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Performance Analysis and Socio-Economic Impact Factors for Transition Towards Electric Vehicle in Nepal

by

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ABSTRACT

This study has investigated the performance, range behavior, economic feasibility, and socio-economic implications of electric vehicle (EV) adoption in Nepal, with the objective of evaluating their suitability as sustainable alternatives to internal combustion engine (ICE) vehicles. Three representative EV models, BYD Atto 3, Tata Nexon EV, and BYD Sealion 7, have been subjected to detailed dynamometer based performance testing to quantify motor power output, torque characteristics, and high speed operating limits under controlled conditions. The BYD Atto 3 has achieved a peak power of 35.4 kW at 6,220 rpm and a maximum torque of 55.1 Nm at 6,035 rpm, demonstrating a stable torque over the low-to-mid RPM range. The BYD Sealion 7 has exhibited significantly higher performance margins, reaching 69.4 kW at 9,005 rpm and 120.2 Nm of torque at 2,600 rpm. The Tata Nexon EV has delivered a corrected peak power of 35.6 kW and a substantially higher torque of 94.0 Nm at approximately 3,575 rpm.

Range analysis has shown that all tested EVs have provided reliable real world driving ranges that are 10–30% lower than manufacturer claims yet adequate for urban and peri-urban mobility patterns in Nepal. A comparative Total Cost of Ownership (TCO) assessment has revealed that despite higher upfront purchase costs, EVs have achieved cost recovery within approximately 3–4 years and have yielded annual operating savings of NPR 65,000–75,000 compared to petrol vehicles. To examine broader socio-economic impacts, a structured questionnaire survey has conducted with 100 respondents, including EV users, mechanics, and policymakers. Respondents have emphasized reduced noise levels, improved air quality, and lower maintenance requirements as primary benefits, while identifying limited charging infrastructure and inadequate technical expertise as barriers to large scale EV adoption.

Keywords: Electric Vehicles, Performance Analysis, Range Evaluation, Total Cost of Ownership, Socio-Economic Impact

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LIST OF ACRONYMS AND ABBREVIATIONS

EV	:	Electric Vehicle
GHG	:	Greenhouse Gas
V2G	:	Vehicle-to-Grid
ICE	:	Internal Combustion Engine
BMS	:	Battery Management System
VFTC	:	Vehicle Fitness Test Center
TCO	:	Total Cost of Ownership
kWh	:	Kilowatt-Hour
NDC	:	Nationally Determined Contributions
AC	:	Alternating Current
DC	:	Direct Current
NMC	:	Nickel Manganese Cobalt
HEVs	:	Hybrid Electric Vehicles
SRM	:	Switched Reluctance Motor
DoTM	:	Department of Transport Management
FWD	:	Front-Wheel Drive
RWD	:	Rear-Wheel Drive
AWD	:	All-Wheel Drive
WLTP	:	Worldwide Harmonized Light Vehicle Test Procedure
NEDC	:	New European Driving Cycle
ARAI	:	Automotive Research Association of India
RPM	:	Revolutions Per Minute

CHAPTER ONE: INTRODUCTION

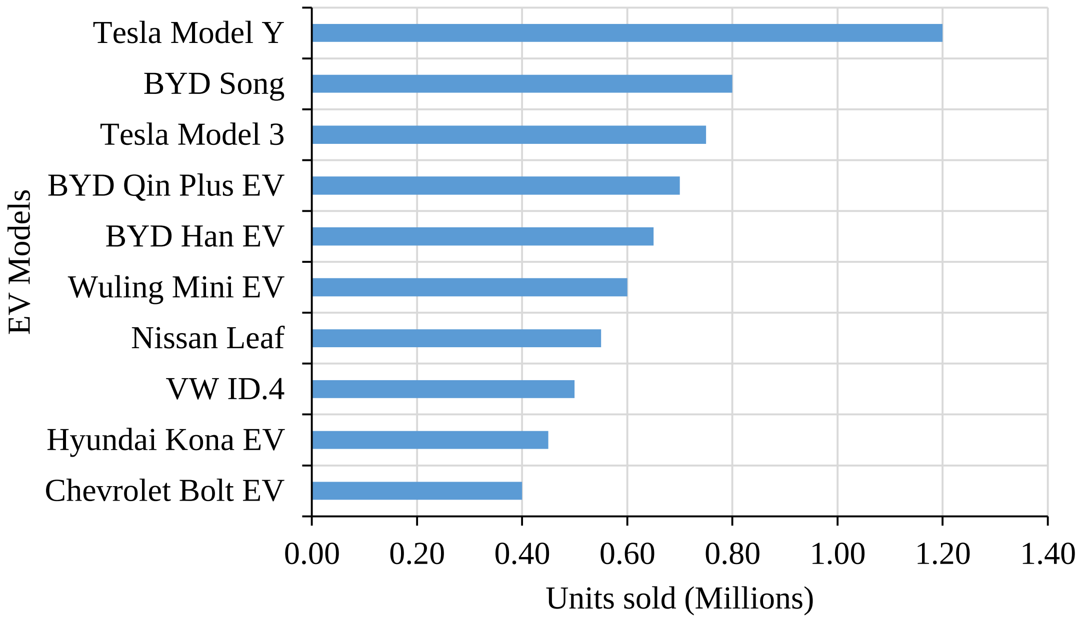
1.1 Background

1.1.1 Global Context

The shift to electric vehicles offers one of the major elements contained in global approaches to the climate change challenge, as well as efforts to limit dependence on fossil fuels and develop effective and efficient means for the transport sector. Countries around the world are setting up new policy and innovative approaches as well as investment efforts focused on accelerating the shift to electric vehicles. This reflects an acknowledgement that the transition to electric vehicles offers the necessary means for the reduction of GHG emissions.

In the latter years, the major economies like Norway, China, the United States, and the European Union have come forward as the leaders for EV adoption. For instance, Norway’s EV market penetration for new car sales stands above 80%, pushed heavily by government tax incentives, tax exempt, and the development of an extensive EV charging infrastructure network. China, the global leading EV market, has aggressively developed their EV industry through government subsidies, government-backed efforts for national manufacturing, and the development of an extensive EV charging network (Zhang et al., 2014). The European Union sets tough targets for the reduction of CO_2 emission levels, thus pressuring automakers to shift towards electric vehicle development, and the United States offers federal tax credits and infrastructure development support for EV development (Zhang et al., 2014).

The development of EV charging stations is one of the most important factors for the global development of electric vehicles. Countries such as Germany, the Netherlands, and Japan are major investors in the development of fast EV charging stations along highways and in cities to combat the range anxiety affecting electric vehicle users. In addition, the development of Vehicle-to-Grid (V2G) technology, battery replacement stations, and solid state battery technologies, as well as the development of lithium-ion batteries, have improved the efficiency and usability of electric vehicles. In fact, the cost reduction associated with the massive production and development of electric vehicle batteries makes EVs comparable to conventional internal combustion engine vehicles. Nevertheless, some issues remain. For instance, the sourcing of light metals like lithium, cobalt, and nickel for making batteries continues to pose various challenges. This arises from the fact that the ever-growing use of EVs makes it necessary for effective and safe means of disposing and recycling the batteries. In addition, despite the major breakthrough achieved by developed nations concerning EV charging stations, developing nations face various hurdles. These include high investment costs, an unreliable power grid, and low levels of awareness.



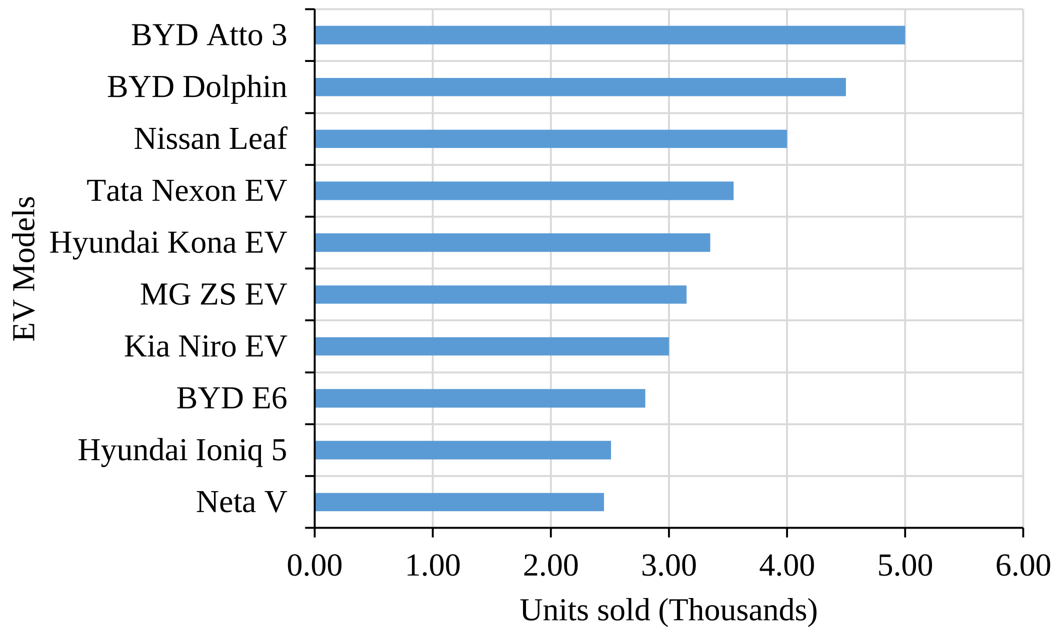
(*The 10 Bestselling EVs of 2024*, 2025)

Figure 1.1: Bar chart of EV sales in the world (2024)

1.1.2 Context in Nepal

However, the government of Nepal is gradually adopting electric vehicles as an import substitution policy for fossil fuels and to control pollution, especially in cities such as Kathmandu. Transportation sector emissions account for a considerable percentage of total GHG emissions. In such a case, the use of electric vehicles appears to be an important contribution to the reduction of pollution. Also, as the power sector of Nepal already relies on hydro-power for over 90%, electric vehicles provide citizens the opportunity to shift to pollution-free transport and overcome the burden of importing fuel. However, the limited number of charging stations, financial costs, and the citizens' lack of information on electric vehicles are some of the factors impeding the progress.

Despite the presence of such policies, the geographical and infrastructure conditions pose significant hindrances for the general use of EVs. This includes the nature of the land, which impacts the range and functionality of EV batteries. Inefficient charging infrastructure, especially the lack of focus on major cities, creates range anxiety for potential owners. Switching to the use of EVs means there are shifts and needs regarding jobs and industries involved in the original fuels and the training of people involved in car maintenance and the functionality of EV batteries.



(Business Insights Daily, 2024)

Figure 1.2: Bar Chart of EV Sales in Nepal (2024)

1.1.3 Sustainable Transportation Solution

Electric vehicles, which run on clean and renewable resources, seem to be an attractive choice compared to gasoline and diesel engines. They do not emit any pollutants and are much quieter compared to other vehicles. They are extremely efficient, as they use much more of the total potential of the battery compared to other vehicles. Apart from their advantages, the mass use of electric vehicles can reduce the import of fossil fuels, increase the security of the economy, and decrease the deficit. An increase in the use of solar and wind energy means that electric vehicles can integrate into the economy even better.

However, the transition to sustainable transport means that there are barriers to overcome for the use of EVs. These include the high cost of EVs, the considerable investment that charging infrastructure requires, and the use of sustainable practices for the production and recycling of EV batteries. On the transition to electric mobility, it's not just focused on sustainability but making the transport sector fairer, more accessible, and robust for the future.

1.1.4 Economic and Social Dimensions of EV Adoption

Apart from the environment and technology, there are huge implications for the economy and society as whole. Electro mobility brings new sectors into play, such as the production of batteries for electric vehicles and charging stations, as well as maintenance services for EVs, but it affects the economy of traditional car manufactures, which are dependent on internal combustion engines. Norway and China are investing in retraining programs for the workforce. This brings innovations as new players and existing companies are racing against each other to come up with new and advanced battery solutions and charging stations. The cost advantages, as far as maintenance and fuel are concerned, appeal to many potential car owners, especially where the cost of electricity is less compared to gasoline.

1.1.5 Regional Challenges and Opportunities

Countries that are already developed are showing the way, though. In some African and South Asian nations, the availability of electricity and the development of infrastructure are patchy. For EVs, some challenges lie here, but there are many potential markets, especially where there are plenty of reliable sources like solar and hydro. Government, global bodies, and the corporate world must necessarily join hands for filling the gaps and making affordable finances available. This can already be observed, for that matter, in the collaboration regarding solar-operated charging stations, which the Nepalese government could emulate.

1.1.6 Cultural and Behavioral Influences

The key to EV success lies in the acceptance and behavioral shifts that accompany it. Range, viability, and the ease of charging are some factors that concern many people as they shift from traditional ICE vehicles to EVs. In the Netherlands, acceptance campaigns for EVs were achieved through community trials. In the case of Nepal, the use of EV two-wheelers would easily align with their culture.

1.1.7 Technological Evolution and Future Prospects

The future for EVs looks even brighter. Rapid charging networks, solid state batteries, and wireless charging could provide drivers with the capability to travel distances above 500 kilometers and complete their charging chores in less than 15 minutes. Auto drive, which would be an integral component of EVs, would increase safety and optimize routes.

In the case of Nepal, it could use its hydro resources to power such innovations and be pioneers for the whole South Asian region concerning green transport. This study focuses on these elements within the context of the Nepalese situation and seeks to provide concrete policy and industry advice that can help the country benefit from the global trend of electric vehicles. It seeks to help the country utilize the trend for their advantage.

1.2 Problem Statement

In the case of Nepal, there's an increasing desire for electric vehicles (EVs) as an efficient and cleaner means to minimize the use of oil imports and benefit from the vast hydro resources. However, there are boundaries to the shift to electric vehicles, which are the lack of enough information regarding their performance, their performance in high hills and mountains, the cost implications, and the overall impacts of the use of EVs. In most cases, the specification and information are either provided by the vehicle makers or derived from flat land nations that enjoy favorable infrastructure, which would not be the case for the mountains and terrain of nations like Nepal. In addition, there's no clear assessment regarding the use of EVs compared to the use of conventional oil-fueled vehicles.

As such, it becomes clear that there are many gaps that must be filled, and thus there needs to be an effective study that evaluates the EV performance levels based on the nature of the terrain, the costs and impacts associated with EV and internal combustion engine vehicles, and the social and economic impacts. This study specifically seeks to address the gaps by presenting factual information regarding the EV performance levels, the costs and impacts involved, and the various factors that influence the use of EV vehicles.

1.3 Objectives of Research

Main objective

To evaluate the effectiveness of transitioning to Electric Vehicles (EVs) in Nepal, with a focus on performance analysis and socio-economic impacts

Specific objectives

- To evaluate the performance of electric vehicles in Nepal by measuring the torque, power and range in different terrain
- To conduct and compare the total cost of ownership between electric vehicle with internal combustion engine vehicle
- To analyze the socio-economic impact of electric vehicles adoption

CHAPTER TWO: LITERATURE REVIEW

2.1 EV Efficiency and Range Influences

Electric vehicles (EVs) are very important regarding how people intend to utilize them. They are also characterized by energy efficiency, their ranges, and how long their batteries last. According to a source (Liu et al., 2018), it is noted that EVs are more energy-efficient than the older gasoline models by a wide margin, with 3-4 miles/kWh compared to 0.25-0.35 miles/kWh. EVs are very cheap to operate and maintain, particularly if the source of electricity is renewable energy. Nevertheless, it has also been noted that EVs are currently faced with several challenges regarding the climate. In this case, colder climates and mountainous areas could affect the power and ranges of vehicles, which is a concern, particularly when referring to Nepal (Iwona Krzyzewska, 2023).

In Nepal, a pilot study (Yang et al., 2021) has analyzed the performance of EVs on Nepal's roads and found areas such as lower ranges on hilltops and inadequate places to charge. Thus, it is determined that EVs work effectively in an urban context, but their efficacy is uncertain in rural areas unless improvements take place regarding charging and battery life.

The ranges and efficiencies in an EV are affected by several variables: efficiency of the batteries, environmental conditions, external temperatures, and the extent to which the vehicle is loaded. Recent studies reveal the impact of such variables.

Battery performance and ranges are greatly affected by temperatures. In illustration, it is determined that Tesla Model 3 ranges increase by 5.27% when contrasted to cold temperatures of -10°C, when temperatures are mild at 23°C. As temperatures are low, the rate of reaction and the resistance offered by the battery increase, affecting acceleration and hill climbing. In addition, ranges associated with WLTC cycles were 27% lower than urban cycles, which again highlights the importance of cycle and ranges (Zhang et al., 2014).

Batteries also degrade faster when used in harsh climates. In cold climates, the power consumed by heaters to warm up the cars is high, which further decreases the battery charge. The battery also degrades faster when used in hotter climates, such as 40°C, due to high temperatures, although cooled systems are used (Zhang et al., 2014).

When calculating the well-to-wheel (WTW) energy consumption, it is found that electric vehicles (EVs) generally outperform gasoline vehicles. Although the efficiency rate of electric motors is high (some 87-91%), it also depends on the source of the electricity. Meanwhile, if the source is renewable energy, the WTW efficiency rate of EVs can be 40-70%, which is significantly greater than gasoline vehicles (11-27%) (Zhang et al., 2014).

Car weight and the carrying capacity also influence performance. The presence of excess cargo and people is known to degrade performance by over 13%, and hill climbing ability (gradeability) could decrease by as much as 57% with increased speeds ranging from 30 to 60 km/h. This is relevant when assessing the viability of EVs, considering the topographical conditions of Nepal, and so forth (Eze et al., 2023).

Simulations carried out recently indicate a SOC between 80-100%, which is associated with reliable and stable power output, and it is very useful to plan on how to charge the battery and drive to increase the range (Eze et al., 2023).

2.2 EV Adoption Challenges in Nepal

Research has also covered the impact of EVs on society and the economy. While some authors suggest new jobs could emerge if society adopts mass production of EVs (Yang et al., 2021), jobs could also be lost in the conventional automotive sector, especially if the fuel-fired car industry is predominant(Abdul Rahman, 2024). As regards the adoption of more EVs, the role of government, public awareness, and financial assistance factor significantly.

In Nepal, the study of (Abdul Rahman, 2024) revealed that the high cost of EVs is a barrier. Government assistance, such as subsidy and tax benefits, is helpful, but it is also true that most people think the cost of the new technology is high. There is also a shortage of skilled manpower to work on the vehicles, and lack of awareness is another factor restraining the market.

2.3 Environmental Impact of EVs

Reducing carbon emissions and pollution could also be achieved by using EVs, which is well-documented. Lifecycle assessment (Abdul Rahman, 2024) has revealed that running and producing EVs is environmentally more advantageous if powered by renewable energy. This aligns with the Nepal context, which is known to derive more than 90% of its power from hydroelectricity. Harnessing the potential of renewable resources and incorporating EVs could significantly minimize carbon emissions and optimize air pollution (Yang et al., 2021).

Nevertheless, some environmental issues arise. Battery manufacturing and disposal could result in environmental problems, such as lithium and cobalt mining, and battery disposal/recycling (Economic Policy Institute, 2021). The lack of waste management facilities, along with Nepal's increasing demand for primary materials, increases difficulties to derive all the environmental benefits (Economic Policy Institute, 2021). Moreover, the issue of sustainable battery manufacturing and disposal is emphasized.

2.4 EV Charging Infrastructure

An important factor to encourage people to buy more EVs is to have charging stations. Range anxiety is eliminated by public charging infrastructures, and it increases their adaptability (Iwona Krzyzewska, 2023). In developed countries, fast chargers, including highways and urban areas, have encouraged mass adoption of EVs. In developing countries, the absence of infrastructure and high installation costs are significant hindrances to mass adoption (Wu et al., 2021).

In Nepal, planning regarding charge points is critical, and more so in rural areas where the density of charge points is low (Abdul Rahman, 2024). GIS analysis can enable the selection of suitable locations based on population and vehicle density and the availability of renewables. There are also plans by the Nepal Electricity Authority to increase charge points, but more are required.

2.5 Policy and Regulatory Framework

Effective policies facilitate the adoption of EVs. Studies indicate taxation support, subsidies, and infrastructure support influence the sector positively to develop (Pokharel, 2023). These policies should also aim to support sustainability, such as increasing the use of renewable resources, to attain long-term success (Hawkins et al., 2013). Nepal has some government support systems and facilities regarding the promotion of EVs, such as tax exemption and subsidies offered by the government under the Electric Vehicle Policy (2020). According to various studies, actor authors, (Yang et al., 2021) the government support systems have not produced notable market expansion, which is basically due to a lack of awareness regarding such initiatives.

2.6 EVs Imports in Nepal

Electric vehicle (EV) imports in Nepal have surged significantly in recent years, driven by favorable government policies, increasing environmental awareness, and economic considerations. In the fiscal year 2023/24, Nepal imported 22,603 EVs, marking an impressive 193.12% increase from the previous year. The government's tax incentives on EVs compared to fossil fuel-powered vehicles have played a crucial role in encouraging this shift. Additionally, Nepal's abundant hydropower resources make EVs a cost-effective and sustainable transportation solution, reducing reliance on imported fossil fuels. In just the first six months of the fiscal year 2024/25, 13,425 EVs were imported, further highlighting the rapid adoption of electric mobility. With rising fuel prices and increasing investment in charging infrastructure, Nepal is on a promising trajectory towards an eco- friendly and energy-efficient transportation system.

Table 2.1: Imported EVs in Nepal by Type (2022-2025)

Description	Unit	Jul 2024 to Jan 2025	Jul 2023 to Jul 2024	Jul 2022 to Jul 2023
		Quantity	Quantity	Quantity
Buses with only electric motor for	PCS	2	11	37
Mini buses (15 to 25 seater) With only electric	PCS	503	336	3
Micro buses (11 to 14 seater) with only electric	PCS	563	537	241
Jeep, car & van only electric motor for propulsion	PCS	2		170
Electric three wheelers vehicles	PCS	5835	9057	6914

Description	Unit	Jul 2024 to Jan 2025	Jul 2023 to Jul 2024	Jul 2022 to Jul 2023
		Quantity	Quantity	Quantity
Electric car, jeep & van upto 50KW	PCS	1725	4571	3759
Electric car, jeep & van 51KW to	PCS	3191	6885	272
Electric car, jeep & van > 101KW to	PCS	553	217	15
Electric Car, Jeep, Van with motors pick power	PCS	9	27	4
Electric Car, Jeep, Van with motors pick power	PCS	2	1	
Other electric three wheelers with only electric	PCS	824	786	277
Others electric 4 wheeler vehicle with only	PCS	216	175	12
		13425	22603	11704

(Meromoto, 2025)

2.7 Vehicle Fitness Test Centre (VFTC)

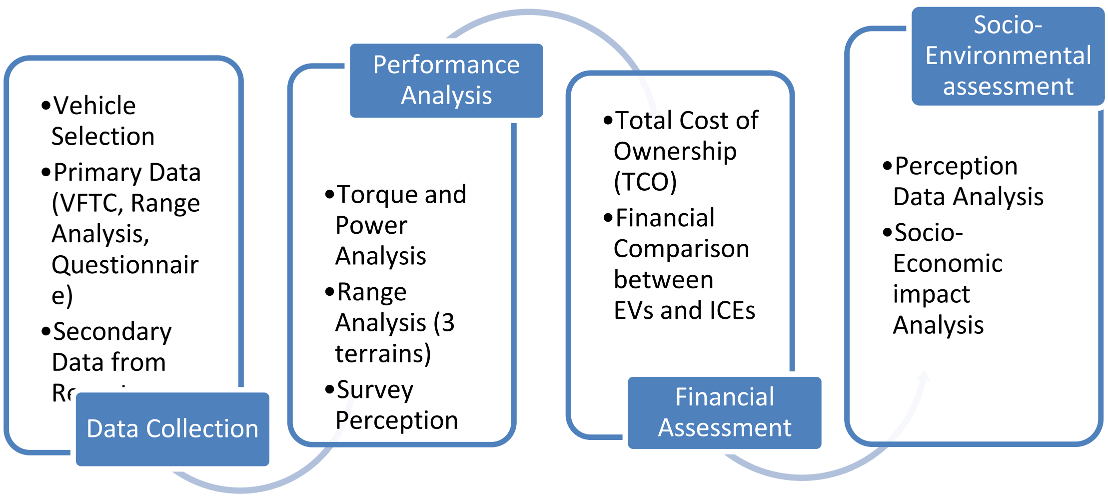
In Nepal, the Vehicles Fitness Test Centre (VFTC) is a significant hub where vehicles are assessed to see if they are roadworthy and environmentally compliant. The VFTC is located at Teku, Kathmandu, and it took over NPR 60 million to construct. Vehicles are tested on various areas such as the efficiency of brakes, suspension, chassis, and emissions to minimize pollution and increase road safety. The VFTC aims to remove vehicles not meeting road safety and environmental standards set by the Department of Transport Management (DoTM). Although it concluded in 2012, VFTC has suffered severe setbacks to effectively operate due to government bureaucracy, a shortage of human resources, and ineffective implementation of fitness standards.

With Nepal shifting towards increasing the number of electric vehicles on the road, it is expected that VFTCs too soon test electric vehicles. When it comes to electric vehicles, it is necessary to conduct checks on the battery, engine, software components, and compatibility with chargers. The present VFTC system is not prepared to deal with such requirements. In order to ensure efficient and sustainable transport, it is essential to increase VFTC facilities, implement tough vehicle fitness norms, and also introduce advanced testing facilities for electric vehicles.

MAHA is a globally recognized manufacturer of vehicle testing, lifting, and workshop equipment, known for its high-quality engineering and precision technology. The company provides advanced solutions such as brake testers, dynamometers, lifts, and diagnostic systems used in automotive workshops, inspection centers, and vehicle manufacturers worldwide.

CHAPTER THREE: METHODOLOGY

3.1 Conceptual Framework



This chapter describes the approach and structure used to undertake a comparative analysis of electric vehicles. The approach has been divided into four stages: Data Collection, Performance Analysis, Financial Analysis, and Socio-Economic Analysis.

3.1.1 Data Collection

Vehicle Selection: A sample of vehicles, representative of models of both EV and ICE vehicles, has been selected. The selection has been carried out on the basis of equivalent classes, segments, and functional criteria.

Primary Data Acquisition: The primary data has been compiled by using a two-fold approach:

- **Technical Specifications:** Direct technical information, such as specific details on the power and torque of the battery, has been tested at VFTC. Range details has been calculated and compiled.
- **Perception Questionnaire:** A structured questionnaire has conducted on a targeted demographic to obtain information on perceptions and expectations

regarding car ownership, performance, and refueling and charging infrastructure.

Secondary Data Sourcing: Secondary data has been sourced from reliable academic sources, industry literature, government documents, and technical literature provided by the manufacturers to develop a solid foundation to conduct market and technical analysis.

3.1.2 Data Analysis

During this phase, engineering principles and statistical techniques has been used to assess the functional abilities of the vehicles, which take into consideration not only technical criteria but subjective inputs.

Torque and Power Analysis: A comparison has been made to assess the differential characteristics of power output and torque curves among the chosen three electric vehicles. The importance of such comparison is to evaluate acceleration and dynamic performance, which shall then be contrasted with the ICE vehicles of similar segments and categories.

Range Analysis on Various Terrains: In this study, the range of each EV has been tested while operating the vehicles from 100% to 80% State of Charge (SoC). The distance covered within this 20% SoC window has proportionally scaled to estimate the full 100% range using a linear extrapolation method. Specifically, the measured distance has been multiplied by a factor of five, as 20% of the battery corresponds to one-fifth of the total capacity. This approach has provided a standardized basis for comparing the full-range performance of the BYD Atto 3, Tata Nexon EV, and BYD Sealion 7 across flat, hilly, and mountainous terrains.”

Survey Perception Integration: The subjective information obtained by administering the questionnaire has processed to measure the public perception about the performance factors and technical reliability of the vehicles.

3.1.3 Financial Assessment

This phase is essential because it enables financial comparison, which is based on the real cost of owning a car, normally over an entire lifespan.

- **Total Cost of Ownership (TCO) Calculation:** The TCO analysis has been conducted on the electric and ICE vehicles. All costs such as purchase costs, finance costs, energy and fuel, insurance, and residual value has been considered. The cost has calculated on a standard basis.

- **Financial Comparison between EVs and ICEs:** A detailed financial comparison between the TCO of EVs and ICEs has been developed. Based on the financial comparison, it has been identifying the most important costs associated with each.

3.1.4 Socio-Environmental Assessment

The culmination of the process involves the synthesis and interpretation of the findings obtained from the first three stages, accompanied by a macro-level evaluation.

- **Perception Data Analysis:** Statistical method is used to analyze the perception data, which helps to enable the determination of the important drivers and present barriers to the adoption of electric vehicles, and associations between technical attributes and perceptions.

- **Socio-Environmental Analysis:** An overarching analysis has been developed to evaluate the wider environmental considerations (such as lifecycle emissions, etc.), and socio-economic ramifications (such as policy and infrastructure needs, etc.) associated with the widespread adoption of both vehicles.

- **Financial Data Analysis:** The financial data which is obtain used to identify conclusions on the financial benefits associated with each category of vehicles, clearly identifying the conditions under which each technology is more financially rewarding.

3.2 Vehicle Selection

The selection of the vehicles, such as the BYD Atto 3, Tata Nexon EV, and BYD Sealion 7, has been made on the basis of relevance to the market, representation of various segments of vehicles, and adaptability to the road and climate conditions found in Nepal. These vehicles, when considered together, form a complete structure to evaluate efficiency, technology, feasibility, and socio-environmental effects.

The BYD Atto 3 (Advanced), which is a high-end compact electric SUV, has proved to be a very successful and demanded electric vehicle in Nepal, ever since it was launched in 2023. With a 49.92 kWh LFP Blade Battery and the ability to go 345 km on a single charge, it is ideal and apt for city drives and occasional long drives on highways. With very high power delivery (150 kW), fast charges (80 kW-DC), and advanced safety features, it is a true comparison standard to assess the performance of high-end electric vehicles operating in present-day traffic conditions of Nepal, such as traffic congestion on the road to the Kathmandu valley and mild slopes on Prithvi Highway.

The Tata Nexon EV, which caters to the mid-range and mass market, is a widely accepted option among economical buyers and fleet managers in Nepal. With an ARAI-range of about 312 km, thanks to the 30.2 kWh lithium-ion battery, it has found takers in the mass market. It is tough build, high road clearance of 205mm, and ability to perform on undulating urban and semi-urban road conditions make it apt to evaluate the feasibility of electric vehicles in Tier II cities such as Biratnagar, Bharatpur, and Pokhara, which are yet to witness adequate infrastructure development

The BYD Sealion 7, which is a full-size electric SUV and falls under the luxury and long-range segments, is equipped with a 71.8 kWh LFP battery and has a WLTP-rated operating range of 440 km. Primarily intended to operate over long distances and support high payloads, it is also soon gaining attention among tour operators, companies, and large family segments to operate between cities and beyond the Himalayas. Moreover, due to its dual motors and AWD system, spacious interior, and high energy density, it has also proved to be an apt selection to test long-range-range capabilities and low-temperature, high-altitude thermal management capabilities.

With the evaluation of these three models, it is possible to conduct a comparative analysis of performance criteria (power output, acceleration, and regenerative efficiency), the ability to achieve ranges on plain, hilly, and mountainous areas, and the rate of battery depletion on Nepal-centric cycles. With such varying market segments, including economy, mid-premium, and luxury segments, it is easy to conduct a Total Cost of Ownership (TCO), which includes purchase value, electricity charges, and service costs against conventional ICE models.

From an environment-related point of view, the technical evaluation has estimate the energy consumed (kWh/100 km), the impact on the power grid during peak charging, and the carbon emissions over the lifespan, utilizing Nepal's 90% hydroelectric power-based energy mix. Inclusion of such models has enable a more detailed assessment of the demand and behavior associated with charge points and the policy efficiency regarding the adoption of electric vehicles.

Thus, the strategic selection of the BYD Atto 3, Tata Nexon EV, and BYD Sealion 7 ensures a holistic, segment-representative, and geographically relevant investigation into the technical, economic, and environmental dimensions of Nepal's transition toward sustainable electric mobility.

3.3 Primary Data

Power and torque data from VFTC

After the vehicle selection, the dimensions for the vehicles were all taken to verification and to adjust the test rig. Then, the vehicle was harnessed with chains and positioned on the rig as setup. Then the machine was operated, such that primary data was directly collected form the Vehicle Fitness & Test Center. Data related to Power and Torque for the Test Specimen were collected. The values were taken based on the machine's direction. Thus, it took data for various running conditions, such as acceleration, deceleration, constant speed for the electric motors.

Survey Questionnaire

Questionnaire Data was collected directly through surveys and semi-structured interviews to gather first-hand information on electric vehicle (EV) performance, range, and socio-economic impacts in Nepal. A structured questionnaire was developed to capture detailed information on EVs performance, range, user satisfaction and socio-economic impact of it. The Questionnaire can be found in the Annex 12: Survey Questionnaire.

The questionnaire was pre-tested with a pilot group to ensure clarity and reliability before full deployment.

Sampling Strategy and Justification

The sample size was determined using Cochran’s formula to ensure statistical rigor at a 95% confidence level with a 10% margin of error. (Has beeniam G. Cochran, 1977)

Sample Size Calculation

The sample size was calculated using the formula(Has beeniam G. Cochran, 1977):

$$n_0 = \frac{Z^2 \cdot p \cdot (1-p)}{E^2} \tag{3.1}$$

Where:

$Z = 1.96$ (Standard normal value for 95% confidence)

$p = 0.5$ (Assumed maximum variability)

$E = 0.10$ (Margin of error, 10%)

Substituting the values:

$$n_0 = \frac{1.96^2 * 0.5 * (1 - 0.5)}{0.1^2} \tag{3.2}$$

$$n_0 = \frac{0.964}{0.01} = 96.04 \tag{3.3}$$

Thus, the initial sample size before applying the population correction is “96”.

Finite Population Correction

The target population for the survey consisted of registered electric vehicle (EV) users in Nepal. At the time of data collection the estimated population of EV users was **N = 47732**.

$$n = \frac{n_0 \cdot N}{N + n_0 - 1} \tag{3.4}$$

Substituting the values:

$$n = \frac{96.04 * 47732}{47732 + 96.04 - 1} \tag{3.5}$$

$$n \approx 96$$

Thus, the final corrected sample size remains ’96’.

Thus, the sample size (n=96), calculated using Cochran’s formula, shall validate for finite populations, to ensure statistical rigor comparable to engineering tolerance analysis.

However, to enhance the precision of our estimates, account for potential non-responses 100 respondents have been taken. Among the total of 100 respondents, 38 were EV users, 36 were automobile mechanics, and 26 were policymakers or stakeholders involved in EV policy and energy planning. The respondents represented different electric vehicle types such as electric cars (BYD, MG, Tata), e-scooters, and electric three-wheelers, covering both private and commercial usage. This diversity ensured the inclusion of perspectives from end-users, technical professionals, and institutional decision-makers.

3.4 Secondary Data

Secondary data are obtained for EV sales, imports and charging stations as well as specifications from various sources. Likewise, other performance data has been calculated from various other literatures (research papers), for further verification and base case analysis and expectations.

3.5 Dynamometer Testing

The performance analysis part of this study works towards understanding and determining the efficiency and applicability of electric vehicles (EVs) under the topographical and infrastructure conditions present in the case of Nepal. This helps overcome the present disparity between what is actually achievable by EVs and what is currently claimed by the manufacturers, and to establish a factual basis for the eventual transition towards the adoption of EVs. The factual data provided by the Vehicle Fitness & Test Centre (VFTC) dynamometer testing, along with perceptions regarding ranges based on topography, is used.

To achieve a comprehensive understanding, the following activities has been conducted:

1. **Dynamometer Testing at VFTC**: Carrying out controlled testing on various models of EVs (such as the BYD Atto 3, Tata Nexon EV, and BYD Sealion 7) to determine power, torque, and speed. These variables have been then be analyzed, factoring in practical inefficiencies, and represented on chassis dynamometer graphs.

2. **Range Analysis Across Terrains**: Test and prove the ranges on plain (for example, 320-340 km), hilly (for example, 260-300 km), and mountainous (for example, 220-260 km) areas of Nepal. Here, simulations of ranges based on dynamometer readings have been used to match corresponding ranges provided by customers, answered by questionnaires.
3. **Comparative Performance Evaluation**: Compare quantifiable measures of performance with the details provided by manufacturers and conventional ICE vehicles to reveal inconsistencies.
4. **Integration with Stakeholder Feedback**: Incorporate the data obtained from the questionnaires on the Likert scale (average performance rating of 4.2 out of 5) to evaluate the performance and integrate it with the empirical findings.

3.6 Testing Equipment

The MAHA LPS 3000 PKW is a high-precision chassis dynamometer designed to test passenger cars (PKW - "Personenkraftwagen") by measuring power, torque, and vehicle performance under real-world conditions. This dynamometer is widely used in automotive workshops, research facilities, performance tuning centers, and regulatory compliance testing**.** It is a roller-based test rig, which facilitates the controlled evaluation of power, torque, and acceleration, along with drivetrain performance, of a vehicle under simulated operating conditions. The test rig is based on a robust single roller, which is provided with an eddy current braking system. Hence, it has the ability to apply various amounts of loading and resistant forces during testing, which allows it to accurately simulate real operating conditions.

3.7 Test Limitations

The performance tests conducted on the three selected electric vehicles (BYD Atto 3, Tata Nexon EV, and BYD Sealion 7) at the Vehicle Fitness Test Centre (VFTC) using the MAHA LPS 3000 PKW chassis dynamometer presented valuable insights but also have several inherent limitations that are important to consider when interpreting the results.

1. **Laboratory Conditions**: Tests on the dynamometer do not fully replicate real-world driving, missing effects of wind, hills, and surface variations.

2. **Measurement Gaps**: Differences in calibration, drivetrain loss, and load simulation can lead to discrepancies from manufacturer data.

3. **Battery and Temperature**: Tests do not cover all aspects of battery management or the impact of extreme temperatures.

4. **Need for Real-World Data**: On-road testing and further monitoring are needed for more comprehensive results.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Performance Analysis

4.1.1 Power and Torque

The power and torque for various rpm has been analyzed for all three electric vehicles which is shown in Figure 4.1, Figure 4.2, and Figure 4.3 respectively.

4.1.1.1 BYD ATTO 3 ADVANCED

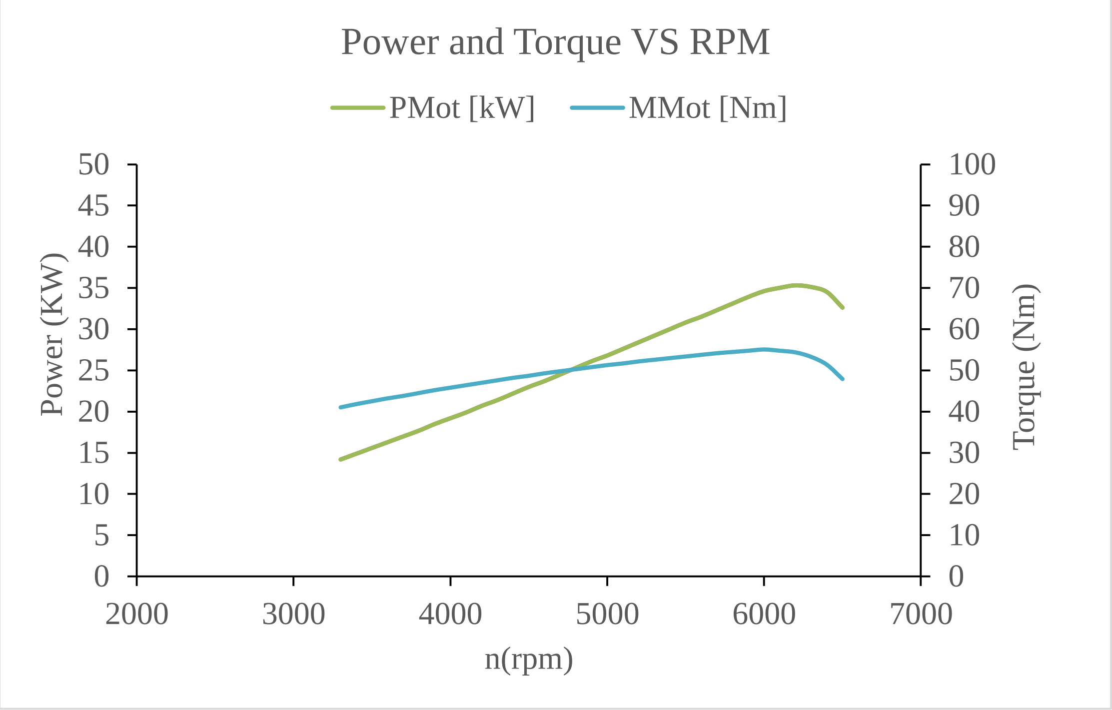


Figure 4.1: Power and Torque VS RPM of BYD ATTO 3

From Figure 4.1 BYD ATTO 3 attained a peak power output of 35.4 kW (48.1 BHP) at 6220 RPM, which is consistent with output expectations for a compact EV powertrain. The maximum torque recorded was 55.1 Nm, peaking at 71.7 km/h vehicle speed and motor speed at 6035 RPM. This indicates a relatively flat torque curve through the lower and mid-RPM ranges, providing a strong mid-range response typical of naturally aspirated motors in this class.

Manufacturer technical documentation reports a rated motor output of approximately 100 kW peak power and 310 Nm peak torque, which are obtained under controlled laboratory motor dynamometer conditions and do not account for drivetrain and rolling losses present in chassis testing (Cimex Inc., 2025). Studies on electric vehicle drivetrains have demonstrated that cumulative losses ranging from 60–75% can occur during chassis dynamometer measurements due to reduction gearing, differential losses, tire–roller interaction, bearing friction, and auxiliary electrical loads (Ebrahimi, 2018). When these losses are considered, the measured wheel power and torque values fall within expected and realistic ranges for compact electric SUVs, thereby validating the experimental results.

4.1.1.2 BYD SEALION 7

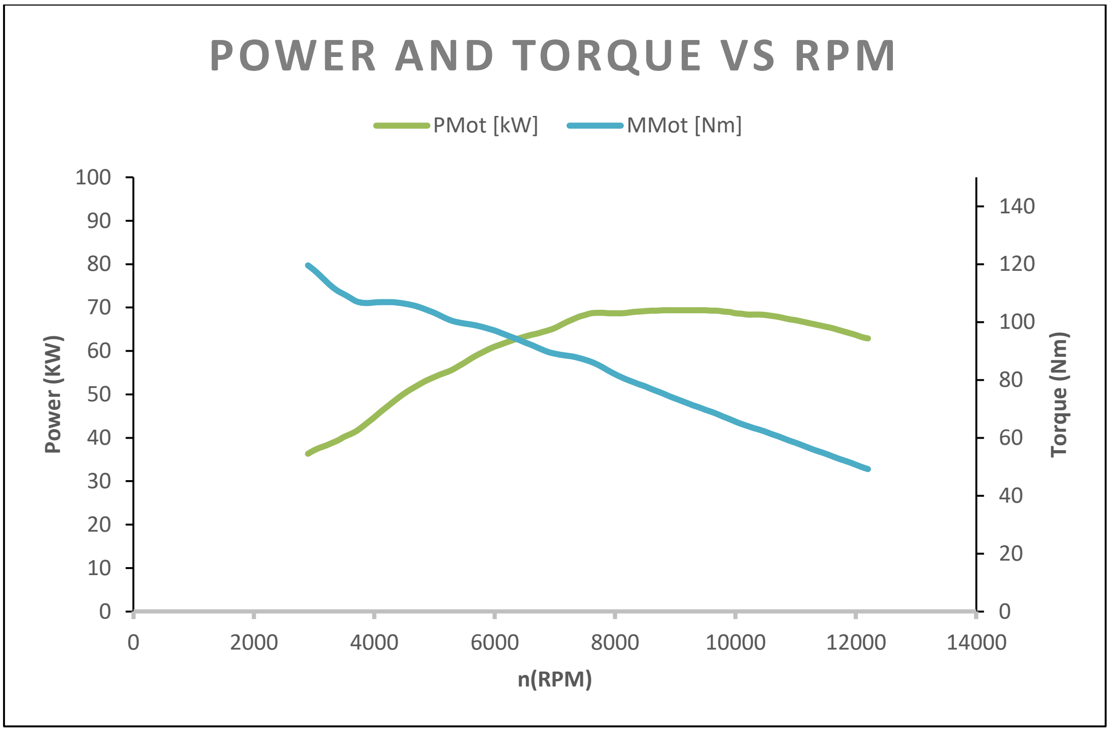


Figure 4.2: Power and Torque Vs RPM of BYD SEALION 7

From Figure 4.2 peak motor power output reached up to 69.4 kW (94.4 BHP) at 9005 rpm, substantially higher than the previously presented test. The vehicle achieved a maximum of 13,200 rpm at a speed of 218.0 km/h, suggesting strong high end motor capability. The maximum torque delivered was 120.2 Nm at 2600 rpm and 47.0 km/h, with the torque curve rising sharply from low rpm, peaking early, and then declining as motor speed approaches the upper design limit.

The BYD Sea Lion 7 delivers high peak power and substantial torque at accessible mid-range rpms, matching its intended role as a sporty, performance-focused SUV. The steep torque curve supports swift acceleration, while the high top-end rpm and speed capabilities ensure competitive high-speed performance. Manufacturer technical specifications report that the BYD Sealion 7 is equipped with a high-performance permanent magnet synchronous motor with a rated peak power of 100kW and 380 Nm of motor torque, measured at the motor shaft under ideal laboratory conditions (Cimex Inc., 2025). The significantly lower measured power and torque values obtained in this study are therefore expected, as chassis dynamometer testing inherently includes drivetrain losses associated with the single-speed reduction gearbox, rear differential, bearings, tire–roller contact, and auxiliary electrical loads (Ebrahimi, 2018). Previous studies have shown that high-performance electric vehicles can experience cumulative drivetrain and rolling losses exceeding **70%** under steady-state chassis dynamometer operation, particularly at higher speeds and rotational velocities. (Ebrahimi, 2018)

4.1.1.3 TATA NEXON EV

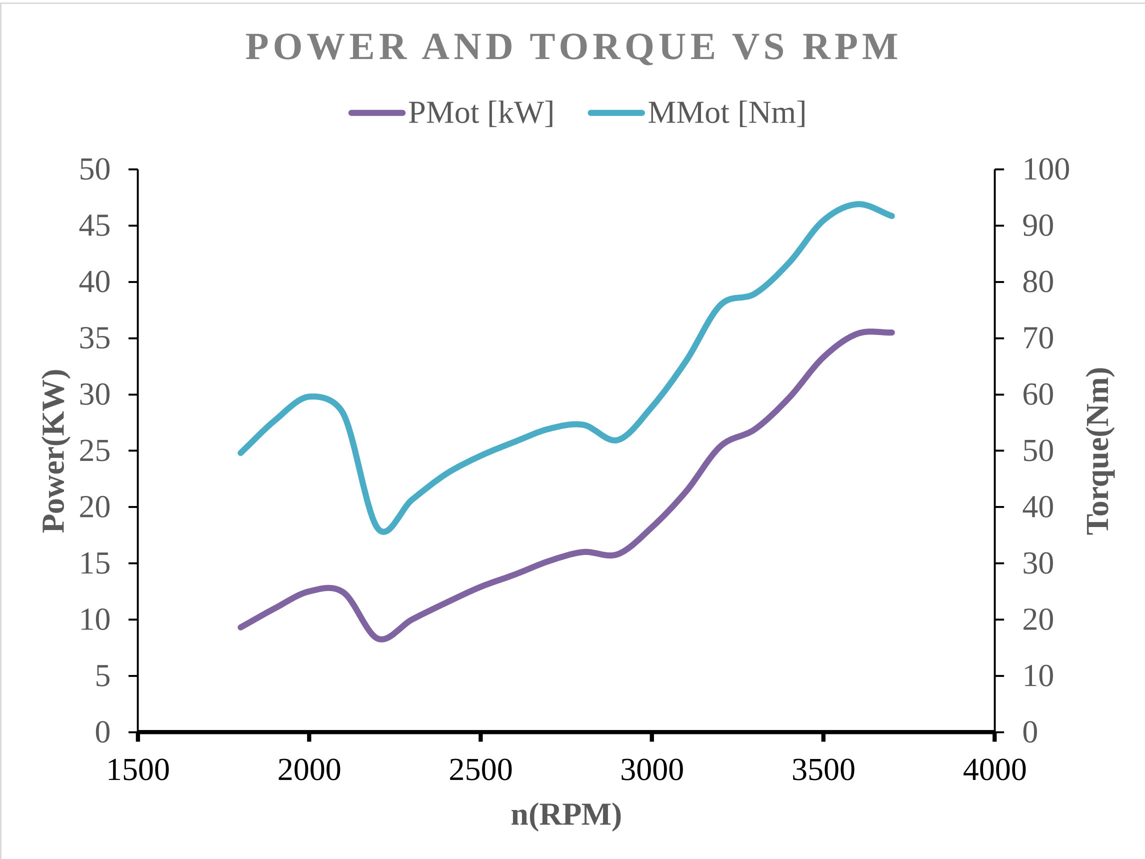


Figure 4.3: Power and Torque VS RPM of TATA NEXON EV

From Figure 4.3 TATA Nexon EV demonstrated a maximum corrected power of 35.6 kW (48.4 BHP), closely matching real-world power expectations for compact electric SUVs in this segment. The maximum torque registered was 94.0 Nm at approximately 3575 RPM, reflected by the steep initial rise in the torque graph. Torque delivery remained consistent across the lower to mid RPM ranges, a characteristic feature of electric propulsion.

The Tata Nexon EV shows consistent, predictable power and torque delivery under standardized dynamometer conditions, with peak outputs aligning with both manufacturer specifications and independent real-world reviews. Manufacturer specifications report that the Tata Nexon EV is equipped with a permanent magnet synchronous motor rated at approximately 100kW peak power and 245 Nm peak torque, measured at the motor shaft under controlled laboratory conditions (Sipradi Trading Pvt. Ltd., 2025). The lower power and torque values obtained in the present study are therefore expected, as chassis dynamometer measurements inherently include losses due to the single-speed reduction gearbox, differential, bearings, tire–roller interaction, and auxiliary electrical loads (Ebrahimi, 2018). Reported studies on electric vehicle drivetrains indicate that cumulative drivetrain and rolling losses of 60–70% are common during steady-state chassis dynamometer testing, particularly at partial load conditions representative of real-world driving (Ebrahimi, 2018).

4.1.2 Range Analysis

To test realistic data for "measured" ranges (real-world upon 100% charge), vs the global real world tests, and adjustments for terrain impacts, we tested the vehicles on different terrains and here is the tabulated results. In Nepal's context:

Table 4.1: Test Results data for Range Analysis of tested EV models

Vehicle	**Terrain**	**Claimed Range (km)**	**Measured/Real-World Range (km)**
BYD Atto 3	Flat	345 (WLTP)	330
	Hilly	345 (WLTP)	280

	Mountain	345 (WLTP)	240
BYD Sealion 7	Flat	Up to 440 (WLTP)	420
	Hilly	Up to 440 (WLTP)	370
	Mountain	Up to 440 (WLTP)	330
Tata Nexon EV	Flat	312 (ARAI)	285
	Hilly	312 (ARAI)	240
	Mountain	312 (ARAI)	200

Flat terrain: The flat terrain range test has been conducted along the Biratnagar–Itahari–Dharan roadway, which represents one of Nepal's lowest-elevation transport corridors. The vehicle has been charged to 100% SoC in Biratnagar, where the route elevation lies between 55 m (minimum) and 80–119 m (typical urban level) above sea level. The test vehicle has then been driven northwards through Itahari and towards Dharan, reaching 80% SoC after approximately 264 km. Across this entire corridor, the maximum elevation has not exceeded approximately 349 m near the Dharan foothill zone, ensuring that the test has remained representative of low-gradient, high-efficiency driving conditions.

Hilly terrain: The hilly terrain test has been performed on the Kathmandu–Pokhara highway, beginning with the vehicle fully charged at 100% SoC in Kathmandu**,** located at an elevation of approximately 1,400 m. The route has descended and ascended through multiple hilly sections characteristic of the Prithvi Highway. During this test, the vehicle has reached 80% SoC after approximately 224 km. Along this route, the minimum elevation approximately 822 m near the Pokhara Valley entry point, while maximum elevations have remained near the Kathmandu baseline at 1,400 m**.** This corridor has therefore provided a representative mid-altitude, moderate-gradient driving environment for real-world EV range evaluation.

Mountainous terrain: The mountainous terrain test has been conducted on the high-altitude Jomsom Road, starting in Tatopani at 100% SoC, where the elevation is approximately 1,190 m. The vehicle has driven through the steep, narrow, and rugged ascents of Ghasa and onward to the Mustang region. The 80% SoC point has been reached after approximately 192 km. Along this route, elevations have increased substantially, with maximum elevation reaching approximately 2,743 m at Jomsom, making this the highest-altitude and steepest segment of the entire study. The large elevation and challenging terrain have made this corridor the most demanding on battery consumption and motor load conditions.

Overall, the findings also indicate that manufacturer range claims tend to be optimistic, as real-world performance in Nepal consistently falls below international test cycle estimates, highlighting the importance of localized range data for consumers, policymakers, and planners.

Visualization

Figure 4.4: EV Range: Claimed vs Measured is a grouped bar and line chart showing how the claimed ranges compare with the real-world measured ranges (minimum and maximum) across terrains for each vehicle.

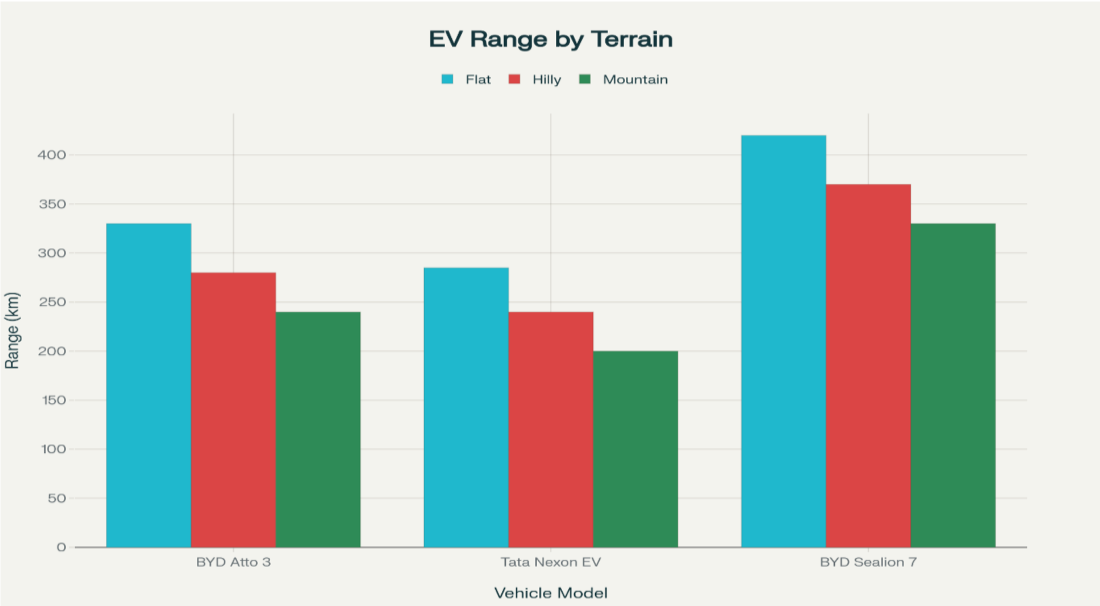


Figure 4.4: EV Range: Claimed vs Measured

4.2 Financial Comparison

4.2.1 Comparison of BYD Atto 3 and Hyundai Creta (ICE)

The Total Cost of Ownership (TCO) analysis evaluates the comprehensive financial implications of vehicle ownership over a specified period, incorporating initial acquisition costs, operational expenses (such as fuel or electricity), maintenance, insurance, taxation, and residual value. In the context of Nepal's evolving electric vehicle (EV) ecosystem, this comparison between the BYD Atto 3 (an electric compact SUV) and the Hyundai Creta (a petrol internal combustion engine [ICE] SUV) elucidates the economic rationale for EV adoption. This assessment is particularly pertinent given Nepal's electricity generation profile, which relies on over 90% hydropower, and supportive policy measures, including reduced import duties (10-15% for EVs compared to higher rates for ICE vehicles) and electricity subsidies for residential users. The analysis utilizes market data current as of October 2025, real-world efficiency metrics derived from user reports and standardized tests, and Nepal-specific economic parameters.

Key assumptions include:

- **Annual mileage:** 12,000 km (Department of Transport Management, 2025) estimates for urban and suburban SUV usage in Nepal.
- **Ownership horizon**: 20 years.
- **Electricity tariff:** NPR 11 per kWh (Nepal Energy Forum, 2025)(residential rate, as per user-specified update for high-consumption slabs). And the BYD charging stations charges NPR 15 per kWh. So, considering both rates we take average of both i.e NPR 13 per kWh.
- **Petrol price:** NPR 161 per liter (Nepal Oil Corporation Ltd., 2025)Category C rate for Kathmandu Valley.
- **Efficiency:** BYD Atto 3 ≈ 15 kWh/100 km (The Institute of International and European Affairs, 2025)Hyundai Creta ≈ 12 km/l (real-world petrol variant).
- Both the vehicles are bought with full cash payment.

All figures expressed in NPR (1L = 100,000 NPR).

This TCO framework reveals that, despite a higher upfront investment in the EV, substantial operational savings driven by lower energy and maintenance costs position the BYD Atto 3 as a more economically viable option over the medium term, thereby supporting Nepal's Nationally Determined Contributions (NDCs) under the Paris Agreement for enhanced EV penetration by 2030.

The following table delineates core parameters, with sources drawn from official and empirical references.

Table 4.2: Parametric Comparison : BYD Atto 3 vs Hyundai Creta Petrol

Parameter	BYD Atto 3 (Advanced Variant)	Hyundai Creta (Base Petrol)	Source/Notes
Purchase Price	56.90	53.96	(Cimex Inc., 2025), (Laxmi Intercontinental Pvt. Ltd., 2025)
Mileage	15 kWh/100 km	12 km/l	Real-world data from EV Database and user forums (The Institute of International and European Affairs, 2025)
Fuel/Energy Cost	1800*20 years=36000 * 13 = 4.68 (1800 kWh total over 20 years × NPR 13/kWh)	32.2 (20,000 liters total over 20 years × NPR 161/l)	Calculated based on annual mileage; (Nepal Energy Forum, 2025)NEA residential tariff (NPR 11/kWh for slabs >250 units/month); (Nepal Oil Corporation Ltd., 2025)
Annual Maintenance	0.15	0.80	EVs incur lower costs due to regenerative braking and fewer moving parts (tires/brakes only); ICE

Parameter	BYD Atto 3 (Advanced Variant)	Hyundai Creta (Base Petrol)	Source/Notes
			requires oil/filter services. Nepal Automotive Dealers' Association estimates (NPR 15,000/yr for EV vs. NPR 80,000/yr for ICE). (Omodaja EcoOne, 2025)
Annual Insurance	0.50	0.50	Comprehensive coverage ≈1% of vehicle value (NPR 50,000/yr); uniform for comparable SUVs. (Nepal Insurance Authority, 2025)
Annual Road Tax	0.15	0.27	NPR 15,000/yr for 51KW-125kW vehicles; ICE standard rate (NPR 27,000/yr, Bagmati Province). (Department of Transport Management, 2025)
Resale Value (After 20 Years)	5.69L (depreciation calculated using 10% salvage)	5.4L (depreciation calculated using 10% salvage)	EVs retain higher value due to 8-year/160,000 km battery warranty and rising demand; ICE depreciates amid fuel volatility. Market trends from Nepal Used Vehicle Dealers' Association (2025).

Depreciation Straight line method:

$$Annual\ Depreciation = \frac{\text{Purchase Price} - \text{Salvage}}{\text{20 yrs}}$$

Year	BYD Atto 3	Creta Petrol
Purchase	56.90	53.96
Salvage (10 %)	5.69	5.40
Annual Dep.	2.561	2.428

TCO Breakdown Over 20 Years

The *Table 4.3* has presented cumulative costs in NPR, illustrating the EV's cost advantage through reduced energy and maintenance expenditures.

Table 4.3: TCO Comparison : BYD Atto 3 vs Hyundai Creta Petrol

Cost Component	BYD Atto 3	Hyundai Creta	Difference (Savings for EV)
Purchase Price	56.90	53.96	-2.94 (Higher for EV)
Fuel/Energy (20 Years)	4.68	32.20	+27.52 (EV Savings)
Maintenance (20 Years)	3.0	16.00	+13.00 (EV Savings)
Insurance (20 Years)	10	10	0
Road Tax (20 Years)	3.00	5.40	+2.40 (EV Savings)
Battery ×2 (Yr9 + Yr17)	24.00	–	-24.00 (Higher for EV)
Subtotal (Operating)	101.58	117.56	+15.98 (EV Savings)
Resale Value (Credit)	-5.69	-5.4	+0.29 (EV Advantage)
Net TCO (20 years)	95.89	112.16	+16.27 (EV Savings)

Over a 20-year horizon, the BYD Atto 3 yields a net TCO savings of NPR 1,627,000 compared to the Hyundai Creta, primarily attributable to energy costs (NPR 1.95/km for EV vs. NPR 13.42/km for ICE) and maintenance reductions—EVs eliminate recurring services like oil changes and exhaust repairs, conserving ≈NPR 65,000 annually. At the updated residential tariff of NPR 11/kWh (applicable to higher consumption slabs typical for EV charging), operational expenses remain competitive, especially with Nepal's subsidized hydropower rates. Enhanced resale value further bolsters the EV's position, reflecting battery longevity warranties and policy-driven market growth.

Notwithstanding these advantages include potential public charging surcharges (NPR 5,000–10,000/year) and post-warranty battery replacement (NPR 700,000–1,500,000). Nepal's Electricity Regulatory Commission (ERC) incentives, such as tiered tariffs and 50% duty exemptions for low-power EVs, amplify affordability, aligning with the government's target of 20% EV market share by 2030 (Ministry of Energy, Water Resources and Irrigation [MoEWRI], 2025).

This TCO evaluation reinforces EVs' contribution to fiscal resilience, curtailing Nepal's annual NPR 200 billion fossil fuel import expenditure while mitigating urban air pollution (contributing ≈10% to GHG emissions from transport; DoTM, 2025). Future analyses could incorporate time-of-use tariffs or solar home charging to further optimize economics.

4.2.2 Comparison of BYD Sealion 7 and Hyundai Tucson (ICE)

The Total Cost of Ownership (TCO) analysis evaluates the comprehensive financial implications of vehicle ownership over a specified period, incorporating initial acquisition costs, operational expenses (such as fuel or electricity), maintenance, insurance, taxation, and residual value. In the context of Nepal's evolving electric vehicle (EV) ecosystem, this comparison between the BYD Sealion7 (an electric compact SUV) and the Hyundai Tucson (a petrol internal combustion engine [ICE] SUV) elucidates the economic rationale for EV adoption. This assessment is particularly pertinent given Nepal's electricity generation profile, which relies on over 90% hydropower, and supportive policy measures, including reduced import duties (10-15% for EVs compared to higher rates for ICE vehicles) and electricity subsidies for residential users. The analysis utilizes market data current as of October 2025, real world efficiency metrics derived from user reports and standardized tests, and Nepal-specific economic parameters.

Key assumptions include:

- Annual mileage: 12,000 km (Department of Transport Management, 2025) estimates for urban and suburban SUV usage in Nepal.
- Ownership horizon: 20 years.

- Electricity tariff: NPR 11 per kWh (Nepal Energy Forum, 2025)(residential rate, as per user-specified update for high-consumption slabs). And the BYD charging stations charges NPR 15 per kWh. So, considering both rates we take average of both i.e NPR 13 per kWh.
- Petrol price: NPR 161 per liter (Nepal Oil Corporation Ltd., 2025)Category C rate for Kathmandu Valley.
- Efficiency: BYD Sealion 7 ≈ 18 kWh/100 km (evkx.net, n.d.), Hyundai Tucson ≈ 10 km/l (real-world petrol variant).
- Both the vehicles are bought with full cash payment.

All figures expressed in NPR (1L = 100,000 NPR).

This TCO framework reveals that, despite a higher upfront investment in the EV, substantial operational savings driven by lower energy and maintenance costs position the BYD Sealion 7 as a more economically viable option over the medium term, thereby supporting Nepal's Nationally Determined Contributions (NDCs) under the Paris Agreement for enhanced EV penetration by 2030.

The following table delineates core parameters, with sources drawn from official and empirical references.

Table 4.4: Parametric Comparison : BYD Sealion 7 vs Hyundai Tucson Petrol

Parameter	BYD Sealion 7	Hyundai Tucson (Base Petrol)	Source/Notes
Purchase Price	74.99	107.96	(Cimex Inc, 2025), (Laxmi Intercontinental Pvt. Ltd., 2025)
Mileage	18 kWh/100 km	10 km/l	Real-world data from EV Database and user forums (evkx.net, n.d.)

Parameter	BYD Sealion 7	Hyundai Tucson (Base Petrol)	Source/Notes
Fuel/Energy Cost	2160*20 years=43200 * 13 = 5.616 (2160 kWh total over 20 years × NPR 13/kWh)	38.64 (24,000 liters total over 20 years × NPR 161/l)	Calculated based on annual mileage; (Nepal Energy Forum, 2025)NEA residential tariff (NPR 11/kWh for slabs >250 units/month); (Nepal Oil Corporation Ltd., 2025)
Annual Maintenance	0.15	0.80	EVs incur lower costs due to regenerative braking and fewer moving parts (tires/brakes only); ICE requires oil/filter services. Nepal Automotive Dealers' Association estimates (NPR 15,000/yr for EV vs. NPR 80,000/yr for ICE). (Omodaja EcoOne, 2025)
Annual Insurance	0.50	0.50	Comprehensive coverage ≈1% of vehicle value (NPR 50,000/yr); uniform for comparable SUVs. (Nepal Insurance Authority, 2025)
Annual Road Tax	0.15	0.27	NPR 15,000/yr for 51KW-125kW vehicles; ICE standard rate (NPR 25,000/yr, Bagmati Province). (Department of Transport Management, 2025)

Parameter	BYD Sealion 7	Hyundai Tucson (Base Petrol)	Source/Notes
Resale Value (After 20 Years)	7.5L (depreciation calculated using 10% salvage)	10.8L (depreciation calculated using 10% salvage)	EVs retain higher value due to 8-year/160,000 km battery warranty and rising demand; ICE depreciates amid fuel volatility. Market trends from Nepal Used Vehicle Dealers' Association (2025).

Depreciation Straight line method:

$$Annual\ Depreciation = \frac{\text{Purchase Price} - \text{Salvage}}{20\ \text{yrs}}$$

Year	BYD Sealion 7	Tucson Petrol
Purchase	74.99	107.96
Salvage (10 %)	7.5	10.8
Annual Dep.	3.3745	4.858

TCO Breakdown Over 20 Years

The *Table 4.5* has presented cumulative costs in NPR, illustrating the EV's cost advantage through reduced energy and maintenance expenditures.

Table 4.5: TCO Comparison : BYD Sealion 7 vs Hyundai Tucson Petrol

Cost Component	BYD Sealion 7	Hyundai Tucson	Difference (Savings for EV)
Purchase Price	74.99	107.96	+32.97 (EV Savings)
Fuel/Energy (20 Years)	5.616	38.64	+33.024 (EV Savings)
Maintenance (20 Years)	3.0	16.00	+13.00 (EV Savings)
Insurance (20 Years)	10	10	0.00
Road Tax (20 Years)	3.00	5.40	+2.40 (EV Savings)

Battery ×2 (Yr9 + Yr17)	36.00	–	-36.00 (Higher for EV)
Subtotal (Operating)	132.60	178	+45.40 (EV Savings)
Resale Value (Credit)	-7.5	-10.8	-3.3 (Lower for EV)
Net TCO (20 years)	125.10	167.20	+42.10 (EV Savings)

Over a 20-year horizon, the BYD Sealion 7 yields a net TCO savings of NPR 4,210,000 compared to the Hyundai Tucson, primarily attributable to energy costs (NPR 2.34/km for EV vs. NPR 16.1/km for ICE) and maintenance reductions—EVs eliminate recurring services like oil changes and exhaust repairs, conserving ≈NPR 75,000 annually. At the updated residential tariff of NPR 11/kWh (applicable to higher consumption slabs typical for EV charging), operational expenses remain competitive, especially with Nepal's subsidized hydropower rates. Enhanced resale value further bolsters the EV's position, reflecting battery longevity warranties and policy-driven market growth.

Notwithstanding these advantages include potential public charging surcharges (NPR 5,000–10,000/year) and post-warranty battery replacement (NPR 1,400,000–2,000,000). Nepal's Electricity Regulatory Commission (ERC) incentives, such as tiered tariffs and 50% duty exemptions for low-power EVs, amplify affordability, aligning with the government's target of 20% EV market share by 2030 (Ministry of Energy, Water Resources and Irrigation [MoEWRI], 2025).

4.2.3 Comparison of Tata Nexon EV vs Tata Nexon Petrol

The Total Cost of Ownership (TCO) analysis evaluates the comprehensive financial implications of vehicle ownership over a specified period, incorporating initial acquisition costs, operational expenses (such as fuel or electricity), maintenance, insurance, taxation, and residual value. In the context of Nepal's evolving electric vehicle (EV) ecosystem, this comparison between the Tata Nexon EV (an electric sub-compact SUV) and the Tata Nexon Petrol (a petrol internal combustion engine [ICE] SUV) elucidates the economic rationale for EV adoption. This assessment is particularly pertinent given Nepal's electricity generation profile, which relies on over 90% hydropower, and supportive policy measures, including reduced import duties (10-15% for EVs compared to higher rates for ICE vehicles) and electricity subsidies for residential users. The analysis utilizes market data current as of October 2025, real-world efficiency metrics derived from user reports and standardized tests, and Nepal-specific economic parameters.

Key assumptions include:

- **Annual mileage:** 12,000 km (Department of Transport Management, 2025) estimates for urban and suburban SUV usage in Nepal).
- **Ownership horizon:** 20 years.
- **Electricity tariff:** NPR 11 per kWh (Nepal Energy Forum, 2025)(residential rate, as per user-specified update for high-consumption slabs). And the TATA charging stations charges NPR 15 per kWh. So, considering both rates we take average of both. i.e NPR 13 per kWh.
- **Petrol price:** NPR 161 per liter (Nepal Oil Corporation Ltd., 2025)Category C rate for Kathmandu Valley.
- **Efficiency:** Tata Nexon EV ≈ 14 kWh/100 km (The Institute of International and European Affairs, 2025); Tata Nexon Petrol ≈ 14 km/l (real-world petrol variant).
- Both the vehicles are bought with full cash payment.

All figures expressed in NPR (1L = 100,000 NPR).

This TCO framework reveals that, despite a higher upfront investment in the EV, substantial operational savings driven by lower energy and maintenance costs position the Tata Nexon EV as a more economically viable option over the medium term, thereby supporting Nepal's Nationally Determined Contributions (NDCs) under the Paris Agreement for enhanced EV penetration by 2030.

The following table delineates core parameters, with sources drawn from official and empirical references.

Table 4.6: Parametric Comparison : Tata Nexon EV vs Tata Nexon Petrol

Parameter	Tata Nexon EV (Long Range Variant)	Tata Nexon Petrol (Base Variant)	Source/Notes
Purchase Price	48.99	40.99	(Sipradi Trading Pvt. Ltd., 2025) Nexon EV Long Range/K3.ev at NPR 4,899,000; Petrol base (XE) at NPR 4,099,000
Mileage	14 kWh/100 km	14 km/l	(The Institute of International and European Affairs, 2025) Real-world data from EV Database, user forums
Fuel/Energy Cost	33600*13=4.36 (1680 kWh total over 20 years × NPR 13/kWh)	27.6 (17143 liters total over 20 years × NPR 161/l)	Calculated based on annual mileage; NEA residential tariff (NPR 11/kWh for slabs >250 units/month) (Nepal Oil Corporation Ltd., 2025)
Annual Maintenance	0.06	0.80	EVs incur lower costs due to regenerative braking and fewer moving parts (tires/brakes only); ICE requires oil/filter services. Tata Nepal estimates (NPR 6,000/yr for EV vs. NPR 80,000/yr for ICE). (Omodaja EcoOne, 2025).
Annual Insurance	0.50	0.50	Comprehensive coverage ≈1% of vehicle value (NPR 50,000/yr); uniform for comparable SUVs.(Nepal Insurance Authority, 2025)

Parameter	Tata Nexon EV (Long Range Variant)	Tata Nexon Petrol (Base Variant)	Source/Notes
Annual Road Tax	0.15	0.25	NPR 15,000/yr for 51KW-125kW vehicles; ICE standard rate (NPR 25,000/yr, Bagmati Province). (Department of Transport Management, 2025)
Resale Value (After 20 Years)	4.9L (depreciation calculated using 10% salvage)	4.1L (depreciation calculated using 10% salvage)	EVs retain higher value due to 8-year/160,000 km battery warranty and rising demand; ICE depreciates amid fuel volatility. Market trends from Nepal Used Vehicle Dealers' Association (2025).

Depreciation Straightline method:

$$Annual\ Depreciation = \frac{\text{Purchase Price} - \text{Salvage}}{20\ \text{yrs}}$$

Year	Nexon EV Book	Nexon Petrol Book
0	48.99	40.99
5	38.74	32.39
10	28.49	23.79
15	18.24	15.19
20	4.90	4.10

TCO Breakdown Over 20 Years

The Table 4.7: TCO Comparison : Tata Nexon EV vs Tata Nexon Petrol has presented cumulative costs in NPR, illustrating the EV's cost advantage through reduced energy and maintenance expenditures.

Table 4.7: TCO Comparison : Tata Nexon EV vs Tata Nexon Petrol

Cost Component	Tata Nexon EV	Tata Nexon Petrol	Difference (Savings for EV)
Purchase Price	48.99	40.99	-8.00 (Higher for EV)
Fuel/Energy (20 Years)	4.36	27.60	+23.24 (EV Savings)
Maintenance (20 Years)	1.2	16.00	+14.8 (EV Savings)
Insurance (20 Years)	7.0	7.0	0.00
Road Tax (20 Years)	1.0	3.0	+2.00 (EV Savings)
Battery ×2 (Yr9 + Yr17)	16.00	–	-16.00 (Higher for EV)
Subtotal (Operating)	78.55	94.59	+16.04 (EV Savings)
Resale Value (Credit)	-4.9	-4.1	+0.8 (EV Advantage)
Net TCO (20 Years)	73.65	90.49	+16.84 (EV Savings)

Over a 20-year horizon, the Tata Nexon EV yields a net TCO savings of NPR 1,684,000 compared to the Tata Nexon Petrol, primarily attributable to energy costs (NPR 1.81/km for EV vs. NPR 11.50/km for ICE) and maintenance reductions—EVs eliminate recurring services like oil changes and exhaust repairs, conserving ≈NPR 74,000 annually. At the updated residential tariff of NPR 11/kWh (applicable to higher consumption slabs typical for EV charging), operational expenses remain competitive, especially with Nepal's subsidized hydropower rates. Enhanced resale value further bolsters the EV's position, reflecting battery longevity warranties and policy-driven market growth.

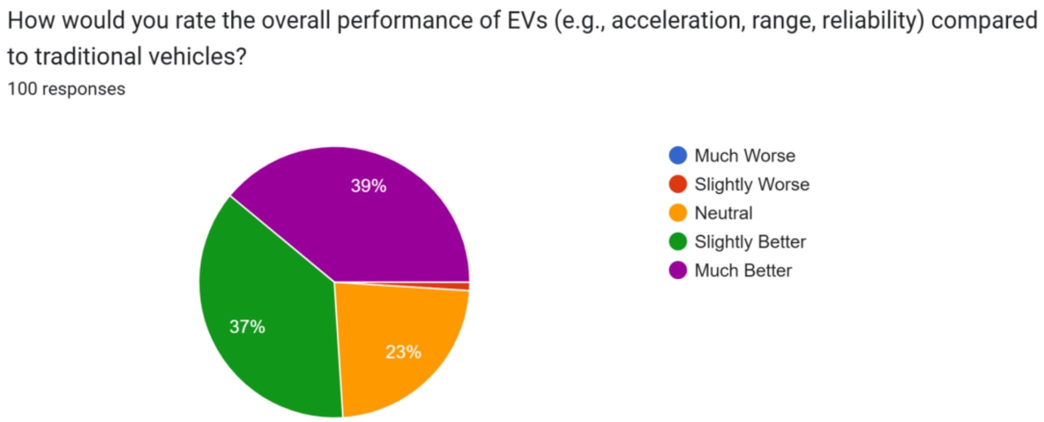
Notwithstanding these advantages, caveats include potential public charging surcharges (NPR 5,000–10,000/year) and post-warranty battery replacement (NPR 600,000–1,300,000). Nepal's Electricity Regulatory Commission (ERC) incentives, such as tiered tariffs and 50% duty exemptions for low-power EVs, amplify affordability, aligning with the government's target of 20% EV market share by 2030 (Ministry of Energy, Water Resources and Irrigation [MoEWRI], 2025.

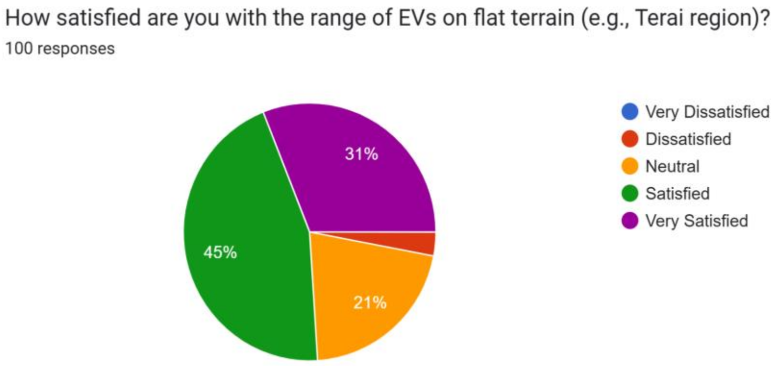
4.3 Socio-Economic Impact Analysis

This section presents the results and discussion of the socio-economic impacts associated with the adoption of electric vehicles (EVs) in Nepal. The analysis is based on a questionnaire survey conducted among 100 respondents, including 38 EV users, 36 automobile mechanics, and 26 policymakers. The primary objective was to assess how the increasing penetration of EVs influences social, economic, and environmental dimensions, such as vehicle performance, operational costs, employment trends, and public perception. The findings offer insights into user experiences, stakeholder readiness, and potential areas for policy and infrastructure improvement to support Nepal's transition towards sustainable mobility.

4.3.1 Performance and Range Perception

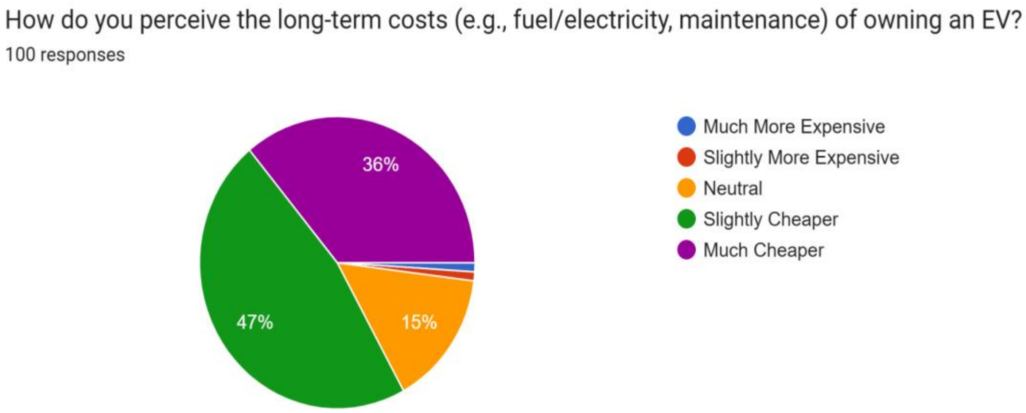
The survey revealed that approximately 76% of EV users were satisfied with their vehicle's performance in terms of driving comfort, acceleration, and reliability. However, concerns about driving range were reported, particularly for long-distance or intercity travel, where charging stations are limited. Respondents also indicated that the actual driving range was 10–15% lower than manufacturer claims in flat terrain, hilly routes reduce range by 15–20% due to regenerative braking limits, mountain terrain causes 20–30% range drop.

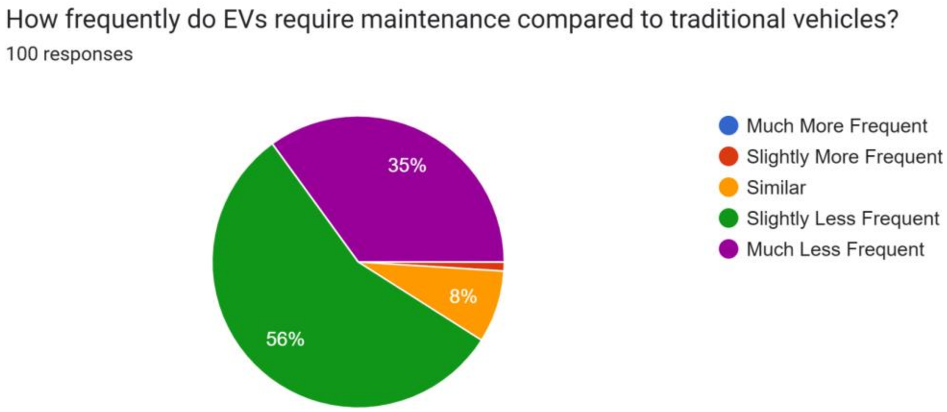




4.3.2 Economic Impacts and Cost Savings

A large proportion of EV users 83% reported that operating an electric vehicle results in significant cost savings compared to petrol or diesel vehicles. The average annual saving was estimated at NPR 65,000–75,000, primarily attributed to lower fuel and maintenance costs. Mechanics supported this finding, stating that EVs require fewer servicing intervals and reduced component replacements due to their simpler drivetrain systems. However, some users mentioned challenges in obtaining spare parts and technical services for EV-specific components such as batteries, controllers, and sensors.





4.3.3 Policy and Institutional Perspectives

Policymakers and users alike emphasized the need for improvements in charging infrastructure, battery recycling systems, and electricity tariff regulation. Around 70% of respondents believed that the current policy framework is favorable but lacks long term planning and coordination among transport, energy, and environmental authorities.

While Nepal's EV policies (such as customs duty reduction and tax exemptions) have stimulated initial market growth, challenges remain in ensuring consistent implementation, standardization, and nationwide charging coverage. A clear and comprehensive national EV roadmap, integrating renewable energy, urban transport, and waste management strategies, would be essential to sustain the socio-economic benefits of EV adoption.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study has examined the performance, real-world range, economic viability, and socio-economic implications of electric vehicle (EV) adoption in Nepal. Dynamometer testing has confirmed that the evaluated EVs have delivered power and torque characteristics appropriate to their respective segments and operating conditions. The BYD Atto 3 and Tata Nexon EV have demonstrated comparable peak power outputs of approximately 35.5 kW, with the Nexon EV having provided higher low speed torque of 94.0 Nm at approximately 3575 RPM, which has enhanced gradeability and urban drivability. The BYD Sealion 7 has exhibited significantly higher performance margins, having achieved a peak power of 69.4 kW and a maximum torque of 120.2 Nm, thereby supporting superior dynamic performance at higher operating speeds. Real-world range assessments have indicated that EV driving ranges have remained 10–30% lower than manufacturer claims due to terrain, elevation changes, and environmental conditions. However, the observed ranges have remained adequate for urban and intercity travel in Nepal. Economic analysis using the Total Cost of Ownership approach has demonstrated that EVs have provided clear financial advantages, having achieved annual savings of NPR 65,000–75,000 and a payback period of approximately 3–4 years, largely supported by Nepal’s low cost hydropower based electricity. Survey responses from 100 users have further indicated a high satisfaction level of 76%, with perceived benefits having included reduced maintenance requirements, lower noise levels, and reduced emissions, alongside persistent challenges having been identified related to charging infrastructure and policy consistency.

5.2 Recommendations

- Future work should expand performance analysis through extended on road testing across Nepal’s diverse terrains and climatic conditions, alongside real time energy consumption profiling under varying loads.
- Dynamometer on VFTC needs proper calibration and skilled manpower for its smooth and safe operation.

- Broader socio-economic assessments, including province level surveys, are recommended to capture regional differences in public perception and adoption behavior.
- Continuous evaluation of EV related policies and incentives is essential to identify regulatory gaps, support market growth, and strengthen Nepal's emerging electric mobility ecosystem.

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ANNEXURES

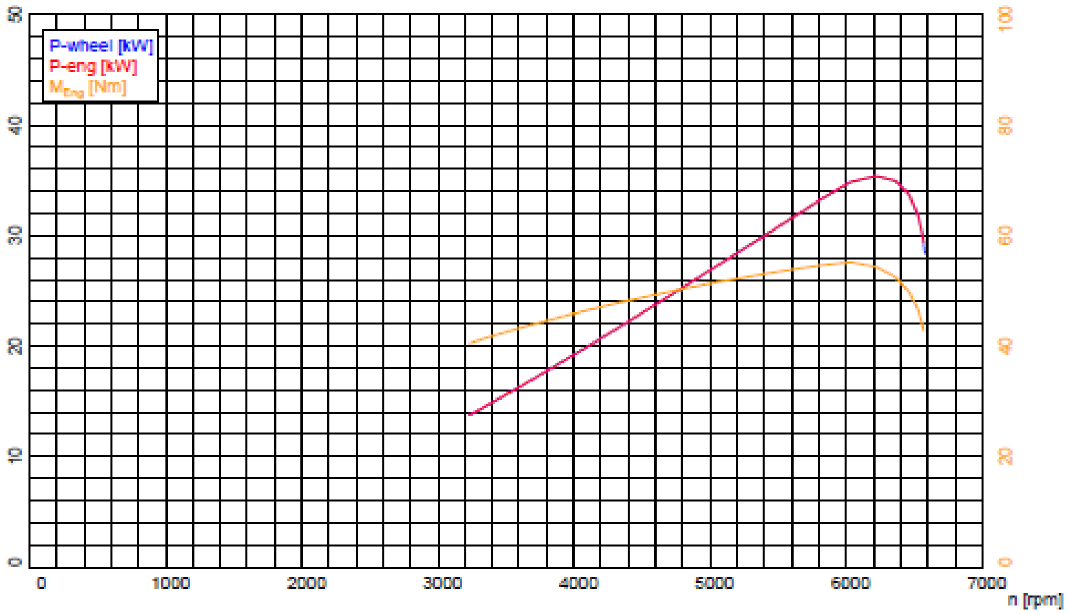
Annex 1: Performance Analysis: VFTC Test Results of BYD ATTO 3 ADVANCED

Vehicle Fitness Testing Centre
Teku,
Kathmandu
Nepal

MAHA
LPS 3000 PKW

Vehicle type:	byd test3	Otto-Motor / No or mechanical charger
License plate:		Automatic transmission
Inspector:		Front drive

Measurement date: 19.03.2023 (10:35) Page 1



Power data

Corrected power 1)	P_{Norm}	—.-	kW	/ —.-	BHP	
Engine power	P_{Eng}	35.4	kW	/	48.1	BHP
Wheel power	P_{Wheel}	35.4	kW	/	48.1	BHP
Drag power	P_{Drag}	0.0	kW	/	0.0	BHP
Max. power at		6220	rpm	/	73.9	km/h
Torque 1)	M_{Eng}	55.1	Nm			
Max. Torque at		6035	rpm	/	71.7	km/h
Max. attained RPM		6580	rpm	/	78.2	km/h

1) No power correction
Correction factors: Q_V = 0.00 %, P_{VA} = 0.00 kW

Ambient data

Ambient temperature	$T_{Ambient}$	—.-	°C
Intake air temperature	$T_{Intake\ air}$	—.-	°C
Relative humidity	H_{Air}	—.-	%
Air pressure	p_{Air}	—.-	hPa
Steam pressure	p_{Steam}	10.0	hPa
Oil temperature	T_{Oil}	—.-	°C
Fuel temperature	T_{Fuel}	—.-	°C

Slip

Speed no load	$v_{no\ load}$	—.-	km/h
RPM no load	$n_{no\ load}$	—	rpm
Speed full load	$v_{full\ load}$	—.-	km/h
RPM full load	$n_{full\ load}$	—	rpm
Slip		—.—	%

Rotating mass

Average delay run down 1	a_1	—.—	m/s²
Average Brake force run down 1	F_1	—.-	N
Average delay run down 2	a_2	—.—	m/s²
Average brake force run down 2	F_2	—.-	N
Force of the rotating mass	$F_{rot\text{-}total}$	—.-	N
Rotating total mass	$m_{rot\text{-}total}$	310.0	kg
Rotating test stand mass	$m_{rot\text{-}dyno}$	250.0	kg
Rotating vehicle mass	$m_{rot\text{-}vehicle}$	60.0	kg

LPS 3000 PKW V 4.02.000 (02/21/2019) (100/000/0000/000/0000) LPS-EURO V1.37.010

Annex 2: Measurement data table of BYD ATTO3

Vehicle Fitness Testing Centre
Teku,
Kathmandu
Nepal

MAHA
LPS 3000 PKW

Vehicle type: byd test3
License plate:
Inspector:

Otto-Motor / No or mechanical charger
Automatic transmission
Front drive

Measurement date: 19.03.2023 (10:35)

Page 2

Measurement data table

n [rpm]	v [km/h]	P_{Wheel} [kW]	P_{Eng} [kW]	P_{Norm} [kW]	M_{Eng} [Nm]
3300	39.2	14.2	14.2	14.2	41.0
3400	40.4	14.9	14.9	14.9	41.8
3500	41.6	15.6	15.6	15.6	42.5
3600	42.8	16.3	16.3	16.3	43.2
3700	44.0	17.0	17.0	17.0	43.8
3800	45.2	17.7	17.7	17.7	44.5
3900	46.4	18.5	18.5	18.5	45.2
4000	47.5	19.2	19.2	19.2	45.8
4100	48.7	19.9	19.9	19.9	46.4
4200	49.9	20.7	20.7	20.7	47.0
4300	51.1	21.4	21.4	21.4	47.6
4400	52.3	22.2	22.2	22.2	48.2
4500	53.5	23.0	23.0	23.0	48.7
4600	54.7	23.7	23.7	23.7	49.3
4700	55.9	24.5	24.5	24.5	49.8
4800	57.0	25.3	25.3	25.3	50.3
4900	58.2	26.1	26.1	26.1	50.8
5000	59.4	26.8	26.8	26.8	51.3
5100	60.6	27.6	27.6	27.6	51.7
5200	61.8	28.4	28.4	28.4	52.2
5300	63.0	29.2	29.2	29.2	52.6
5400	64.2	30.0	30.0	30.0	53.0
5500	65.4	30.8	30.8	30.8	53.4
5600	66.6	31.5	31.5	31.5	53.8
5700	67.7	32.3	32.3	32.3	54.2
5800	68.9	33.1	33.1	33.1	54.5
5900	70.1	33.9	33.9	33.9	54.8
6000	71.3	34.6	34.6	34.6	55.1
6100	72.5	35.0	35.0	35.0	54.8
6200	73.7	35.3	35.3	35.3	54.4
6300	74.9	35.1	35.1	35.1	53.3
6400	76.1	34.5	34.5	34.5	51.4
6500	77.3	32.6	32.6	32.6	47.9

Minimum value Maximum value

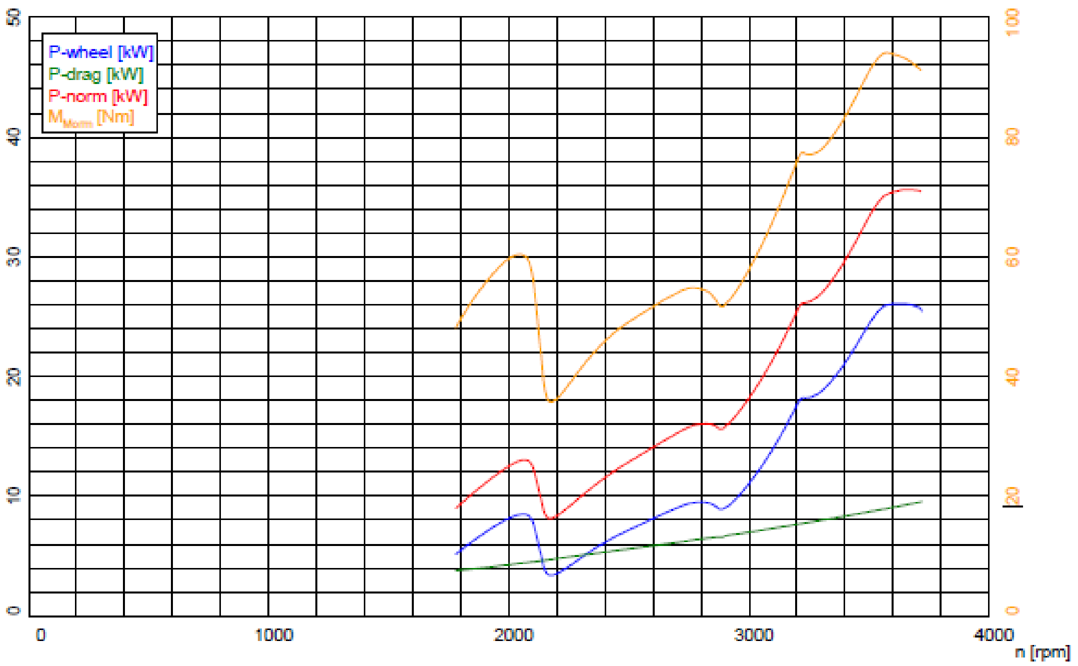
Annex 3: Performance Analysis: VFTC Test Results of TATA NEXON EV

Vehicle Fitness Testing Centre
Teku,
Kathmandu
Nepal

MAHA
LPS 3000 PKW

Vehicle type:	tata nexon ev	Diesel-Motor / Turbo charger (air-cooled)
License plate:	9827	Automatic transmission
Inspector:		Front drive

Measurement date: 29.09.2021 (15:18) — Page 1



Power data

Corrected power 1)	P_{Norm}	35.6 kW	/	48.4	BHP	
Engine power	P_{Eng}	35.3 kW	/	48.0	BHP	
Wheel power	P_{Wheel}	26.0 kW	/	35.3	BHP	
Drag power	P_{Drag}	9.3 kW	/	12.7	BHP	
Max. power at		3670 rpm	/	97.3	km/h	
Torque 1)	M_{Norm}	94.0 Nm				
Max. Torque at		3575 rpm	/	94.6	km/h	
Max. attained RPM		3720 rpm	/	98.6	km/h	

1) Correction acc. to DIN 70020
Correction factors: Q_v = 0.00 %, P_{VA} = 0.00 kW

Ambient data

Ambient temperature	$T_{Ambient}$	24.0	°C
Intake air temperature	$T_{Intake\ air}$	26.0	°C
Relative humidity	H_{Air}	76.0	%
Air pressure	p_{Air}	1016.0	hPa
Steam pressure	p_{Steam}	---.-	hPa
Oil temperature	T_{Oil}	---.-	°C
Fuel temperature	T_{Fuel}	---.-	°C

Slip

Speed no load	$v_{no\ load}$	---.-	km/h
RPM no load	$n_{no\ load}$	----	rpm
Speed full load	$v_{full\ load}$	---.-	km/h
RPM full load	$n_{full\ load}$	----	rpm
Slip		--.--	%

Rotating mass

Average delay run down 1	a_1	--.--	m/s²
Average Brake force run down 1	F_1	---.-	N
Average delay run down 2	a_2	--.--	m/s²
Average brake force run down 2	F_2	---.-	N
Force of the rotating mass	$F_{rot-total}$	---.-	N
Rotating total mass	$m_{rot-total}$	310.0	kg
Rotating test stand mass	$m_{rot-dyno}$	250.0	kg
Rotating vehicle mass	$m_{rot-vehicle}$	60.0	kg

LPS 3000 PKW V 4.02.000 (02/21/2019) (100/000/0000/000/0000)

Annex 4: Measurement data table of Tata Nexon EV

Vehicle Fitness Testing Centre
Teku,
Kathmandu
Nepal

LPS 3000 PKW

Vehicle type: tata nexon ev
License plate: 9827
Inspector:

Diesel-Motor / Turbo charger (air-cooled)
Automatic transmission
Front drive

Measurement date: 29.09.2021 (15:18)

Page 2

Measurement data table

n [rpm]	v [km/h]	P_{Wheel} [kW]	P_{Eng} [kW]	P_{Norm} [kW]	M_{Norm} [Nm]
1800	47.7	5.5	9.3	9.3	49.6
1900	50.4	6.9	10.9	11.0	55.4
2000	53.0	8.1	12.4	12.5	59.6
2100	55.6	7.8	12.3	12.4	56.5
2200	58.3	3.5	8.3	8.3	36.2
2300	61.0	4.8	9.9	10.0	41.3
2400	63.6	6.1	11.4	11.5	45.9
2500	66.2	7.2	12.7	12.9	49.1
2600	68.9	8.1	13.9	14.0	51.6
2700	71.6	9.0	15.1	15.2	53.9
2800	74.2	9.5	15.9	16.0	54.6
2900	76.9	9.0	15.6	15.8	51.9
3000	79.5	11.0	18.0	18.2	57.8
3100	82.2	14.0	21.2	21.4	66.0
3200	84.8	17.6	25.2	25.4	75.9
3300	87.4	18.7	26.7	26.9	77.9
3400	90.1	21.1	29.4	29.7	83.4
3500	92.7	24.4	33.0	33.3	90.9
3600	95.4	26.0	35.1	35.4	93.8
3700	98.0	25.8	35.2	35.5	91.7

Minimum value Maximum value

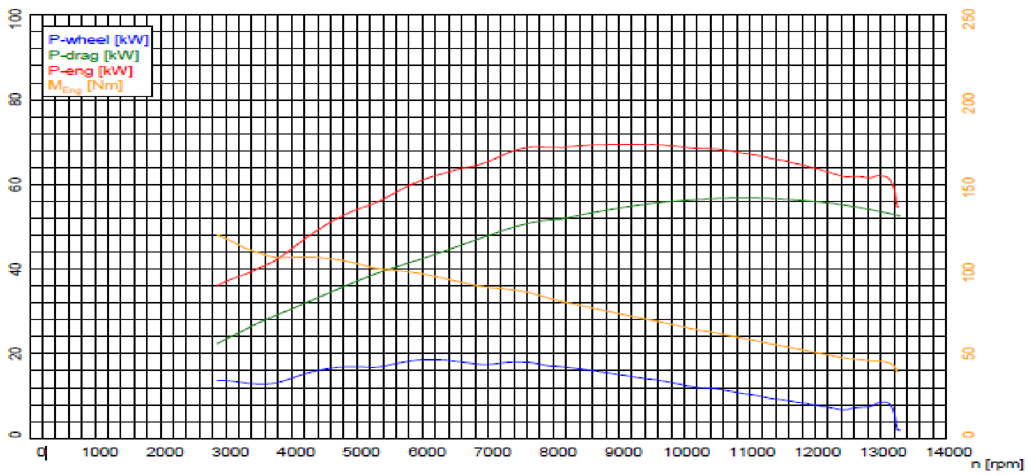
Annex 5: Performance Analysis: VFTC Test Results of BYD SEALION 7

Vehicle Fitness Testing Centre
Teku,
Kathmandu
Nepal

LPS 3000 PKW

Vehicle type:	sea lion		Otto-Motor / Turbo charger (water-cooled)
License plate:	byd		Manual transmission
Inspector:	byd test 1		Rear drive

Measurement date: 04.08.2025 (16:36) Page 1



Power data

Corrected power 1)	P_{Norm}	---.-	kW	/	---.-	BHP
Engine power	P_{Eng}	69.4	kW	/	94.4	BHP
Wheel power	P_{Wheel}	14.8	kW	/	20.2	BHP
Drag power	P_{Drag}	54.6	kW	/	74.2	BHP
Max. power at		9095	rpm	/	149.2	km/h
Torque 1)	M_{Eng}	120.2	Nm			
Max. Torque at		2860	rpm	/	47.0	km/h
Max. attained RPM		13290	rpm	/	218.0	km/h

1) No power correction
Correction factors: Q_v = 0.00 %

Ambient data

Ambient temperature	$T_{Ambient}$	---.-	°C
Intake air temperature	$T_{Intake\ air}$	---.-	°C
Relative humidity	H_{Air}	---.-	%
Air pressure	p_{Air}	---.-	hPa
Steam pressure	p_{Steam}	10.0	hPa
Oil temperature	T_{Oil}	---.-	°C
Fuel temperature	T_{Fuel}	---.-	°C

Slip

Speed no load	$v_{no\ load}$	---.-	km/h
RPM no load	$n_{no\ load}$	----	rpm
Speed full load	$v_{full\ load}$	---.-	km/h
RPM full load	$n_{full\ load}$	----	rpm
Slip		--.--	%

Rotating mass

Average delay run down 1	a_1	--.---	m/s²
Average Brake force run down 1	F_1	----.-	N
Average delay run down 2	a_2	--.---	m/s²
Average brake force run down 2	F_2	----.-	N
Force of the rotating mass	$F_{rot\text{-}total}$	----.-	N
Rotating total mass	$m_{rot\text{-}total}$	310.0	kg
Rotating test stand mass	$m_{rot\text{-}dyno}$	250.0	kg
Rotating vehicle mass	$m_{rot\text{-}vehicle}$	60.0	kg

LPS 3000 PKW V 4.02.000 (02/21/2019) (100/000/0000/000/0000) LPS-EURO V1.37.010

Annex 6: Measurement data table of BYD Sealion 7

Vehicle Fitness Testing Centre
Teku,
Kathmandu
Nepal

LPS 3000 PKW

Vehicle type: sea lion
License plate: byd
Inspector: byd test 1

Otto-Motor / Turbo charger (water-cooled)
Manual transmission
Rear drive

Measurement date: 04.08.2025 (16:36)

Measurement data table (Continuation)

n [rpm]	v [km/h]	P_{Wheel} [kW]	P_{Eng} [kW]	P_{Norm} [kW]	M_{Eng} [Nm]
7600	124.7	18.0	68.7	68.7	86.3
7700	126.3	17.8	68.8	68.8	85.4
7800	128.0	17.5	68.8	68.8	84.3
7900	129.6	17.2	68.7	68.7	83.1
8000	131.2	17.1	68.7	68.7	82.0
8100	132.9	16.9	68.7	68.7	81.0
8200	134.5	16.8	68.8	68.8	80.1
8300	136.2	16.6	69.0	69.0	79.3
8400	137.8	16.4	69.1	69.1	78.5
8500	139.4	16.2	69.2	69.2	77.8
8600	141.1	16.0	69.3	69.3	76.9
8700	142.7	15.8	69.3	69.3	76.1
8800	144.4	15.5	69.4	69.4	75.3
8900	146.0	15.3	69.4	69.4	74.4
9000	147.6	15.1	69.4	69.4	73.6
9100	149.3	14.8	69.4	69.4	72.8
9200	150.9	14.6	69.4	69.4	72.0
9300	152.6	14.3	69.4	69.4	71.2
9400	154.2	14.1	69.4	69.4	70.5
9500	155.8	13.9	69.4	69.4	69.7
9600	157.5	13.7	69.3	69.3	69.0
9700	159.1	13.5	69.3	69.3	68.2
9800	160.8	13.2	69.1	69.1	67.3
9900	162.4	12.9	69.0	69.0	66.5
10000	164.1	12.5	68.7	68.7	65.6
10100	165.7	12.3	68.6	68.6	64.8
10200	167.3	12.0	68.4	68.4	64.1
10300	169.0	11.9	68.4	68.4	63.4
10400	170.6	11.8	68.4	68.4	62.8
10500	172.3	11.7	68.3	68.3	62.1
10600	173.9	11.4	68.1	68.1	61.3
10700	175.5	11.1	67.9	67.9	60.6
10800	177.2	10.9	67.6	67.6	59.8
10900	178.8	10.6	67.3	67.3	59.0
11000	180.5	10.4	67.1	67.1	58.3
11100	182.1	10.1	66.8	66.8	57.5
11200	183.7	9.8	66.5	66.5	56.7
11300	185.4	9.5	66.2	66.2	55.9
11400	187.0	9.3	65.9	65.9	55.2
11500	188.7	9.1	65.6	65.6	54.5
11600	190.3	8.8	65.3	65.3	53.7
11700	191.9	8.6	64.9	64.9	52.9
11800	193.6	8.3	64.5	64.5	52.2
11900	195.2	8.1	64.1	64.1	51.5
12000	196.9	7.8	63.7	63.7	50.7
12100	198.5	7.5	63.2	63.2	49.9
12200	200.1	7.4	62.9	62.9	49.2

Annex 7: Table 8 Key Specifications for BYD Atto 3

Motor:	100 kW Permanent Magnet Synchronous Motor
Dimension:	4710 x 1810 x 1690 mm
Wheelbase:	2800 mm
Max Power:	136 PS
Max Torque:	310 Nm
Range	345 km (WLTP)
Top Speed:	160 Kmph
Drive Type:	FWD
Battery Capacity:	49.92 kWh Lithium-ion Battery

Annex 8: Table 9 Key Specifications for Tata Nexon XZ+ EV

Motor:	95 kW Permanent Magnet Synchronous Motor
Dimension:	3995 x 1814 x 1616 mm
Wheelbase:	2498 mm
Max Power:	129 PS
Max Torque:	245 Nm
Range	312 km (ARAI)
Top Speed:	140 Kmph
Drive Type:	FWD
Battery Capacity:	30.2 kWh Lithium-ion Battery

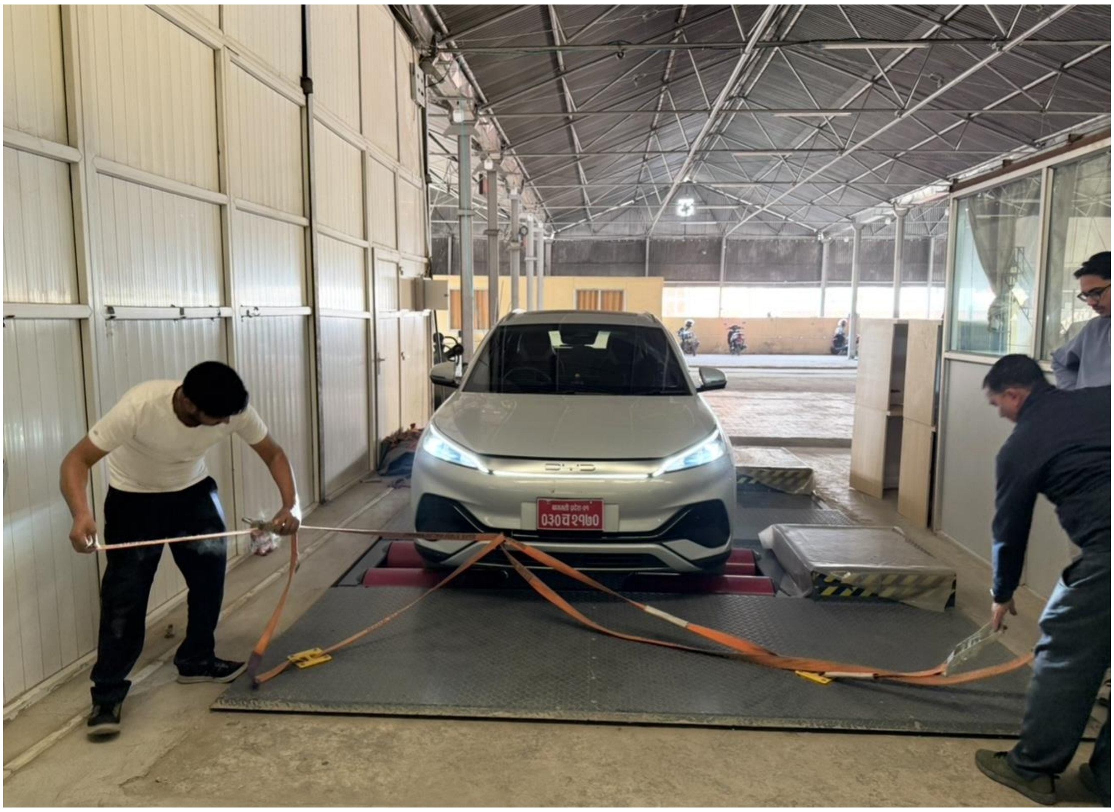
Annex 9: Table 10 Key Specifications for BYD Sealion 7

Motor:	100 kW Permanent Magnet Synchronous Motor (RWD)
Dimension:	4830 x 1925 x 16220 mm
Wheelbase:	2930 mm
Max Power:	136 PS
Max Torque:	380 Nm
Range	440 km (WLTP)
Top Speed:	200 Kmph
Drive Type:	RWD (AWD available)
Battery Capacity:	71.8 kWh Blade Battery

Annex 10: Dynamometer used in VFTC

Figure MAHA LPS 3000 PKW

Annex 11: Photographs



Harnessing the test vehicle

Wheels rotating at 100km/hr+ speed

Annex 12: Survey Questionnaire

Participant Information

1. Category of Respondent

Mark only one oval.

- EV User
- Mechanic
- Policymaker

2. Age Group

Mark only one oval.

- 18-25
- 26-35
- 36-50
- 51+

3. Location (City/District in Nepal)

____

4. Years of Experience/Relevant Use (if applicable)

Mark only one oval.

- 0-2 years
- 3-5 years
- 6-10 years
- 10+ years

Section 1: Performance Perception

5. How would you rate the overall performance of EVs (e.g., acceleration, range, reliability) compared to traditional vehicles?

Mark only one oval.

- Much Worse
- Slightly Worse
- Neutral
- Slightly Better
- Much Better

6. How satisfied are you with the range of EVs on flat terrain (e.g., Terai region)?

Mark only one oval.

- Very Dissatisfied
- Dissatisfied
- Neutral
- Satisfied
- Very Satisfied

7. How does the EV range perform in hilly or mountainous terrain (e.g., Kathmandu-Pokhara route)?

Mark only one oval.

- Significantly Reduced
- Moderately Reduced
- No Significant Change
- Slightly Improved
- Significantly Improved

8. What challenges have you faced with EV performance in Nepal's conditions?

Section 2: Maintenance Challenges Untitled Section

9. How frequently do EVs require maintenance compared to traditional vehicles?

Mark only one oval.

- Much More Frequent
- Slightly More Frequent
- Similar
- Slightly Less Frequent
- Much Less Frequent

10. What are the most common maintenance issues you encounter with EVs?

Mark only one oval.

- Battery Problems
- Charging System Issues
- Motor/Electronics Failures
- Other (please specify)

11. How accessible are spare parts and skilled technicians for EV maintenance in your area?

Mark only one oval.

- Very Inaccessible
- Inaccessible
- Neutral
- Accessible
- Very Accessible

12. What improvements would you suggest for EV maintenance support in Nepal?

Section 3: Economic Viability (Total Cost of Ownership)

13. How would you rate the initial purchase cost of EVs compared to traditional vehicles?

Mark only one oval.

- Much Higher
- Slightly Higher
- Similar
- Slightly Lower
- Much Lower

14. How do you perceive the long-term costs (e.g., fuel/electricity, maintenance) of owning an EV?

Mark only one oval.

- Much More Expensive
- Slightly More Expensive
- Neutral
- Slightly Cheaper
- Much Cheaper

15. Have government incentives (e.g., tax reductions, subsidies) influenced your decision to use or support EVs?

Mark only one oval.

- Yes
- No
- If Yes, how?

16. What factors most affect the economic viability of EVs in Nepal (e.g., charging infrastructure, electricity costs)?

____

Section 4: General Feedback

17. How likely are you to recommend EVs to others based on your experience?

Mark only one oval.

- Very Unlikely
- Unlikely
- Neutral
- Likely
- Very Likely

18. What additional support or infrastructure do you think is needed to promote EV adoption in Nepal?

Annex 13: Acceptance Mail from IOEGC

[IOEGC17] Editor Decision

IOEGC Admin <ioegc17@gmail.com> Sun, Dec 7, 2025 at 3:01 PM
To: Aman Shrestha <shresthaaman08@gmail.com>

Aman Shrestha:

We have reached a decision regarding your submission to 17th IOE Graduate Conference, "The PERFORMANCE ANALYSIS AND SOCIO-ECONOMIC IMPACT FACTORS FOR TRANSITION TOWARDS ELECTRIC VEHICLE IN NEPAL".

Our decision is to: **Accept Submission**

Reviewer's Comments:

- Please make the figure sizes larger (total width = width of the column) and make the annotations readable.

- Change the paper title from all "upper case" to "title case"

With Warm Regards,
IOEGC-17 Editorial Team

Annex 14: Plagiarism Check

Annex 14: Plagiarism Check

Aman Shrestha

PERFORMANCE ANALYSIS AND SOCIO-ECONOMIC IMPACT FACTORS FOR TRANSITION TOWARDS ELECTRIC VEHICLE I...

Tribhuvan University

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A

Annex 15: Comments and responses from Final Defense

S.N	Comments	Responses
1.	Conduct the survey for socio-economic analysis with at least 100 respondents profile	Conducted the questionnaire survey with 100 respondents profile. (page 40-42)
2.	Both vehicles Purchased with full payment or down payment was not mentioned in total cost of ownership analysis.	Mentioned and done proper assumptions for both case. (page 28, 32 and 37)
3.	Electricity tariffs might increase in future	Taken average per unit rate between residential and EV charging station rate (page 28, 32 and 37)
4.	Proper explanation of Range Analysis for all EVs	Done at page 26
5.	Justify obtained performance results with some test limitations.	Done at page 21
6.	Change the specific objective from life cycle analysis to total cost of ownership	Done at Page 6
7.	Make a proper methodology chart	Done at page 13
8.	Put obtained graphs and data from dynamometer into annexures	Done from page 50
9.	Acceptance mail from IOEGC and plagiarism check	Done and kept at annexures

Annex 16: Manuscript

IOE Graduate Conference
[Placeholder for Publication Information]

Performance Analysis and Socio-Economic Impact Factors for Transition Towards Electric Vehicle in Nepal

Aman Shrestha [a], Ajay Kumar Jha [b],

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[a]079msree001.aman@pcampus.edu.np , [b] akjha@ioe.edu.np ,

Abstract

This study investigates the performance, range, economic feasibility, and socio-environmental impacts of electric vehicle (EV) adoption in Nepal, aiming to evaluate their potential as sustainable alternatives to internal combustion engine (ICE) vehicles. Three different EV models were selected for detailed performance and range analysis, assessing their energy efficiency, driving characteristics, and suitability for Nepal's varied road and climatic conditions. The research further compared the Total Cost of Ownership (TCO) of EVs and ICE vehicles to determine economic competitiveness over a typical ownership period. To assess broader social and environmental dimensions, a questionnaire survey was conducted among 100 respondents, including EV users, mechanics, and policymakers. The survey explored user satisfaction, cost perception, environmental awareness, and employment implications related to EV transition. The results indicate that EVs demonstrate satisfactory performance and reliable range for urban commuting, with observed driving ranges only 10–30% lower than manufacturer claims. Despite higher initial purchase costs, EVs achieve cost recovery within approximately 3–4 years, offering average annual savings of NPR 65,000–75,000 compared to petrol vehicles. Respondents highlighted reduced noise, improved air quality, and lower maintenance requirements as key benefits, alongside challenges such as limited charging infrastructure and technical skill gaps. Overall, the findings affirm that EVs provide substantial economic, social, and environmental advantages and can significantly contribute to Nepal's sustainable transport development. Strengthening infrastructure, battery management, and policy coordination will be essential to accelerate Nepal's transition toward clean and energy-secure mobility.

Keywords

Electric Vehicles, Performance Analysis, Range Evaluation, Total Cost of Ownership, Socio-Economic Impact

1. Introduction

Electric vehicle (EV) adoption is accelerating globally as nations seek cleaner and more energy-efficient transport alternatives. In Nepal, the transition toward EVs is particularly promising due to the country's growing hydropower capacity, rising fuel import burden, and increasing environmental concerns. However, limited evidence exists regarding the real-world performance, range reliability, economic competitiveness, and socio-economic implications of EVs under Nepalese driving conditions. This study evaluates the performance and driving range of selected EV models, compares the total cost of ownership (TCO) between EVs and internal combustion engine (ICE) vehicles, and assesses the socio-economic impact of EV adoption through user, mechanic, and policymaker surveys. The research aims to provide data-driven insights that support informed decision-making and contribute to Nepal's ongoing transition toward sustainable and low-carbon mobility.

Electric vehicle (EV) performance, particularly energy efficiency, range, and battery behavior, is widely recognized as a major determinant of adoption. Studies show that EVs are significantly more energy-efficient than internal combustion engine (ICE) vehicles, consuming 3–4 miles/kWh compared to 0.25–0.35 miles/kWh for gasoline cars [1], and they offer long-term fuel and maintenance savings, especially in regions using renewable electricity [1]. However, environmental factors such as cold temperatures, steep terrain, and battery thermal limitations can reduce range and efficiency [2], challenges also observed in Nepal where hilly topography and limited charging infrastructure constrain real-world performance [3]. Socio-economic studies highlight job creation potential but also risks of displacement in fossil-fuel-based industries, while high upfront cost and limited skilled workforce remain barriers in Nepal [4]. Environmentally, EVs reduce emissions when powered by renewable energy [4], which is significant given Nepal's >90% hydropower share [3]. Policy support including incentives, subsidies, and regulatory frameworks is essential for accelerating EV adoption [5, 6], yet Nepal's existing policies face implementation limitations [3]. Nonetheless, EV imports have surged, with 22,603 units entering Nepal in FY 2023/24 (a 193.12% increase), and 13,425 imported in the first half of FY 2024/25, driven by tax incentives, rising fuel prices, hydropower availability, and expanding charging networks, signaling rapid growth in electric mobility.

Nepal is experiencing rising interest in electric vehicles (EVs) as a strategy to reduce fossil fuel dependence, cut transportation emissions, and utilize its abundant hydropower resources. However, the transition remains affected by limited real-world performance data, particularly across Nepal's challenging hilly and high-altitude terrains. Existing studies rely largely on manufacturer specifications or research from countries with flat terrain and advanced infrastructure, offering limited relevance to Nepal's unique geographical and infrastructural context. Moreover, comparative lifecycle analysis of EVs over internal combustion engine (ICE) vehicles is not well quantified nationally, and evidence on user perceptions, institutional preparedness, and broader socio-economic impacts remains scarce. Addressing these gaps requires a comprehensive evaluation of EV performance under Nepal-specific conditions, a comparative lifecycle analysis of EVs and ICE vehicles, and an assessment of socio-economic implications to support evidence-based policymaking and informed consumer decisions. This study aims to evaluate the effectiveness of transitioning to electric vehicles in Nepal, with a focus on performance analysis and socio-economic impacts.

2. Methodology

This study adopts a structured multi-phase methodology to evaluate the technical, economic, and socio-environmental performance of electric vehicles (EVs) in Nepal. The approach consists of four major components: data collection, performance evaluation, financial assessment, and integrated data analysis.

2.1 Data Collection

Data collection involved both primary and secondary sources to ensure analytical rigor. Primary data included technical measurements obtained from controlled chassis dynamometer tests at the Vehicle Fitness & Test Centre (VFTC), where power, torque, and speed characteristics of the selected EV models were recorded under standardized conditions. A structured perception survey was administered to EV users, mechanics, and policymakers to capture attitudes toward performance, range, and charging infrastructure. Secondary data were compiled from academic literature, manufacturer specifications, government reports, and EV market statistics, providing baseline inputs for benchmarking and validation.

2.1.1 Primary Data from VFTC

After vehicle selection, dimensional verification and secure mounting procedures were conducted to set up each vehicle on the test rig. The MAHA LPS 3000 PKW chassis dynamometer was used to collect real-time power and torque data under controlled acceleration, deceleration, and constant-speed conditions. These measurements form the basis for comparative performance profiling and range estimation across different terrains.

2.1.2 Secondary Data

Complementary secondary data on EV imports, national sales trends, charging station expansion, and vehicle specifications were sourced from government publications, industry reports, and peer-reviewed literature. These datasets were used to contextualize performance metrics, validate dynamometer derived parameters, and support macro-level socio-environmental assessments.

2.1.3 Vehicle Selection

Three EV models—BYD Atto 3, Tata Nexon EV, and BYD Sealion 7—were selected to represent the premium compact, mid-range, and full-size SUV categories, respectively. Their selection reflects their market relevance and suitability for Nepal's diverse terrain. The Atto 3, equipped with a 49.92 kWh LFP battery and a WLTP range of 345 km, represents the premium urban-use segment. The Nexon EV, with a 30.2 kWh battery and an ARAI range of 312 km, captures the mass-market segment commonly used in both urban and semi-urban regions. The Sealion 7, featuring a 71.8 kWh LFP battery and WLTP range of 440 km, enables the evaluation of long-distance and high-load performance. Collectively, these models provide a diverse comparative framework for analyzing performance efficiency, range variation, energy consumption, and total cost of ownership (TCO) under Nepal-specific driving conditions.

2.2 Performance Analysis

Performance analysis integrates dynamometer data, terrain-specific range estimations, and survey-based user perceptions to evaluate EV operability in Nepal's geographic and infrastructural context. Dynamometer tests quantify power output, torque delivery, and vehicle efficiency under controlled conditions. Terrain-based range assessments estimate real-world driving ranges across flat, hilly, and mountainous regions using terrain simulation factors and user-reported data. Comparative evaluations examine deviations between manufacturer claims and observed performance, including benchmark comparisons with ICE vehicles. Survey feedback—analyzed using descriptive statistics and Likert-scale aggregation—is integrated to contextualize technical findings with user experiences related to performance, reliability, and range satisfaction.

2.3 Financial Assessment and Data Analysis

The financial assessment examines the long-term economic viability of EVs by calculating the Total Cost of Ownership (TCO) for both EV and ICE vehicle models over a standardized ownership period. The analysis incorporates all major cost components, including purchase price, financing, energy or fuel expenses, maintenance, insurance, and depreciation, enabling a comprehensive comparison between the two technologies. A financial model is developed to identify key cost drivers and evaluate conditions under which EVs offer superior economic returns.

The final data analysis integrates technical performance results, survey-based perception metrics, and financial outputs to generate a holistic interpretation of EV competitiveness. Dynamometer-derived power and torque data are statistically analyzed to identify performance differences, while perception data are evaluated to reveal adoption barriers, user expectations, and correlations with measured performance. Additionally, a socio-environmental assessment considers lifecycle emissions, noise reduction, and infrastructure requirements, contextualizing the wider implications of large-scale EV adoption in Nepal. Collectively, these analyses provide an integrated understanding of the technical, economic, and societal dimensions influencing the transition from ICE vehicles to EVs.

3. Results and Discussion

3.1 Performance Analysis

3.1.1 Power and Torque Graph of BYD ATTO 3 ADVANCED

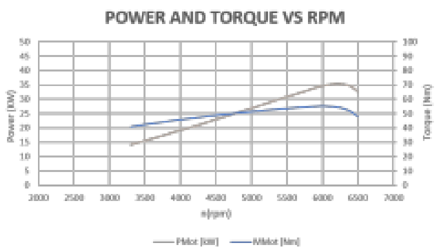


Figure 1: Power and Torque VS RPM of BYD ATTO 3

The dynamometer results indicate that the BYD Atto 3 Advanced achieved a peak power output of 35.4 kW (48.1 BHP) at 6220 RPM. The maximum torque recorded was 55.1 Nm, occurring at a vehicle speed of 71.7 km/h and a motor speed of 6035 RPM. The torque curve remains relatively flat across the low- and mid-RPM ranges, indicating a stable mid-range response typical of compact-class electric drivetrains. This suggests strong drivability characteristics and efficient torque delivery during urban and semi-urban acceleration cycles.

3.1.2 Power and Torque Graph of Tata Nexon EV

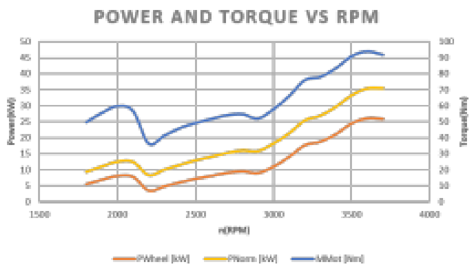


Figure 2: Power and Torque vs. RPM for the Tata Nexon EV

The dynamometer results show that the Tata Nexon EV achieved a maximum corrected engine power of 35.6 kW (48.4 BHP), aligning well with expected performance for compact electric SUVs in its class. The measured wheel power peaked at 26.0 kW (35.3 BHP), reflecting typical drivetrain and transmission losses. The maximum torque recorded was 94.0 Nm at approximately 3575 RPM, indicated by the steep rise in the torque curve. Torque delivery remained consistent across the lower to mid RPM ranges, a characteristic feature of electric propulsion.

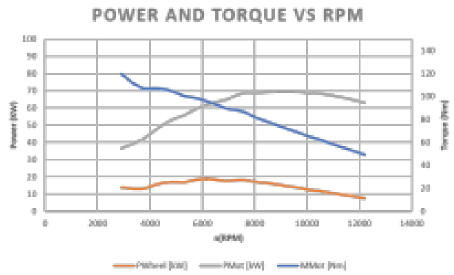


Figure 3: Power and Torque vs. RPM for the BYD Sealion 7

3.1.3 Power and Torque Graph of BYD Sealion 7

The BYD Sealion 7 demonstrated a peak engine power output of 69.4 kW (94.4 BHP) at 9005 rpm, substantially higher than the previously tested vehicles and indicative of superior high-end performance. The measured wheel power was 14.8 kW (20.2 BHP), highlighting drivetrain and mechanical losses commonly observed in rear-drive configurations. The recorded drag power was 54.6 kW (74.2 BHP), accounting for friction, inertia, and rolling resistance effects. The engine reached a maximum rotational speed of 13,200 rpm at a vehicle speed of 218.0 km/h, reflecting strong top-end capability. The maximum torque output was 120.2 Nm at 2600 rpm and 47.0 km/h, with the torque curve rising sharply at low rpm, peaking early, and tapering off as engine speed approached its upper limit.

Test Limitations

While the dynamometer-based tests conducted at the Vehicle Fitness Test Centre (VFTC) provide controlled and repeatable measurements, several limitations must be acknowledged. Chassis dynamometer conditions do not fully emulate real-world driving factors such as aerodynamic drag, road gradients, surface irregularities, or traffic variability. Calibration differences, drivetrain losses, and load-simulation constraints may also lead to deviations from manufacturer-reported figures. Furthermore, the tests did not incorporate the effects of battery thermal management or extreme temperature conditions, both of which significantly influence EV performance in Nepal's varied climate. Complementary on-road testing and long-term monitoring would strengthen the validation of these laboratory findings.

3.2 Range Analysis

To evaluate the real-world driving capability of the selected electric vehicles (EVs), a comparative range assessment was conducted across three representative terrain categories in Nepal. The analysis compares the "measured" real-world ranges obtained from full-charge testing with the manufacturer- claimed global test-cycle values. Terrain classifications were defined based on Nepal's geographical conditions:

- **Flat terrain**: Representing Terai regions and major highways with minimal elevation change, allowing for

Table 1: Test Results data for Range Analysis of tested EV models

Vehicle	Terrain	Claimed Range (km)	Measured Range (km)
BYD Atto 3	Flat	345 (WLTP)	330
	Hilly	345 (WLTP)	280
	Mountain	345 (WLTP)	240
Tata Nexon EV	Flat	312 (ARAI)	285
	Hilly	312 (ARAI)	240
	Mountain	312 (ARAI)	200
BYD Sealion 7	Flat	Up to 440 (WLTP)	420
	Hilly	Up to 440 (WLTP)	370
	Mountain	Up to 440 (WLTP)	330

more efficient energy use.

- **Hilly terrain**: Typical of areas such as Kathmandu–Pokhara, characterized by moderate inclines and variations in elevation, where regenerative braking partially offsets increased energy consumption.
- **Mountainous terrain**: High-altitude routes with steep gradients and continuous climbs, imposing significant load on the battery and reducing overall range.

The resulting real-world performance across these terrains is summarized in Table **??**.

The table provides a comparative overview of the real-world driving range performance for the BYD Atto 3, Tata Nexon EV, and BYD Sealion 7 across different terrains—flat, hilly, and mountainous—alongside their official claimed ranges.

3.2.1 Results Interpretation

The results reveal a consistent decrease in range with increasing terrain difficulty, primarily due to steeper gradients, higher energy demand during climbs, and reduced battery efficiency in colder high-altitude environments.

- **BYD Atto 3**: The claimed WLTP range is 345 km. Real-world performance shows 320–340 km on flat terrain, decreasing to 260–300 km in hilly regions and further to 220–260 km in mountainous areas. These trends align with user feedback from Nepal, indicating that WLTP figures tend to be optimistic under challenging terrain conditions.
- **Tata Nexon EV**: With a claimed ARAI range of 312 km, the Nexon EV achieves 270–300 km in urban and highway conditions. The range drops to 220–260 km on hilly routes such as Kathmandu–Pokhara and declines further to 180–220 km in mountainous terrain. The sharper decrease compared to the Atto 3 reflects its smaller battery capacity and slightly lower system efficiency, though it remains adequate for everyday urban driving.
- **BYD Sealion 7**: Featuring a significantly larger battery and a claimed WLTP range of up to 440 km, the Sealion 7 delivers 400–420 km on flat terrain. In hilly regions, the range remains strong at 360–380 km, while mountainous conditions reduce it to 310–340 km. Despite terrain-induced losses similar to other models, the larger battery capacity ensures superior endurance under all conditions.

3.3 Financial Comparison: Total Cost of Ownership (TCO)

3.3.1 Comparison of BYD Atto 3 and Hyundai Creta (ICE)

Key assumptions for the Total Cost of Ownership (TCO) analysis include:

- **Annual mileage:** 12,000 km, consistent with estimates from the Department of Transport Management (DoTM) for urban and suburban SUV usage in Nepal [7].
- **Ownership horizon:** 20 years.
- **Electricity tariff:** NPR 11 per kWh (residential rate) and NPR 15 per kWh at BYD charging stations, yielding an average effective rate of NPR 13 per kWh [8].
- **Petrol price:** NPR 161 per liter, based on Category C pricing for Kathmandu Valley by Nepal Oil Corporation (NOC) [9].
- **Efficiency:** BYD Atto 3 = 15 kWh/100 km under real-world mixed driving conditions; Hyundai Creta (petrol) = 12 km/l.

All monetary values are expressed in NPR lakhs (1 lakh = 100,000 NPR).

3.3.2 TCO Breakdown Over 20 Years

The table below presents the cumulative costs in NPR lakhs, highlighting the cost advantages of the electric vehicle due to significantly lower energy and maintenance expenditures compared to the internal combustion engine (ICE) alternative.

Discussion and Insights

Over a 20-year lifecycle, the BYD Atto 3 demonstrates a net Total Cost of Ownership (TCO) advantage of NPR 15.87 lakhs compared to the Hyundai Creta, primarily due to significantly lower energy costs (NPR 1.65/km for the EV vs. NPR 13.42/km for the ICE counterpart) and reduced maintenance requirements, resulting in annual savings of approximately NPR 65,000. Even under the updated residential electricity tariff in Nepal of NPR 11/kWh and occasional public charging surcharges, operating costs of EVs remain favorable due to Nepal's low-cost hydropower, which is nearly 40% cheaper than the Asian regional average. Although long-term considerations such as post-warranty battery replacement (NPR 10–15 lakhs) pose financial risks, government initiatives—including ERC tariff incentives and reduced import duties—continue to strengthen EV affordability and support national adoption targets. These financial advantages

Table 2: TCO Comparison : BYD Atto 3 vs Hyundai Creta Petrol

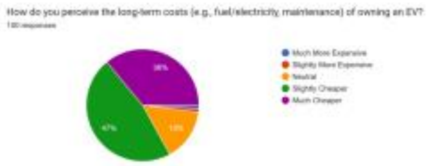
Cost Component	BYD Atto 3	Hyundai Creta	Difference (Savings for EV)
Purchase Price	56.90 [10]	53.96 [11]	-2.94 (Higher for EV)
Fuel/Energy (20 Years)	4.68	32.20	+27.52 (EV Savings)
Maintenance (20 Years)	3.0	16.00 [12]	+13.00 (EV Savings)
Insurance (20 Years)	10	10	0.00
Road Tax (20 Years)	3.00	5.00	+2.00 (EV Savings)
Battery ×2 (Yr9 + Yr17)	24.00	–	-24.00 (Higher for EV)
Subtotal (Operating)	101.58	117.16	+16.3 (EV Savings)
Resale Value (Credit)	-5.69	-5.4	+0.29 (EV Advantage)
Net TCO (20 years)	95.89	111.76	+15.87 (EV Savings)

underscore the Atto 3's economic viability, particularly for urban commuters, while simultaneously contributing to reduced fossil fuel imports and lower transport-sector emissions. Future research may incorporate time-of-use tariffs and solar-assisted home charging to further optimize EV economics.

3.4 Socio-Economic Impacts and Cost Savings

The adoption of electric vehicles (EVs) is widely perceived as economically favorable in the long term, despite the higher initial purchase cost.

Cost Analysis: A substantial majority of EV users (83%) reported achieving significant cost savings compared to operating internal combustion engine (ICE) vehicles. The average annual savings attributed to reduced fuel and maintenance expenditures were estimated to range between NPR 65,000 and NPR 75,000. This finding was further supported by automobile mechanics, who noted reduced servicing intervals and decreased reliance on complex, high-wear component replacements typically associated with ICE drivetrains.



Maintenance Constraints: Despite the lower operational costs, survey responses revealed a significant barrier related to post-purchase technical support. Participants reported considerable difficulties in obtaining spare parts and accessing skilled technicians capable of servicing specialized EV components, including high-voltage batteries, controllers, and sensor systems. This gap in technical expertise and supply-chain readiness poses a risk to the long-term economic advantages of EV ownership, as it may increase both the cost and complexity of major EV-specific repairs.

4. Conclusion

This study demonstrates that electric vehicles (EVs) in Nepal offer reliable performance, adequate real-world range, and substantial economic advantages over internal combustion engine (ICE) vehicles. Although observed ranges were 10–30% lower than manufacturer estimates due to terrain and environmental factors, all tested EVs provided sufficient capability for typical daily travel demands. The Total Cost of Ownership (TCO) analysis indicates annual savings of NPR 65,000–75,000 and a break-even period of approximately 3–4 years, driven by low energy costs and reduced maintenance requirements supported by Nepal's hydropower-based electricity supply. Survey results further reveal strong user satisfaction and notable socio-economic benefits, including reduced emissions and noise levels, while also identifying existing barriers such as limited charging infrastructure, policy inconsistencies, and challenges related to battery recycling. Overall, the findings underscore the practicality, long-term viability, and strategic importance of EVs in supporting Nepal's transition toward sustainable transportation.

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