Examining total cost of ownership: battery electric vs internal combustion engine vehicles

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Battery electric (BEVs) are gaining immense popularity, no longer confined to early tech enthusiasts but captivating a much broader audience and swiftly transforming the landscape of the automotive industry.

The surge of BEV popularity is driven by two pivotal factors: the introduction of numerous new BEV models and the growing affordability of electric driving. Ayvens' Mobility Guide 2023 highlights that, notably in many European countries, BEVs are not only gaining favour but are also proving to be more cost-effective to drive than traditional internal combustion engine (ICE) vehicles.

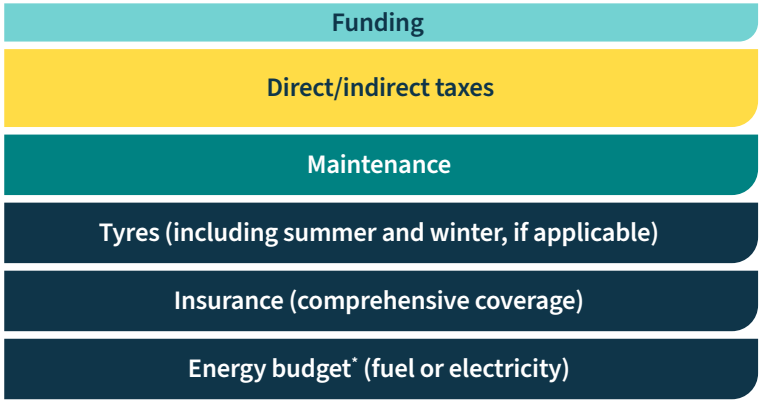
While the overall trend is positive, it's essential to consider some macroeconomic factors that can cause changes to the TCO. **Both BEV and ICE TCOs are influenced by energy prices changes and changes to governmental incentives.** Recent examples include Germany's BEV purchase subsidy cancellation in December 2023 and France's decision to limit BEV bonuses for passenger car only to individuals from February 2024.

The crucial question emerges: what is the comparative cost of operating an BEV versus a similar ICE model, and where are the cost differences? Within this white paper, we analyse the total cost of ownership (TCO) to compare the differences in cost elements between BEVs and ICE vehicles.*

** The underlying analysis is based on benchmark quotations of Q4 2023.*

Decoding total cost of ownership: exploring the cost

To compare the total cost of ownership (TCO) for both ICE vehicles and BEVs it's important to have the same set of parameters for both powertrains. Within an operational lease contract, the main building blocks are detailed below:



The **energy budget** is one of the most significant cost factors acting as a pivotal cost differentiator, mainly due to the notably lower cost of electricity compared to traditional fossil fuels. Ensuring a genuine like-for-like TCO comparison means the cost of fuel and electricity **must be included**.

Electricity prices can vary more significantly across regions and countries compared to the prices of petrol and diesel. For example, rapid charging stations along highways are normally much more expensive than charging at home. Our data-driven approach uses a **mix of 60% home charging, 30% workplace charging, and 10% public charging done by our clients**, and guides our TCO calculations by incorporating average prices from these charging scenarios.

Beyond the scope of the cost elements, the TCO analysis uses a specific lease mileage and contract duration to determine the costs. For the purposes of this analysis, we adopt a standardised contract duration of **48 months and mileage of 120,000 km**. This choice aligns with a common industry practice driven by the optimal balance between decreasing depreciation and increasing maintenance costs over time.

As a forward-looking initiative, it's important to highlight that advancements in BEV technology, charging infrastructure, and macroeconomic factors such as energy costs, taxation, inflation and interest rates, could introduce further volatility in future TCO assessments. Continued monitoring and adaptation of these factors will be crucial for staying abreast of the evolving electric mobility landscape.

** Costs associated to home chargers (hardware and installation) can be part of the TCO, however, as the costs vary greatly depending on individual needs, it was not included in this analysis.*

A thorough examination of BEVs vs. ICEs in 16 countries

To ensure a fair and comprehensive comparison between BEVs and ICE vehicles, it's vital to evaluate **comparable models**. In this study, we undertake a comparative analysis between the top representative ICE models in each market (a selection of both petrol and diesel vehicles) and a basket of representative battery electric vehicles (only fully electric versions).

Leasing costs for these vehicles differ across countries and the lease price is influenced by factors such as local taxation, labour costs, fuel expenditures, and governmental incentives for BEVs. Additionally, country-specific demand plays a role in shaping the initial vehicle sale price and its resale value. This study aims to offer a nuanced and **comprehensive perspective by studying the average leasing costs for ICEs versus BEVs across 16 European countries.**

Countries in research

- Austria
- Belgium
- Denmark
- Finland
- France
- Germany
- Ireland
- Italy
- Netherlands
- Norway
- Poland
- Portugal
- Spain
- Sweden
- Switzerland
- United Kingdom

Dissecting specific cost components in electric vehicles versus internal combustion engine vehicles

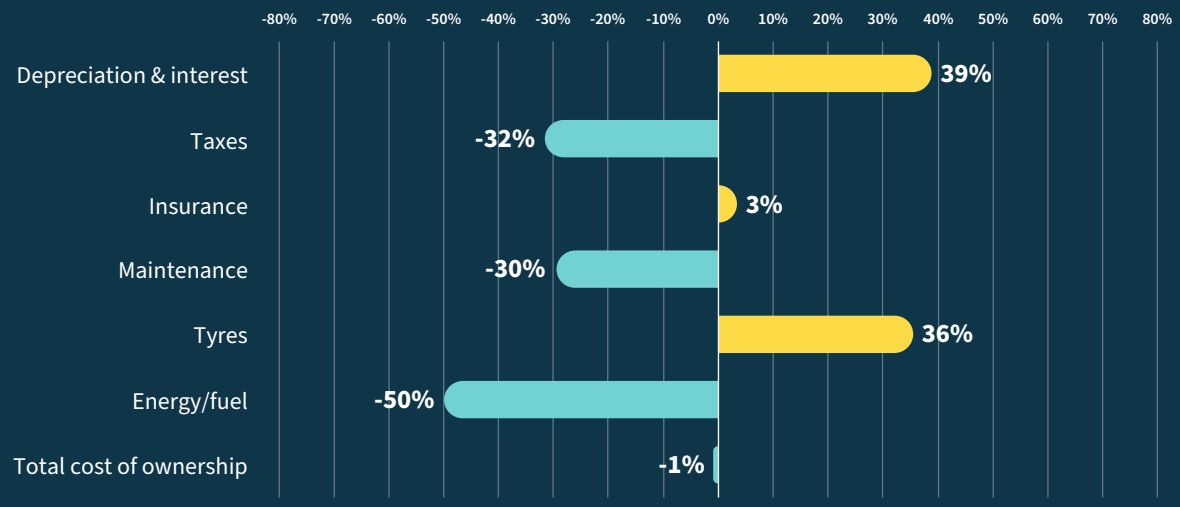
When analysing the overall TCOs between BEVs and ICE vehicles there are clear differences in the cost components.

Explanation of each component difference:

- **BEVs typically come with a higher initial list price,** which leads to higher depreciation and interest expenses.
- BEV adoption is still supported through government incentives. But **incentives are gradually being phased out** in western and northern European countries, where BEV adoption is high.
- **Insurance premiums** for BEVs are often influenced by their higher list price and their heavier weight, making them slightly more expensive than those for ICE vehicles.
- BEVs have fewer moving components compared to ICE vehicles so generally they **require less maintenance.**
- The heavier weight and higher torque of a BEV leads to **greater wear on tyres** and the higher tyre costs compared to ICE.
- The **cost efficiency of electricity is the biggest advantage of BEVs.** When comparing the same journey, BEVs typically incur only half the energy costs compared to ICEs.
- All elements considered, the **TCO of BEVs is slightly advantageous to the TCO of ICE.**

These comparisons, however, **vary significantly on a country level**. In countries with higher BEV readiness, the TCO for BEVs can be substantially more beneficial than in less mature markets, shaping a diverse landscape in the adoption and economic feasibility of BEVs globally. **Comparisons** between BEVs and ICE vehicles are performed over a **representative basket of models in equivalent segments**. Amongst others, we considered in the compact segment the VW Golf versus the VW ID.3, in the B-SUV segment the Peugeot 2008 versus the e-2008, in the D2 segment the Tesla Model 3 versus the BMW 3 series.

Difference in BEV cost compared to ICE vehicles

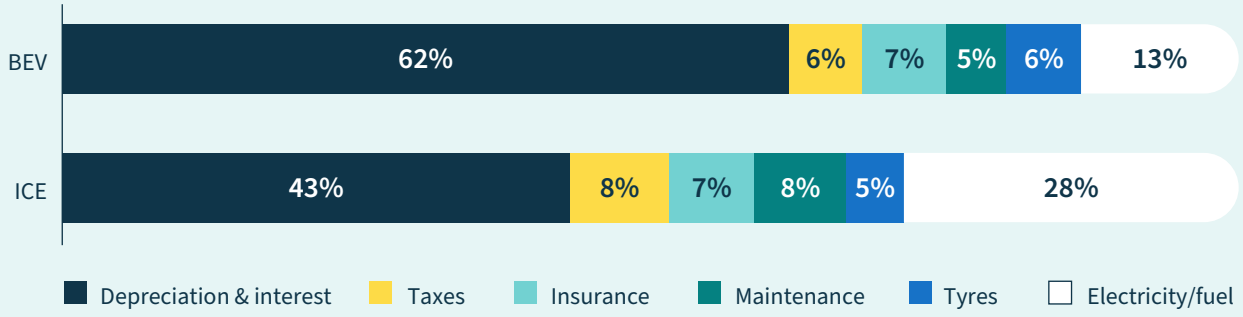


TCO factors: examining BEV and ICE affordability in detail

When it comes to BEVs, **depreciation and interest costs tend to be much higher than for ICE** vehicles. This is mainly due to the higher average purchase price for BEVs compared to their fossil fuel counterparts. Conversely, for **ICE** vehicles, expenses related to **fuel are much higher** than that of battery electric vehicles, representing one-third of an ICE's total cost of ownership. This is nearly twice the corresponding costs of an electric vehicle.

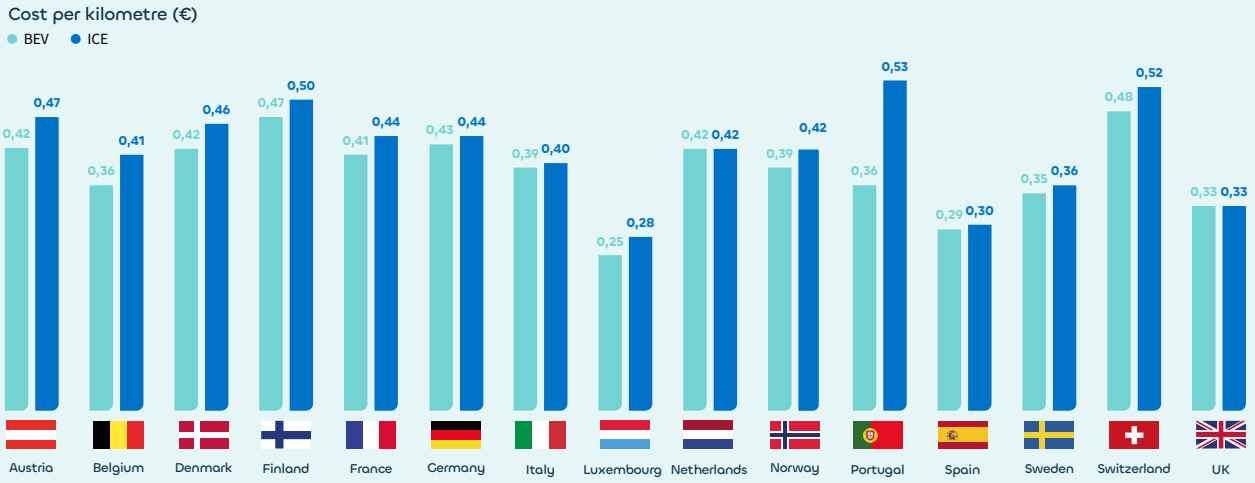
The crux of the cost issue revolves around the high purchase price of BEVs and the ongoing efforts of original equipment manufacturers (OEMs) to make BEVs more economically accessible. As manufacturers work to introduce more budget-friendly BEV models, the prospect of an affordable transition to electric vehicles becomes increasingly viable for a significant portion of people. An essential aspect contributing to this powertrain shift is the strategic **facilitation of cost-effective charging solutions**, predominantly at home or the workplace, where 80% of charging sessions are taking place. In Germany, a VW Golf covering 2500 km monthly, will require a €233 of fuel budget. Its 100% electric counterpart, the VW ID.3. will require only €125 worth of energy to cover the same mileage. By promoting a favourable and **convenient environment for affordable charging**, the path towards embracing BEVs is well on its way to becoming a practical reality for a growing number of people.

TCO breakdown



Conclusions

This analysis underscores the economic viability of BEVs by comparing the TCO between ICE vehicles and BEVs. On average, the overall cost of **operating a BEV consistently outperforms that of a comparable ICE**. In fact, across the countries examined in this study, several scenarios strongly indicate that BEVs present a more cost-effective option.



Cost per km for 48 months/120.000 km

The cost advantages of BEVs become more pronounced with an extended lease duration and increased mileage. This is attributed to diminished operational costs, particularly in terms of reduced road taxes and energy expenses, coupled with the ability to amortize the higher initial investment value over a prolonged period.

Diving deeper into the comparison, notable differences in specific cost elements emerge when contrasting ICE vehicles with BEVs. **A significant factor is the cost associated with fuel and electricity**, consistently tipping in favour of BEVs. This highlists the imperative nature of **including these aspects in a comprehensive TCO evaluation**.

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