltage (MV), the €/kWh cost of a BTAU6 tariff with an average EUF (Electric Utilisation Factor) utilisation rate of 22% was considered. This EUF figure was assumed based on the hypothesis that the company tends to maximise loads to reduce costs. [50]
- For charging from public low voltage points of withdrawal, the €/kWh cost of the current BTVE tariff was considered. This value is kept fixed over time and reaches the break-even point with a BTAU tariff at a Point of Delivery (POD) utilisation rate[51] of 6.8%. This assumption allows the BTVE tariff to remain valid even if it is exceeded in the forecast from 2030 onward.
- For charging from public medium voltage PODs, the €/kWh cost of the MTAU tariff with an EUF utilisation rate of 2 percent (calculated on the average current utilisation rates of public charging) was considered. In the scenario analysis, from 2035 onwards, this value was increased to 6 percent due to the increase of electric vehicles in the circulating fleet.

It should be noted that for the tariffs of the charging options from public infrastructure, considering the POD utilisation rate allows for an evaluation of the weight of the various components on the final price without affecting the available power. For public charging, an additional value was also considered to align the final tariffs applied to the charging service with the market average for the period.[52]

For all types of charging, an average PUN (*Prezzo Unico Nazionale,* National Single Price) of electricity equal to €90/MWh was considered, based on the first quarter of 2024.

[48] ARERA: ARERA - The Italian Regulatory Authority for Energy, Networks and Environment

[49] https://www.arera.it/atti-e-provvedimenti/dettaglio/23/297-23

[50] A medium-voltage business recharge case was not included because even applying an MTAU2 tariff would result in a delta that would be insignificant for the purpose of the analysis given the point utilisation rate.

[51] Average electric utilisation factor (Fattore Utilizzo Eelettrico, FUE) is calculated as the ratio between the power available at the point and the energy delivered in one year.

[52] The values considered are intended to quantify what could be an average gross margin defined as the difference between the cost of energy and the final price that goes to cover CPO operating costs and return on investment

Given the current mechanism, the formation of the market price of energy incorporates the share related to the European Emission Trading System. According to the operating mechanism of the EU-ETS, the revenues from emission trading auctions are redistributed to member states for use in supporting climate spending, renewable energy, efficiency and other purposes[53], the ETS share of the energy price can be considered as a form of fiscal taxation.

For 2023, considering that in the Italian *day-ahead electricity market* (Mercato del Giorno Prima, MPG), for almost all hours, the (marginal) price of energy is determined by the variable costs of gas-combined cycle power plants, the value of this component was estimated based on the annual average value for ETS auction prices, equal to €85.3/tCO2[54], and the average emission factor of gross electricity production from a combined-cycle power plant, published by Ispra[55] for 2022, equal to 362.1 gCO2/kWh.

Table 1A - Summary of cost components applied to different plug-in electric vehicle charging options in the configuration adopted by the analysis (€/kWh)

€/kWh 2023	Domestic	Other uses	BTAU Offices	BTVE	MTAU
Energy* *(of which ETS1 component)*	0,102 *(0,031)*	0,117 *(0,031)*	0,117 *(0,031)*	0,117 *(0,031)*	0,117 *(0,031)*
Transportation and meter management	0,064	0,136	0,028	0,060	0,206
System overhead charges	0,0297	0,1431	0,0540	0,0723	0,1970
Excise duty	0,0227	0,0125	0,0125	0,0125	0,0125
VAT	0,0218	0,0899	0,0465	0,0796	0,1436
Total cost *(of which additional for recharge service)*	**0,240**	**0,499**	**0,258**	**0,441** *(0,100)*	**0,796** *(0,120)*

** Includes energy price and dispatching costs applied to different utilities; for public recharges, a cost surplus was applied to the value of the Energy component as a proxy for operators' margin.*

With the increase in the share of renewables in the energy mix, the market price will reflect the costs of the ETS for a progressively smaller number of hours. Since it is still uncertain how the long-term price of energy will be set for 2030 and beyond, the scenario analyses developed in the report assume an ETS allowance cost calculated in relation to the total emissions from generation and forecasted consumption volumes (cf. from draft NECP-2023 and ECCO-Artelys scenario)[56], as well as an ETS

[53] Use of auctioning revenues generated under the EU Emissions Trading System | European Environment Agency's home page (europa.eu)

[54] EU ETS Auctions (eex.com)

[55] FE_energy_electric_2023-V1.xlsx (live.com)

[56] PNIEC_2023.pdf (mase.gov.uk); Scenario of a decarbonised Italian power system by 2035 (eccoclimate.org)

allowance price in line with forecasts developed by the main industry players in relation to the primary international trend scenarios .[57]

Fuelling components

With regard to fuels, the model considers the fuelling of gasoline, diesel and LPG in internal combustion engine vehicles with reference to the average fuel prices at the pump and related taxes applied in 2023, as reported by the Ministry of Environment and Energy Transition.[58]

As with the price of electricity, the fuel price was assumed to include the value of the ETS component associated with emissions from the refining process. The estimated value for this component was calculated by considering the average specific emissions of fuel refining in Europe.[59] In the scenario analyses, the impact of the ETS component for transport (called ETS2), which will come into force in 2027, is considered.

Table 2A - Summary of cost components applied to fuels

€/l 2023	Gasoline	Diesel fuel	LPG
Net price *(of which ETS component)*	0,800 *(0,016)*	0,852 *(0,020)*	0,466 *(0,016)*
Excise	0,728	0,617	0,147
Vat	0,336	0,323	0,135
Price at the pump	***1,865***	***1,792***	***0,749***

The following table shows the cost components of fuels with reference to energy content expressed in kWh, which is used as the unit of measurement for the comparative analyses presented in the report.

Table 3A - Summary of cost components applied to fuels expressed in €/kWh

€/kWh 2023	Gasoline	Diesel fuel	LPG
Net price *(of which ETS component)*	0,0855 *(0,0017)*	0,0854 *(0,0020)*	0,0645 *(0,0023)*
Excise	0,0778	0,0619	0,0204
Vat	0,0359	0,0324	0,0187

[57] Global Carbon Market Outlook 2024 | BloombergNEF (bnef.com); EU ETS Market Outlook 1H 2024: Prices Valley Before Rally | BloombergNEF (bnef.com); EU carbon prices to triple by 2035, analysts predict, publishing among first ETS Phase 5 forecasts " Carbon Pulse (carbon-pulse.com)

[58] Energy and mining statistics - Ministry of Environment and Energy Security (mase.gov.it)

[59] Estimating the CO2 intensities of EU refinery products (Concawe, 2022)

Price at the pump	*0,1992*	*0,1796*	*0,1036*

Scenario assessments of fiscal and parafiscal revenue differentials from fuel and electricity consumption

For scenario assessments aimed at estimating the changes in fiscal revenue associated with the reduction in fuel consumption and the progressive electrification of mobility, a calculation model was developed that processes the total average fuel and electricity consumption based on the composition of the circulating car fleet, the average energy efficiency of vehicles and the average annual driving distances.

In calibrating the model, the average fuel consumption considered for combustion engine vehicles was derived from data on total distances and CO_2 emissions reported in the Ispra/Copert database[60] for the vehicle fleet in circulation in Italy in 2021, cross-referenced with the quantitative composition information of the circulating fleet published by Anfia and Unrae. [61]

Table 4A – Details of specific car emissions and composition of the vehicle fleet considered

Type of medium	Billion vehicle_km	Emissions (MtCO2) Total	Specific emissions (gCO2/km)	No. vehicles (Millions of units)
Gasoline	108,99	17,64	161,89	17,8
Diesel	230,08	38,48	167,26	17,1
LPG	24,67	4,27	173,00	2,8
Plug-in hybrids (PHEVs)	1,90	0,27	140,82	0,11
Non-plug-in hybrid (MHEV)	9,07	1,24	136,66	1,01
Electrical (BEV)	1,05	0,00	0,00	0,12
Total car	**390,71**	**64,52**	**165,14**	**40,0**

For the conversion from CO_2 emissions to energy consumption, the conversion factors used by the IPCC were applied[62], for the conversion of energy units to tons of fuel, the official standard values for the lower heating values by the European

[60] The database of average emission factors for the vehicle fleet in Italy (isprambiente.it)

[61] ANFIA - Associazione Nazionale Filiera Industria Automobilistica; UNRAE - Unione Nazionale Rappresentanti Autoveicoli Esteri

[62] National Inventory Submissions 2021 | UNFCCC

Commission were used[63] . Average density values were adopted for converting weight units to litres of fuel (gasoline 0.761 kg/l; diesel 0.835 kg/l; LPG 0.45 kg/l).

When compared with the consumption of fuels for road vehicles reported in the official statistics of the Ministry of Environment and Energy Security[64] for the year 2021, the model returns values with a margin of error of 5 percent for gasoline vehicles, and less than 2 percent for diesel and LPG vehicles. These differences were deemed acceptable for the purposes of the study.

In summary, the average fuel consumption and distances used in the model are reported in the following table. Note, that for electric vehicles, it was assumed that the average annual distance travelled would be equivalent to that of a diesel vehicle, which is higher than that resulting from the Ispra/Copert data analysis, in line with the assumption of more intensive future distance travelled for electric vehicles.

Table 5A - Averages of fuel consumption per carrier and distance travelled for the standard vehicle models adopted as the baseline in the scenario

	Gasoline	Diesel fuel	LPG	MHEV	PHEV	BEV
Litres per 100 km	*6,613*	*6,337*	*10,078*	*5,582*	*5,335*	
kWh per 100 km	*61,924*	*63,206*	*72,824*	*52,274*	*53,213*	*15,800*
Average annual kilometres	*6.121*	*13.460*	*8.868*	*8.792*	*16.693*	*13.460**

** A configuration with the same average distance travelled as diesel vehicles recorded by the Ispra/Copert database for the year 2021 was chosen for electric vehicles*

Additional assumptions adopted in the scenario assessments carried out and used in the analyses can be found in the relevant dedicated chapter of the report.

[63] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R1773 (Annex VIII)

[64] Oil Bulletin - Energy and Mining Statistics - Ministry of Environment and Energy Security (mise.gov.it)

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This paper was edited by:
Massimiliano Bienati, Head of Transport Policy, ECCO
massimiliano.bienati@eccoclimate.org
Francesca Andreolli (Contributed), Senior Energy and Efficiency Researcher, ECCO
francesca.andreolli@eccoclimate.org
Gabriele Cassetti (Contributed), Senior Researcher Energy Systems, ECCO
gabriele.cassetti@eccoclimate.org
Michele Governatori (Contributed), Head of External Relations - Energy, ECCO
michele.governatori@eccoclimate.org
Matteo Leonardi (Coordination), Co-Founding Executive Director, ECCO
matteo.leonardi@eccoclimate.org

Thanks are expressed to:
Andrea Zatti (Contributed), Professor of European Public Finance and Public Policy and Environment, University of Pavia
andrea.zatti@unipv.it

For interviews or more information on the use and dissemination of the contents of this briefing, please contact:

Andrea Ghianda, Head of Communications, ECCO
andrea.ghianda@eccoclimate.org

+39 3396466985

www.eccoclimate.org

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