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# Are Electric Vehicles Discharging Tax Revenues? The Türkiye Case

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**ABSTRACT**

Türkiye, in tandem with global trends, is witnessing a significant uptick in electric vehicle (EV) sales, prompting concerns about substantial impacts on traditional tax revenues derived from fuel-related products and the automotive sector. Data from the Automotive Distributors Association in Türkiye highlights a noteworthy increase in the EV market share from 0.03 percent (155 units) in 2020 to 4.8 percent (28,931 units) between January and August 2023. This study, utilizing forecasting methodologies such as the Exponential Smoothing Model and Holt's Exponential Smoothing, projects total vehicle numbers for 2025 and 2030. Employing the Total Cost of Ownership model, encompassing registration, motor vehicle tax, fuel/charging costs, and maintenance, the research compares tax revenues from electric and internal combustion engine vehicles. The findings underscore an imminent government challenge, anticipating tax revenue losses of approximately $567.5 million for 2025 and $1.9 billion for 2030.

**Keywords:** Electric Vehicles (EVs); Tax Revenues; Total Cost of Ownership Model (TCO).

**JEL Classification Codes:** H20, H21, Q58

**Referencing Style:** APA 7

## INTRODUCTION

Electric vehicles (EVs) hold a significantly advantageous position when compared to internal combustion engine vehicles (ICEVs), primarily due to their higher efficiency, greater environmental friendliness, and reduced energy consumption. This advantage has also been reflected in recent years in the sales figures of vehicles. When viewed globally, EV sales in 2021 doubled to reach 6.6 million units compared to the previous year. According to sales figures for the first quarter of 2022, it is observed that they reached 2 million units, indicating a 75% increase compared to the same quarter of the previous year (IEA, 2022).

The 2023 report of the International Energy Agency (IEA) states that the global transition to EVs has brought about a change in tax revenues generated from gasoline and diesel, amounting to $11 billion. However, the widespread adoption of EVs usage has generated $2 billion in tax revenue. Consequently, the net tax revenue loss amounts to $9 billion. Despite China having the largest stock of EVs, the highest tax revenue loss has been experienced in Europe due to the high rates of taxes applied to petroleum products *(for example, fuel tax rates in Germany are ten times higher than those in China)*. The report estimates that tax revenue losses globally will reach around $60-70 billion by 2030.

The assumption that the increase in EV sales will result in a decrease in governments' revenue from fuel taxes, which holds a significant share among their income sources, is supported by research findings in the literature (Table 1). Governments find themselves in a situation where, on one hand, they strive to achieve sustainability goals by considering environmental factors, and on the other hand, they face a significant loss of revenue.

In Türkiye, EV sales are steadily increasing as well. The growing sales pose a risk of eroding the significant revenue source of the central government budget, which is generated from fuel tax revenue. Therefore, the study aims to assess possible revenue loss due to the rapid increase in sales of EVs in Turkish automotive market compared to ICEVs. This study focuses on how the proliferation of electric vehicles would affect the

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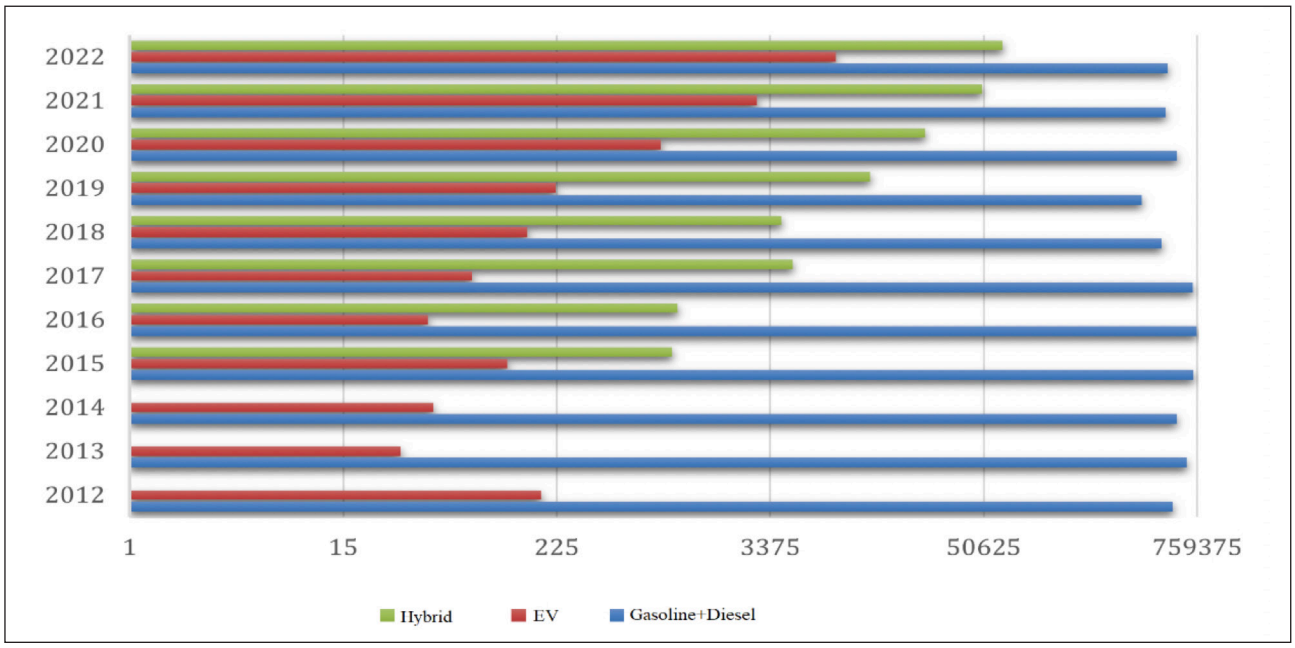


**Figure 1:** Sales of New Vehicles: Türkiye

**Source**: (ODMD, 2023)

public revenues, particularly within the current tax system. It compares the tax revenues generated by fossil-fuel vehicles (VAT, excise duties, road tax, etc.) with the tax revenues generated by EVs in categories such as registration, fuel, inspection, and maintenance. Thus, this study contributes to making the calculation fiscal losses/gains for both types of vehicles more transparent, particularly in the context of Turkey. Furthermore, while studies in the literature generally highlight tax differentials on fuel across countries, this study provides a more comprehensive examination from a public revenue perspective by considering multiple aspects such as vehicle registration, fuel consumption, and vehicle maintenance.

## EVs* AND TÜRKİYE

In Türkiye, starting in 2016, the sales volume of ICEVs** such as gasoline and diesel has been declining, while the sales volume of hybrids and EVs has been on the rise. The increase in sales of hybrid vehicles is particularly noteworthy. In 2015, the sales of hybrid vehicles had not even reached 1,000 units, but by the year 2022, 64,387 units had been sold. The average increase in hybrid vehicle sales between 2015 and 2022 was approximately 110%. In contrast, during the same years, there has been a 1% decrease in sales of ICEVs. While there has been a general increase in EV sales in the reference years, the change in the last two years is of great significance. This change signals that in the coming years, EV sales will gradually increase.

In 2022, the total count of charging stations in Türkiye stood at 2,514, a substantial increase from the 1,357 recorded in 2020. Specifically, in 2020, there were 1,288 Alternating Current (AC) charging stations and 66 Direct Current (DC) charging stations. Fast forward to the first quarter of 2023, and we observed a remarkable 86% growth, bringing the AC charging stations to 2,402 and an astounding 715% surge in DC charging stations, totalling 538.

The vehicle sales figures show in Türkiye (ODMD, 2023) that there has been a decline in the market share of diesel-fueled vehicles, while electric and hybrid vehicles have been steadily gaining market share. In 2018, the market share of diesel vehicles sold in Türkiye was 58.09%, but by 2022, this figure had decreased to 17.43%. While the demand for diesel vehicles has been decreasing, there is a growing interest and demand for hybrid and electric vehicles. Hybrid vehicles, which had a market share of 0.80% in 2018, reached a share of 10.86% of total vehicle sales in 2022. A similar trend is observed in the demand for electric vehicles. In Türkiye, there were 155 electric vehicles sold in 2018, while in 2023 (January-August) 28,931 EVs were sold. In terms of market share, electric vehicles, which showed a significant increase from 0.03% to 4.8% (according to June 2023 data from(ODMD, 2023)), are likely to approach sales of ICEV in the coming years.

* EVs represents electrical passenger cars/vehicles (automobiles) and excludes the other vehicles such as buses, trucks.

** ICEVs represents internal combustion engine passenger cars/vehicles (automobiles) and excludes the other vehicles such as buses, trucks.

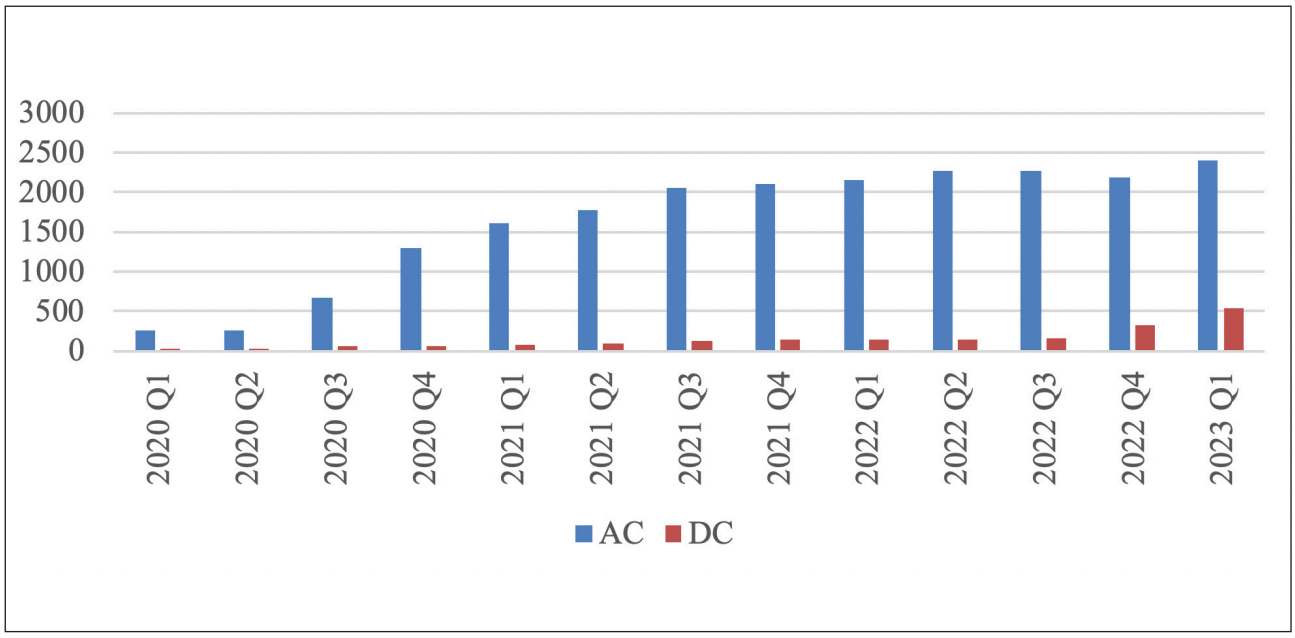


**Figure 2:** Charging Stations in Türkiye

**Source:** (EAFO, 2023)

This transformation is reflected in public revenues. Governments may come up against revenue losses, since consumer preferences shift from ICEVs to EVs for various reasons, such as environmental consciousness, fuel/charging costs, maintenance costs, technology, etc. (Bhat and Verma, 2023; Corradi et al., 2023; Rapson and Muehlegger, 2023; Rezvani et al., 2015; Singh et al., 2020).

In Türkiye, the best-selling EV in 2022 was the BMW IX *(luxury)* model with 1,502 units sold. The Renault Zoe *(economy)* model ranked second with sales of 1,155 units. In the third and fourth positions were the Skywell brand, with its ET5 and EV6 models, respectively (TEHAD, 2023).

The best-selling ICEVs in 2022 were Fiat Egea Sedan with 68,779 units, followed by the Renault Clio HB with 41,607, and the Toyota Corolla model with 30,948, respectively (ODMD, 2023). The study regards these sale rankings; however, it considers different fuel/engine types to examine the distinction between ICEVs and EVs. Accordingly, the research included top-tier models of the best-selling vehicles in Türkiye in 2022, top models are the 1.6 MultiJet diesel version of the Fiat Egea Sedan in the first place, the 1.0 TCe gasoline version of the Renault Clio HB in the second place, and the 1.8L hybrid gasoline version of the Toyota Corolla in the third place. Thus, it becomes possible to make an optimal assessment in terms of public tax revenues between EVs and ICEVs.

## LITERATURE REVIEW

The increasing prevalence of EVs adoption on a global scale has become a significant driving force due to their low carbon emissions and environmental sustainability advantages. This transformation profoundly influences people's perceptions by emphasizing the fact that EVs represent a more environmentally friendly and economical alternative compared to conventional ICEVs. While the growing adoption of EVs makes significant contributions to environmental issues, due to the disparities in tax treatment between EVs and ICEVs, it impacts fiscal ways of current fuel taxes. Therefore, the issue of optimal taxation emerges as a problem that needs to be addressed. The EVs adoption's impacts on tax revenues bring about raise concerns in research in the countries.

This literature review focuses on aggregate predictions at an international/national/state scale by analyzing past data related to EV sales or vehicle registrations and on calculations revealing possible tax revenue losses. There are various studies in the literature that examine the impact of EVs usage on tax revenues both at the regional and national levels. Table 1 represents these studies.

**Table 1:** Summary of Literature Review

| *Author(s)* | *Sample* | *Period* | *Tax Revenue Loss* |
|---|---|---|---|
| (IEA, 2023) | Global | 2030 | $60-70 billion |
| (Davis and Sallee, 2020) | The USA | 2019 | $250 million (annual) |
| (Davis and Sallee, 2020) | California | - | $90 million (annual) |
| (Jia et al., 2019) | Virginia | 2019-2025 | $200-900 million (annual) |
| (Van Dyke et al., 2022) | Kentucky | 2016-2022 | $1,3 million |
| (Ricciuti, 2020) | California | 2020 | $27,5 million |
| (Bonilla et al., 2022) | Mexico | 2022-2050 | $74,1 billion (cumulative) |
| (Soltani-Sobh et al., 2015) | Washington | 2031 | $106 million |
| (Hall, 2012) | The USA | 2050 | $74,1 billion (cumulative) |
| (Carlsson and Johansson-Stenman, 2003) | Sweden | 2002-2010 | $6,410 (per vehicle) |
| (Leurent and Windisch, 2015) | France | 2015 | $26,603 (per vehicle) |
| (Shafiei et al., 2018) | Iceland | 2015-2050 | %28-%35 |
| (Hensher et al., 2021) | Sydney | 2055 | %66 |
| (Rajagopal, 2023) | India | 2021-2035 | %85 |

While there is no specific study for Türkiye, there are numerous research efforts in other countries that discuss the anticipated impact of EVs on reducing tax revenues, employing various methods for estimation. The common thread among these studies is the likelihood of a decrease in tax revenues as EV sales increase.

## METHODOLOGY

### Total Cost of Ownership Model

Total Cost of Ownership Model (TCO) considers the costs incurred throughout the entire service life of a product. This process encompasses costs from the initial purchase transaction through the end of the ownership period. The main objective of TCO is to comprehensively assess all the expenses associated with owning and operating a particular product over its entire lifespan. This entails considering not only the upfront purchase cost but also ongoing expenditures, such as maintenance, fuel, insurance, taxes, and fees that accrue from the point of acquisition until the end of the ownership period. TCO primarily concentrates on individual or private costs, in contrast to social costs and benefits. These costs can be further segmented into various categories for a more detailed evaluation (Parker et al., 2021).

In this study, TCO has been employed as the foundation for comparing the ownership costs of EVs to those of traditional ICEVs. Then, the model calculates potential public revenue sources. The model includes tax revenues generated from fuel sales, the fiscal advantages associated with EVs, and the revenues generated through initial registration taxes and fees. The model is based on Parker et al. (2023). The original model covers a five-year period and is based on a 7% annual discount rate. The original model follows:

$$TCO = P + ST + TF - I + C + \left(\sum_{n=0.5}^{4.5} \frac{F+TX+IN+M}{(1+r)^n}\right) - \frac{R}{(1+r)^5} \qquad (1)$$

Where TCO is Total Cost of Ownership, *P* is the purchase price, *ST* is sales tax, *TF* is title fee, *I* is public subsidies, *C* is home charger *(wallbox)* costs, F is annual fuel costs, *TX* is annual taxes and fees, *IN* is annual insurance costs, *M* is annual maintenance and repair costs, *R* is resale value after five years, and *r* is the annual discount year.

The study aims to develop a user-centered perspective to calculate the total public revenues based on the taxes paid by users during the ownership *(purchase, usage, and maintenance)* of a vehicle. Consequently, the components contributing to the costs have been revised accordingly. The TCO is based on vehicle purchase price, fuel consumption, maintenance, and installation of home charger costs for home chargers. The model calculates the public revenues through these costs, and it is employed to calculate tax revenue loss:

**Tax Revenue Loss**= $[(TS_i) * (S_i + A_i + B_i)] - [(TS_e) * (S_e + A_e + W_e + B_e)]$ (2)

The model (2) is used for the calculation of tax revenue loss, and in the model, *TS* is total sales of vehicles, *S* is tax revenue from the purchase price, *A* is tax revenue from fuel costs, *B* is tax revenue from maintenance and repair costs, *W* is tax revenue from installation costs for a home charger. Finally, *i* and *e* represent ICEVs and EVs, respectively.

Utilizing this model, the total annual costs for users of ICEVs and EVs are calculated. Subsequently, tax amounts are determined based on these costs. These models cover a one-year period. Tax revenues are calculated by considering the amounts of excise duty[3], VAT (Value-added Tax), license plate costs, MVT (Motor Vehicles Tax) and Stamp Duty paid in the registration. Then, the total amount of tax revenue obtained by the government is calculated.

Vehicle-kilometer statistics in Türkiye according to vehicle types show that the annual average kilometers for all vehicle types were as follows: 14,236 km for the year 2019, 13,593 km for the year 2020, and 14,239 km for the year 2021.

Subsequently, the study assumes an annual vehicle kilometer traveled (VMT) of 15,000 kilometers. The rationale for this assumption is that after the initial registration stage *(purchased from dealers as "brand new")*, it is recommended by the vehicle dealer to have the first periodic maintenance of the respective vehicles performed at authorized service centers within the first 15,000 kilometers or 1 year.

Tax revenues generated from EVs and ICEVs were assessed under four main categories: initial registration, motor vehicle tax, fuel/charging cost, and maintenance. Accordingly, evaluating tax revenues generated over an average usage period of 15,000 kilometers or 1 year starting from the purchase of a brand-new vehicle, it can be easily stated that lower tax revenues are obtained from EVs compared to ICEVs. At the registration stage, the tax revenues obtained from EVs *(for economy vehicles)* are approximately two times lower than those of vehicles with gasoline and diesel engines. This difference increases to approximately three times when compared to a vehicle with hybrid/gasoline engine. The most notable point where EVs differentiate from other vehicle types is in the taxation based on fuel/charging. In this regard, the calculations of this study show

**Table 2:** Tax revenues per vehicle

| | **EVs** *(Renault ZOE)* | | **Gasoline** *(Renault Clio)* | **Diesel** *(Fiat Egea)* | **Hybrid-Gasoline** *(Toyota Corolla)* |
|---|---|---|---|---|---|
| **Initial Registration** *(SCT, VAT, MVT, Stamp Duty) (a)* | 277,675.35 TL | | 541,719.86 TL | 591,931.05 TL | 817,599.20 TL |
| **MVT** *(Annual) (b)* | 1,959.00 TL | | 2,545.00 TL | 4,434.00 TL | 7,834.00 TL |
| | *Wallbox* | *Charging Station* | | | |
| **Fuel/Charging** *(c)* | 693.3 TL *(VAT+BTV)* | 3,318.75 TL *(VAT)* | 12,384.50 TL *(SCT+VAT)* | 8,861.85 TL *(SCT+VAT)* | 9,388.25 TL *(SCT+VAT)* |
| **Maintenance** *(d)* | 258.83 TL *(VAT)* | 258.83 TL *(VAT)* | 948.17 TL *(VAT)* | 1,037.42 TL *(VAT)* | 969.43 TL *(VAT)* |
| **Total Tax Revenues** | 280,586.48 TL *(a+b+c+d)* | 283,211.93 TL *(a+b+c+d)* | 557,597.53 TL *(a+b+c+d)* | 606,264.32 TL *(a+b+c+d)* | 835,790.88 TL *(a+b+c+d)* |
| **Tax Revenues per km** | ₺18.70 | ₺18.88 | ₺37.17 | ₺40.42 | ₺55.72 |

**Source:** Author's own creation

[3] This represents the Special Consumption Tax (SCT). Special Consumption Tax rates for vehicles are determined according to the cylinder volume of the engine and the tax-free sales amount. While 45%, 50%, and 80% SCT is applied for vehicles up to 1600 cubic centimeters, 130% and 150% SCT are applied for vehicles with a cylinder volume between 1600 cubic centimeters and 2000 cubic centimeters. The tax rate is 10% for vehicles with an engine power of 160 kW (218 HP) and below and a tax base that is not exceeding 1.25 million TL; 40% for vehicles with an engine power of 160 kW (218 HP) below and a tax base that is exceeding 1.25 million TL; 50% for vehicles with an engine power over 160 kW (218 HP) and a tax base that is not exceeding 1.35 million TL; and 60% for vehicles with an engine power over 160 kW (218 HP) and tax base that is exceeding 1.35 million TL.

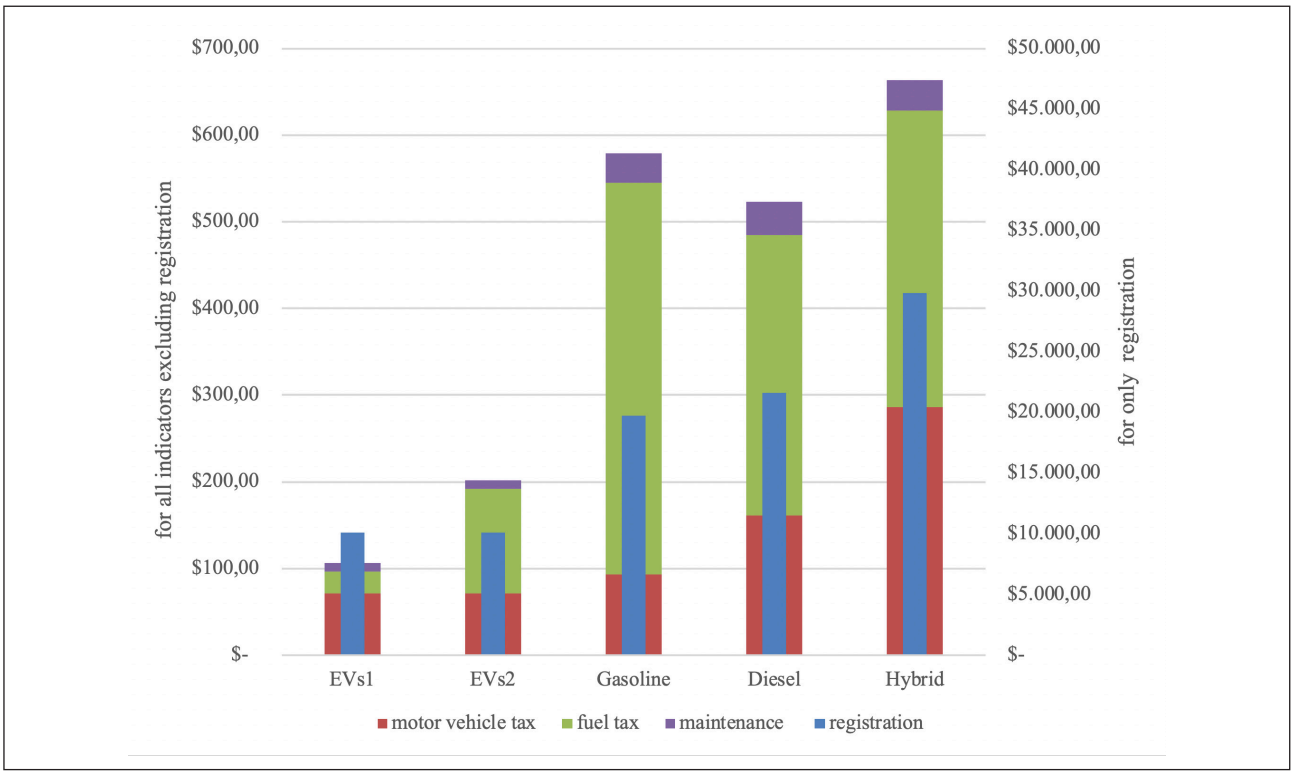


**Figure 3:** Tax Revenues Per Vehicle.

**Source:** Author's own creation

that the tax revenue obtained from a vehicle with gasoline engine after 15,000 km of usage is significantly higher, up to 18 times, than the total tax revenue obtained from an EVs *(wallbox/home charging)*. Due to the fact that EVs have relatively low maintenance costs, the tax revenues are also decreasing. When compared to the maintenance of a vehicle with diesel engine, the government collects four times lower tax revenues.

When considering various tax aspects *(initial registration, motor vehicle tax, fuel/charging, and maintenance),* tax revenues per kilometer levied after 15,000 kilometers of usage are calculated as follows: $0.68 for EVs1 *(for wallbox),* $0.69 for EVs2 *(for charging station),* $1.36 for vehicles with gasoline engine, $1.47 for vehicles with diesel engine, and $2.03 for the vehicles with hybrid-gasoline engine. The tax revenue per kilometer obtained from EVs is approximately 2 times lower than that of diesel and gasoline vehicles and about 3 times lower than hybrid gasoline vehicles. These results support the claim that increasing ownership of EVs could potentially lead to a reduction in tax revenues.

### Forecasting and Scenarios

Vehicle sales trends in Türkiye (ODMD, 2023) show that there is not as sharp of a transition to EVs as European countries. The market share of vehicles with diesel engines has been decreasing while the market share of EVs and hybrid-gasoline vehicles has been steadily increasing. In 2018, the market share of diesel vehicles sold in Türkiye was 58.09%, but by 2022, this figure had declined significantly to 17.43%. While the demand for diesel vehicles has decreased, there has been a growing interest and demand for hybrid and EVs. Hybrid vehicles, which had a market share of only 0.80% in 2018, increased their share within total vehicle sales to 10.86% by 2022. This trend can be attributed to several factors, including advancements in technology, the expansion of electric vehicle model varieties, environmental awareness, and the significant rise in fossil fuel costs in recent times, all of which have revitalized the demand for EVs.

In Türkiye, the sales of EVs were only 155 units in 2018, but by 2022, the number had surged to 7,733 units. Looking at market share, EVs have made a significant leap from 0.03% to 4.8% (according to June 2023 data from (ODMD, 2023)). It appears likely that in the coming years, EVs may come closer to the sales figures of ICEVs. It would not be wrong to state that one reflection of this transformation will be on tax revenues. If consumer preferences continue to shift from ICEVs to EVs, it is likely that there will be a reduction in tax revenues. In order to examine this assertion, the study conducts estimations to determine the potential decrease in tax revenues in the event of such a transformation.

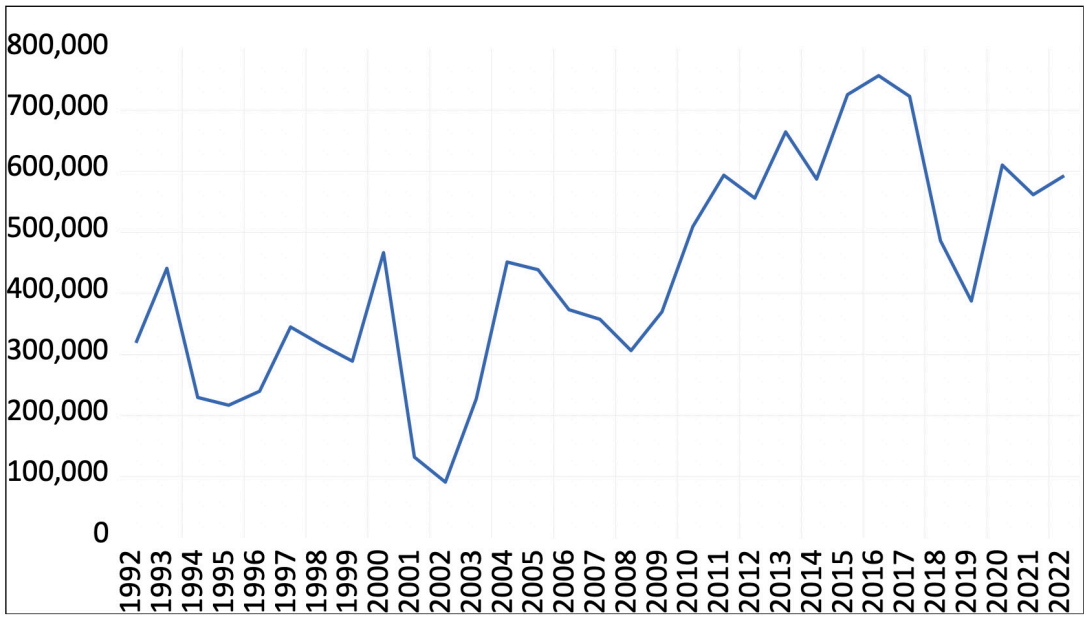


**Figure 4:** Vehicle Sales in Turkiye Between 1992-2022

**Source:** (ODMD, 2023; OSD, 2023)

Utilizing annual vehicle sales data for the period of 1992-2022 in Türkiye (ODMD, 2023; OSD, 2023), an estimation was conducted for the years 2025 and 2030 using the Exponential Smoothing method. The Exponential Smoothing method is a relatively simple but powerful approach for estimation. It can produce more successful results when compared to more complex estimation methods (Billah et al., 2006). This method, which was proposed in the late 1950s, is based on making estimations using a weighted average of the past values of the variable, where the weights decrease exponentially with the distance of the observations. In other words, more recent *(closer in time)* observations have a higher weight in the estimating process (Hyndman and Athanasopoulos, 2018).

There are various estimators used in the Exponential Smoothing method. Estimations have been leveraged by examining the graphical representation of vehicle sales data between the years 1992 and 2022 to make an inference about the selection of the most appropriate estimator.

Figure 4 shows that an increasing trend in vehicles sales is evident. Additionally, although there are periodic fluctuations in the data, it can be stated that there is no seasonal effect due to the data being annual. Based on the graphic, it is deemed appropriate to forecast using the Brown's Double Exponential Smoothing method, which captures the trend but does not include seasonality and the Holt's Exponential Smoothing method, which is devoid of seasonality.

In the recent years, a slowdown has been observed in the trend of EV sales data. Taking this slowdown into account, a forecast has been made utilizing the ETS Exponential Smoothing method. In this forecast, the Dampened Trend method has been utilized.

The model is developed by means of the first single exponential smoothing method. The model also considers the calculation of the second single exponential smoothing based on the first single exponential smoothing result. This approach is known as "double" exponential smoothing. The equations used for the Double Exponential Smoothing method for the time series 'y' are as follows (EUM, 2020).

$$S_t = \alpha y_t + (1-\alpha)S_{t-1}$$

$$D_t = \alpha S_t + (1-\alpha)D_{t-1}$$

In this context, $St$ represents the single smoothed series, $Dt$ stands for the double smoothed series, and $\alpha$ is the smoothing parameter ($0 < \alpha \leq 1$).

Prediction in this method is calculated through the following formula:

$$y_{T+k} = \left(2 + \frac{\alpha k}{1-\alpha}\right) S_T - \left(1 + \frac{\alpha k}{1-\alpha}\right) D_T = \left(2S_T - D_T + \frac{\alpha}{1-\alpha}(S_T - D_T)k\right)$$

In the Holt's Exponential Smoothing model, employed for a series exhibiting a linear trend and no seasonal pattern, two parameters are used for estimating. The

smoothed series, denoted by *y*, is derived via the subsequent equation [8].

$$y_{t+k} = \alpha + bk$$

In this equation, α and b denote the constant components signifying smoothing and trend, respectively.

$$\alpha(t) = \alpha y_t + (1-\alpha)(\alpha(t-1) + b(t-1))$$

$$b(t) = \beta\big(\alpha(t) - \alpha(t-1)\big) + (1-\beta)b(t-1)$$

The equation used for estimating is as follows:

$$y_{T+k} = \alpha(T) + b(T)k$$

α(T) represents the smoothing constant, and b(T) represents the slope parameter.

As part of the research, two different estimating methods were employed, and the results were compared. At this stage, the Holt's Exponential method was utilized for estimating in the years 2025 and 2030, as the results obtained through this method were deemed more meaningful.

## RESULTS

To determine the loss in tax revenue resulting from the transition from ICEVs to EVs, it is first necessary to establish the total number of vehicles and their market share. Table 3 presents the vehicle sales and market shares in Türkiye for the year 2022.

In 2022, a total of 592,660 new vehicles were sold in Türkiye. The market share of the vehicles sold shows that gasoline engine vehicles are in the lead with 68.99%, followed by diesel and hybrid vehicles. EVs, on the other hand, obtained a market share of 1.3% with 7,733 units in the total vehicle market. Although this market share may seem low, it represents a significant increase when compared to the 0.51% EV market share in 2021. Furthermore, after expressing the 2022 vehicle sales figures and market shares, the market shares were recalculated by subtracting the 2022 EV sales from the

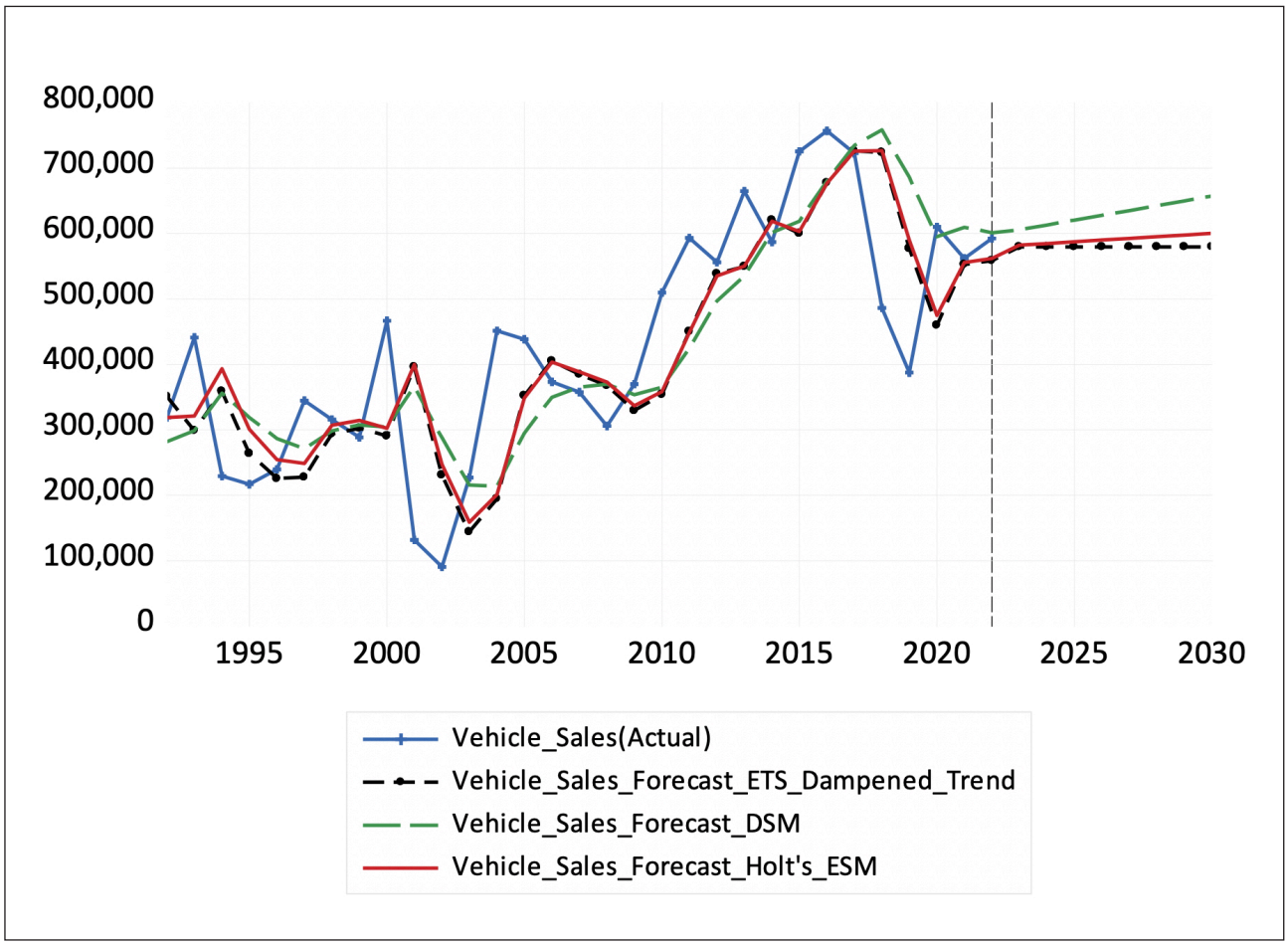


**Figure 4:** Forecasting Chart (2030)

Note: The figure displays a vertical line in the year 2022. The forecasting was performed utilizing the Eviews 12 software package.

**Table 3. Number of vehicle sales and market share**

| | 2022 | | 2022 *(excluding EVs)* | |
|---|---|---|---|---|
| | Unit | Share | Unit | Share |
| Diesel | 103,311 | 17.4317% | 103,311 | 17.6622% |
| Gasoline | 408,920 | 68.9974% | 408,920 | 69.9096% |
| Electricity | 7,733 | 1.3048% | - | - |
| Hybrid | 64,387 | 10.8641% | 64,387 | 11.0077% |
| Autogas | 8,309 | 1.4020% | 8,309 | 1.4205% |
| Total | 592,660 | 100% | 584,927 | 100% |

**Source:** (ODMD, 2023; OSD, 2023)

total vehicle sales to determine the market shares for 2025 and 2030. This distribution was used within the scenarios created for the respective years.

The scenarios in the study were based on the "Mobility Vehicle and Technologies Roadmap" strategy document published by the Ministry of Industry and Technology of the Republic of Türkiye in 2022. These scenarios align with the Ministry's objective to raise the market share of EVs to 10% and 30% for 2025 and 2030, respectively.

In the forecasting made using the Holt's Exponential Smoothing method, the total number of vehicles sold for the year 2025 is 587,523, while for the year 2030, it is 600,457. Assuming that the market share distribution remains the same as in 2022 for the year 2025, the resulting tax revenue loss within the framework of the goal set by the Ministry of Industry and Technology of the Republic of Türkiye for 2025, which aims to achieve a 10% market share for EVs, is presented in Table 4.

The first scenario for evaluating the impact of EVs on tax revenues, with respect to ICEVs, assumes that the estimated total vehicle sales volume is 587,523, and the market share of EVs is 10%. In order to calculate the tax revenues generated under this circumstance, the market shares for the year 2022 were applied to the year 2025 (Scenario A).

In the second phase, the scenario where the market share of EVs is 10% was calculated based on the overall vehicle market shares in 2022, excluding EVs. According to this assumption, in 2025, assuming that the sales shares are based on the year 2022 and that the selected brands/models for the initial purchase and maintenance, as well as if the specified tax rates/costs in the study remain the same. The total tax revenue *(excluding Autogas)* will be approximately 343.6 billion TL (Scenario A). In addition, in 2025, when the market share of EVs is 10%, and the market share of other vehicle types is distributed according to this ratio, assuming all other conditions remain the same, the total tax revenue *(excluding Autogas)* will be approximately 327.8 billion TL (Scenario B).

In Scenario B, the total tax revenue derived from EVs amounts to approximately 16.4 billion TL, whereas in Scenario A, it is 2.1 billion TL. Despite the annual tax revenue from EVs being approximately 8 times higher in Scenario A, the total tax revenue remains at approximately 327.8 billion TL. Consequently, if the market share shifts in favor of EVs in this manner, there will be an estimated tax revenue loss of approximately 15.7 billion TL *($567.5 million)* for the year 2025.

The second scenario for evaluating the impact of EVs on tax revenues, with respect to ICEVs, assumes that the estimated total vehicle sales volume is 600,457 and the market share of EVs is 30%. In order to calculate the tax revenues generated under this circumstance, the market shares for the year 2022 were applied to the year 2030 (Scenario A). Accordingly, assuming that in 2030, the sales shares remain the same as in 2022, the total tax revenue *(excluding Autogas)* will be approximately 351.2 billion TL (Scenario A).

However, in addition, in 2025, when the market share of EVs is 30% and the market share of other vehicle types is distributed according to this ratio, assuming all other conditions remain the same, the total tax revenue *(excluding Autogas)* will be approximately 298.1 billion TL (Scenario B). In Scenario B, the total tax revenue derived from EVs amounts to approximately 50.5 billion TL, whereas in Scenario A, it is 2.2 billion TL. Despite the annual tax revenue from EVs being approximately 23 times higher in Scenario A, the total tax revenue remains at approximately 298.1 billion TL. Consequently, if the market share shifts in favor of EVs in this manner, there will be an estimated tax revenue loss of approximately 53.1 billion TL *($1.9 billion)* for the year 2030.

**Table 4:** Results for Scenarios *(10% market share for EVs)*

| | **2022** (excl. EVs) | | **2025 (A)** | | | | **2025 (B)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Unit** | **Share** | **Unit** | **Share** *(year of 2022)* | **Taxes per vehicle** | **Total Tax Revenue** | **Unit** | **Share** | **Taxes per vehicle** | **Total Tax Revenue** |
| Diesel | 103,311 | 17.6622% | 102,415 | 17.4317% | 606,264.32 TL | 62,090,560,332.80 TL | 93,393 | 15.8960% | 606,264.32 TL | 56,620,843,637.76 TL |
| Gasoline | 408,920 | 69.9096% | 405,376 | 68.9974% | 557,597.53 TL | 226,036,656,321.28 TL | 369,662 | 62.9187% | 557,597.53 TL | 206,122,618,134.86 TL |
| Electricity | - | - | 7,666 | 1.3048% | 280,586.48 TL | 2,150,975,955.68 TL | 58,752 | 10.0000% | 280,586.48 TL | 16,485,016,872.96 TL |
| Hybrid | 64,387 | 11.0077% | 63,829 | 10.8641% | 835,790.88 TL | 53,347,696,079.52 TL | 58,205 | 9.9069% | 835,790.88 TL | 48,647,208,170.40 TL |
| Autogas | 8,309 | 1.4205% | 8,237 | 1.4020% | - | - | 7,511 | 1.2784% | - | - |
| **Total** | **584,927** | **100%** | **587,523** | **100.00%** | **-** | **343,625,888,689.28 TL *($ 12.3 billion)*** | **587,523** | **100%** | **-** | **327,875,686,815.98 TL *($ 11.8 billion)*** |
| | | | | | | | | | *Estimated Tax Revenue Loss for 2025 (A)-(B) | **15,750,201,873.30 TL *($ 567.5 million)*** |

**Source:** Author's own creation

**Table 5.** Results for Scenarios *(30% market share for EVs)*

| | **2022** (Excl. EVs) | | **2030 (A)** | | | | **2030 (B)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Unit** | **Share** | **Unit** | **Share** *(year of 2022)* | **Taxes per vehicle** | **Total Tax Revenue** | **Unit** | **Share** | **Taxes per vehicle** | **Total Tax Revenue** |
| Diesel | 103,311 | 17.6622% | 104,670 | 17.4317% | 606,264.32 TL | 63,457,686,374.40 TL | 74,238 | 12.3635% | 606,264.32 TL | 45,007,850,588.16 TL |
| Gasoline | 408,920 | 69.9096% | 414,300 | 68.9974% | 557,597.53 TL | 231,012,656,679.00 TL | 293,844 | 48.9367% | 557,597.53 TL | 163,846,688,605.32 TL |
| Electric | - | - | 7,835 | 1.3048% | 280,586.48 TL | 2,198,395,070.80 TL | 180,137 | 30.0000% | 280,586.48 TL | 50,544,006,747.76 TL |
| Hybrid | 64,387 | 11.0077% | 65,234 | 10.8641% | 835,790.88 TL | 54,521,982,265.92 TL | 46,268 | 7.7055% | 835,790.88 TL | 38,670,372,435.84 TL |
| Autogas | 8,309 | 1.4205% | 8418 | 1.4020% | - | - | 5,970 | 0.9943% | - | - |
| **Total** | **584,927** | **100%** | **600,457** | **100.00%** | **-** | **351,190,720,390.12 TL *($ 12.6 billion)*** | **600,457** | **100%** | **-** | **298,068,918,377.08 TL *($ 10.7 billion)*** |
| | | | | | | | | | *Estimated Tax Revenue Loss for 2030 (A)-(B) | **53,121,802,013.04 TL *($ 1.9 billion)*** |

## CONCLUSION AND POLICY IMPLICATIONS

The changing global trends and preferences in the automotive industry are progressively increasing the demand for electric vehicles. In response to this growing demand, vehicle manufacturers are shifting their production structures towards electric vehicles. A similar shift in demand can also be observed in Türkiye, with an increase in electric vehicle sales. While the transition to electric vehicles is accelerating for various reasons, such as environmental awareness, cost considerations, income levels, one of the consequences of this transformation is its impact on public revenues, particularly in terms of taxes.

Public revenues derived from EVs and ICEVs were comprehensively analyzed, encompassing aspects such as initial registration, motor vehicle tax, fuel/charging, and maintenance. Accordingly, tax revenues collected per kilometer during an average usage of 15,000 kilometers or 1 year, starting from the purchase of a new vehicle, were calculated collectively. In this study, public revenues collected from imported vehicles entering the domestic market (customs stage) have not been fully calculated due to limitations, mainly due to the reluctance of car companies to share more detailed financial information. In addition, the relatively new nature of electric vehicles and technologies leads to uncertainty in predicting how many electric vehicles will be sold in the future compared to fossil fuel vehicles. As time progresses on and clearer figures become available, the differences in public revenues between these vehicles will become much clearer.

Accordingly, tax revenues collected per kilometer during an average usage of 15,000 kilometers, considering different tax categories *(initial registration, motor vehicle tax, fuel/charging, and maintenance),* are calculated as follows: EVs *(economy vehicles)* amount to 18.70 TL *($0.67)* per kilometer, gasoline vehicles are at 37.17 TL *($1.34)*, diesel vehicles reach 40.42 TL *($1.46)*, and hybrid-gasoline vehicles stand at 55.72 TL *($2.01)* per kilometer.

The emergence of transportation alternatives stemming from the widespread adoption of electric vehicles necessitates a long-term perspective. Developments in battery technology, the advancement of charging infrastructure, and the resolution of the range issues through the emergence of new technologies contribute to accelerating the dissemination of electric vehicles. Therefore, policymakers should address these issues earnestly and formulate and implement long-term strategies to compensate for potential tax revenue losses. In this regard, it would be helpful in the policy-making process to consider several alternative policy suggestions.

Regulatory changes that encourage the installation of a minimum of three wallbox/home charging units in buildings with parking facilities can be implemented to offset the loss of the tax revenue in question. If such a regulatory amendment were to be enacted, with the installation of at least three charging units in one million buildings *(with parking facilities),* taking into account the tax revenue generated during the installation phase, it would be possible to compensate for the tax revenue loss arising from electric vehicles.

Türkiye is a country rich in alternative energy sources with high efficiency. Therefore, it is advisable to promote the use of solar panels to address various aspects: meeting the charging needs of electric vehicles, ensuring sustainability, minimizing negative environmental impacts, avoiding overloading the electrical grid for energy requirements, and mitigating potential public revenue losses resulting from the proliferation of electric vehicles.

With the increasing adoption of electric vehicles, the number of commercial charging stations is also on the rise. In this context, regulatory measures can be put in place by the Energy Market Regulatory Authority (EPDK) to mandate that a certain percentage of stations opened under the electric vehicle charging network operator license granted to companies (e.g., 40%) must generate energy from alternative sources *(such as wind energy, solar energy, etc.)*. This would not only promote sustainability but also potentially increase public revenues as a result of these additional investments.

In order to encourage and incentivize the usage of electric vehicles while also mitigating the potential loss of tax revenue resulting from this transition, it is deemed appropriate to impose an additional emissions tax per kilometer on internal combustion/fossil fuel-powered vehicle owners. Considering the existing vehicle stock in Türkiye, when calculated, the proposed emissions tax per kilometer can be as low as 0.05 TL.

In addition to the diminishing effect of the widespread adoption of electric vehicles on public revenues, there is also potential for a reduction in public expenditures in the context of mitigating negative externalities caused by environmental factors. Consequently, existing public expenditures aimed at preventing or mitigating negative

externalities may, in the future, equal or exceed the possible loss in public revenue that could arise with the proliferation of electric vehicles. In this context, it is recommended that future researchers in this field conduct an analysis of income *(potential revenue losses/ gains)* versus expenditure *(expenditures related to the mitigation of negative externalities)* using different data and methodologies to assess the results.

## DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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