



Comparison of a Tesla Model 3 Electric Vehicle and a Toyota Camry Conventional Internal Combustion Engine Vehicle

Kamal N. Abdalla^{1*}, Amin Albahi Ahmed¹ and Hisham Hafiz Hassan¹

¹Department of Mechanical Engineering, University of Khartoum, Sudan

*Corresponding author (E-mail: kamalnaser@uofk.edu)

ARTICLE INFO

Keywords:
*electric, conventional,
sustainability, charging, fuel cost*

Article History:
Received on:
Accepted on

Article Type:
Research Article

DOI: 10.53332/uofkej2234

ABSTRACT

The accelerating shift toward sustainable transportation has intensified the debate over whether electric vehicles (EVs) can effectively replace conventional internal combustion engine (ICE) vehicles. In this study, a comprehensive comparative analysis between a Tesla Model 3 electric vehicle (EV) and a Toyota Camry XSE V6 conventional (ConICE) car was conducted. The impacts of each vehicle on owners, the ecosystem, and society. The study quantitatively evaluates cost, emissions, performance, and infrastructure requirements over a 10-year period. Key findings revealed that while the Tesla Model 3 has a slightly higher initial cost than the Toyota Camry XSE V6, but it offers substantial long-term savings. Over a life cycle of ten years period, Tesla EV consumes around \$7,740 in electricity compared to around \$20,905 consumed in fuel by the Toyota Camry XSE V6 and requires ~\$3,000 in maintenance versus ~\$8,000 for the Toyota Camry XSE V6. Emission analysis shows that the Tesla emits ~8.1 tons of CO_{2e} over its life cycle, compared to ~32.3 tons of CO_{2e} emitted by the Toyota Camry representing an approximately 75% reduction. Performance-wise, both vehicles are similar in acceleration (0–100 km/h in approximately 5.7 seconds but differ in range (430 km for the Tesla vs. 921 km) and refuelling speed (30–40 minutes vs. 6 minutes). These results suggest that EVs, despite infrastructural and battery-related challenges, are significantly more cost-effective and environmentally friendly in the long term. Electric vehicle adoption could significantly reduce greenhouse gas emissions, enhance energy security and global automotive markets. However, EV adoption will require strategic investments in adequate charging infrastructure, battery recycling, and supportive laws and policies to ensure an equitable and sustainable transition.

1. INTRODUCTION

The transportation sector especially in urban areas is one of the largest contributors to global greenhouse gas (GHG) emissions, significantly impacting climate change and air quality concerns. Conventional internal combustion engine (ICE) vehicles, which rely

on fossil fuels such as gasoline and diesel, have been the dominant mode of transportation for over a century. Considering the environment and long-term sustainability in addition to the depletion of fossil fuel resources many countries are gradually shifting to the adoption of electric vehicles as a viable alternative to conventional vehicles [1].

Electric vehicles (EVs) operate using an electric motor powered by a rechargeable battery, eliminating the direct combustion of fossil fuels. This shift from gasoline to electricity has been widely recognized as a potential solution for reducing carbon emissions and reliance on non-renewable energy sources. The global automotive industry has witnessed rapid advancements in EV technology, with significant improvements in battery efficiency, charging infrastructure, and overall vehicle performance. Despite these advancements, the widespread adoption of EVs presents numerous challenges, including battery production impacts, charging infrastructure development, and cost-effectiveness compared to conventional vehicles.

This study seeks to explore the life cycle assessment (LCA) of electric and conventional vehicles, providing a comprehensive comparison of their environmental impact, cost implications, performance, and infrastructure requirements. By assessing these factors, this study aims to determine whether EVs truly offer a sustainable and practical alternative to ICE vehicles in the future.

2. LITERATURE REVIEW

Conventional Internal Combustion Engine (ICE) vehicles have been fundamental to transportation for decades. These vehicles have historically dominated the market due to their affordability and well-established refuelling infrastructure. Meanwhile the 21st century has seen rapid advancements in Electric Vehicles (EV) technology. These advancements have been driven by concerns over environmental sustainability, energy efficiency, and technological progress. The UN Commission on Environment and Development in its report (Our Common Future) called for a socially and environmentally sustainable world in the near future [2]. The automotive industry responded to this trend by producing more hybrid and pure electric cars in search for an alternative to conventional cars [3]. The use of pure electric vehicles was found to improve the environment significantly when environmental indicators that measure air pollution were examined and evaluated [4]. The number of EVs in the global market has been increasing steadily since 2012 and reached about 25% in 2025[13]. The numbers of EVs are expected to increase steadily especially in Europe since many governments are providing users with operational and financial incentives [5].

3. METHODOLOGY:

To ensure a fair and unbiased evaluation, this study selected two well-known vehicles in the world markets with similar power outputs and classifications. The first one is the popular Tesla Model 3 EV [12] and the other one is the Toyota Camry XSE V6 [14] conventional car. The primary technical and economic data regarding performance, emissions, efficiency, durability and cost were obtained from data published by vehicle manufacturers and vehicle certification and environmental agencies as found in references [6], [7], [8], [9],[12], [13]and [14] and presented in Tables 1 and 2 below. The approach used in this investigation is to evaluate the cost-effectiveness, environmental impact, and operational efficiency of the Tesla Model 3(EV) compared with the Toyota Camry Internal Combustion Engine vehicle. A systematic approach is applied to ensure that all aspects of comparison, including purchase price, fuel/energy expenses, maintenance costs, pollutant emissions, and government incentives, are thoroughly examined.

3.1 Evaluating the Initial Purchase Cost

To ensure a fair and unbiased evaluation, in this study the above-mentioned two vehicles were selected with nearly similar power outputs and classifications, as shown in Table 1 below.

The first stage of cost analysis involves comparing the initial purchase price. EVs generally have a higher upfront cost due to battery technology but due to subsidies and incentives the initial price may sometimes lower than that of the ICE which on the other hand may not benefit from similar incentives and may be subject to higher registration fees due to carbon emission concerns.

Table 1: Important features of the Tesla Model 3 and Toyota Camry XSE V6 cars

Feature		Tesla Model 3	Camry XSE V6
Power Output		(211 kW)	(224 kW)
Acceleration 0-100 km/h		5.8 seconds	5.6 seconds
Drivetrain		RWD	RWD
Body Style		Sedan	Sedan
Retail Price (Approx.)		\$42,490 [5]	\$36,000 [6]

Energy Efficiency	15 kWh/100km	7.7 Lit/100km
Annual Distance Driven	15,000 km	15,000 km
Electricity Cost / kWh	\$0.344 [8]	—
Gasoline Cost / Litre	—	\$1.81 [7]
Annual Energy/Fuel Cost	\$774	\$2,090.5
10-Year Energy/Fuel Cost	\$7,740	\$20,905
Oil Changes	Not needed	Required (2x/year)
Brake Wear	Low	Moderate
Transmission Service	None	Needed

3.2 Ongoing Operational Costs and Energy Expenditures:

Operational costs that account for recurring expenses over a vehicle's lifetime, include fuel, electricity, maintenance, and insurance. Performance and range comparison are shown in Table 2 below. ICE vehicles rely on gasoline or diesel, subject to price volatility and regional taxation policies while EVs consume electricity, with costs depending on grid pricing, home charging efficiency, and potential peak-hour tariffs.

EVs generally have lower maintenance requirements due to fewer moving parts, no oil changes, and reduced brake wear via regenerative braking. In contrast, ICE vehicles require frequent oil changes, filter and brake linings replacements, and exhaust system repairs. Regarding insurance it is known that rates depend on repair costs, part availability, and risk assessment by insurers. Some studies suggest that EV insurance premiums may be higher due to specialized repair procedures and battery replacement concerns. According to EPA [10] estimate the Toyota Camry XSE emits about 345 grams of CO_{2e} per mile (~216 grams per km) and so the emissions during the chosen life period will amount to about 32.3 Tons of CO_{2e}. According to the life-cycle assessment carried out by Green NCPA[11] the Tesla EV emits a total of ~8.1 Tons of CO_{2e} during its production and battery charging. From Table 2, it is shown that the Toyota Camry

XSE V6 has a longer driving range and faster refueling, while the Tesla offers instant torque, lower noise, and advanced technologies such as Autopilot. The total emissions include the emissions produced during manufacturing and operation of each vehicle.

Table 2: Performance comparison between Tesla Model 3 [12] and Camry XSE V6 [14].

Feature	Tesla Model 3	Camry XSE V6
Range (Full Tank/Charge)	430 km	921 km
Charging/Refueling Time	30-40 min	6 min
Top Speed	225 km/h	190 km/h
Driving Experience	Quiet,	Traditional feel
Total emissions (for Ten Years)	~8.1 Tons CO _{2e} [11]	~ 32.3 Tons of CO _{2e} [10]
Fuel/Energy cost (for Ten Years)	~ \$ 7,740	~ \$ 20,905
Maintenance cost (for Ten Years)	~ \$ 3,000	~ \$ 8,000

4. INTERPRETATION OF RESULTS

Electric Vehicles generally have a higher initial purchase price compared to ICE vehicles due to the cost of battery manufacturing, but because of government subsidies and incentives such as tax rebates, purchase subsidies, and lower registration fees, the impact of this financial burden was reduced in many countries, making EVs more attractive to consumers. Another major advantage of EVs is their significantly lower energy costs compared to ICE vehicles as shown in Table 2 above. The cost of electricity per mile is consistently lower than that of gasoline or diesel, reducing overall fuel expenses for EV owners. Furthermore, ICE vehicles contain more moving parts that require periodic maintenance, such as engine oil changes, exhaust system repairs, and transmission servicing. In contrast, EVs have a simpler drivetrain with fewer components that need regular servicing. Also, the absence of an internal combustion engine (ICE) means that EVs experience fewer mechanical failures and require fewer replacement parts, further lowering the total cost of ownership.

One area of concern is EV depreciation, which has been historically higher due to uncertainties surrounding battery longevity and resale value. However, as battery technology improves and secondary markets for used EVs develop, depreciation rates are

expected to stabilize, making EVs a more financially sound investment. The lifetime of an EV battery typically ranges between 10 to 20 years, depending on usage, charging habits, and environmental factors. Most manufacturers offer warranties of 8 to 10 years or 100,000 to 150,000 miles, reflecting confidence in their durability. Advances in battery chemistry, such as solid-state technology, are further expected to extend lifespan and reduce degradation over time. This progress will help mitigate depreciation concerns and enhance the long-term value of electric vehicles.

CONCLUSIONS:

The above comprehensive analysis conducted throughout this study has highlighted the fact that the total expenditure on a conventional car has exceeded the total purchase price and maintenance costs of an electric vehicle in ten years' time approximately. While EVs generally involve a higher upfront purchase cost, they offer significant long-term financial benefits due to lower operational and maintenance expenses. The role of government subsidies and incentives remains a critical factor in enhancing the affordability and attractiveness of EVs, bridging the gap between their initial cost and long-term economic viability. Conventional ICE vehicles, despite their lower purchase prices, impose higher lifetime costs attributed to rising fuel prices, frequent maintenance, and mechanical wear.

Furthermore, the environmental benefits of EVs, particularly in reducing greenhouse gas emissions and dependence on fossil fuels, reinforce their position as a sustainable alternative for the future of transportation. However, challenges related to charging infrastructure expansion, battery lifespan and production sustainability, and consumer awareness must be addressed to facilitate a smooth transition to widespread EV adoption.

The transition from conventional ICE vehicles to EVs, driven by economic, technological, and environmental considerations, represents a conceptual shift in the automotive industry. In developing and low-income countries such as Sudan, significant challenges remain in terms of infrastructure, affordability, and battery-production sustainability. Strategic investments, appropriate policy measures, and consumer education are therefore required to accelerate the transition, by addressing policy improvements and con-

sumer education the transition toward cleaner and more cost-effective transportation will accelerate the EVs adoption and extension for a sustainable, economically viable, and environmentally responsible future.

REFERENCES:

- [1]. D. S. Havale, S. M. Yeole, and A. Khang, "Electric Vehicles: Paving the Way for Sustainable Green Transportation and Environmental Protection," in *Driving Green Transportation System Through Artificial Intelligence and Automation*:
- [2]. *Approaches, Technologies and Applications*, Springer, 2025
- [3]. United Nations World Commission on Environment and Development (WCED), 1987, "Report of the World Commission on Environment and Development"
- [4]. Maklari, Eszter, "Economic comparison between conventionally powered and electric cars" *Acta Academiae Beregasiensis Economics*, Volume 3, 2023.
- [5]. Nagyvárad R. "Characteristics and consumer habits of the trade of environmentally friendly cars in Hungary". Budapest School of Economics, Faculty of Commerce,
- [6]. Hospitality and Tourism. p84, (2015).
- [7]. Gelmanova Z.S. et al, "Electric cars: Advantages and disadvantages" *Journal of Physics*, Conference series, 2018
- [8]. Arka 360's Tesla Price Guide, <https://ark360.com>, (Accessed June 2025)
- [9]. UK Office for National Statistics, <https://www.ons.gov.uk>, (Accessed June 2025)
- [10]. U.S. Environmental Protection Agency www.epa.gov, (August 2025)
- [11]. Green Life Cycle Assessment, 2024 (Independent European Initiative of vehicles sustainability) www.greenncap.com.
- [12]. Tesla, "model 3, Technical performance data." [Online]. Available at: <https://www.tesla.com/model3>
- [13]. Executive summary – Global Electric Vehicles Outlook 2025 "Expanding sales in diverse markets". International Energy Agency
- [14]. 2024 Toyota Camry XSE V6, Price, Specs and Review by Motowheeler