

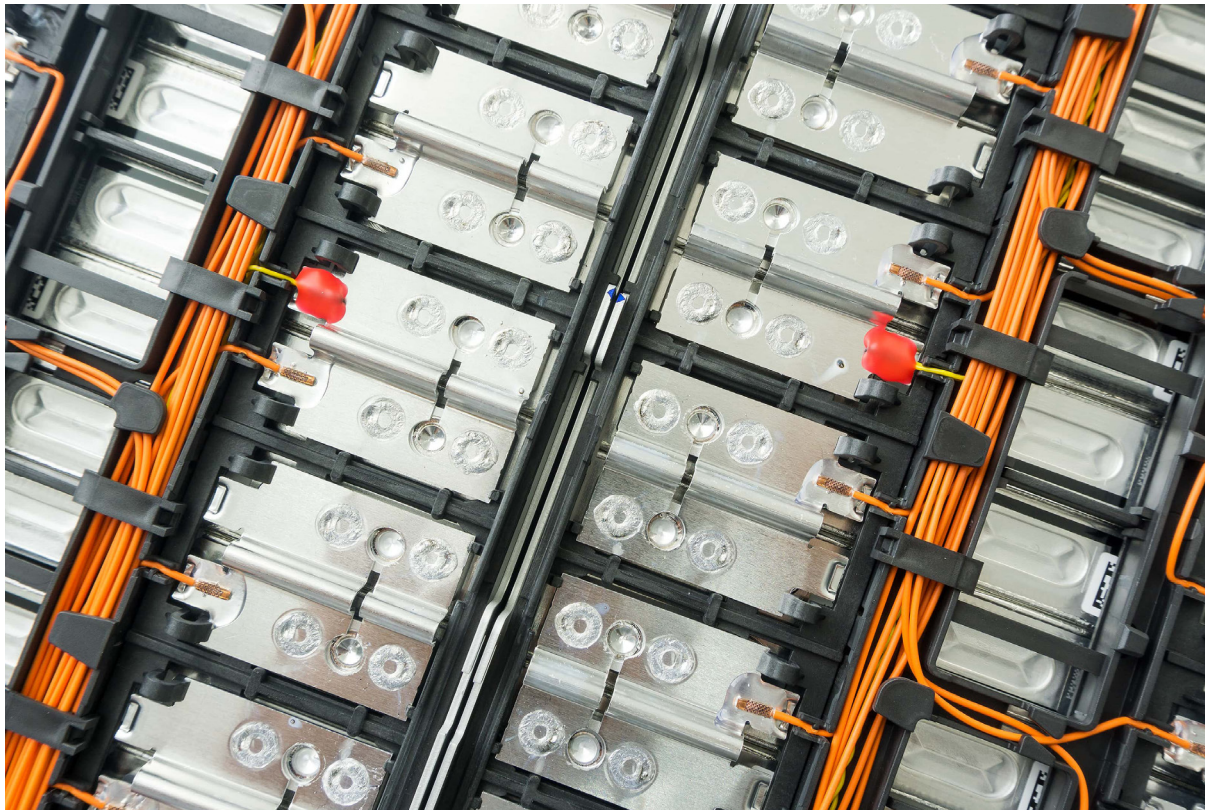


Electric Vehicles: Make In Pakistan Perspective

JUNE 2023

Moving from policy to action





ELECTRIC VEHICLES: MAKE IN PAKISTAN PERSPECTIVE

Moving from policy to action

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List of Acronyms

2W	Two Wheeler
CD	Customs Duty
CSR	Corporate Social Responsibility
E2W	Electric two wheeler
EDB	Engineering Development Board
EV	Electric Vehicle
FED	Federal Excise Duty
GHG	Green House Gases
ICE	Internal Combustion Engine
LCV	Light commercial vehicles
LULUCF	Land use, land-use change, and forestry
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
ST	Sales Tax

Foreword

This study entitled ‘**Electric Vehicles: Make-in-Pakistan Perspective**’ has been completed by The Pakistan Business Council (PBC) as part of its “**Make-in-Pakistan**” initiative.

Electric vehicles (EVs) offer a unique opportunity to transition to a fleet of vehicles, using which would reduce greenhouse gas emissions, limit usage of fossil fuels (net of the fuels used in generating electricity to power EVs), alleviate the burden on Pakistan’s external account, while allowing the possibility to manufacture EVs and their parts locally.

Despite the opportunity, the high price point of EVs makes it less commercially viable in Pakistan, especially given the limited purchasing power of consumers in the wake of the high inflation economic environment. The available market opportunity is mainly in the 2-wheeler and 3-wheeler segments, which offer a mobility solution for consumers who cannot afford to buy more expensive four-wheelers.

There is also an opportunity to export auto-parts for EVs manufactured in other countries, for which international quality standards need to be adopted and implemented for global acceptability of the EV auto-parts manufactured in Pakistan.

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This sector report is intended to inform Pakistan’s overall industrialization policy.

Ehsan A. Malik

CEO, The Pakistan Business Council

A photograph of a dark grey electric scooter parked at a charging station. A red charging cable is plugged into the scooter's port and the station's outlet. The background features modern glass-fronted buildings and some greenery. A blue rectangular box with white text is overlaid on the lower left portion of the image.

EXECUTIVE SUMMARY

1. Executive Summary

Electric vehicles (EVs) have the potential to drive multi-faceted growth in Pakistan, but clear and focused policy measures are crucial for success. India and several ASEAN countries have already demonstrated successful transitions to EVs, establishing local industries in the process. The global market, regulated by the United Nations WP.29 guidelines, prescribe standards for universal adoption, facilitating cross-border acceptance. This ensures that investments made to create export-focused EV products have consistent long-term demand regardless of the country of origin.

The report explores how EVs can be facilitated in Pakistan through policy and procedural frameworks, leading to a range of long-term benefits. The total cost of ownership (TCO) of EVs remains higher than internal combustion engine (ICE) vehicles, mainly due to high battery costs. However, the economic benefits are significant, including lower fuel imports, a reduction in unutilized generation capacity, and contributions towards greenhouse gas (GHG) reduction. With an export focused vision, the transition to EVs can usher a new era for the auto industry, one which contributes valuable forex to the exchequer instead of draining it.

There is a favorable market opportunity for electric vehicle (EV) adoption in Pakistan's two-wheeler and three-wheeler market segments. Achieving standardized inter-operable parts will create a large enough market for complete localization of EV components. To enable the use of three-wheelers for personal/non-commercial purposes, the government needs to revise regulations to allow three wheelers for personal, non-commercial use. Two-wheeler and three-wheeler adoption will necessitate charging and battery swapping infrastructure. With readily available home, office and public charging infrastructure adoption of four wheelers will be natural.

The four-wheeler market is hindered by price sensitivity, and the limited domestic demand alone cannot support large-scale local indigenization. To establish such a market and drive growth, Pakistan needs to tap into the global market to access larger customer base and leverage economies of scale. While it may not be feasible for Pakistan to export complete cars in any form, car parts can easily meet the required WP.29 standards and become export-ready. Developing the industry with a vision for global market will contribute to long-term industrial growth. It will lead to economies of scale, enabling the production of globally competitive and cost-effective cars.

Hybrids present a unique opportunity; more expensive than standard EVs, they cater to the eco-friendly and less price sensitive consumer segment. While the scope for indigenization is limited, easing their introduction can serve as a test bed for infrastructure development and regulation.

For the successful adoption of EVs in heavy and light commercial vehicles, substantial investment in charging infrastructure is necessary. Strategically located public chargers along metro routes and motorways can encourage adoption.

Regulatory measures and fiscal incentives have already been introduced to facilitate EV adoption. Adopting the EV regulatory framework set forth by WP.29 is recommended as an initial step to define the EV vision and establish focused policies in Pakistan. However, further clarification is needed in building codes, tariff regulations, and quality specifications. Addressing challenges related to raw material supply chains for EV components, such as lithium and rare earth metals, is crucial to avoid future import dependency. Developing domestic sources or securing sustainable international supply chains is paramount. Regulatory oversight is also necessary to ensure sustainable and efficient use of resources throughout the EV lifecycle. Implementing government charging infrastructure in model cities can catalyze market action and encourage consumer adoption of EVs.

To achieve indigenization of the EV industry, establishing a link between government-funded intellectual property (IP) development and industries, and open-sourcing these developments is essential. Cross-functional industries, such as electronics, that contribute to the EV ecosystem should receive sectoral tax exemptions through HS code extensions.

Moreover, a complete overhaul of the existing people-oriented processes, to an IT-focused one-window portal is necessary to streamline operations and enhance efficiency. This will simplify procedures for businesses, investors, and stakeholders in the auto industry.

Making bold and deliberate decisions is crucial for creating a sustainable and future-proofed auto industry in Pakistan. By adopting standardization, focusing on localized parts manufacturing, promoting indigenization through open-sourced IP, providing time restricted, sharply focused fiscal support, and embracing digital transformation, Pakistan can pave the way for a thriving and competitive EV ecosystem.

A photograph of a row of blue electric vehicle charging stations in a parking garage. The focus is on the foreground station, which has a black charging cable plugged into it. The station has a digital display showing 'Check Out' and 'Charging' status. A green light is illuminated, indicating the vehicle is charging. The background shows other similar stations and the structure of the parking garage.

INTRODUCTION

2. Introduction

Humanity is at a defining epoch; our actions have contributed to global warming which if continued without any change, will result in mass extinction of species, including our own. To address this, countries have adopted policies to ensure that the increase in global temperatures remains below 2°C. The transport sector is a major emitter of Greenhouse Gases (GHGs) directly contributing to global warming. Electric Vehicles (EVs) are a breakthrough solution to drastically limit the GHG emissions from the sector. By utilizing zero fossil fuels, EVs result in near zero operating emissions.

Pakistan is among the top 10 vulnerable countries due to climate change. The challenge is not only ecological, as demonstrated by the recent floods that affected one-third of the country; there are also evident immediate and long-term economic impacts. While Pakistan's transport sector currently contributes minimally to GHG emissions (9%¹), a holistic approach is needed to introduce EVs and ensure that future GHG contributions level off and eventually decrease.

The economy faces another challenge in the form of the oil import bill, 60² – 76%³ of which is consumed by the transport sector. EVs address this challenge by enabling a transition to greener fuel sources.

The current account deficit is a major cause of stress in the economy. Weak industrialization levels have made Pakistan reliant on trade. EVs present a unique opportunity to reduce the deficit by creating a new local industry and limiting imports. A successful establishment of this industry will also lead to exports, further improving the balance of trade. From a technological perspective, the transition is relatively easy as the infrastructure requirements for multiple EV components (e.g., chargers, motors) are readily available.

EVs are expected to alleviate the drain on national fiscal resources by better utilization of generation capacity. Overnight charging of EVs, will alleviate the unabsorbed capacity payments under the current 'take or pay' arrangements. The impact on capacity payments will increase as EVs see widespread adoption.

To successfully tap into the benefits of EVs, initial regulatory steps have been taken, providing fiscal incentives to promote EV adoption. However, a focused and goal-oriented vision that reflects the Pakistani market is needed for successful technology adoption. The price-sensitive market is dominated by two-wheelers, which provide the necessary economies of scale to explore new technologies. Additionally, the market is vendor-agnostic, allowing the same parts to be used across multiple brands. EVs replace Internal Combustion Engine (ICE) car components (e.g., engines, fuel) with motors and batteries, which come in various quality grades. The regulatory approach needs to clearly define all new components and categorize them into appropriate performance and capacity brackets to ensure

1 NDC 2021 Tbl 4.1 <https://unfccc.int/sites/default/files/NDC/2022-06/Pakistan%20Updated%20NDC%202021.pdf>

2 TDAP, Petroleum Sector of Pakistan and Its Trade Dynamics, <https://tdap.gov.pk/wp-content/uploads/2022/03/13-Petroleum-Sector-of-Pakistan-and-its-Trade-Dynamics-1.pdf>

3 PIDE <https://pide.org.pk/Research/Gas-and-Petroleum-Market-Structure-and-Pricing.pdf>

consumer confidence and encourage the early majority instead of just early adopters.

The smaller four-wheeler market is also price-sensitive but lacks scale, which is further limited by vendor-specific components. The regulatory approach here needs to focus more on market creation, tapping into the global market as an enabler. However, to unlock this potential, UN standards need to be implemented, some of which have been around for six decades but remain unimplemented in Pakistan. This highlights the challenges in policy vision and subsequent implementation. Fortunately, in today's IT-driven world, solutions can be easily created to automate and ensure implementation.

The Heavy Commercial Vehicle (HCV) market is too small to be considered for localization. EV-enabled public mass transit schemes provide a way to explore and test the market. With the learnings from these schemes, definitive policy actions can be formulated to transform bulk intercity travel.

Light Commercial Vehicle (LCV) market has niche opportunities, some passenger routes on the motorway and intracity B2B delivery services have strong EV potential. A dearth of charging infrastructure and lack of clarity on tariff is hindering opportunity realization.

The study indicates the presence of an untapped market that may be suitable for EVs – the three-wheeler market. This product sits ideally between cars and two-wheelers and has the potential to transform the overloaded and accident-prone two-wheeler consumer base into a safer segment. It also fills the price gap between a car and a bike. A key enabler here is to review and change the policy which limits three wheelers to be used for any purpose other than commercial transport.

In the less price sensitive end of the market, there is space for powerful EVs and hybrids. Hybrids derive power from both batteries and fuel, offering worry-free travel with limited charging infrastructure and a similar driving feel to standard cars. Due to their combination of engines and motors, hybrids are technologically more complex than either ICE cars or EVs. Enabling hybrids in Pakistan will allow early adopters to support the nascent charging infrastructure.

Retrofitting existing cars to become EVs is a practical option. From a purely engineering perspective, this may not yield highly efficient cars, but from a market perspective, it enables a market segment to benefit from EVs via home-based chargers.

A key enabler for EVs is the availability of chargers. From a localization perspective, Pakistan has good technical resources for manufacturing chargers. Regulations have also clarified charger requirements for both intercity and intracity charging. However, building codes and regulations need to be updated, and specifications should be made available. Charger installation has been slow due to minimal demand. Implementing EV-only zones and providing government infrastructure in model cities will encourage consumer adoption of EVs.

Despite all their advantages, EVs are a double-edged sword. The raw materials required for creating

components have monopolistic and weak supply chains. Lithium, Nickel, and rare earths are used in batteries and motors. Batteries have a limited lifespan and will eventually dominate import bills to sustain new production and maintain older fleets. Without regulatory oversight, Pakistan may face a future where the current account deficit is due to lithium. Currently, commercial solutions exist in the form of lead-acid batteries, which is a thriving local industry. These solutions are practical for low-power EVs in the two-wheeler and possibly three-wheeler segments. Similarly, motor solutions exist without utilizing rare earth metals. The current motor manufacturing industry needs a technological overhaul to support EVs effectively.

Pakistan is a unique country, characterized by a large population, low industrialization, and a weak economy. Moving forward, the approach should be deliberate and conservative, taking the best policies from peer countries. ASEAN countries offer a similar mix in the transport sector and have successfully kickstarted local EV Original Equipment Manufacturers (OEMs). India has had a decade-long EV transition experience, and recent policies have achieved notable successes. However, it is India's core 'India first' approach, combined with decades of a closed-market economy, that has enabled high levels of industrialization and positioned India to enable localized EVs.

The document reviews the global EV market and compares the approaches of peer countries to EVs. This is followed by a review of the Pakistani market, including feedback from relevant stakeholders. The report concludes with a series of policy recommendations to guide EV enablement and effective 'Make in Pakistan' policies. The annexures provide a focused overview of ancillary topics, including the UN reference regulatory framework for EVs and the National Electric Vehicle Policy of Pakistan.



EVs: GLOBAL MARKET

3. EVs: Global Market

3.1. Global Outlook

Global outlook for EVs is exponential – EV sales doubled in 2021 year on year; a decade ago's annual sales are now weekly sales. Currently, one in every 10 cars sold globally, is an EV. These exceptional numbers are a direct result of sustained policies. Foremost are subsidies and incentives which doubled in 2021 to \$ 30 billion. Additionally, a key driving mandate is the required phase out of ICE vehicle sales. The automobile industry has responded with alacrity and has set targets beyond what has been mandated by policy. This has resulted in a vast selection of EVs attracting all segments of the consumer base.

China, EU and USA lead the global EV consumer market. Emerging populous economies Brazil, India and Indonesia account for less than 0.5% EV sales. China has dominated the EV consumer market with 2021 sales (3.3 million) beating *global* 2020 sales. From a market segmentation point of view, the domination is even more conspicuous – 95% in global 2 / 3-wheeler sales and 90% in global electric bus and trucks sales were Chinese. The European market showed high growth as well, with an increase of about 65% with 2.3 million in sales. The US market in 2021 was about 600,000 EVs.

Over 16.5 million electric cars were on the road in 2021, a tripling in just three years

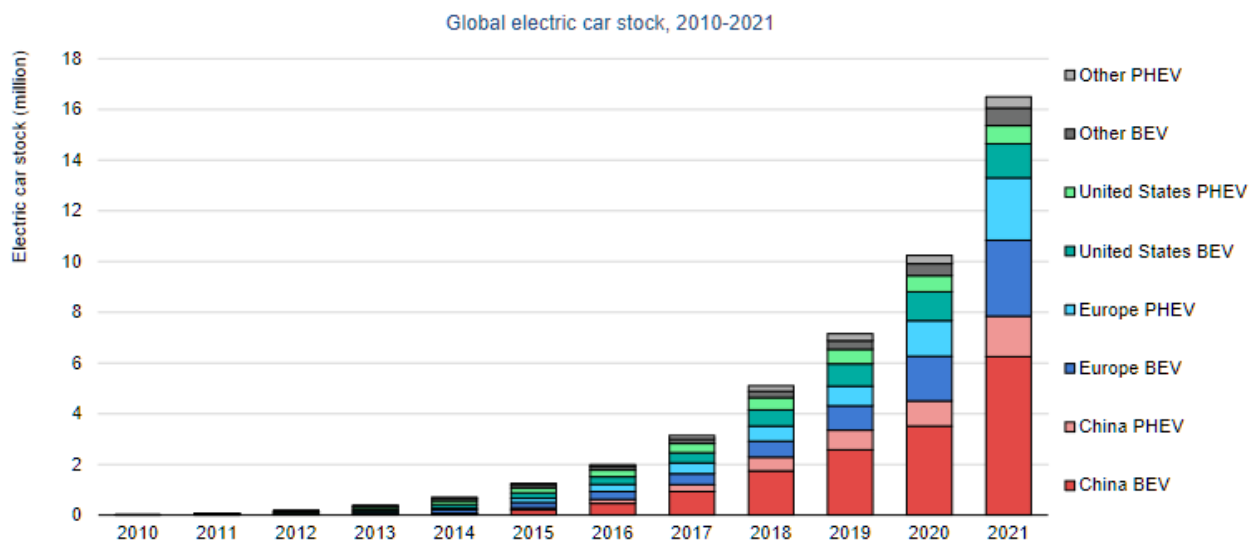


Figure 1 : Global EV Cars Growth⁴

⁴ Global EV Outlook 2022

Future global growth is strongly tied to the Paris Agreement (2015) and the resulting Net Zero Emissions by 2050 (NZE) target. To achieve NZE, countries have announced ambitions and targets termed as Announced Pledges Scenario (APS). A conservative and holistic look at the on-ground policies may be better indicative of the future, these are referred to as Stated Policies Scenario (STEPS). Based on STEPS, global vehicle sales of EVs in 2030 will be around 20%, which is an 11x increase from current EV count. One division poised for high growth is the EV trucks and busses, which is predicted to increase to 25% from the current 0.3% of rolling stock.

To meet market demand, manufacturers are scaling production and innovating, with China leading the world by example. The Chinese domestic market requirements of physically smaller cars has significantly contributed to cost effective manufacturing – the price differential to ICE vehicles is only about 10%.

Manufacturer	2030 Target
Toyota	3.5 million annual sales with 30 BEV models
Volkswagen	70% EU sales and 50% worldwide sales to be EV
Ford	50% US sales and 100% EU sales to be EV
Volvo	100% sales to be EV
BMW	50% sales to be EV
Mercedes	2025 onwards all new models to be EV
Hyundai	1.9 million annual BEVs production
Kia	1.2 million annual BEVs production

Table 1 : Auto Manufacturer EV plans

Global public EV infrastructure plans to meet the market requirements are insufficient. This dearth is expected to be filled by home and office-based chargers. The impact of EVs on the utility grid via grid level simulation shows the impact to be minimal.

Battery supply chain is the weakest link in the EV ecosystem, since the exponential demand for lithium does not have a robust mining supply. Establishing functional mines is a decade long process – from exploration, discovery, feasibility and development, even expansion of functional mines requires a minimum of 3 – 5 years. Current lithium mines are located in Australia, Chile and Congo and controlled by a few companies. To meet the projected demand, the lithium mining and refining industry needs to grow by at least 5 times in a decade.

It is pertinent to note that clear phase out mandates were introduced to shift the transition from ICE vehicles to EVs. These were supported with subsidies. From a local perspective, whereas both exist on paper, actual implementation leaves a lot to be desired. The constant cosmetic approach to enablement does more harm than good as the industry adopts a ‘wait and see’ approach, delaying technology adoption. Additionally, given the weak Lithium supply chain, Pakistan needs to judiciously plan *quality* battery imports.

3.2. UN led development

To enable global trade, consistency of vehicles and their requirements need to be standardized. The global forum leading the endeavor is, the UNECE World Forum for Harmonization of Vehicle Regulations colloquially known as **WP.29**. It is an institutional framework of the UNECE **Inland Transport Committee** (ITS). The organograms below, show the structural complexity of the ITS and WP.29 – its diverse *working parties*, each of which have several *working groups* which focus on a particular domain.

From an EV perspective the working group is the *EVE, Electric Vehicles and the Environment*. The function⁵ of the EVE group is information exchange, minimizing differences of regulations and possible development of Global Technical Regulations (GTRs). EVE's first mandate was the development of a regulatory reference guide for EVs. The document⁶ provides a well-grounded methodology for developing local regulatory frameworks for EVs. It reviews worldwide regulatory approaches on vehicles, batteries, infrastructure and market development initiatives. A review of the document is available in the relevant annexure. Current focus is on battery durability and energy efficiency.

A key learning for Pakistan from WP.29's EV endeavor is that prior to enabling a global EV ecosystem, an across-the-board review of existing and under development regulations related to EVs in key countries was carried out by EVE. The purpose was to lay the foundation for global regulations by identifying similarities and differences in the current ones. These regulations encompassed the EV ecosystem – Vehicles (including range, efficiency, recycling and reuse), Batteries (including performance, durability, recycling and reuse), Infrastructure (charging methodologies and vehicle as a battery source) and Market deployment (including govt. incentives, awareness programmes and government mandated purchasing). This enabled markets to be consistent in their understanding of each ecosystem component e.g., previously a car definition included number of passengers, now it is based on engine capacity and / or designed max speed. All of this led to opening up of global trade.

⁵ EVE TORs, <https://wiki.unece.org/pages/viewpage.action?pageId=2523151>

⁶ EV Regulatory Ref. Guide, ECE/TRANS/WP.29/2014/81, <https://unece.org/index.php?id=38750>

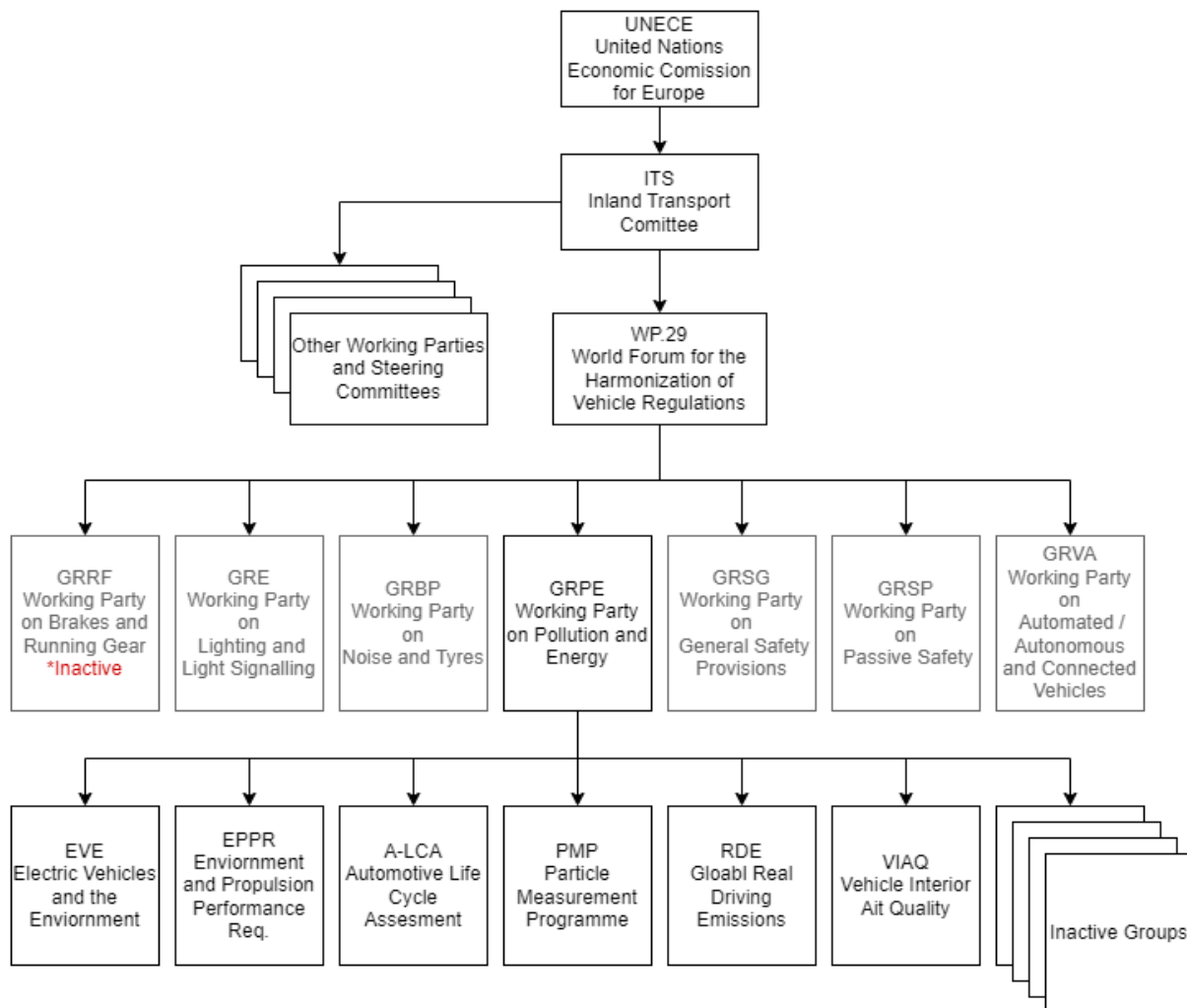


Figure 2 : WP.29 Sub groups organogram

3.3. Peer Countries Outlook

An alternate view of the EV market is present in peer countries. The transport sector is dominated by 2 wheelers which account for the majority of the travel demands. A review of the ASEAN market⁷ is noteworthy as it also closely reflects the Pakistani transport sector.

The ASEAN countries accounted for close to 22% of the global 2-wheeler market⁸ out of which 91% was generated by Indonesia, Thailand, Philippines and Vietnam. The significant size of the market has created opportunities for development and it has been captured by the local industry – about 80% of all 2W EVs sold in Indonesia were locally manufactured, competing against the Japanese and Chinese giants. Similarly in Vietnam, the share of local manufacturers was close to 67%. In Thailand and Philippines, the market was dominated by China and Taiwan, local companies hold was 15% in Thailand and 29% in Philippines.

⁷ <https://theicct.org/publication/asia-pacific-lvs-ndc-tia-23w-market-asean-countries-jun22/>

⁸ ASEAN Motorcycles Industry - Facts & Data 2022 | MotorCyclesData
<https://www.motorcyclesdata.com/2022/10/22/asean-motorcycles-industry/>

It is worth noting that the battery technology used in the price sensitive E2W category included the commonly available, low cost and low efficiency lead acid batteries. Its market share was 86% in Philippines and 75% in Vietnam. Overall, in the 04 ASEAN countries it was about 68%. Lead acid battery based EVs generally did not have the capability be charged via battery swaps.

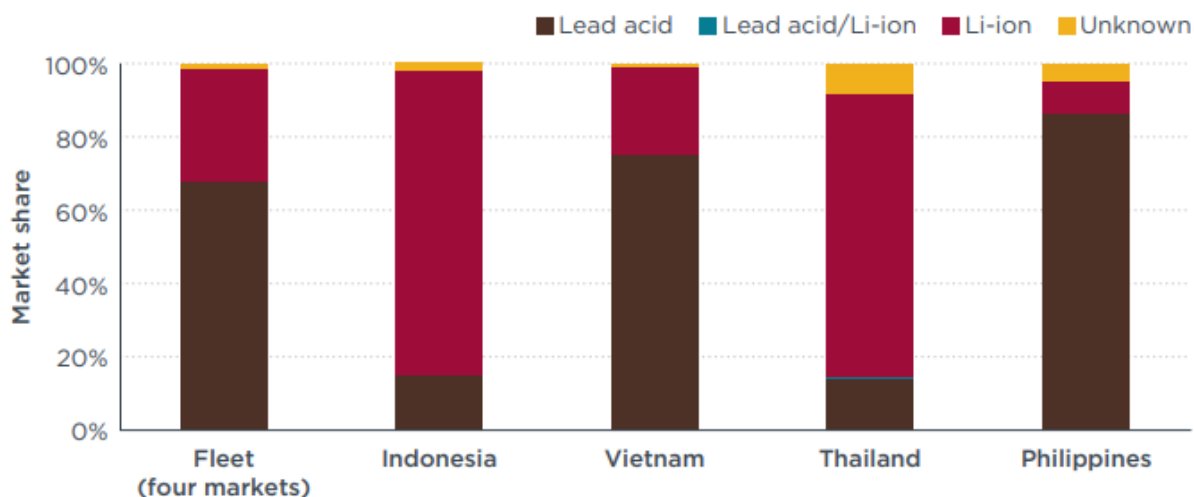


Figure 3 : 2-Wheeler EVS Battery Technology

From a driving range perspective, about half the E2W had a range of 70 – 90 kms, a quarter had max range of 50 – 70km. Indonesia was an exception with the market being dominated by just 2 low range vehicles. This anomaly is further augmented by the fact that the battery size in Indonesia and Vietnam was same, in the range of 1 – 1.5kW. The cause is unknown but conjecturally it may be due to a difference in the way range is defined in each country or the efficiency of the E2W model itself.

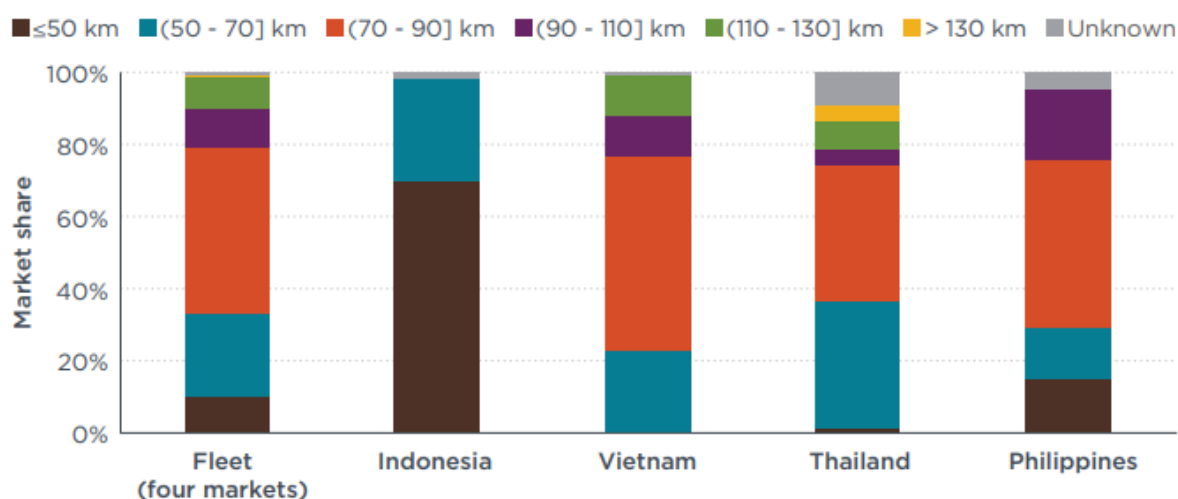


Figure 4 : 2-Wheeler EV ranges

ASEAN countries like Indonesia and Vietnam have been able to successfully kickstart their local EV industry based on its market demand. A transition from 2-wheeler based industry to 4-wheeler will

naturally follow as the relevant laws and ecosystem e.g., chargers have already been defined and established. Both countries' progress provides alternate blueprints for Pakistan to follow – imported Lithium based batteries with low range (Indonesia) or lead acid-based batteries with higher ranges (Vietnam). The counter intuitive range claims may be due to differences in how the vehicle is tested – a fully loaded vehicle will have less range than a slightly loaded vehicle.

■ 3.3.1. India

India's EV regulatory journey⁹ has been led by the central government, it set up the '*National Council for Electric Mobility*' (NCEM, 2011), followed by the '*National Automotive Board*' (NAB, 2012) with the mandate of implementation of policies and disbursement of funds. Ministries involved in the journey were the Ministry of Road Transport and Highways which allowed retrofitting of cars to EVs by updating the *Central Motor Vehicle Rules 1989* (2018). The Ministry of Power notified charging infrastructure standards and guidelines and removed licensing requirements for EV charging (2018). These were further updated in 2019 to define tariffs and city-wide charging infrastructure provisioning¹⁰. The Ministry of Housing and Urban Affairs amended the building bye laws with provisions for EV charging infrastructure (2018). However, it was the Department of Heavy Industries effort that laid the groundwork for notable progress. It envisaged the *National Electric Mobility Mission Plan 2020* (NEMMP 2020) in Jan 2013 which outlaid \$ 2.5 Billion for EVs. India's flagship policy - FAME, '*Faster Adoption and Manufacturing of Electric and Hybrid Vehicles*' was launched in April 2015 as a two year plan. After multiple extensions, FAME was phased out and FAME-II 2019 – 2024, introduced. FAME II outlaid \$ 1.44 Billion to support 1 million electric two wheelers, 0.5 million electric three wheelers, 55k electric four wheelers, 7k EV Buses.

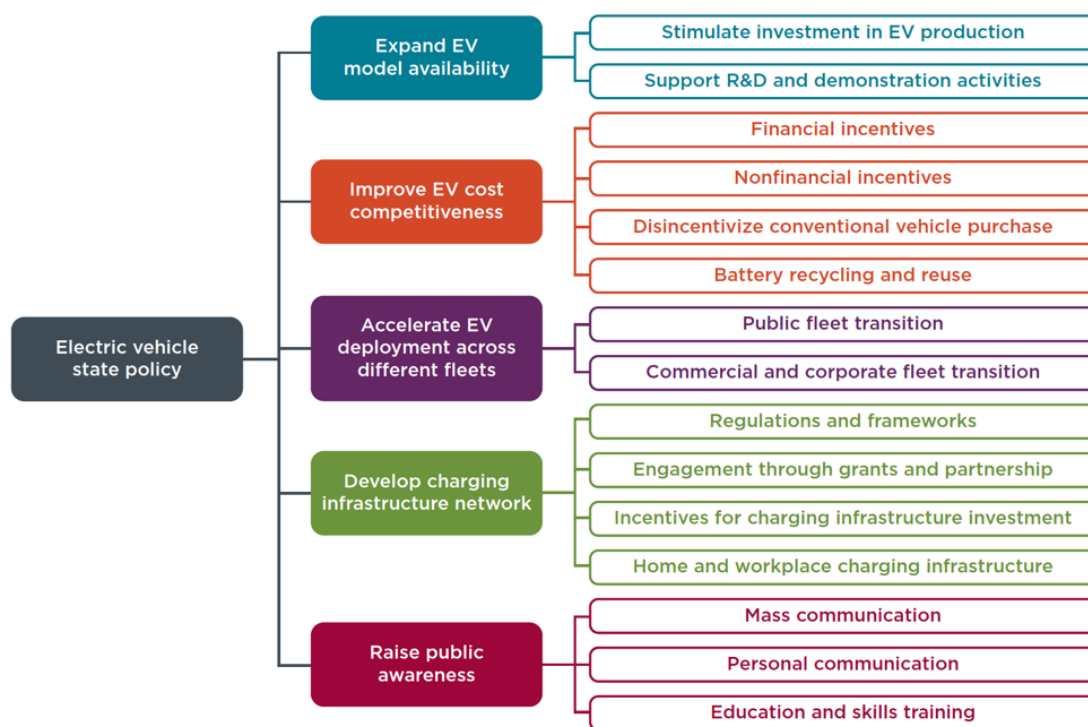


Figure 5 : Reference consumer barriers for state level EV policy formulation

⁹ A timeline showing the iterative and improving policies. <https://e-amrit.niti.gov.in/national-level-policy>

¹⁰ State level tariffs available at <https://e-amrit.niti.gov.in/electricity-cost-for-charging>

India has 28 states and 8 union territories, each with its own vision and set of policies for accomplishing it, these exist independently of the national vision¹¹. Each state has further state level policies complementary to federal ones. Currently 24 out of 28 states have notified EV focused policies, the remaining have draft policies formulated.

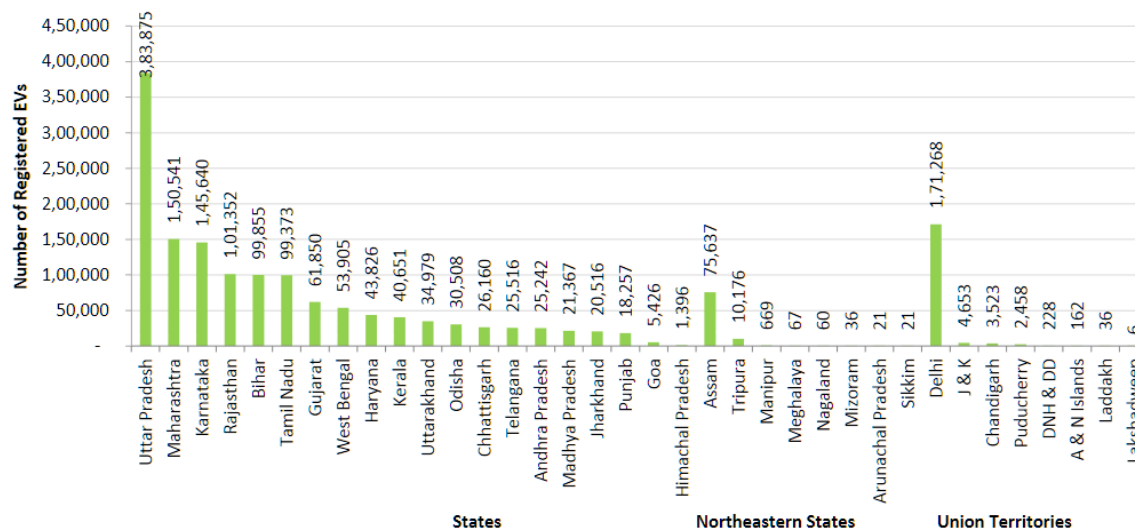


Figure 6 : EVs registered state wide

Generally, the policies guide EV adoption by standard toolkits - targets, market creation via subsidies and industry establishment via subsidies. Targets are set for EV sales by companies and EV purchase by government and public transport busses. For market creation, consumer purchasing is incentivized by different state level policies ranging from fixed / percentage-based amount per EV to battery capacity-based amount. Notable approaches include, Delhi where ICE three wheelers may be scrapped for credits to purchasing a new e-3W and Maharashtra where first 100k EVs are subsidized. These exist with standard incentives like exemptions / reductions to vehicle registration fees, road taxes, parking charges, and occasionally, vehicle purchase taxes. For industry establishment the government offers tax breaks for land purchase and utilities at reduced rate.

Recent statistics show a total of 2.37 million EVs have been sold / registered in India. The total number of registered motor vehicles in India (over 338 million), the share of EVs is less than one percent. This slow adoption is due to many reasons. The chief challenge is the price. Government subsidies are applied stringently and not all EVs are able to pass the requirements, hence not all EVs are subsidized. From a TCO perspective the battery life for e-2W is 02 to 04 years and 08 years for an EV; the price of a new battery pack equals that of a brand new ICE car. Safety has also been a consumer concern; even with proper usage some EVs caught fire, which led to new stringent battery standards. From a range perspective, the charging time becomes a challenge - standard chargers require 6 - 7 hours charging time, whereas fast chargers take an hour. Compared to ICE vehicles this is extremely high and coupled with general unavailability of charging stations, EVs become even less attractive.

¹¹ Side by side comparison of state level policies are available on <https://e-amrit.niti.gov.in/state-level-policies>

FAME is a government initiative aimed at promoting the adoption of electric and hybrid vehicles in India. The program focuses on reducing pollution, decreasing dependence on fossil fuels, and promoting localization. The program has played a significant role in driving the growth of the electric vehicle industry in India. The over-arching goals were:

1. **Financial Incentives:** FAME provides upfront discounts on the purchase price or a subsidy on the loan interest rate to buyers of electric and hybrid vehicles to make them more affordable.
2. **Subsidies for Manufacturers:** FAME offers financial support for research and development activities, investment in manufacturing facilities, and technology upgradation.
3. **Charging Infrastructure Development:** The program provides financial assistance to set up charging stations, both in public and private spaces, and encourages the development of innovative charging solutions.
4. **Public Transport Electrification:** FAME emphasizes the electrification of public transportation systems. It supports the adoption of electric buses, taxis, and other commercial vehicles to reduce emissions and improve air quality in urban areas.
5. **Awareness and Capacity Building:** FAME undertakes initiatives to create awareness among consumers about the benefits of EVs. It also supports capacity building programs for stakeholders to enhance their skills and knowledge in this domain.

A summary of its impact is below:

1. **Electric Vehicle Sales:** Since the launch of FAME in 2015, the sales of electric vehicles in India have witnessed significant growth. According to the Society of Manufacturers of Electric Vehicles (SMEV), more than 2.37 million electric vehicles were sold in India between April 2018 and May 2023.
2. **Charging Infrastructure:** As of March 2023, the country had more than 6,586 public charging stations installed across various cities and highways, compared to just a few hundred in 2015.
3. **Domestic Manufacturing:** FAME has encouraged domestic manufacturing of electric vehicles and components. According to the Department of Heavy Industry, the domestic production of EVs increased from 125,000 units in 2017-18 to 511,000 units in 2020-21.
4. **Carbon Emission Reduction:** The adoption of electric and hybrid vehicles supported by FAME has contributed to a reduction of 129 million kgs of CO₂ emissions¹.

Current guiding policies are FAME-II, PLI Scheme, Battery Swapping Policy, Special Electric Mobility Zones and Tax Reductions.

PLI Scheme: The Department of Heavy Industry launched the Production Linked Incentive for Advanced Chemistry Cell Battery Storage (PLI-ACC Scheme). The goal is to encourage domestic and international investors to invest in battery manufacturing facilities. The \$2.5 Billion incentives are available against investments which become operational in 02 years and achieve at least 60% value addition within an additional 05 years. The stringent requirements exclude small players and encourage large industries participation.

Battery Swapping Policy: Battery swapping will standardize batteries across India. To ensure success swapping stations will have standard set of pre-charged batteries that consumers can easily replace across a wide range of vehicles. This will also impact EV pricing as this enables battery-as-a-service business model.

Special Electric Mobility Zones: EV only zones will be ecologically attractive as they will be relatively less polluted. Apart from EVs, EV busses will be available for zonal transport.



EVs: PAKISTAN MARKET

4. EVs: Pakistan Market

4.1. Vehicle Market overview

The auto sector in Pakistan contributes to about 15% to Large Scale Manufacturing. The market volume of vehicles in Pakistan is summarized in the chart below.

The auto vehicles market is typically divided in to 03 broad categories:

1. Cars, Jeeps and Light Commercial Vehicles
2. Trucks and Buses
3. Tractors, 2 Wheelers and 3 Wheelers

Of the above 2 wheelers dominate the numerical count and account for 86% of the total. The next category is Cars at 6% and 3 wheelers at 3.5%. The heavily skewed production shows the potential in auto sector in Pakistan favors 02 wheelers. The prime reason for the disparity is the limited purchasing power of the masses. It also highlights an untapped market segment between the 2W and standard car segments.

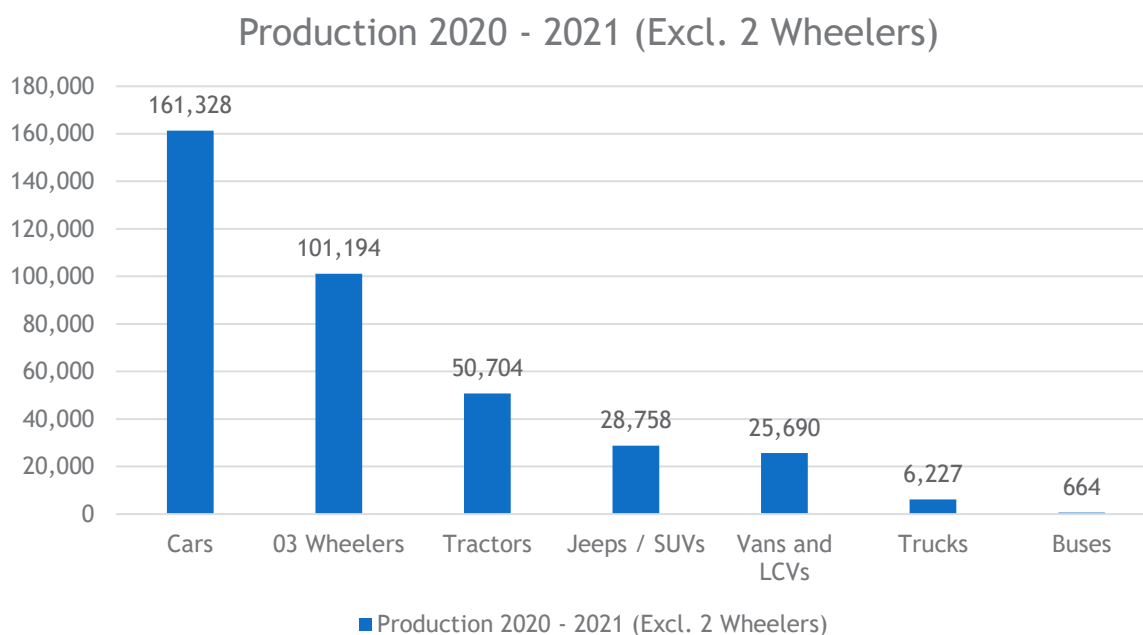


Figure 7 : Pakistan Vehicle Production 2020 – 2021 , excluding 2 wheelers

An analysis on breakdown of cars manufactured during the same year, further emphasizes the limited purchasing power – close to a quarter of the cars are 660 cc. The list contains cars that are used primarily for commercial purposes (Bolan and Corolla¹²), removal of which will increase the ratio of cheaper cars.

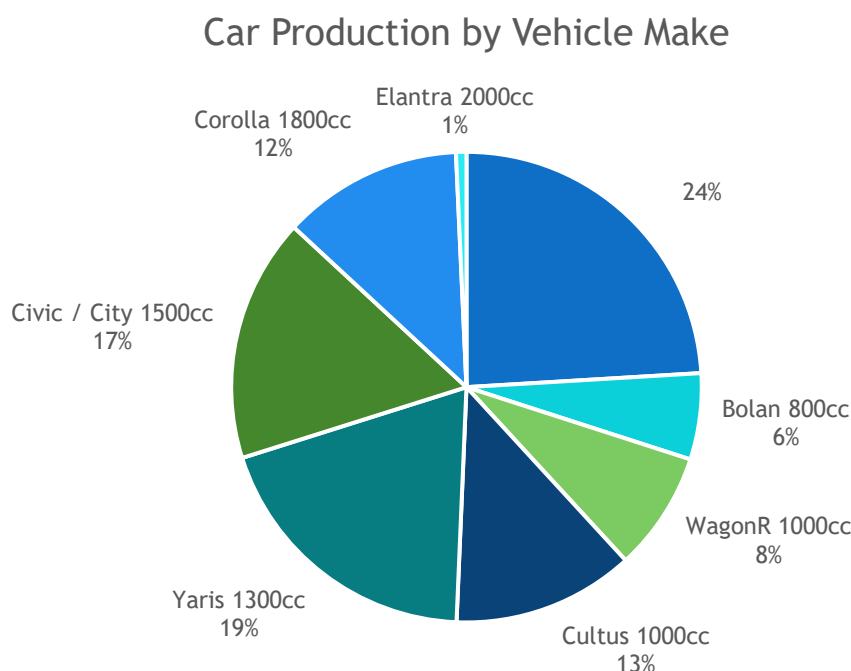


Figure 8 : Car production by vehicle make 2020-21

Given the current data and future trends, mass scale adoption of EV's in Pakistan likely lies with 2 wheelers and low powered cars. EV's are markedly more capex intensive which makes their market adoption an even more delicate matter. With price sensitivity comes a compromise on quality which is common in Pakistan. Without clear standards and their subsequent enforcement, EV's may see a faltering future.

4.2. Regulatory Regime

The regulatory body in Pakistan for matters related to the auto industry is the Engineering Development Board. The current five year plan is titled Auto Industry Development and Export Policy 2021-2026 (AIDEP 2021-2026). The focus is to enable horizontal and vertical growth in the auto sector – vehicle assembly, localization, industry expansion. Additional emphasis is on exports and implementing the WP-29 safety regulations.

¹² Corolla is a popular car used in the telecom industry to enable servicing of remote towers across the country. It is also used commercially for intercity transport between cities

Pakistan's first EV policy, the National Electric Vehicle Policy (NEVP) was introduced in 2019 by the Ministry of Climate Change. The policy envisages EV penetration targets via a five year goal, a 2030 goal and an ultimate 2040 goal. To achieve the goals, it provides a regulatory framework and an attractive fiscal regime.

A detailed review and recommended proposals are presented in a proceeding section.

4.3. Fiscal Regime

The current regulatory policies provide comprehensive fiscal incentives including income tax reduction, customs and federal duties reduction, SBP directed financing support and fee exemptions on EVs. The incentives are available for all EV classes, they also extend to charging infrastructure and localization of technology. Both policies provide supplemental and incremental incentives for enabling EVs uptake by the customer and kickstart the industry.

A detailed review and recommended proposals are presented in a proceeding section.

4.4. Market perspective to regime

The market has welcomed the policy and its benefits – a clear impetus is provisioned. However, operationally the market is guarded at the moment due to the uncertain economic conditions of the country.

■ 4.4.1. Leading Auto Manufacturers¹³

The auto industry is currently facing a crisis; however, the general feedback on the fiscal regime has been positive. The future outlook for individual players is diverse, and each company is leveraging its strengths to pursue its own vision.

From a fiscal perspective, electric vehicle (EV) kits are approximately 80% more expensive than their internal combustion engine (ICE) counterparts. EV prices range from \$18,000 to \$30,000 USD, while ICE vehicles are priced around \$15,000 USD. Percentage-based taxes further contribute to a significant increase in the end-user price, with the typical tax on a finished car reaching nearly 45% of the price. However, the current tax regime includes exemptions that offer attractive options to reduce prices for end users.

Auto financing plays a vital role in the global automotive industry, and in Pakistan, nearly half of car purchases are financed through banks. However, the high KIBOR rate, currently around 21%, poses a significant obstacle to market sustainability, as it drives up the cost of financing and vehicle ownership for consumers.

¹³ Industry interview notes

The current price range of EVs makes them predominantly accessible only to high-end consumers. Due to the scarcity of public charging infrastructure, hybrid vehicles offer a favorable solution by combining fuel and electric power, providing a worry-free travel experience. This segment is actively being explored, and the launch of local hybrid models is expected in the near future.

There is also a market opportunity for low-speed, low-range EVs, which are more affordable and have a maximum speed of around 60 km/hr. Priced between \$8,000 to \$10,000 USD, these low-speed EVs are more accessible to a wider range of consumers.

■ 4.4.2. Heavy and Light Commercial Vehicles (HCV / LCV)

The future prospects of electric vehicles in the HCV and LCV segments are currently deemed commercially unviable. The major obstacle impeding the widespread adoption of EVs in these segments is the inadequate charging infrastructure. However, as fuel costs continue to rise, the commercial viability of EVs may improve in the future.

In terms of indigenization, it is anticipated that the current localization levels of 20-30% in the automotive industry will decrease for EVs. This shift is attributed to the need for the motor and battery industry to undergo significant transformations to meet the standards and specifications of electric vehicles. Attaining higher levels of localization for EV components will be crucial in reducing costs, promoting domestic manufacturing, and enhancing the overall competitiveness of EVs in the market.

■ 4.4.3. Three Wheelers

The primary barrier to the widespread adoption of electric three wheelers, from the industry's standpoint, is the prohibition on registering three wheelers as private use vehicles. However, three wheelers have the potential to bridge the market gap between two-wheelers and four-wheelers, offering an affordable, safer, and family-friendly option. This transition would be advantageous for the considerable number of overloaded two-wheeler users, providing them with a viable alternative.

■ 4.4.4. OMCs

Oil Marketing Companies (OMCs) have started testing the waters and have installed a few electric vehicle (EV) charging stations in major cities. Their objective is to establish at least a dozen stations across Pakistan within the year. They have gained valuable insights from their initial endeavors and have adapted to the market conditions. Initially, they introduced 50 kW chargers but have now progressed to 180 kW chargers. The current charging infrastructure predominantly consists of chargers of European origin, but there are plans to explore and incorporate Chinese vendors in the future.

The current focus is on promoting the standardization of EV chargers and tariff structures in collaboration with the Ministry of Climate Change (MoCC) and the National Energy Efficiency and Conservation Authority (NEECA). Furthermore, there are future plans to explore the establishment of one-stop rapid battery swapping stations, providing an efficient solution for EV charging.

■ 4.4.5. Charging Station OEM

Pakistan's persistent power challenges have created a strong demand for power electronics talent. Hence, the power electronics based EV charging industry is actively present in Pakistan. This industry can be broadly classified into two categories: assemblers and OEMs. Assemblers purchase pre-made kits and, with the addition of locally manufactured enclosures, create finished products. On the other hand, OEMs design and assemble the kits themselves, relying on basic electronic components such as resistors, capacitors, and PCBs etc. as raw materials.

Pakistan's policy framework is accustomed to assemblers, and policies are organically conducive to their growth. OEMs are unable to get the same support from a policy perspective. Whereas significant tax benefits are available to assemblers on import of pre-made kits, the same benefits are not extended to OEMs raw materials. To encourage shift from assemblers to OEMs, Turkey, has extended their Harmonized System (HS) code by two digits, which identifies specific industries. This way duty exemptions are granted to those industries only.

In the electronics industry, transactions have transitioned from bank and letter of credit (L/C) based systems to credit card-based purchases for electronic components. However, the absence of company credit card services in Pakistan poses a challenge. Additionally, using personal credit cards for material purchases does not qualify for tax credits.

Another pressing need is the ability to maintain a USD-based account. Despite the fact that all electronic raw materials are valued in USD, the electronics-focused industry in Pakistan currently lacks the capacity to maintain such accounts. Having a USD account is crucial for safeguarding production against currency fluctuations in the future.

From a business perspective, EVs present a promising opportunity in Pakistan. With a few charging stations already deployed on the motorway and good networking with station owners, the industry is well-prepared to rapidly expand charger deployment across the country. However, given the limited number of EVs currently in the country, the charging stations are operating at a loss. .

■ 4.4.6. Battery Industry

The EV focused battery industry (Li-ion based), being electronics focused, faces similar opportunities and challenges as charging OEMs. However, there is a key difference: battery OEMs do not have standalone requirements, as their specifications are defined by the local automotive industry. Each car has its unique battery model that must fit the mechanical shape and other requirements of the vehicle. Consequently, the production volume for a particular battery model is significantly lower.

One potential solution is the implementation of standardized batteries. Having a common battery model that can be used across a specific class of vehicles, regardless of the vehicle OEM, would enable higher production volumes and help battery OEMs achieve economies of scale. Without a significant and consistent demand, the growth potential in this segment appears limited. Currently, the standardized battery solution is more applicable to the two-wheeler and three-wheeler industries, where there is relatively less variation among OEMs, and parts are often interchangeable.

■ 4.4.7. Startups

Innovative solutions in the e-mobility sector often concentrate on addressing a core challenge, while relying on existing external sources to fulfill ancillary requirements¹⁴. Startups operating in the e-mobility space face significant challenges. The low-speed two-wheeler EV industry, for example, requires expertise in electronics and plastics, which differs from the traditional focus on mechanics and metals in the internal combustion engine (ICE) OEM industry. Current regulations have hindered progress by mandating that ICE OEM facilities be available in-house in order to obtain OEM licensing for EVs. To facilitate the rapid development of local EVs, new regulations will need to be implemented. These regulations should enable streamlined processes and encourage collaboration among different industries to foster the growth of the EV sector.

4.5. Research and Development Outlook

Traditionally, Pakistan has been a consumer-oriented country with limited emphasis on innovation and indigenization, primarily due to the easy availability of imported products. This has created a cycle where the lack of skilled talent discourages businessmen from taking risks, resulting in a market that primarily requires operation and maintenance engineers. Consequently, highly talented individuals either transition into management roles or seek opportunities abroad.

The academic, industrial and commercial R&D landscape in the auto sector in Pakistan has primarily been focused on import substitution through technology transfers and reverse engineering. While this approach has led to the localization of simple parts, more complex parts like engines, transmissions, and suspensions still have low localization levels of less than 5%. In low end car models localization levels are about 60-70%.

Genuine R&D efforts aimed at Pakistan-specific innovation have had limited success thus far. In the EV domain, current R&D activities are primarily centered around conversion kits. These kits revamp an ICE car by adding motors, battery packs and necessary electronics. Although these projects hold significant commercial potential, they often operate independently and lack open-source collaboration, despite being funded by taxpayers' money.

¹⁴ Careem, Uber, food delivery services all focus on creating cohesion between stakeholders. Everything else is pre-existing.

Pakistan does have a thriving power electronics industry, which has benefited from the country's intermittent power grid. Local development of charger infrastructure is ongoing and expected to be deployable by the next year. There is also potential for the development of power converters for driving motors; however, this requires the design of the motor itself, which is currently unavailable in the local industry.

On board computer (OBC) for cars is straight forward electronics; the challenge however is in having a complete functional specification of the car. The specification would provide complete technical details to enable design and development of an on-board computer. To give a glimpse of the technical depth of such a specification, we can look at a small invisible component – the indicator lamp switch (technically referred to as a relay).

- Electrical Specs: Voltage / current switching capability (output) in terms of volts and amps, a max resistance to ensure max power dissipated is limited; operating capability (input) in terms of volts and amps, a max resistance to ensure max power dissipated is limited etc.
- Mechanical Specs: An MTBF (mean time between failures) of thousands of hours, operating cycles, turn on and turn off time limitations, dimensions and weight considerations, etc.
- Environmental Specs: Operating temperature and humidity specs; shock and vibration resistance levels etc.

Whereas such a component is easily available commercially off the shelf, the challenge manifests in the overall indicator *module* comprising of the OBC hardware, OBC firmware, electrical cabling, multiple components all working together towards a spec.

Pakistan has a thriving induction motor industry that caters to residential requirements, and the relevant technology to prototype Brushless DC motors (BLDC) and induction motors. With the addition of gears, users may be provided comparable driving experience. However, the local industry currently cannot meet the quality requirements for EV applications and hence is likely to be import-dependent for EVs in the future.

Research in battery technologies and alternate fuels is non-existent as it requires significant investment and has little scope for commercial success.

The Pakistani market has shown a tendency for quick acceptance of imported goods, which is further influenced by regulatory policies that apply tariffs based on the availability of local products. In recent times, a prudent measure has been adopted, albeit with weak implementation, which involves time-limited relaxation in tariffs along with the requirement for localization. This approach aims to stimulate and support the growth of a domestic market for various products.

4.6. Total Cost of Ownership for ICE and EV

International Energy Agency (IEA) is a global body which recommends policies that enhance the affordability and sustainability of energy by taking an all-fuels, all-technology approach. It has a quick tool to compare TCO of EVs against ICE cars across diverse countries. Based on current fiscal regimes, the TCO across all countries is consistently in favor of ICE vehicles. This underlies the need for fiscal reforms to ensure EVs financial benefits are available in the long run and not only due to subsidies.

TCO calculations are dependent on vehicle usage. Table 2 shows that with an average vehicle usage of 10,000 kms annually driven over 10 years, the ICE vehicles are more economical to own. There are however niche use cases in which consumer segments owning vehicles for exceptional longevity and high mileage may flip the TCO in favor of EVs over ICE vehicles. For example, A TCO study¹⁵ for Pakistan using exceptional car longevity (200,000 kms) showed a marginally positive TCO in favor of EVs – 22.5 PKR/km ICE vs 22.0 PKR/km EV. Overall, on operational and maintenance cost basis, evidence suggests that EVs have a higher TCO than ICE vehicles.

S #	Country	EV USD/km	ICE USD/km	EV USD/yr.	ICE USD/yr.
1	India	0.26	0.25	2,611	2,532
2	Indonesia	0.28	0.22	2,791	2,241
3	South Africa	0.43	0.37	4,326	3,725
4	Argentina	0.64	0.51	6,443	5,105
5	Ukraine	0.38	0.34	3,845	3,404
6	Pakistan	0.35	0.29	3,524	2,868

Table 2 : 10 year TCO calculation based on 10,000 km travel annually¹⁶

A positive TCO for EVs can be foreseen on a country level as the EV transition will contribute significantly to reduction in fuel imports. Additionally, in the near future, there will be a positive impact on the reduction in unutilized generation capacity, yielding additional financial benefits to the country. These financial benefits may then be passed to the consumers to accelerate EV adoption. In the long term, Pakistan's energy policy will need to be linked to EV penetration to ensure EV charging does not adversely impact fuel imports for energy generation.

From an environment perspective, EVs contribution to reduction in GHG emissions is measurable. These contributions are already committed by Pakistan to the Paris Agreement as Nationally Determined Contributions.

¹⁵ LUMS Electric Vehicles in Pakistan: Policy Recommendations

¹⁶ <https://www.iea.org/data-and-statistics/data-tools/electric-vehicles-total-cost-of-ownership-too>

For Pakistan, however, EVs *raison d'être* has to be transforming an import based auto industry to an export focused one. Recent successes have been observed in exporting cars¹⁷ and new entrants have a vision for export from Pakistan. A notable market opportunity lies in catering to the left-hand traffic in Pakistan, as Chinese joint ventures can manufacture vehicles for the global market while the joint venture focuses on the smaller left-hand traffic market, this is actively being explored in the local auto industry. A low hanging fruit is the auto parts industry which is agile and needs to adopt product specific WP.29 regulations to unlock global trade.

It is important to note that the current lithium based EVs will pose a significant long term risk and if deliberate actions are not taken timely, Pakistan may transition from an oil importing country to a lithium importing one¹⁸. Current policy options to lower the risk are to standardize batteries to ensure economies of scale. Additionally, Vietnam has successfully transitioned to lead acid based batteries for their localized electric two wheelers.

In the current economic scenario, EV TCO does not support a direct transition to an EV dominated domestic auto market. However, with the right policies backed with sound planning and implementation, Pakistan can enable a sustainable EV market over time. A workable solution would be to initiate e2W and e3W domestically, and to introduce an export focused vision for EV auto-parts to establish an industry with sufficient economies of scale.

4.7. Key bottlenecks for enablement of the EV industry

The following section highlights some of the bottlenecks faced by the EV industry, the recommendations to their resolution are proposed in the relevant section.

One of the core challenges for EVs is the missing economies of scale. The Pakistani market is rather small – the top selling ICE car in Pakistan, Toyota Yaris had an annual production of 29,000 in 2020 – 2021 while in the same period Tesla Model 3 sales were *501,000 units*.

Pakistan's annual demand is flexible, and is highly dependent on external factors. A clear Minimum Order Quantity (MOQ) would reduce uncertainty and enable long term supply chain planning. With firm bulk orders planned and placed – competitive pricing will be achieved, lowering the overall cost of the car.

From a governmental side the bottleneck highlighted is the difference in policy and its actual implementation. From the differences arising from an interpretation of the policy to interdepartmental communication delays, all cause wasted man-hours.

Pakistan was formally notified of becoming a member of the 1958 Agreement (first of three agreements)

¹⁷ <https://tribune.com.pk/story/2356278/pakistan-exports-its-first-suv-class-vehicle>

¹⁸ Covered under second last paragraph of 'Global Outlook' section of this document

of WP-29 Q2 2020, **6 decades later!** The impact of a delayed joining has been tremendous – with minimal or no regulatory oversight substandard products have made ingress in to the market. These products fail early and often, creating a negative perception of the technology in the consumer mind. This widens the chasm between early adopters and early majority, delaying market penetration of a technology / product.

From the consumer perspective their limited purchasing power coupled with the exorbitant entry costs have all but rung the death knell for the nascent industry. The vehicle production numbers consistently indicate the Pakistani EV market will be dominated by the 02-wheeler industry. Regulatory regime has introduced policy to shift the trend to lower powered cars (Meri Gari Scheme).

Addressing these bottlenecks will require collaborative efforts between the government, industry players, and other stakeholders to create an enabling environment for the EV industry in Pakistan. This includes ensuring clear policies, effective implementation, fostering a supportive ecosystem, and exploring avenues to enhance affordability and accessibility of EVs for the masses.

A close-up, low-angle shot of a blue metal server rack. The rack has multiple bays with gold-colored connectors visible. A red light effect is visible in the background, creating a warm glow. The text "POLICY APPROACH" is overlaid in white on a dark blue rectangular background.

POLICY APPROACH

5. Policy Approach

5.1. Regulatory Regime

■ 5.1.1. Engineering Development Board

Pakistan's apex body for regulating the auto sector is the Engineering Development Board. Pakistan's historical regulatory regimes may be classified in to 04 distinct periods:

1. Deletion Program 1987 – 2004
2. Tariff Based System 2005 - 2006
3. Auto Industry Development Program 2007-2012
4. Automotive Development Policy 2016 – 2021

Most of the policies in the auto industry have focused on localization and discouraging imports of localized parts by imposing higher customs duties. Successful localization of low-tech parts was achieved for cars like Mehran, Bolan, and Cultus, with around 70% of parts being localized. The first five-year plan (2007-2012) had ambitious goals, including plans for 500,000 annual production, technology acquisition, establishment of a testing agency, and localized cluster development. However, apart from localized cluster development, the rest of the plan could not be realized due to a lack of government funding and weak implementation.

The second five-year plan (2016-2021) aimed to encourage new investments, improve quality standards, and reorganize auto bodies. It was successful in attracting new investments, with approximately 21 new entrants committing \$1 billion to the auto sector. Additionally, Pakistan was able to accede to WP.29, indicating its commitment to international vehicle regulations.

The current five-year plan is titled the Auto Industry Development and Export Policy (AIDEP) 2021-2026. It is a comprehensive policy aiming to guide the auto sector towards safer cars, exports, and local manufacturing. The key areas of focus in the policy include:

Promotion of New Technologies: Building upon the National Electric Vehicles Policy, the AIDEP further specified the quantity of EVs allowed annually and time duration till such an incentive could be availed. The policy outlines regulatory and fiscal regimes for two-wheelers, three-wheelers, cars, buses, charging infrastructure, and safety standards. It also extends incentives to hybrid and plug-in hybrid vehicles.

Tariff Plan: The policy provides incentives to new entrants in order to stimulate production, with these incentives expected to continue throughout the policy period.

New Product Policy: Considering the dominance of two-wheelers in Pakistan's auto industry, the Meri Gari Scheme offers fiscal incentives to encourage customers to upgrade to small cars (less than 1000 cc). For two-wheelers and three-wheelers, the policy provides fiscal incentives for new higher power models. The tractor industry is also incentivized through fiscal measures by extending support to the current tractor portfolio. Any new model that expands the range of engine horsepower (HP) within the 35-85 range may avail these benefits.

Safety Regulations: To enhance auto exports, the industry needs to implement UN vehicular standards. Pakistan became a member country of the 1958 UN Agreement in April 2020, marking the first step towards this goal. The policy aims to prioritize the implementation of 17 safety standards out of the approximately 160 that need to be adopted by the industry.

Local Part Manufacturing: To promote local part manufacturing, protective tariffs will continue to be implemented. These tariffs apply to a list of locally manufactured parts, while higher duties are imposed on imported competing parts. Tax credits are also available for establishing new businesses, and fiscal incentives for importing machinery to enable local manufacturing are being considered.

Export Promotion: Recognizing the limited potential for exports due to restrictive contracts of auto manufacturers and the lack of standards adoption in the sector, the policy provides some incentives and mandates an increasing value of exports.

These key areas of the AIDEP aim to drive the growth and development of the auto industry in Pakistan, promoting safer vehicles, boosting local manufacturing, and facilitating exports.

■ 5.1.2. National Electric Vehicle Policy (NEVP)

Pakistan's Electric Vehicle (EV) policy was introduced in November 2019 under the leadership of the Ministry of Climate Change. The primary objective of the policy is to tackle climate change challenges caused by the transport sector while simultaneously addressing the country's oil import bill and fostering the growth of a new industry. Additionally, the policy aims to alleviate the burden of idle capacity payments associated with excess energy generation and has a future-oriented focus on promoting exports. The policy provides incentives to BEVs only.

EV Penetration Targets	Medium Term Targets (2025)	Cumulative Long-Term Targets (2030)	Ultimate Targets (2040)
Cars (including Vans, Jeeps and small Trucks)	100,000	30% of New Sales (Approximately 60,000)	90% of New Sales
Two and Three Wheelers Four Wheelers of UNECE 'L' Category	500,000	50% of New Sales (Approximately 900,000)	
Buses	1000	50% of New Sales	
Trucks	1000	30% of New Sales	

Table 3 : EV Penetration Targets, NEVP

To enable EV penetration the policy envisages the following infrastructure:

1. Major cities: 01 fast charger per 3km x 3km area.
2. On motorways 01 charger every 15 – 30 kms. Initial deployment on M1 - M5, M9 and N5.
3. Battery swapping stations are a proposed alternate to charging stations.
4. DISCOs to be responsible for enabling and providing the necessary electric infrastructure.
5. Smart charging (demand shaping via policies) to be available on Level 2 and above charging stations, to reduce stress on the national grid.

A detailed review is presented in the relevant Annexure.

5.2. Fiscal Regimes

Pakistan's fiscal regime are well established and revolve around concessionary taxes and tax credits. Limited other measures are available to direct consumer behavior towards national objectives.

Tax Benefits: Sales tax, customs duty and FED have been significantly reduced – ST 0%, FED 0%, CD 1%. These incentives are applicable on:

- EVs – CBUs (limited qty of imports only) and CKDs
- EV conversion kits
- EV ancillary equipment – chargers etc.
- EV parts – batteries, motors, electronics etc.
- EV components for parts
- EV based plant and machinery

EV Financing: To enable financing the transition, the government has provided 'Green Banking' incentives and a separate land lease policy for EV OEMs.

Tax Holiday: 05-year tax holiday is available to startups which manufacture EV parts and EV related equipment.

CSR Contributions: CSR based tax reduction is also provided against investments in installing EV charging infrastructure.

Consumer Focused Incentives: Vehicle related fees (registration and annual) have been waived off. Additionally, toll tax for intercity travel on highways and motorways is halved. Consideration for EV specific zones are also under review.

5.3. Policy Recommendations for Sustained EV Adoption

■ Regulatory Framework

The regulatory framework should provide a detailed and comprehensive plan for EV adoption in Pakistan. The existing framework demonstrates progress in fiscal regimes but lacks specificity in defining EV components for the industry. This gap leaves room for arbitrary interpretation and application of the law. The definition of hybrid and applicable tax concessions is a case example where consumer and government interpretations caused unnecessary litigation¹⁹. The WP.29 regulatory framework document presents an ideal approach to developing a comprehensive framework for Pakistan, addressing these policy gaps and providing clear guidance for the industry's development.

■ Standardization and Enforcement

Standardization plays a crucial role in the development of any industry. It ensures low quality products do not enter the market and allows customers to test the product *as it was intended to be used*. A case example of local UPS industry is relevant²⁰. High levels of standardization promote interoperability, allowing components from different vendors to be used interchangeably.

In Pakistan enforcement of standards is non-existent, allowing poor quality vehicles and parts to be imported. These low quality and low-cost products set the market precedent and after the early adopters there are few repeat customers. A prime target for exploitation is the battery which is the costliest part of an EV. An effective proposal will be to have a few standard battery models which will be used by all manufacturers – this will solve multiple problems, including enabling mass volumes ensuring lower costs per unit product and vendor interoperability.

Standardization is closely linked to global trade which is defined by WP.29 standards, which is covered in the next section.

■ Global Trade

Pakistan's recent accession to WP.29 agreements is a positive step. However, to leverage this membership effectively, a clear time-bound plan must be established to enforce all standards mandated by WP.29. Implementing these standards is crucial for unlocking global trade opportunities, which are essential for the growth of the EV industry. Currently, the domestic market in Pakistan does not have sufficient purchasing power to sustain a thriving EV industry without access to global markets.

There are about 160 standards, most of them being generic and applicable to all types of vehicles. EV related ones are few and relate to specific features e.g., Regulation No. 100 - concerns the approval of vehicles with electric powertrain vehicles, hybrid electric powertrain vehicles, and hydrogen fuel cell

¹⁹ As per FBR, Hybrids require electric propulsion. As per consumer the car was labelled Hybrid and had some features e.g., regenerative braking and electric start / stop. <https://www.brecorder.com/news/40223075/50pc-duty-imposed-on-import-of-mild-hybrid-vehicles>

²⁰ Local non standardized 'on/off' UPS burnt out significant fans and destroyed all fan regulators – the customer paid the obvious price, the market rejected UPS technology for quite some time and the high-quality industry suffered due to the resulting 'Pakistani UPS = poor quality' perception.

vehicles. This regulation includes provisions related to high-voltage batteries and their safety requirements.

■ Open-source technology

Encouraging the use of open-source technology can foster innovation and collaboration in the EV industry. 'Open source' refers to designs and IP being publicly available. Government-funded research projects should require mandatory partnerships with industries where the research outcomes will be directly utilized. Currently, none of this research is publicly available and the research organization, usually academia, try to profit of it via their commercialization offices. Furthermore, establishing a central knowledge repository accessible to all citizens can promote transparency and enable entrepreneurs to access designs and plans for setting up relevant industries. This approach ensures that research funded by taxpayers' money benefits the wider society and facilitates the growth of the EV sector.

■ Customs Code Revision

Revising the customs codes to reflect sectoral policies and encourage local industries is essential. Increasing the specificity of HS codes by adding two digits to denote the industry sector, as done by Turkey²¹, can support the localization of EV parts manufacturing. Currently, EV-specific parts (e.g., PCB) are subject to standard duties when imported, making it more cost-effective to import completely knocked-down (CKD) EV parts rather than manufacturing them locally. Aligning customs codes with sectoral policies will incentivize local production and contribute to the growth of the domestic EV industry.

■ Import Limitations

Policies should not only focus on enabling industry but prioritize the development of a local industry, as is the vision manifested by India²². A time-limited import strategy, accompanied by increasing tariffs over time, can incentivize local development. This approach encourages the localization of high-tech parts and components in the EV industry, ensuring long-term sustainability and growth.

■ One Window Portal and Time-bound Processes

The non-existent IT-based infrastructure in government business processes is a consistent barrier to rapid growth. Manual processes and lack of time-bound activities lead to inefficiencies and delays. Implementing a comprehensive IT-based system with rigidly time-bound processes, can greatly improve efficiency and reduce bureaucratic hurdles. Currently *individual processes* are *loosely* time bound.

Policy directives are broad, however on ground implementation requires specific narrow instructions. This gap is left open for interpretation on the local authority. Without clear directives, decision paralysis occurs which slows overall progress.

21 Customs Tariff Rates of Turkey. (2023, January). Retrieved from <https://www.tariff-tr.com/>

22 Atmanirbhar Bharat, 'self-reliant India'. https://en.wikipedia.org/wiki/Atmanirbhar_Bharat

To address challenges in policy implementation, a single one-window system accessible to all relevant departments should be developed. This system would streamline department-specific functions and provide a centralized platform for efficient coordination and decision-making. Developing such a system may be challenging but once completed it will eliminate the largest hurdle in policy implementation.

■ National Center for Electric Vehicles

The establishment of a center envisaged in the National Electric Vehicles Policy (NEVP) should serve as a startup enabler, providing detailed technical, business, and HR objectives. Additionally, it should offer all designs necessary for investors at any stage to kick-start businesses in the EV domain. By making technology readily available, investment can directly result in local manufacturing, reducing time and potential failure associated with technology development. The center may be expanded to provide additional services (e.g., consultancy, product testing laboratory) to enable it to be self-sustaining.

■ Government role for affordability

The prime enabler to affordability is economies of scale. The government can play a pivotal role to enable affordability of EVs by enabling consistent and long-term demand. The current policies make business attractive however, it does not directly create markets. Market creation is expected to be organic and driven by the industry. A few proposals to ensure large scale volumes are put forward below:

1. **Charging Tariff:** Given the complexity in determining tariffs, an efficient way adopted by India is to have a national tariff policy which states *“the electric vehicle (EV) commission shall not exceed the Average Cost of Supply (ACoS) by more than 15%”*²³. To encourage EV adoption and give time for policy makers to determine local tariffs, the government could easily reduce it for a limited time. EVs are not expected to add significant electricity burden immediately, the time bound tariff relaxation would incentivize the early birds.
2. **Easy loans for EV purchase:** Government employees already have access to easy loans for auto purchase and can significantly facilitate the transition to EVs. Awareness campaigns and education on the benefits of EVs to encourage employees to choose electric vehicles over conventional ones will enable quicker adoption by government employees.
3. **Mandatory Phase-out Policy:** This policy aims to remove highly inefficient vehicles that have been in operation for an extended period, such as 40-year-old vehicles, from the roads. By phasing out these vehicles, the market will experience increased demand for newer and more efficient vehicles, reducing the need to sustain a wide variety of parts for outdated models.

²³ <https://e-amrit.niti.gov.in/electricity-cost-for-charging>

EU member states have regulations in place that require periodic vehicle inspections to ensure roadworthiness and compliance with safety and emission standards. These inspections, often referred to as “MOT tests” (Ministry of Transport tests), are conducted at regular intervals to assess the condition of the vehicle and its components. While there is no maximum lifespan defined, if a vehicle fails to meet the required standards during the inspections, it may be deemed unfit for the road and subject to repair or retirement. Additionally, older vehicles may face more stringent emission standards in certain cities or be subject to higher taxes and fees due to their environmental impact. This approach encourages consumers and the industry to plan for constant upgrades, ensuring that the industry remains up to date with the latest technology advancements in electric vehicles.

Implementing this policy effectively would require a well-structured disposal strategy involving all stakeholders. This strategy should address the environmental impact of vehicle disposal, recycling of usable parts, and responsible disposal of non-recyclable components. Collaboration with relevant government agencies, industry players, and environmental organizations will be essential to develop and implement an effective disposal strategy that aligns with sustainable practices.

4. **Export Focus:** Price sensitivity is one of the core challenges for auto industry’s growth. However, this is a local challenge. With exports, Pakistan’s low-cost talent may be exploited for higher returns and volumes. To enable car exports Pakistan has a long and arduous journey ahead – international requirements require significant technical infrastructure upgrades. Parts export is however a low hanging fruit that may be exploited relatively easily.

■ Battery Technology Research

Given that the battery is the costliest component of an EV, conducting battery research focused on creating a Pakistan-centered product using local materials is crucial. This would contribute to lower costs and easier implementation. Additionally, conducting a detailed survey to establish the prospects of a lithium supply chain in Pakistan is necessary to ensure a sustainable and reliable source of this critical resource.

A blue bus is parked at a charging station. Two red overhead charging arms are extended towards the bus. The scene is set against a clear blue sky. A dark blue rectangular box with the word "CONCLUSION" in white capital letters is overlaid on the lower part of the image.

CONCLUSION

6. Conclusion

The auto industry in Pakistan requires a transformation to enable the successful adoption of electric vehicles (EVs). While there are successful policy and regulatory references available from other countries, it's important to consider the unique challenges and consumer mindset in Pakistan. The introduction of favorable fiscal regimes is a step in the right direction, but there is a need for further clarification in the regulatory regime.

The current market in Pakistan shows potential for EV adoption in the two-wheeler segment, and with the right regulations, the three-wheeler segment can also be facilitated. However, the adoption of EVs in four-wheelers and commercial vehicles requires government intervention to overcome challenges and create an enabling environment.

Looking towards the future, it is crucial for Pakistan to have a global-focused outlook. This requires effective coordination among government organizations, ranging from policy makers to standards enforcement agencies. Collaboration and alignment with international standards and practices will be beneficial in establishing a competitive EV ecosystem.

In addition to policy and regulations, several other recommendations have been proposed to guide policymakers in the transformation of the auto industry. These recommendations may include infrastructure development, incentives for research and development, support for local manufacturing of EV components, education and training programs, and public awareness campaigns to promote EV adoption.

By considering these factors and implementing the necessary changes, Pakistan can pave the way for a successful transition to EVs and position itself better in the global automotive industry.



ANNEXURES

7. Annexures

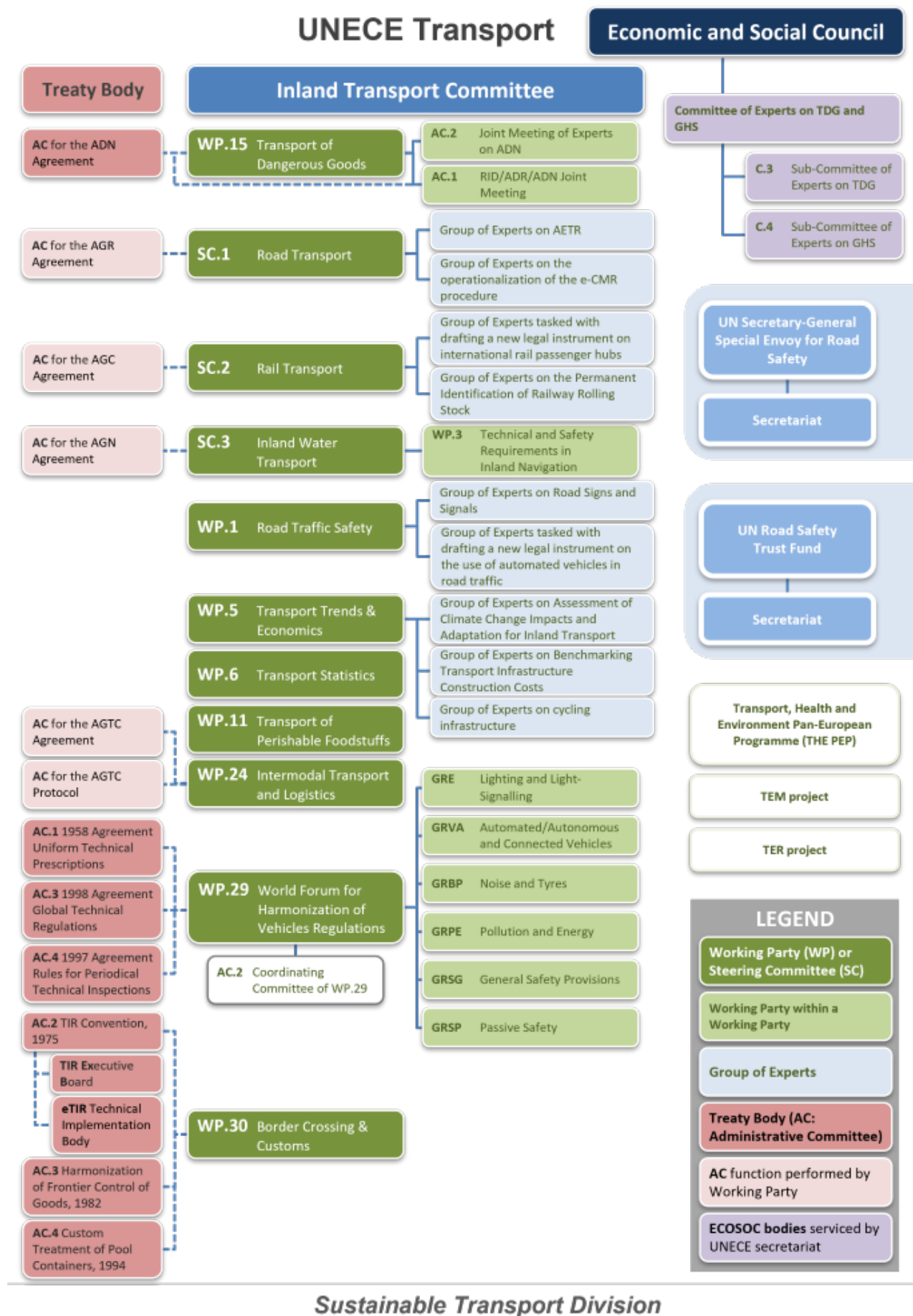
7.1. WP.29 and EVE Regulatory Framework

WP.29, also known as the World Forum for Harmonization of Vehicle Regulations, operates under three UN Agreements that provide a legal framework for member countries (Contracting Parties) to establish regulations pertaining to vehicles and their equipment:

1. **UN Regulations associated with the 1958 Agreement:** These regulations include provisions related to safety and the environment. They encompass performance-oriented test requirements and administrative procedures, such as type approval specifications. They facilitate the mutual recognition of type approvals granted by member countries.
2. **UN Global Technical Regulations (GTRs) associated with the 1998 Agreement:** GTRs consist of globally harmonized requirements and test procedures for vehicle performance. Unlike UN Regulations, GTRs do not include administrative provisions for type approvals or mutual recognition.
3. **UN Rules associated with the 1997 Agreement:** These rules pertain to the periodic technical inspections of in-use vehicles. Member countries reciprocally recognize international inspection certificates granted in accordance with the UN Rules, subject to certain conditions.

Meetings and Decision-Making: WP.29 holds three sessions per year, typically in March, June, and November. Each of the Working Parties conducts two sessions annually. Proposals for new regulations or rules are submitted and discussed in informal groups before being deliberated in the relevant working party. Finally, the proposal is considered for approval during the WP.29 session. Initially, proposals are submitted as informal documents and are later formalized into working documents that adhere to UN standards of formatting, translation, etc. These documents must be submitted to the UNECE secretariat three months prior to a meeting. An agenda, listing all the documents to be discussed, is also submitted three months in advance. Following the meeting, a report is compiled and distributed. Decisions are typically made by consensus, and a specified timeframe is allowed for registering objections. Once this period elapses, the regulation comes into force.

WP.29, positioned within the overall UNECE (United Nations Economic Commission for Europe) transport division, is a complex organization that demonstrates a wealth of experience and knowledge on various transport-related matters. Accessing the expertise and resources within the organization can be relatively straightforward due to its comprehensive structure and capabilities.



LEGEND

- Working Party (WP) or Steering Committee (SC)
- Working Party within a Working Party
- Group of Experts
- Treaty Body (AC: Administrative Committee)
- AC function performed by Working Party
- ECOSOC bodies serviced by UNECE secretariat

■ 7.1.1. UN Electric Vehicle Regulatory Reference Guide²⁴

The EV Reference Guide is intended to serve as a single point of reference to worldwide, EV requirements' landscape as it was at the time of data collection (September 2013). The guide is organized by *attributes* specific to EV and categorized according to

1. Vehicle: Range, Consumption / Efficiency, User Information, Labelling, Recycling and Reuse.
2. Battery: Performance, Durability, Recycling and Reuse.
3. Infrastructure: On board charging, Off board charging, Wireless charging and Vehicle as an electricity source.
4. Market deployment support: Regulatory incentives, Financial incentives, Consumer Awareness and government purchasing.

The data was compiled via a questionnaire which was distributed to the stakeholders to respond to. The governmental stakeholders were relevant regulatory bodies from China, India, Japan, Korea, EU, Canada and USA. There were other non-governmental stakeholders as well.

The intent was to provide a general response and not a specific answer e.g., under EV range, the required answer was whether it was mandated and not a detailed response of the test conditions and actual range classifications etc.

	Electric Range	Energy Efficiency	User Information	Recycling / Reuse	Labelling
Definition	The max distance an EV can travel using only battery power.	Energy required to travel X km in standardized conditions.	EVs to include symbols for warnings, battery capacity, etc.	Requirements for recycling and/or reusing vehicle components	To indicate fuel efficiency, total battery capacity (kWh), etc.
Canada	Voluntary	No Regulation	No Regulation	CAREC	Voluntary
China	GB/T 18386-2005	GB/T 18386-2005	GB/T 4094.2-2005	GB 22128-2008	GB 22757-2008
EU	UN-R101, A9	UN-R101, A7	No Regulation	EOL-V 2000/53/EC	Alphabetized grade system
India	AIS 040	AIS 039	No Regulation	WIP	No Regulation
Japan	TRIAS 99-011-01	TRIAS 99-011-01	JEVS Z 804-1998	EOL-V Act No. 87	Fuel Economy labels
Korea	SAE J1634	SAE J1634	No Regulation	Act No. 11913	Fuel economy labels
USA	US EPA/NHTSA	US EPA/NHTSA	No Regulation	No Regulation	Fuel economy labels

Table 4 : Regulatory overview on vehicle attributes

²⁴ Electric Vehicle Regulatory Reference Guide, ECE/TRANS/WP.29/2014/81, <https://unece.org/index.php?id=38750>

	Performance	Durability	Recycling	Re-use
Definition	Methods for testing battery power, capacity, battery charge, etc.	Methods for determining life cycle count, vibration resistance, temperature, etc.	Battery material recycling standards	Alternate uses for batteries after their useful life in vehicles.
Canada	No Regulation	In progress	Mandated	No Regulation
China	QC/T743-2006	QC/T 743-2006	WIP	No Regulation
EU	UN-R101, A2 IEC 62660-1:2010	ISO 12405-1:2011, ISO 12405-2:2012 IEC 62660-2	2006/66/EC	2005/64/EC
India	N/A for Lithium	No Regulation	No Regulation	No Regulation
Japan	Required	No Regulation	Act No. 87	No Regulation
Korea	ISO 12405-1 KS C IEC 62660-1	KS C ISO 12405-1 KS C IEC 62660-2	No Regulation	No Regulation
USA	Voluntary J1798	J2288 J2380	No Regulation	No Regulation

Table 5 : Regulatory overview on battery attributes

	On-board Charging System	Off-board Charging Standard	Wireless Charging	Vehicle as Electricity Supply
Definition	Specifications including voltage, current, port for AC and/or DC power	Specifications including port for DC power, BMS interface etc.	Standards for wireless charging	Specifications for transferring electricity from EVs to the grid
Canada	No Regulation	CSA and CEC	No Regulation	No Regulation
China	GB/T 20234.1-2011 GT/T 20234.2-2011	GB/T 20234.1-2011 GB/T 20234.3-2011 GB/T 27930-2011	WIP	Q/GDW 397-2009 Q/GDW 398-2009 Q/GDW 399-2009
EU	IEC 61851 IEC 62196	IEC 62196-3 IEC 62196-2	WIP	WIP
India	No Regulation	No Regulation	No Regulation	No Regulation
Japan	SAE J1772	JARI JEVSG105 IEC 62196-3	WIP	EVPS-001/002/003/004
Korea	KS C IEC 61851-1 KS C IEC 61851-22	KS C IEC 61851-1 KS C IEC 61851-23	WIP	No Regulation
USA	SAE J1772	SAE J1772	WIP	J2836, J2847, J2931

Table 6 : Regulatory overview of infrastructure attributes

	Regulatory Incentives	Consumer Awareness	Government Purchasing
Definition	Incentive for deployment of electrified vehicles	Increase awareness about electrified vehicles.	Mandatory EV fleet induction within government operations
Canada	Yes	Yes	Yes
China	Yes	Yes	Yes
EU	Yes	Yes	Yes
India	Yes	Yes	Yes
Japan	Yes	Yes	Yes
Korea	Yes	Yes	Yes
USA	Yes	Yes	Yes

Table 7 : Regulatory overview on market deployment attributes

7.2. National Electric Vehicle Policy

The National Electric Vehicle Policy was formulated by the Ministry of Climate Change with the prime focus on tackling climate change and a means for reducing the fuel import bill. A summary of the incentives proposed in the NEVP is presented below.

Incentive	M1 and N1 Category Vehicles	2 / 3 wheelers, L Category Vehicles	Buses	Trucks
Existing Incentives in Auto Dev Policy 2016 - 2021	Available	Available	No mention	No mention
Imports: EVs.	Add. CD = 0% Add. ST = 0%	No mention	CD = 1%	CD = 1%
Imports: Int. standards compliant EV components and parts, not manufactured locally.	CD = 1% ST = 0%	CD = 1% ST = 0%	CD = 1%	CD = 1%
Imports: CKDs	No mention	CD = 1% ST = 0%	CD = 1%	No mention
FED	0%	No mention	No mention	No mention
Locally manufactured EVs	ST = 1% EVs up to 50kW LCV up to 150kW	ST = 1%	ST = 1%	ST = 1%
Registration and Annual Fees	0 PKR			
EV specific zonal incentives	Yes	Yes	BRTs and Metros to be prioritized	No mention
'Green banking' incentives via Banks	Yes Financing at 1+4% via SBP	No mention	Yes	No mention
Toll tax on NHAs	50% reduction	No mention	50% reduction	50% reduction

Table 8 : Policy incentives for EVs

Incentives for EV assemblers:

1. Auto Development Policy 2016 – 2021 incentives will continue to hold.
2. Facility conversion to EV assembly facility via Greenfield Investment Regulation available in Auto Development Policy 2016 – 2021
3. No customs duty or income tax or sales tax on import of machinery, equipment and / or plant for EVs. Available to new and existing manufacturers
4. Lower financing options for EV manufacturing plants.
5. Land lease policy to be formulated for EV manufacturers. One key provision being, initial rate to be lower for the first 10 years.
6. EV export policy to be formulated as per WTO rules.
7. To test the market the following incentives available:
 - a. 100 CBUs per variant at 50% duty, applicable to all cars except 2 and 3 wheelers.
 - b. 10 CBUs per variant at 50% duty, applicable to 2 and 3 wheelers.

Incentives for EV component OEMs:

1. All batteries, motors and electronics etc. utilized in an EV not being locally manufactured as per international standards will be imported at 1% CD and 0% ST.
2. All components for batteries, motors and electronics etc. utilized in an EV not being locally manufactured as per international standards will be imported at 1% CD and 0% ST.
3. All components for conversion kits will be imported at 1% CD.
4. 05 years income tax exemption for companies setting up independent manufacturing facility for manufacturing EV related equipment.
5. All inputs (machinery, equipment etc.) for manufacturing of EV related parts by the OEMs and vendors to be exempted from all duties and taxes for 5 years from the start of manufacturing.
6. As part of the Green Banking initiative, loans to be at 5% to EV part manufacturers

Incentives for OMCs and other EV charging station providers:

1. Public level 2 chargers installation cost may be allocated as CSR contribution.
2. EV chargers and battery swapping station imports have 1% CD
3. Level 3 EV chargers' components can be imported at 1% CD

National Center for Electric Vehicles: The policy envisages a center to act as a catalyst for the EV transformation in Pakistan. The objectives range from:

- Technical Aspects: Develop Pakistan specific EV designs, EV data collection and validation, produce relevant standards and possibly regulate electric mobility.
- Business Aspects: Develop business models to attract local and international investment, in manufacturing and O&M. Identify opportunities for maximum indigenous production of EV parts and possibly ensure that EVs on roads are locally assembled with significant indigenization by 2023.
- HR Aspects: Train workforce on EV technology.

EV model cities: Lahore and Islamabad to be designated as EV model cities and Green Rickshaw / Green Taxi schemes to be launched.

Government Agency roles: The policy also defines the stakeholders and their responsibilities in the EV ecosystem enablement. From incentive planning, to EV charging network plan and from, Rescue 1122 training for EV related emergencies to specifying EV types and models the policy puts the responsibility on a particular agency. The stakeholder map with brief responsibilities is as follows:

1. Ministry of Climate Change: Own the EV policy along with Ministry of Industries and Production.
2. Ministry of Industries and Production: Specify EV types, models and other options.
3. Engineering Development Board: Liaison between academia and industry to seek indigenization of high value parts.
4. Ministry of Commerce: Provide incentives plan.
5. Ministry of Planning, Reform and Development: EV targets in 05-year plans.
6. Ministry of Finance: Implement tax incentives via FBR.
7. Ministry of Energy: Power division to provide blueprint for National Center for EVs. Petroleum division to monitor impact on oil value chain.
8. Ministry of Communications: EV network map.
9. Ministry of Foreign Affairs: Encourage international investment.
10. Provincial Governments: Provincial policies.
11. NEPRA: EV tariffs.
12. DISCOs: Smart metering.
13. NTDC: Energy generation with a focus on supporting EV consumption.
14. Banking Sector: Provide financial support for potential EV purchasers

7.3 Reducing Climate Impact of ICE: Euro Fuel Standards

European Emission Standards (Euro 1 – 6) are vehicle emission standards aimed at limiting pollution, including most greenhouse gases such as Carbon Monoxide (CO), Carbon Dioxide (CO₂), Nitrous Oxides (NO_x), and hydrocarbon-based emissions. However, they do not include additional non-exhaust emissions, such as those from tires. These standards have been adopted globally through country-specific regulations and serve as a good reference for policymakers in addressing climate change.

A quick tabular comparison of their evolution for passenger cars is presented below. Similar tables are available for 2 and 3 wheelers, commercial vehicles and trucks and buses.

Tier	Date (type approval)	Pakistan Adoption	CO	THC	NMHC	NO _x	HC+NO _x	P	PN [# / km]
Euro 1	July 1992		3160	–	–	–	1130	180	–
Euro 2	January 1996	16 years later (2012)	1000	–	–	–	700	80	–
Euro 3	January 2000		660	–	–	500	560	50	–
Euro 4	January 2005		500	–	–	250	300	25	–
Euro 5b	September 2011	9 years later (2020)	500	–	–	180	230	4.5	6 × 10 ¹¹
Euro 6d	January 2020		500	–	–	80	170	4.5	6 × 10 ¹¹

Table 9 : Diesel passenger cars (Category M), mg/km. COP values only.

Tier	Date (type approval)	Pakistan Adoption	CO	THC	NMHC	NO _x	HC+NO _x	P	PN [# / km]
Euro 1	July 1992		3160	–	–	–	1130	–	–
Euro 2	January 1996	16 years later (2012)	2200	–	–	–	500	–	–
Euro 3	January 2000		2300	200	–	150	–	–	–
Euro 4	January 2005		1000	100	–	80	–	–	–
Euro 5b	September 2011	9 years later (2020)	1000	100	68	60	–	4.5	–
Euro 6d	January 2020		1000	100	68	60	–	4.5	6 × 10 ¹¹

Table 10 - Petrol passenger cars (Category M), mg/km. COP values only.

Enforcement of these standards is done through ‘Emission Test Cycles,’ which assess emissions under specific conditions (temperature, load, and speed) that vehicles are expected to operate under. Vehicles are allowed to be driven on roads only after passing these tests.

However, lessons learned from the enforcement of these tests revealed that some automobile manufacturers optimized their vehicles to pass the tests by incorporating code in the vehicle's computer. This code detected when the car was being tested and modified its operations to ensure the test was passed. As a result, real-world emissions were found to be up to 40 times higher than the standard²⁵. In response to these systematic failures, a different approach to testing emissions, focusing more on real-world conditions, was adopted.

The adoption of emission standards has been abrupt and disruptive in many countries. For example, in Singapore, China, India, and Japan, the decision to implement these standards resulted in the complete halt of certain vehicle line-ups and even led to some companies exiting the country. To provide some examples, the Chinese government stopped the production of around 530 cars, Fiat ceased operations in India, and older Japanese cars had to be retrofitted with emission controllers²⁶.

Pakistan's experience with adopting emission standards has been consistent with its overall approach – delayed approval, slow acceptance, and complicated enforcement. Upgrading fuel required upgrading engines, which took time to procure and implement. Pakistan mandated the use of Euro 2 fuel in January 2012, and eight years later, in August 2020 (for petrol) and January 2021 (for diesel), the country upgraded to Euro 5 fuel. Imported fuel now meets Euro 5 standards, but local oil refineries are still being upgraded to produce Euro 5-compliant fuel, resulting in a complicated mix of fuels available at stations.

On the vehicle side, auto assemblers have requested two years to upgrade their cars, as their suppliers are still manufacturing Euro 4 kits²⁷. The final step in this journey is to mandate the removal of cars produced during the time of Michael Jackson's heyday (to put the timeline into perspective). These vehicles, which dominate the public transport sector, are a reflection of the nation's mindset regarding the expected lifespan of a vehicle. Failing to implement such a mandate serves as a reminder to policymakers of the potential recurring economic and ecological costs in the future.

Pakistan's transition also revealed issues of fuel adulteration. Pakistan's learning during the transition was of fuel adulteration. To pass tests, Oil Marketing Companies (OMCs) were adding harmful chemicals to increase the Research Octane Number (RON) value²⁸. These chemicals were detrimental to both the vehicles and human health. The discovery was made by a top Japanese assembler whose flagship car had to be taken off the roads. This revelation came in November 2017, five years after the Euro 2 mandate was implemented and enforced.

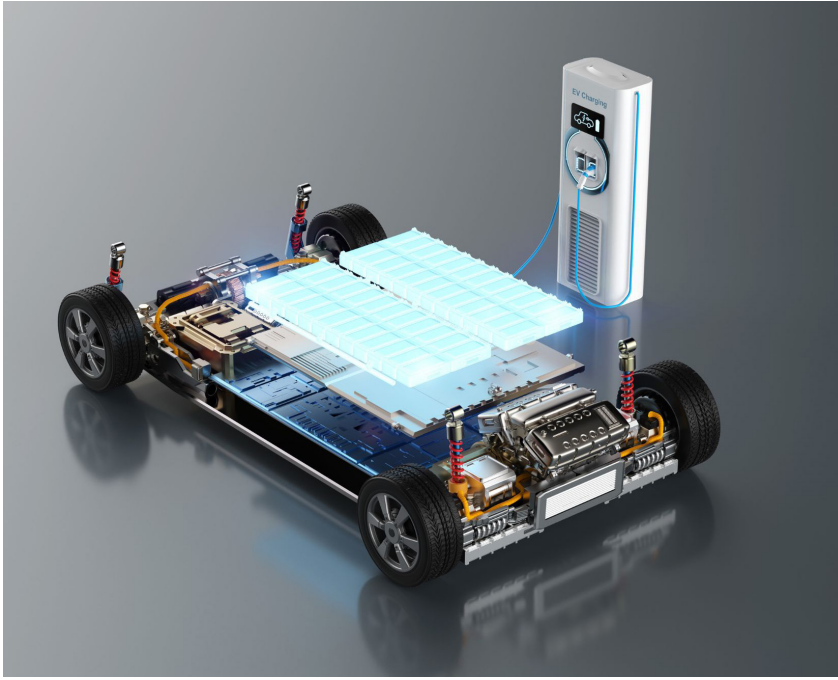
25 Volkswagen to Stop Sales of Diesel Cars Involved in Recall : <https://www.nytimes.com/2015/09/21/business/international/volkswagen-chief-apologizes-for-breach-of-trust-after-recall.html>

26 Will Switching to Euro-5 Solve Pakistan's Environmental Problems?: <https://carspiritpk.com/switching-euro-5-solve-environmental-problems/>

27 Auto industry seeks 2 years to switch over to Euro IV/V : <https://www.brecorder.com/news/40002637>

28 OGRA Tests Confirm Petrol is Damaging Car Engines in Pakistan: <https://propakistani.pk/2018/03/12/ogra-tests-confirm-petrol-is-damaging-car-engines-in-pakistan/>

In conclusion, addressing climate change in the transport sector involves not only the transition to electric vehicles but also significant reductions through emissions control. Pakistan may have had a delayed start in this regard, but it is now on the right path with key stakeholders working towards this cause. However, to ensure satisfactory results, constant independent supervision of the components is necessary. Lastly, a mandatory phase-out of obsolete cars is essential to effectively address climate change, as without it, these vehicles will continue to contribute significantly.



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