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The Impact of Fiscal Incentives on Total Cost of Electrified Vehicle Ownership in Indonesia

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Abstract

The Indonesian government has provided fiscal incentives to develop a battery electric vehicle (BEV) market, such as luxury goods tax (PPnBM) exemptions, vehicle title transfer fee (BBNKB) reduction, and motor vehicle tax (PKB) reduction for BEV users. With several fiscal incentives, BEV prices are expected to compete with Internal Combustion Engine Vehicle (ICEVs), thus consumers will switch to buying and using BEVs. Consumers, however, do not solely consider the price of BEVs; they also consider the total cost of ownership (TCO). In that regard, this study aims to construct a TCO model and calculate the total cost of ownership of Electrified Vehicles (x-EVs) and ICEVs. This study also attempts to analyze the impact of various fiscal incentives on the TCO of BEV. The result of this study shows that (1) without any fiscal incentives, the amount of x-EV's TCO (Total Cost of Ownership) is comparably higher than that of ICEV; (2) PHEV's and HEV's TCOs are lower than the TCO of ICEV with the provision of PPnBM-free incentives and PPnBM reduction, respectively; and (3) three fiscal incentives (PPnBM exemption and BBNKB and PKB discount) are urgently required to lower the TCO of BEV and penetrate the Indonesian market.

Keywords: Electrified Vehicle, Battery Electric Vehicle, Total Cost of Ownership, Fiscal Incentive
JEL Classification: O23, O25

INTRODUCTION

To support the Low Carbon Emission Program (LCEP), the Government of Indonesia has set a policy encouraging the automotive industry to produce energy-saving and low-emission cars (environmentally friendly), more specifically to develop Battery Electric Vehicles (BEVs)[1] as stated in the Presidential Decree (Perpres) Number 55/2019. The regulation also urges consumers who still use conventional cars or internal combustion engine vehicles (ICEVs) to shift to BEVs. The government even targets the sale of BEVs at 20% of the automotive market in 2025.

[1] Battery Electric Vehicles (BEV) do not require a fuel-based engine as a driving system. Instead, it utilizes an electric motor as the driving system and a battery to store electricity.

To achieve those targets, the Indonesian government has been providing more fiscal and non-fiscal incentives, as stated in Perpres Number 55/2019. One of the fiscal incentives given is the exemption of the luxury goods tax (PPnBM) to BEV sales as stated in Government Regulation (PP) 73/2019, which will take effect in October 2021 (ICEV sales will be imposed PPnBM with a range of 10%-70%, depending on its emission rate). Other incentives are the vehicle title transfer fee (BBNKB) and vehicle tax (PKB) exemption or reduction, which have been regulated in the Ministry of Home Affairs Regulation (Permendagri) Number 8 of 2020. In Permendagri Number 8/2020, the rate of BBNKB is still at 12.5%, and the rate of PKB averages at 1.75%. However, Permendagri No 8/2020 stated that the tax basis of BBNKB and PKB for BEV amounts to 30% of the vehicle's selling price (NJKB)[2]. Compared to ICEV, the basis of PKB and BBNKB equals 100% of NJKB. Therefore, the rate of BBNKB for BEV is at most 12.5% x 0.3=3.75% and the rate of PKB is at most 1.75% x 0.3= 0.525% of the selling price. By providing the aforementioned fiscal incentives, hopefully, the price and TCO of BEV will be closer to those of ICEV, making the market penetration and BEV demand rise significantly.

Perpres 55/2019 aims to develop the BEV industry unequivocally. Therefore, various fiscal incentives tend to be only in favor of BEV. For Hybrid Electric Vehicles (HEVs) and Plug-in Hybrid Electric Vehicles (PHEVs), the fiscal incentive provided is a lower PPnBM rate than ICEV. However, both PHEVs and HEVs have the same BBNKB and PKB schemes as ICEVs. Hence, HEVs and PHEVs are ineligible for BBNKB and PKB tax reduction despite their effectiveness in fossil fuel usage compared to ICEVs.

How can the government incentivize the public to purchase electrified vehicles? This question has been an ever-evolving inquiry as countries worldwide have been folding more electrified vehicles into their market mix. This paper is an extension of a work originally presented by Riyanto, et al. (2019) at the 6th International Conference on Electric Vehicular Technology (ICEVT) related to the total cost of ownership of electrified vehicles in Indonesia. This study used the framework established by Riyanto et al (2019) to delve into what possible impacts fiscal incentives generate on the Indonesian electrified vehicle market, especially in its early stages.

The experience of other countries which had previously developed electric cars demonstrated that the market for BEVs is still quite scarce, and its sales growth has not been encouraging. In Italy, for instance, the sale of BEVs only accounted for 0.01% in 2017. Meanwhile, in Austria, France, Switzerland, and Germany, BEV's sales only amounted to roughly 1.5% to 3% during the same year despite various fiscal incentives provided by the government in appealing to consumers to switch to BEV (Danielis, et al., 2018). Many countries, aside from developing the BEV market, have also started to develop environmentally friendly vehicles. This new market will develop gradually as the penetration of HEVs and PHEVs begins.

The factors causing the low interest in switching to BEV could be two things (Coffman, et al., 2017; Danielis, et al., 2018), namely (1) monetary factors such as EV prices, tax, operating costs, parking costs; (2) non-monetary factors such as mileage range, size, and type of car, brand, charging time, and charging

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[2] For DKI Jakarta, the BBNKB has been waived (stated in Governor Regulation Number 3 of 2020).

infrastructure. According to Danielis, et al. (2018), monetary factors are represented by *the total cost of ownership* (TCO). Elrram (1995) defined TCO as "*TCO is defined both as a purchasing tool and a philosophy, aimed at understanding the true financial cost of buying specific goods such as a car*." Furthermore, Danielis, et al. (2018) described the tight connection between TCO and the level of car sales. Currently, BEVs have a higher TCO compared to ICEVs. Hence, the level of BEV sales is still relatively lower than the sales of ICEV.

According to Danielis, et al. (2018), there are two components in the total cost of ownership of a specific commodity for consumers: (1) the price to be paid by consumers to buy the commodity and (2) the society-oriented TCO that is the price to be paid by the society for the existence and use of said commodity (this includes externality cost of air pollution). The difference in the TCOs between countries, other than being determined by the price of a car purchase, is determined by the structure of costs that is related to the price of fuel or electricity, insurance, tax, and subsidy (Lévay, et al., 2017; Palmer, et al., 2018). Studies have also shown that the TCO of a vehicle depends on the pattern of vehicle use (purpose of the trip, urban vs. highway), residential density (Windisch, 2013; Wu, et al., 2015), user's segment, and whether it is a primary or secondary family vehicle (Propfe, et al, 2012; Plötz, et al., 2013). Several TCO models include the vehicle's price, import duty, PPnBM, insurance, maintenance, tire substitution, resale value, and fuel consumption. For BEV cars specifically, the TCO is very dependent on battery replacement costs and the process of battery recycling or reuse. The TCO models' description and the comparison of them in some countries can be explained as follows.

TCO study in the USA was conducted in the Hawaiian Islands by Coffman, et al. (2017). In general, the TCO model in this study adopted the consumers' perspective in evaluating the cost of purchasing and operating a vehicle over a certain period. The study used the TCO model without a tax credit. Gilmore and Lave (2013) have also calculated TCO using net present value (NPV) from every vehicle in the USA. Results of this study show that for passenger vehicles, the TCO of diesel-based TDI (Turbocharged Direct Injection) vehicles and HEVs is lower than ICEVs in the discount rate ranging from 0% to 10%. An exception is made for the Honda Civic, which has the TCO of the conventional vehicle and is lower than that of the TDI or HEVs in the discount rate of 10%. In terms of luxury passenger vehicles, the TCO of TDI vehicles is also lower compared to conventional gasoline vehicles in the discount rate ranging from 0% to 10% so that it will not affect the consumers' decision. As for Trucks, the TCO of TDI vehicles is lower than conventional gasoline vehicles in the discount rate ranging from 0% to 5%, but not up to 10%.

Another study regarding TCO in the USA was conducted by Little (2015). The TCO is represented in dollars from the vehicle ownership cost during vehicle usage and wraps all the input costs in the 20 years of a vehicle's life cycle. This study concludes that BEVs (Battery Electric Vehicles) are significantly more expensive to own and more difficult to operate than ICEVs (Internal Combustion Engine Vehicles). For compact passenger vehicles in 2015, BEV ($68,492) is 44% more costly than ICEV ($47,676). For mid-size passenger vehicles in 2015, the difference in cost is even more visible as BEV ($85,854) is 60% more costly than ICEV ($53,649).

In Belgium, TCO is studied by Messagie, et al. (2013). This study measures the total cost of ownership (TCO) to evaluate the cost of electricity-based vehicles (HEV, PHEV, and BEV) compared to conventional vehicles that use gasoline and diesel fuel. The result for the 'medium cars' segment is more promising for BEV. Costs per km range from 0.27-0.33€/km for gasoline-based cars, 0.28-0.31€/km for diesel-based cars, 0.27-0.38€/km for HEV, 0.39-0.42€/km for BEV, and 0.45-0.50€/km for PHEVs. In this segment, the portion of depreciation expense among all the vehicle types is uniform: 43% for a gasoline-based vehicle, 51% for a diesel-based vehicle, 53% for HEV, 55% for BEV, and 70% for PHEVs. Generally speaking, PHEV is still the most expensive alternative.

Lévay, et al. (2017) have calculated the TCO of EV and ICEV in a few European countries: Italy, Norway, the Netherlands, the United Kingdom, Germany, France, Hungary, and Poland. Data points were presented in vehicle models to reveal the variety of possibilities in the connection between cost and sales for every car segment (big, medium, and small cars). This division shows that the bigger the EV car, the higher the sales and the lower the TCO compared to its ICE counterpart. Small EVs have the lowest relative sales and the highest relative TCO, while high EVs have the highest relative sales and the lowest relative TCO. Deployment of data points reveals an incredible difference relative to TCO. Small EV cars have higher TCO loss than medium and large EV cars. Most data points in the picture lie above 100%, which means that small EV cars have a TCO higher than their ICE counterparts. The TCO of the electricity-based Volkswagen e-Up is 150% more than that of its gasoline-based version in all countries except Norway. Meanwhile, the TCO of an electrified Renault Zoe does not exceed 150 of % of a conventional Renault Clio in most countries. For medium-sized cars, only two data points are above 150%, while the other eight are below 100%, signalling that EVs are cheaper (TCO-wise) than their ICE counterpart. Big EV models show the same pattern in comparison to the medium models, except for the Volvo V60 PHEV, which is consistently above 150% and more expensive than the Tesla Model S and Mitsubishi Outlander PHEV.

Rusich & Danielis (2015) calculate TCO, which includes the expense of owning a car for ten years as well as vehicle capital cost, the retail price of a car reduced by subsidy, in Italy. The result is that the TCO of gasoline-based ICEV is way cheaper than other ICEV and BEV types, while hybrid diesel ICEV is the most expensive type of ICEV. In the BEV category, renting a BEV battery is less costly than buying a BEV with its battery. Generally, hybrid vehicles have a higher TCO than ICEVs, followed by BEVs.

Another TCO study in Italy was conducted by Danielis (2018). The TCO model in this study consists of various expenses required to travel for several years and several kilometers. This study describes two types of expenses used: constant expenses and variable expenses. The constant expense includes a one-time payment for a car purchase, such as tax, price, and insurance, while the variable expense is the expense that can change based on usage intensity and the distance traveled, which encompasses fuel cost. Both expenses are called consumer-oriented costs. There is also the society-oriented cost, which is the emission of air and noise pollution costs. Due to this reason, in this study, the TCO model comprises consumer-oriented costs and society-oriented costs. The assumed retail price is based on the manufacturer's suggested retail price (MSRP), with a residual value of zero under the consideration that the average period for vehicle ownership in Italy is ten years.

Based on other countries' experiences, Indonesia, as one of the countries that will develop the BEV market using fiscal incentives as stated in Perpres 55/2019, needs to delve deeper into the comparison between the TCOs of BEV and ICEV well as that of HEV and PHEV in the Indonesian automotive market. Further research is needed to examine the impact of fiscal incentives on the TCO of BEVs in Indonesia. This research also analyzes the impact of fiscal incentives in proportion to BBNKB and PKB reduction applied to HEV and PHEV based on their CO2 emission rate. If the BBNKB and PKB for BEVs are waived and reduced, respectively, while HEV and PHEV acquire proportional BBNKB and PKB reduction based on the amount of CO2 emitted, their BBNKB and PKB tariffs must be lower than ICEV yet still higher than BEV. Hence, this study aims to first build a TCO model and compute the value of the total cost of ownership for xEVs (BEV, PHEV, and HEV) and ICEV in Indonesia and second, analyze the impact of fiscal incentives on the TCO of BEV relative to the TCOs of ICEV, HEV, and PHEV.

METHODS

Theoretically, the TCO of a vehicle is determined by the vehicle's initial purchase price (also called the on-the-road price (OTR price)), maintenance costs, and operational costs. The OTR price that was paid by the consumer included the merchant's price (of the road price) plus PPNBM, BBNKB, and the first-year payment for PKB. The PPnBM exemption incentive, as well as BBNKB and PKB reduction, will reduce the OTR Price, which in turn reduces TCO. The simple framework of how the impact of fiscal incentives on TCO is illustrated in Figure 1.

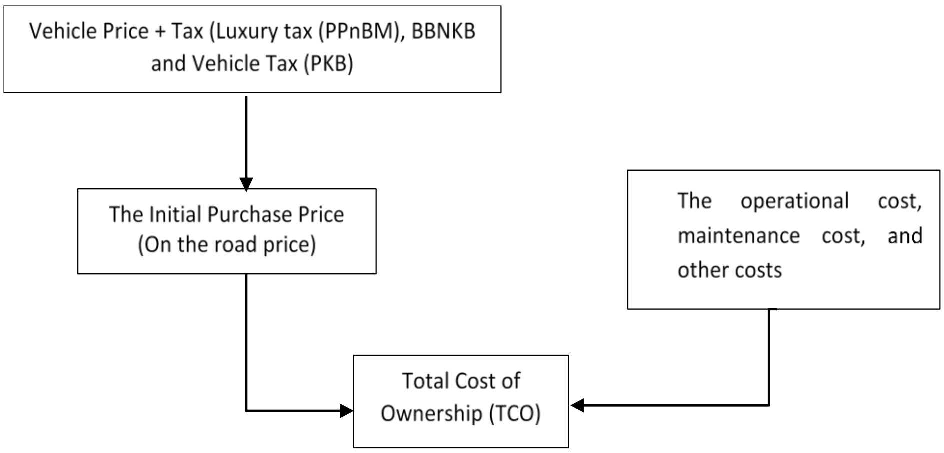

Figure 1. The Framework of How the Impact of Fiscal Incentives on TCO

Based on the framework illustrated in Figure 1, this study will calculate and compare the analysis of the TCO of electrified vehicles (HEV, PHEV, and BEV) and ICEV by adopting the models used by Coffman (2017) and Danielis (2018). Aside from utilizing a consumer-oriented model, the TCO model developed in this study also attempts to consider society-oriented aspects, including the social cost of CO2 emissions from ICEV, HEV, and PHEV. The full models and assumptions used in this study are shown below.

TCO Model

In general, this study uses the model used by Coffman, et al. (2017) and Danielis, et al. (2018) in calculating the TCO. The model that is used is shown below:

$$TCO = P + \sum_{t=1}^{N} c_t(1+r)^{-t} - R(1+r)^{-N} \quad (1)$$

The model is explained in detail below:

a. P is the Initial Purchase Price

This study also uses the initial purchase price for a one-time cost to purchase cars when time (t) equals 0. The provision of fiscal incentives in the form of PPnBM exemption and BBNKB and PKB reductions lowers the initial purchase price, which in turn decreases the TCO. Since consumers will use the vehicle for the next few years, the initial price will also face a decline over time because of existing assumptions, such as depreciation and the car's age.

b. R is the Resale Value

One of the primary considerations for automobile consumers in Indonesia is its resale value, and the decline of such value over time places a burden on the TCO.

c. r is the discount factor

The discount factor is also a crucial component in the calculation. An economic calculation from different points in time can be adjusted to represent its value in the present using the discount factor. The discount factor used in this study is 10 percent per year. A 10% rate is commonly used in cost-benefit and TCO analyses in developing countries, especially when market uncertainties—such as resale value, maintenance cost, and charging infrastructure—are still high. It also aligns with consumer loan interest rates and opportunity costs, thus representing a realistic and conservative benchmark. Moreover, previous international studies have applied discount rates between 5–10%, and this value ensures consistency with broader economic assessments in the Indonesian context.

d. C_t is the operational cost, maintenance cost, and social cost.

The last component for this calculation is the cost of operation and maintenance for the cars related to this case. Maintenance cost includes:

i. Engine costs: oil, tune-up, parts;
ii. Vehicle costs: brake pads, shock-breaker, among others;
iii. Electric components costs;
iv. Equipment costs.

Meanwhile, operational costs include:

i. Fuel or electricity cost.
ii. Insurance costs.
iii. Tax fees.
iv. Parking costs.

We also consider the cost for BEV customers when traveling out of town. Since BEVs can only be used within the city, consumers would have to rent an ICE car to travel out of the city. Regarding this matter, we assume that there are at least 14 days in a year during which BEV users rent an ICE vehicle for long-distance traveling. Thus, they would have to rent an ICE car with a rental fee of

Rp250,000 per day in 2019. The total fee for a rental is Rp3,500,000 per year in 2019, which will increase each year due to inflation.

Furthermore, in the calculation, the social cost is counted based on the CO2 emission produced by the use of fossil fuel in ICEVs, HEVs, and PEVs. All the calculations above are carried out with the assumptions that will be explained further in the next subchapter.

Assumptions in Calculating TCO

In economic analysis, assumptions used in calculations are essential in determining the value sensitivity. In this study, the underlying assumptions used are shown in Table 1.

In general, some critical assumptions that are used in this study are as follows:

a. The Assumption of Ownership Period

This study employs two periods in the assumption of the ownership period. 5- and 10-year periods are used in the calculation, and the values from the two periods are compared. A 5-year-period value is used to analyze TCO for consumers using their cars for a short term. Meanwhile, a 10-year-period value is used to calculate the TCO of consumers who will sell their cars, especially BEV users, when replacing the battery.

b. The Assumption of Annual Kilometers Travelled (AKT)

This study uses three scenarios to assume annual kilometers traveled (AKT), which are 10,000 km per year, 18,000 km per year, and 25,000 km per year. A 10,000 km per year of AKT reflects consumers who use their cars for short distances, which is less than 30 km per day. 18,000 km and 25,000 km of AKT per year are designated for consumers traveling medium and long distances. The result of the TCO in this study will be in Rupiah per km (IDR/km).

c. The Assumption of the Initial Purchase Price

For the convenience of the simulation, this study will assume a car price of up to IDR 250 million, which will affect BEV penetration into the Indonesian market. It also reflects the market share of cars in Indonesia. The battery capacity for PHEV and BEV is adjusted with the price of ICEV. For PHEV, the battery capacity is 8.8 kWh and 13.5 kWh for BEV. The model and dashboard that have been developed can be used for various ICE cars' desired price simulations in adjusting the compatible battery capacity and price. The HEV, PHEV, and BEV assumed prices are 1.2x the ICE's price, 1.4x the ICE's price, and 1.5x the ICE's price, respectively. These multipliers reflect the additional costs associated with electric powertrain technology, particularly battery systems, which remain a significant cost component in x-EVs. The 1.5x multiplier for BEVs accounts for both the high upfront cost of batteries and the relatively limited domestic production capacity in Indonesia, which currently relies heavily on imported EV components. Similarly, HEVs and PHEVs are assumed to be moderately more expensive than ICEVs due to the dual drivetrain and more complex engineering. These ratios are conservative yet realistic, providing a consistent basis for evaluating fiscal policy impacts on consumer affordability and TCO across vehicle types.

d. The Assumption of Fuel Consumption Efficiency in the ICE, HEV, and PHEV and the Distance Traveled in Kilometers of PHEV and BEV per kWh with battery

This study assumes that BEV batteries carry a power of 13.5 kWh, which can sustain a 65 km travel per battery recharge. In terms of fuel efficiency of ICEVs, HEVs, and PHEVs, this study employs the empirical data results of experimental research conducted by the Ministry of Industry in collaboration with Universitas Indonesia (UI), Universitas Gajah Mada (UGM), and ITB (Institut Teknologi Bandung) teams. The data is shown in Table 2.

The study by the UI team shows that HEV and PHEV cars have lower fossil fuel consumption at 46% and 65% compared to that of ICE cars. UGM's study finds that the fossil fuel consumption for HEVs and PHEVs is 52% and 82% lower than ICEVs. ITB's study, however, concludes that the fossil fuel consumption of HEVs and PHEVs is 51% and 74% lower than ICEVs. Bearing these results in mind, the TCO will be calculated for ICEVs, HEVs, and PHEVs.

Table 1. Assumptions Used in the Study

Assumption	**The value that will be simulated**			**Unit**
Ownership	**5**		**10**	**Year**
Annual Kilometers Travelled (AKT)	**10,000**	**18,000**	**25,000**	**km/year**
ICEV Price		250,000		000 IDR
Insurance		4.00%		From the car's price per year
Yearly Tax for ICEV		1.75%		From the car's price per year
Depreciation		9.00%		From the car's price per year
Fuel Cost		Forecasting Result (Appendix 1)		IDR / liter
Electricity Cost		Forecasting Result (Appendix 1)		IDR/kWh
Oil Change Cost		700		000 IDR
Tune Up Cost		500		000 IDR
Brake Pad Change Cost		1,000		000 IDR
Tire Cost		2,000		000 IDR
HEV Battery Capacity		3.3		Kwh
PHEV Battery Capacity		8.8		Kwh
BEV Battery Capacity		13.5		Kwh
Exchange Rate as of 2027		16,507		IDR
Inflation		4%		
Discount Rate		10%		
Cost for Alternative Transportation		3,500		000 IDR/Year
ICEV: HEV Price Ratio		1.25		
ICEV: PHEV Price Ratio		1.40		
ICEV: BEV Price Ratio		1.50		
Parking/day		10,000		IDR
Social Cost ICEV		175.00		IDR/KM
Social Cost HEV		88.08		IDR/KM
Social Cost PHEV		72.33		IDR/KM
Social Cost BEV		0.00		IDR/KM

Source: Compiled by the author

Table 2. The Assumption of Fuel Consumption Efficiency in ICEVs, HEVs, and PHEVs (Km/Liter)

Study Team	**ICEV**		**HEV**		**PHEV**	
	COROLLA 1	**COROLLA 2**	**PRIUS 1**	**PRIUS 2**	**PRIUS 1**	**PRIUS 2**
UI	12.5	11.1	21.6	22.0	32.0	36.2
ITB	10.9	10.8	21.9	22.5	41.4	42.6
UGM	10.7	10.5	23.0	21.1	54.7	68.5

Source: Ministry of Industry, 2019

e. The Assumption of Component Replacement and Maintenance Costs

Component replacement and maintenance costs follow the standard replacement technic in standard factory cars. Assuming that PHEV and BEV batteries are replaced in the 10^{th} year, if the battery is damaged before the 10^{th} year, it will be replaced for free due to its warranty.

f. The Assumption of Electricity and Fuel Costs

The value of electricity and fuel prices used in this study refers to the team's forecasting, where the electricity value is determined based on the nation's power plants data and the US Energy Information Administration, while fuel prices follow the trend laid out by the World Bank and preexisting data from Pertamina. Based on these components, three scenarios will be used in this study: the low fuel price (10% lower than the moderate fuel price), the moderate fuel price, and the high fuel price (10% higher than the moderate fuel price). The results of the electricity and fuel price assumption forecasting are described in Figure 2.

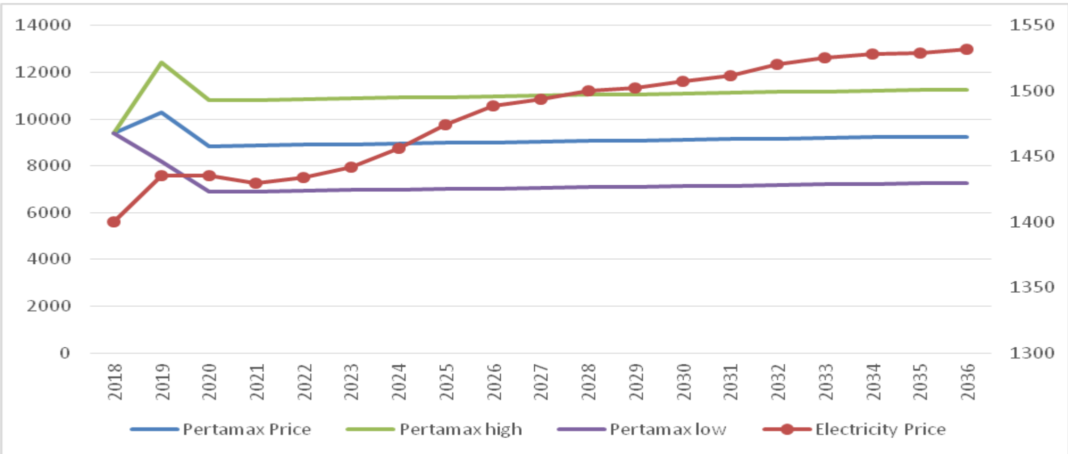

Figure 2. The Assumption of Electricity and *Pertamax* Costs Used in the TCO Calculation. Note: The Vertical Left Axis is Pertamax (gasoline) Prices, and the Vertical Right is Electricity Prices.
Source: Estimated by the author.

g. The Assumptions of Exchange Rate and Inflation

This study refers to the assumptions of long-term inflation in Indonesia, which is 4%. Meanwhile, the assumption of the exchange rate (IDR to USD) used in the simulation can be seen in Table 3.

Table 3. The Assumption for the Exchange Rate

Year	**IDR to USD**
2020	14,400
2021	13,800
2022	13,750
2023	14,033
2024	15,562
2025	15,157
2026	15,283
2027	16,507
2028	16,276
2029	16,244
2030	15,567
2031	15,511
2032	15,830
2033	17,555

Source: Estimated by the author

h. The Social Cost Calculation

From the previous explanation, the social cost in this study is calculated based on the CO2 emissions from transportation. This study employs the cost of carbon value at USD 50 per ton of CO2 according to the estimation by the US Government (IAWG, 2010).

Table 4. The Assumption of the Carbon Value Costs

Total emission	**ICE**	**HEV**	**PHEV**	**BEV**
Emission Total (gr/km)	250	125.8	103.3	0
Cost of carbon (IDR/km)	175	88	72.3	0

Source: Compiled by the author

The study also utilizes the referential value from the three institutions' joint study regarding the acceleration of electric cars in Indonesia, using the km/liter value of fuel in the shape of the average distance traveled in km/liter in the study. The value is multiplied by the value of the conversion from liter to gram of CO2. In short, the cost of carbon value in this study is described in Table 4.

Simulation Scenario of Fiscal Incentives Impact on TCO

In order to examine the impact of fiscal incentives on BEV, PHEV, and HEV TCOs, this study calculates several simulations of various incentive scenarios and compares these scenarios to the baseline scenario (without incentives). The scenarios used are based on PP 73/2019 regulation on PPnBM and Permendagri Number 8/2020. PP Number 73/2019 regulates the PPnBM rate of BEV and PHEVwhich is at 0% (PPnBM exemption only applies to BEVs and PHEVs).

Meanwhile, the PPnBM rate applied to ICEV and HEV for the MPV Low-Medium segment is at 20% and 5%.

Meanwhile, BBNKB and PKB tax rates are regulated in Permendagri Number 8/2020. Based on the regulation, the BBNKB rates applied to ICEV and BEV are described in Table 5.

Table 5. Assumed BBNKB Rate Tax

Vehicle Type	BBNKB Rate (%)	NJKB Tax Base Line (%)	Percentage of BBNKB to NJKB
ICEV	12.5%	100	=12.5% *100% NJKB = 12.5% * NJKB
BEV	12.5%	30%	=12.5%* 30% NJKB = 3.75% * NJKB

Source: Compiled by the author

Moreover, a similar calculation is conducted on the PKB rate of ICEV and BEV described in Table 6.

Table 6. Assumed PKB Rate Tax

Vehicle Type	PKB Rate (%)	NJKB Tax Baseline	Percentage of PKB to NJKB
ICEV	1.75%	100%	1.75%
BEV	1.75%	30%	0.525%

Source: Compiled by the author

Meanwhile, the fiscal incentives in the form of BBNKB and PKB applied to HEVs and PHEVs have not been regulated until now. As explained in the introduction regarding the CO2 emission of HEV and PHEV, which is lower than ICEV, this study will calculate a scenario of HEV and PHEV TCOs with BBNKB and PKB reduction, depending on the emissions emitted by HEVs and PHEVs compared to ICEVs and BEVs. The results of the experiment conducted by three universities (Universitas Indonesia (UI), Universitas Gajah Mada (UGM), and Institute Teknologi Bandung (ITB)) show the emission reductions of each vehicle in Table 7.

Table 7. Assumed Emission Reductions

Vehicle Type	UI	UGM	ITB	Geometric Mean
BEV	1.00	1.00	1.00	1.00
PHEV	0.54	0.63	0.59	0.59
HEV	0.46	0.52	0.51	0.50
ICEV	0.00	0.00	0.00	0.00

Source: Compiled by the author

Therefore, PKB and BBNKB rates for all types of vehicles are in Table 8.

Table 8. Calculations with PKB and BBNKB Rates Applied

Type of Car	PKB rate	BBNKB rate
BEV	0.525%	3.75%
PHEV	0.89%	5.18%
HEV	1.06%	6.30%
ICEV (recently)	1.75%	12.50%

Source: Compiled by the author

Referring to the aforementioned regulations, the simulated scenario used to analyze the impact of the fiscal incentives in this study is summarized in Table 9.

Table 9. Summary of Assumed Incentives Applied under Different Scenarios

Fiscal Incentives Applied to Different Scenarios	**PPnBM Tariff**				**BBNKB Rate**				**PKB Rate**			
	ICEV	**HEV**	**PHEV**	**BEV**	**ICEV**	**HEV**	**PHEV**	**BEV**	**ICEV**	**HEV**	**PHEV**	**BEV**
Baseline (No Incentive)	20%	20%	20%	20%	12.5% (12.5% x 100% NJKB) NO INVENTIVE				1.75% (1.75% x 100% NJKB) NO INCENTIVE			
Incentive 1: PPnBM reduction/ exemption for HEV, PHEV, and BEV (Based on PP73/2019)	20%	10%	0%	0%	12.5% (12.5% x 100% NJKB) NO INCENTIVE				1.75% 1.75% x 100% NJKB NO INCENTIVE			
Incentive 2: PPnBM reduction/ exemption + BBNKB reduction only for BEV	20%	10%	0%	0%	12.5% x NJKB	12.5% x NJKB	12.5% x NJKB	3.75%x NJKB	1.75% 1.75% x 100% NJKB NO INCENTIVE			
Incentive 3: PPnBM and BBNKB reduction/exemption for BEV, PHEV, and HEV	20%	10%	0%	0%	12.5% x NJKB	6.3% x NJKB	5.18% x NJKB	3.75%x NJKB	1.75% 1.75% x 100% NJKB NO INCENTIVE			
Incentive 4: PPnBM and BBNKB + PKB reduction/exemption for BEV, PHEV, and HEV	20%	10%	0%	0%	12.5% x NJKB	6.3% x NJKB	5.18% x NJKB	3.75% x NJKB	1.75%	1.06%	0.89%	0.525%

Source: Compiled by the author

Every scenario will be analyzed based on the AKT of each vehicle (infrequent, moderate, and frequent) and lower, moderate, and high fuel price scenarios.

RESULTS AND DISCUSSIONS

The study attempts to compare the TCOs of ICEVs and electrified vehicles such as BEVs, PHEVs, and HEVs. With this in mind, the TCO of ICEV will be represented with a value of 1, while the TCO of BEV, PHEV, and HEV are represented by the relative values of 1. For instance, the TCO number for BEV is 1.29, implying that the TCO of BEV is approximately 29% more expensive than that of ICE. This instance applies the other way around; if the TCO of HEV in a specific scenario equals 0.97, then it is assumed that its TCO is 3% less expensive than ICE.

In general, this section will elaborate on exercises and assumptions surrounding TCO. The result will be presented based on the TCO values of each car and other aspects affecting it, for example, assumed mileage per year, period of ownership, and fuel prices. In short, the results and the discussions will resemble sensitivity analysis by altering underlying assumptions.

TCO without the Incentive of EV

Table 10 provides the results of HEV, PHEV, BEV, and CEV TCOs with the AKT and fuel prices assumptions.

Table 10. Total Cost of Ownership Ratio between x-EVs and ICEV (ICE = 1) under No Incentives Scenario

Period of Ownership	Fuel Price Scenario	AKT								
		10.000 Km/Year			18.000 Km/Year			25.000 Km/Year		
		HEV	PHEV	BEV	HEV	PHEV	BEV	HEV	PHEV	BEV
5 Years	Low	1.03	1.15	1.32	0.98	1.06	1.22	0.94	1.00	1.14
	Moderate	1.02	1.13	1.29	0.96	1.03	1.18	0.92	0.97	1.08
	High	1.01	1.11	1.26	0.95	1.01	1.14	0.90	0.94	1.04
10 Years	Low	1.00	1.14	1.30	0.95	1.05	1.20	0.92	0.99	1.12
	Moderate	0.99	1.12	1.26	0.94	1.02	1.15	0.90	0.96	1.06
	High	0.98	1.10	1.23	0.92	1.00	1.11	0.88	0.93	1.01

Source: Author's calculations

From Table 10, we can conclude that even without any incentives, the TCO of BEV will still be higher than that of ICEV under any period of car ownership, AKT, and fuel price assumptions. As the AKT increases, the TCO of BEV decreases asymptotically close to the TCO of ICEV. For example, under a 5-year ownership and a moderate fuel price scenario, the increase in AKT from 10,000 km/year to 18,000 km/year for BEV will reduce the TCO from 1.29 times more expensive relative to the ICEV to 1.18 times more expensive relative to the ICEV.

As for HEV and PHEV, their TCOs are slightly closer to ICEV. TCO of PHEV will be lower than that of ICEV only if its AKT equals 25,000 km/year, and with a period of ownership of ten years. Under these conditions, HEVs and PHEVs will attract many rational consumers to consider long-term ownership of the vehicle since their TCOs are lower than those of ICEVs. The HEV market will then develop even without incentives and charging stations provided by the government. The government will still develop BEV according to Perpres 55/2019. Thus, fiscal incentives of BEV and PHEV in the form of PPnBM tax exemption will be applied as regulated in PP 73/2019. The impact of these fiscal incentives on TCO is described in the following subchapter.

The Impact of PPnBM tax exemption on TCO of BEV and PHEV

The first simulation results are obtained by applying PPnBM tax exemptions to BEV, PHEV, and HEV, which amounts to 10% as stated in PP 73/2019 (lower than those of ICEV, which amounts to 20%). Compared to the previous result (baseline scenario), the HEV is efficient for low-mileage vehicle users in every period of ownership and almost in every fuel price scenario, except for the low fuel price scenario with the assumption of five years of vehicle ownership. For vehicles with AKTs of 18,000 km/year or 25,000 km/year, the same result can be obtained without any incentive given in every fuel price scenario and period of ownership.

The TCO of PHEV is already lower compared to that of ICEV for low-mileage vehicles with the high fuel price scenario and five years of ownership (as it is 0.98 times lower than ICEV). For vehicles with an AKT of 18,000 km/year, in this scenario, even under the moderate fuel price scenario and ten years of ownership, the TCO of PHEV is lower than that of ICEV. For high-mileage usage

(25,000 km/year), the same result can be seen without any incentive given in every fuel price scenario and period of ownership.

Table 11. Total Cost of Ownership Ratio between EVs and ICEV (ICEV = 1) under the First Incentive Scenario

Period of Ownership	Fuel Price Scenario	AKT								
		10.000 Km/Year			18.000 Km/Year			25.000 Km/Year		
		HEV	PHEV	BEV	HEV	PHEV	BEV	HEV	PHEV	BEV
5 Years	Low	1.01	1.11	1.16	0.96	1.03	1.08	0.92	0.97	1.00
	Moderate	1.00	1.10	1.13	0.94	1.01	1.04	0.90	0.95	0.96
	High	0.99	1.08	1.11	0.93	0.98	1.00	0.89	0.92	0.92
10 Years	Low	0.99	1.11	1.15	0.94	1.03	1.07	0.90	0.97	1.00
	Moderate	0.97	1.09	1.12	0.92	1.00	1.02	0.88	0.94	0.95
	High	0.96	1.07	1.09	0.91	0.97	0.98	0.87	0.91	0.90

Source: Author's calculations

Lastly, by providing PPnBM exemption for BEVs, the TCO of BEV becomes lower than that of ICEV but only for high-mileage usage (25,000 km/year) in every period of ownership and almost every fuel price scenario. For vehicles with an AKT of 18,000 km/year, the PPnBM exemption can only be effective for BEVs when the fuel prices are relatively high (See Table 11).

The Impact of PPnBM Exemption (for BEV and PHEV) and BBNKB Reduction Applied Only to BEV

Table 12 shows the impact of PPnBM incentives (PPnBM exemption for BEV and PHEV) and BBNKB reduction applied only to BEV. In comparison to the previous result, the TCOs of HEVs and PHEVs are quite similar to those of ICEVs when fiscal incentives were not provided for the vehicles. As fiscal incentives provided for BEV are not only in the form of PPnBM exemption but also a BBNKB reduction, the TCO of BEV is lower.

Table 12. Total Cost of Ownership Ratio between EVs and ICE (ICE = 1) under the Second Incentive Scenario

Period of Ownership	Fuel Price Scenario	AKT								
		10.000 Km/Year			18.000 Km/Year			25.000 Km/Year		
		HEV	PHEV	BEV	HEV	PHEV	BEV	HEV	PHEV	BEV
5 Years	Low	1.01	1.11	1.09	0.96	1.03	1.01	0.92	0.97	0.95
	Moderate	1.00	1.10	1.06	0.94	1.01	0.98	0.90	0.95	0.90
	High	0.99	1.08	1.04	0.93	0.98	0.94	0.89	0.92	0.87
10 Years	Low	0.99	1.11	1.08	0.94	1.03	1.01	0.90	0.97	0.94
	Moderate	0.97	1.09	1.05	0.92	1.00	0.97	0.88	0.94	0.90
	High	0.96	1.07	1.03	0.91	0.97	0.93	0.87	0.91	0.85

Source: Authors' calculations

Furthermore, this scenario enables BEV to become an appealing option even for vehicle users with an AKT of 18,000 km/year with five years of ownership assumption and either moderate or high fuel price scenarios. With ten years of ownership and moderate fuel price scenario assumptions, the TCO of BEV is low. However, under both five and ten years of ownership assumption and a low fuel price scenario, BEV becomes less appealing despite its TCO decreasing closer to that of ICEV (only 1.01 times more expensive than ICEV). Unfortunately, this scenario has yet to make BEV a more attractive option for low-mileage usage in every fuel price scenario and period of ownership.

The Impact of PPnBM Incentives and BBNKB Reduction Proportional to the Amount of CO2 Emitted for BEV, PHEV, and HEV

Table 13 describes the impact of PPnBM incentives and BBNKB reduction proportional to the amount of CO2 emitted by each type of electric vehicle. From the table, we can conclude that with PPNBM incentives and BBNKB reduction, the TCO of HEV will be relatively cheaper than that of ICEV in any period of car ownership scenario, AKT, and fuel price scenarios. As the AKT increases, the TCOs of PEV and BEV become cheaper relative to those of ICEV. For example, during the 5 years of ownership, the TCO of PHEV becomes relatively cheaper at every fuel price scenario, had the level of AKT increased from 10,000 km/year to 18,000 km/year or 18,000 km/year to 25,000 km/year. TCO of BEV also turns relatively cheaper at 18,000 km/year and every fuel price scenario except for the low fuel price scenario, as well as at every low fuel price scenario with an AKT of 25,000 km/year. As the period of ownership extends, the TCO of HEV becomes relatively cheaper at every AKT level and fuel price scenario.

Table 13. Total Cost of Ownership Ratio between EVs and ICEV (ICEV = 1) under the Third Incentive Scenario

Period of Ownership	Fuel Price Scenario	AKT								
		10.000 Km/Year			18.000 Km/Year			25.000 Km/Year		
		HEV	PHEV	BEV	HEV	PHEV	BEV	HEV	PHEV	BEV
5 Years	Low	0.97	1.06	1.09	0.92	0.98	1.01	0.89	0.93	0.95
	Moderate	0.96	1.04	1.06	0.91	0.96	0.98	0.87	0.90	0.90
	High	0.95	1.03	1.04	0.89	0.94	0.94	0.86	0.88	0.87
10 Years	Low	0.95	1.06	1.08	0.90	0.98	1.01	0.87	0.93	0.94
	Moderate	0.94	1.04	1.05	0.89	0.96	0.97	0.85	0.90	0.90
	High	0.93	1.02	1.03	0.87	0.93	0.93	0.84	0.87	0.85

Source: Author's calculations

Meanwhile, the TCOs of PHEV and BEV will only be cheaper if the AKT levels increase. TCO of all-electric vehicles is comparatively cheaper with the assumption of a 5- or 10-year period of ownership and an AKT of 25,000 km/year. In comparison to the previous incentive given in point 4.3, this incentive works in favor of PHEV since its TCO is less expensive than that of ICEV in low and moderate fuel price scenarios at 5 years of ownership and in a low price scenario at 10 years of ownership.

The Impact of PPNBM Incentive, BBNKB Reduction, and Proportional PKB Reduction Based on CO2 Emitted to TCO of BEV, PHEV, and HEV

Table 14 describes the impact of BBNKB and PKB reduction depending on the amount of CO2 emitted to the TCO of each type of electric vehicle. From the table, it can be concluded that with PPNBM incentives, BBNKB reduction, and proportional PKB reduction, the TCO of almost all-electric vehicles will be cheaper than that of ICEV in any period of car ownership, AKT, and fuel price scenarios.

Table 14. Total Cost of Ownership Ratio between EVs and ICEV (ICEV = 1) under the Fourth Incentive Scenario

Period of Ownership	Fuel Price Scenario	AKT								
		10.000 Km/Year			18.000 Km/Year			25.000 Km/Year		
		HEV	PHEV	BEV	HEV	PHEV	BEV	HEV	PHEV	BEV
5 Years	Low	0.93	1.00	1.00	0.88	0.93	0.93	0.85	0.88	0.88
	Moderate	0.92	0.99	0.98	0.87	0.91	0.90	0.84	0.86	0.84
	High	0.91	0.97	0.96	0.86	0.89	0.87	0.83	0.84	0.80
10 Years	Low	0.90	1.00	0.99	0.86	0.93	0.93	0.83	0.88	0.87
	Moderate	0.89	0.98	0.96	0.85	0.90	0.89	0.82	0.85	0.83
	High	0.88	0.97	0.94	0.84	0.88	0.86	0.81	0.83	0.79

Source: Author's calculations

For example, the TCO of PHEV and BEV does not compete with that of ICEV with the previous incentive and an AKT of 10,000 km/year in any period of ownership and fuel price scenarios. The TCO of PHEV and BEV can compete with that of ICEV if their AKTs are at 10,000 km/year in any period of ownership and almost all fuel price scenarios with this incentive. As the AKT increases, the TCO of all-electric vehicles will be radically cheaper in comparison to that of ICEV in any period of ownership, AKT, and fuel price scenarios, and even cheaper compared to the previous incentives. With this incentive, the TCOs of all-electric vehicles are less costly than those of the ICEV had the AKT or period of ownership increased.

Potential Side Effects: Distributional Impact and Industry Disruption

While the simulation results demonstrate that fiscal incentives—particularly the combination of PPnBM exemption, and BBNKB and PKB reductions—are effective in lowering the total cost of ownership (TCO) for x-EVs, especially BEVs, it is important to recognize the potential unintended consequences of such policies. First, the distributional impact of current incentives deserves attention. As the analysis assumes a uniform application of fiscal support, the actual benefit may disproportionately favor wealthier, urban-based consumers who can afford to purchase new x-EVs, particularly BEVs, which remain more expensive upfront despite subsidies. In contrast, low- and middle-income consumers—particularly those living in rural or outer island areas—may lack both the purchasing power and supporting infrastructure (such as charging stations) to take advantage of the policy. This raises equity concerns, as public resources may be captured primarily by upper-income groups, exacerbating socio-economic disparities. Furthermore, unless additional targeted policies are implemented, the fiscal incentives may fail to stimulate widespread adoption across different income levels and regions.

Second, there is a risk of industry disruption. The Indonesian automotive sector and its supporting ecosystem—comprising parts suppliers, repair shops, and fuel distribution networks—are predominantly geared toward ICEV technology. A rapid transition to electrified vehicles, especially BEVs with significantly fewer mechanical components, may result in job displacement and reduced business for existing service providers. Small and medium enterprises (SMEs) that specialize in ICE-related components or maintenance could face financial stress or market exit. This transition challenge is particularly acute in regions where the automotive aftersales economy plays a substantial role in employment and local income.

These side effects underscore the need for a carefully phased policy approach. While fiscal incentives can be powerful tools to accelerate the adoption of x-EVs, they should be accompanied by complementary measures that address equity and industrial adjustment. This includes targeted subsidies for low-income groups, support for charging infrastructure in non-metropolitan areas, and retraining programs for workers affected by the shift to EV technology. Such efforts will ensure that the transition toward a low-emission transport system is not only economically efficient but also socially inclusive and just.

CONCLUSION AND RECOMMENDATION

Conclusion

By considering several vital aspects such as period of ownership, assumed fuel price, and average kilometers traveled in analyzing the impact of various fiscal incentives on the TCO of x-EVs, this study concludes that an extended period of ownership, high fuel prices, as well as high average kilometers traveled contribute negatively to the total cost of ownership in varying degrees. Without any fiscal incentives, the TCOs of x-EVs are comparably higher than those of ICEVs. TCOs of PHEVs and HEVs can be less than those of ICEVs with the provision of PPnBM-related incentives. The PPnBM exemption is not sufficient to lower the TCO of BEV to compete with the TCO of ICEV. Three fiscal incentives (PPnBM exemption, the reduction of BBNKB and PKB) are required to coexist simultaneously to lower the TCO of BEV and penetrate the Indonesian market.

This study suggests that to build the market of HEV and PHEV, the Indonesian government only has to provide a PPnBM incentive. To build and grow the BEV market, the government must provide all three aforementioned tax incentives.

Recommendation

In the context of Indonesia's decentralized fiscal system, the most feasible and equitable fiscal instruments to promote electrified vehicles (x-EVs) are centrally controlled taxes such as the luxury goods tax (PPnBM), combined with coordinated adjustments to regional taxes like the vehicle title transfer fee (BBNKB) and the annual vehicle tax (PKB). Among these, the PPnBM exemption for BEVs is the most administratively straightforward and already supported by national regulations (PP 73/2019 and PP 74/2021). However, to ensure broader adoption across regions and income groups, the central government should facilitate regional implementation of BBNKB and PKB reductions through incentive-based intergovernmental transfers or matching grants to local governments.

Equity considerations are also crucial. Current fiscal incentives tend to benefit higher-income urban households who can afford new BEVs. To improve fairness, policy design should prioritize affordability and accessibility by targeting fiscal support toward middle- and lower-income consumers, particularly those with high vehicle usage, such as ride-hailing drivers or delivery operators. Additionally, incentives should be structured to promote the adoption of more affordable hybrid and plug-in hybrid vehicles, which can serve as transitional technologies and are less dependent on charging infrastructure.

Potential industrial disruptions must also be addressed. A rapid shift to BEVs could adversely affect domestic supply chains reliant on ICE components and conventional repair services. Therefore, a gradual transition strategy should be adopted, including reskilling programs for mechanics and financial support for small and medium enterprises (SMEs) involved in ICE-related industries to retool toward EV-compatible parts and services.

Finally, fiscal incentives should not operate in isolation. They must be complemented by investment in EV infrastructure, regulatory clarity, and the development of a second-hand EV market. A periodic evaluation mechanism, conducted every 2–3 years, should also be institutionalized to monitor the effectiveness, equity, and fiscal sustainability of the incentive schemes. This would allow adjustments in line with technological developments, market uptake, and national environmental targets.

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