# SCOPE OF ELECTRIC VEHICLES IN PAKISTAN

## MEETING TARGETS OF PAKISTAN'S NATIONAL ELECTRIC VEHICLE POLICIES 2020-2025

INTEGRATED ENGINEERING
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SCOPING OF ELECTRIC VEHICLES IN PAKISTAN: Meeting targets of Pakistan National electric Vehicles Policies – 2020 – 2025

17th JUNE 2022

The Integrated Engineering Centre of Excellence at the University of Lahore is a research and development organisation that is actively developing electric vehicle technologies and vehicles, developing concepts for the integration, policy evaluation and recommendations, and collaborative research and development under the IECE@UOL – ALIERA UK GREEN TECHNOLOGIES INITIATIVE 2020-2030.

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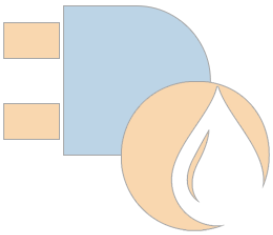

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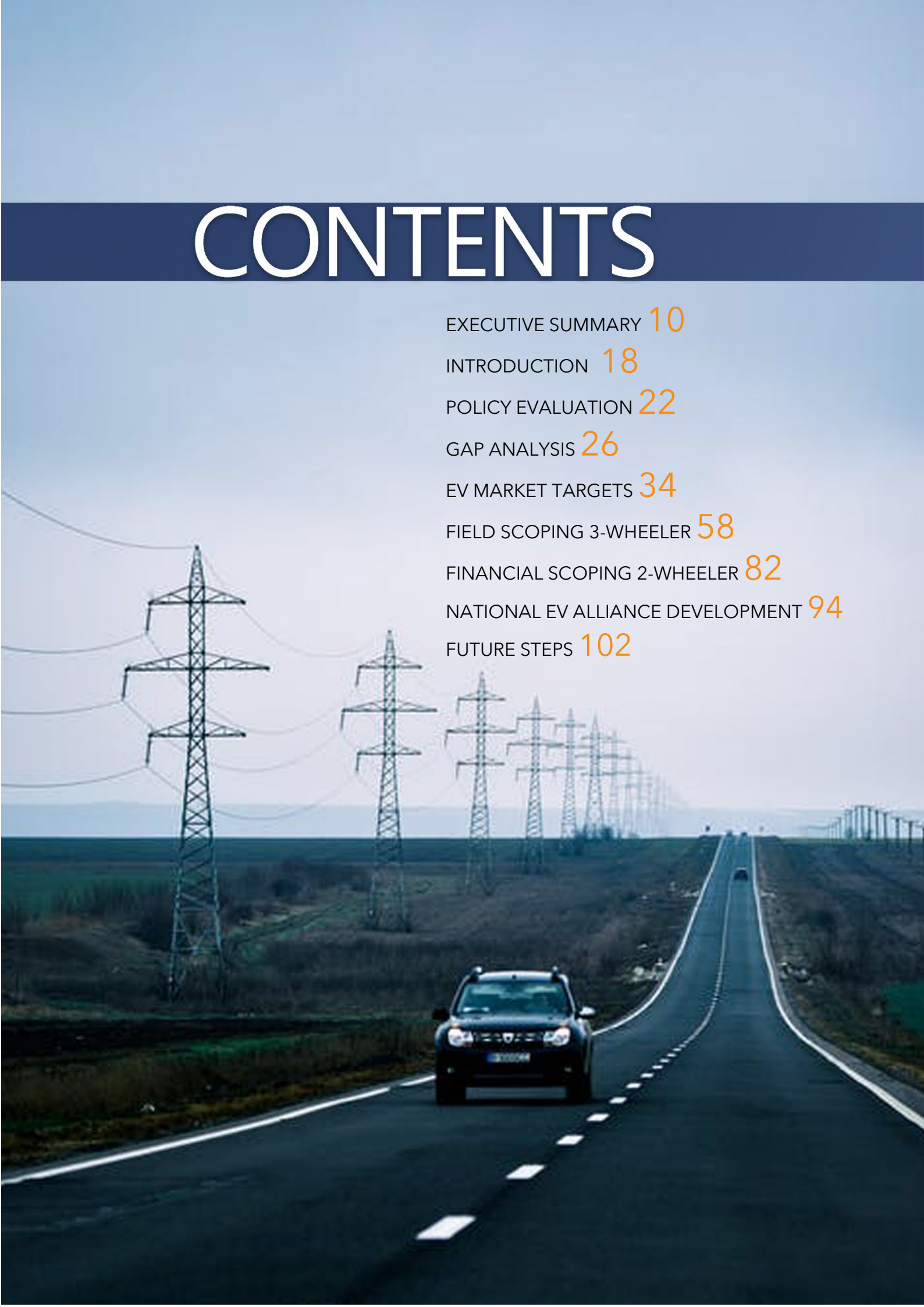


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## 1 1 LIST OF ABBREVIATIONS

| | |
|---|---|
| AIDEP | Auto Industry Development and Export Policy |
| BEV | Battery Electric Vehicle |
| CAGR | Cumulative Annual Growth Rate |
| CBU | Completely built Unit (ready to be sold) |
| CIPP | Context, Input, Process &Product |
| CKD | Complete Knock Down Kit (to be assembled) |
| CNG | Compressed National Gas |
| CSO | Civil society organisation |
| DVSA | Driver and Vehicle Safety Agency |
| EDB | Engineering development board |
| EPB | Export Promotion Bureau |
| EV | Electric Vehicle |
| FFV | Flexible Fuel Vehicles |
| GAPS | Gap analysis |



| | |
|---|---|
| GCU | Government College University, Lahore |
| ICE | Internal Combustion Engine |
| IECE | Integrated Engineering Centre of Excellence |
| IVA | Individual vehicle approval |
| IVC | Individual approval certificate |
| LPG | Liquid Petroleum Gas |
| LUMS | Lahore university of Management Sciences |
| MoCC | Ministry of Climate Change Pakistan |
| NEDC | New European Driving Cycle |
| NEECA | National Energy Efficiency & Conservation Authority |
| NEPRA | national electric power regulatory authority |
| NEVP | National Electric Vehicle Policy - MoCCPAK |
| NGO | Non-governmental Organisations |
| NTA | National Type Approval |
| NUST | National University of Science and Technology |
| PHEV | Plug in Hybrid Electric Vehicle |
| REESS | Rechargeable Energy Storage System |
| RTD | Research and Technology Development |
| ToT | Transfer ot Technology |
| UNECE | United Nations Economic Commission for Europe |
| VCA | Vehicle Certification Agency |
| WLTC | Worldwide harmonized Light vehicles Test Cycles |




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# EXECUTIVE SUMMARY


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# 1 EXECUTIVE SUMMARY

## 1 1 THE TASK

The National Electric Vehicle Policy, NEVP 2019, rolled out by the Ministry of Climate Change, Pakistan in December 2020, has set aims and recommendations to leverage the potential of EVs against the dangers of climate change.

While the intentions and performance Indicators seem justified and copious, there is no overlying relating coherence between recommendations and KPIs. There is a lack of a defined ecosystem within the policy to tie them all together to achieve the goal of 30% of the new passenger vehicles, bikes, buses, and heavy-duty trucks to be electrified by 2030; this figure rising to 90% of all sales by 2040.

The Integrated Engineering Centre of Excellence, at the University of Lahore, therefore, was tasked with the following:

- Identifying existing gaps in the electric vehicle policy; Identification of technical, financial, and regulatory barriers in the accomplishment of official targets under EV Policy 2021
- Mapping of potential civil society partners; conducting an EV scoping study in which the IECE team would perform stakeholder analysis, in which manufacturers, technologists, researchers and consumers are surveyed for their views on the EV policy
- Developing a national alliance on clean transportation with the help of CSOs and NGOs
- Seeking the stance of financial institutions on the financing of electric vehicles and eco-conscious investment for transportation
- Understanding the relation between reducing gender disparity and e-mobility
- Seeking the potential of retrofitting of existing vehicles to promote sustainable transportation

To summarise the analysis, and the plan of action and recommendations, we can break down the process into several topics:

## 1 2 SITUATIONAL MAP

### *1 2 1 Impact of the NEVP*

- The impact of the NEVP is invisible. It is not marketed. In fact, marketing and media has not been able to present a complete picture
- The NEVP has been superseded by AIDEP policy (which interferes with HYBRID vehicles)
- Most of the Policies have been reverted end of 2021 till now by Parliamentarian policies
- The policies have been ignored by the IMF in providing funds to Pakistan (Which is still under negotiations). Levy on Petrol, reducing the GSTs and duties on Solar Panels have been reverted to go back to the Policy however the same effect is required for EVs.
    - UPDATE – 17/06/2022 As of the 16th of June, 2022, the senate standing committee on finance was held under Senator Saleem Mandiwala and a further review of the budget has been made in accordance with newer IMF policies which now have included recommendations made for the EV policy rejecting the GST increase, and a further recommendation to reduce it for smaller vehicles.

Plan of Action: A EV stakeholders group / national alliance with IECE have been actively involved in providing information to Parliamentarians through white papers, and a strict campaign to lead IMF to its state goals of catering to a countries Climate action impact. According to the update in the last section, some of the actions have influenced the IMF which has allowed rescinding some of the tax increases on EVs.

### *1 2 2 Current EV Penetration Map*

- Figures from the End of 2021, and current trends as of June 2022, are bleak and are currently not predicting growing towards the market penetration goals set for 2025 for all 4 types of vehicles: cars, 2 and 3 wheeled vehicles, buses, and trucks. Each of them falls short at current trends including no news about EV trucks at all.
- The goals are unrealistic, and current policy does not give enough incentives / have changed polices to change or ignore incentives to achieve the goals

Plan of Action: There are three plans of action for this:

- Increase the market share of EVs by increasing the CAGR (Cumulative Annual Growth Rate) of EVs by including Imported CKD and CBUs in the mix.
- Increase the CAGR by reducing the new vehicle market size; concentrate on developing and promoting retrofitting current vehicles to electric reducing the cost of new vehicles
- Correct the 2025 penetration goals to a more realistic high growth market based on high, but realistic CAGR which is based on global and Pan-Asian current predictions

### *1 2 3 Realistic Income Figures / Impact on the Environment*

Income and savings from EV penetration is based on certain criteria of making certain assumptions:

- The current grid can sustain all Electric vehicles that are predicted to be incorporated into the system by 2025. The extra requirements are not managed correctly
- The sustainability and GHG impact of producing providing electricity to these EVs are downplayed by declaring Hydro-Electricity generation as a renewable energy source.
- A charging network has not been properly implemented yet (as it is not scoped correctly in this NEVP; a NEECA based policy has taken over the mantle to develop that) which has just only arrived an entire year after the release of the NEVP

Plan of Action: Smart Charging recommendations are made in the document, including increasing the reliance on distributed renewable energy sources to rejuvenate the acceptance of EVs and to create an ecosystem to incorporate an off-grid energy source for each vehicle system.

This study shows the impact of Electric vehicles on the climate, import costs, sustainability, and an industry that can survive in its own ecosystem, therefore should be given its own status as an industry.

## 1 3 NEVP Policy Incentives

This is the stickiest and most volatile point of the document as most recommendations have been ignored or overridden, reinstated, and then backtracked on numerous occasions over the past year and a half in the life of the NEVP policy. Some of the NEVP policy backtracks include:



Increase in Sales tax on EVs, even though was promoted to be reduced and removed

Preferential treatment to Hybrid vehicles, which was implemented by the AIDEP policy after Toyota intervention overriding the NEVP giving EVs a disadvantage

Registration on EV vehicles were proposed to be zero, has been severely increased for EVs without proper guidelines in Policy yet.

Changing policy on imports of CKD and CBU units. With proposed low duties and taxes on both systems, these were increased, and then completely banned for a short while in December. Currently, they have been banned yet again 22 May 2022. As mentioned earlier, these are required to increase the CAGR of EVs in Pakistan to meet the current goals for 2025, 2030 and beyond.

Crude oil being subsidised, removing any incentives for people to adapt electric vehicles. There has been a 10% regulatory customs duty imposed on petroleum products from China end of May 2022. A 10% duty is applicable on local production of these products. This does go against CPFTA signed in 2019. This allows to ease IMF obstacles after a meeting at Doha between the govt and the IMF. On June 10th, A petrol Levy of Rs50 has been announced. These are steps in the direction to be taken that can help the adaption of EVs.

Local manufacturers have been incentivized in the NEVP. Most of these incentives have been redacted, including a proposal to reduce the number of licences for EV production.

CKD import now has an extra regulation step added to it from the State bank of Pakistan.

Plan of Action: The recommendations given include removal / reduction of sales tax to the Policy recommendation levels. Reduction of Custom duties on CBUs to be revised back to that of the Policy statements for all vehicles. Reducing the difference between duty structures of CKD and CBUs to levels which are closer to that of other countries in the region including the Philippines, Thailand etc.

To protect this young and vulnerable sector, there is a need for policy to be more resilient and not bundled with policies on the regular vehicles, market, The Electric Vehicle industry must be treated as a separate entity with its own subsidies, incentives and plans of action separate from FFV vehicle market. The EV industry must not be made a scape goat for the past practises adhered by the automotive industry as it is being done by policy today. The variance in taxes, CBU & CKD imports, duties, regulation are all impacting the EV industry from even rising which does not have the experience and buoyancy that the FFV market has made in the past 40 years in Pakistan

## 1 4 Aspects Missing from the NEVP

### *1 4 1 GHG Accounting*

Plan of Action: Even the updated 2021 NDCs have used the transportation emission values for 2018-19, therefore a huge gap still exists with regards to GHG accounting and realizing the actual environmental impacts of transportation. This study has calculated the GHG emissions for vehicles on drive cycles for Pakistan. They are summarised in the study.

The study proposes a critical review into renewable energy projects noted in Pakistan's NDCs document as well.



### *1 4 2 Vehicle Technology Layer*

Plan of Action: An aspect missing from the NEVP, is technical specifications, regulations, and testing requirements for EVs (and vehicles in general) to be developed, assembled, manufactured, and imported into Pakistan.

### *1 4 3 Market Survey & Mapping – Stakeholder Layers*

Plan of Action: Using a survey-based approach, data from 534 three-wheeler drivers were collected from the major metropolitan cities of Pakistan and it was observed that there exists an opportunity to introduce electric three-wheelers to achieve holistic sustainability. ("Clean and sustainable transportation through electric vehicles – a user …") This is part of a journal paper, and this document as well.

A similar survey has been conducted for 2 wheeled vehicles with emphasis on running costs and cost of the vehicle. That data has been presented to another stakeholder group which is financial institutes to further promote EVs. The running cost between an electric motorcycle and a FFV motorcycle, at 80km a day.

### *1 4 4 Development of a Stakeholders' group*

Plan of Action: Two separate researcher, manufacturers, developers, and importer groups have been identified and developed for to be part of an action group for the promotion of Electric Vehicles in Pakistan. Around 21 groups were consulted for the development of this document, and a dissemination plan of action will be developed for the next steps.

## 1 5 Next Steps

### *1 5 1 Electrical Vehicles Ecosystem*

In conclusion, the document proposes a complete ecosystem development and assigning stakeholders into each aspect of the ecosystem; to complete an ecosystem of manufacturing, distribution, development, maintenance, financing, policy, testing specifications and regulations, requires a complete mapping exercise to assign all resources to the ecosystem.

### *1 5 2 Retrofitting and Dynamic Distributed Energy System*

it is imperative to introduce interventions that lead to a sustainable transportation system. In this regard, retrofitting of existing vehicles with electric motors and electric systems is a fantastic opportunity that needs to be explored.

## 1 6 Working Team & Acknowledgements

This scoping study was conducted by the IECE team of Dr Aazir Khan Director of IECE, Saad Amjad PhD candidate at University of South Florida, Dr Aamir Khan Head of Department of Mechanical Engineering at the University of Lahore for the duration of the project acknowledging the work of Arooj Mobasher, Zeeshan and Yasin who developed the field work and desk research.

We would like to thank Nasir Mahmood, pro-rector of the University of Lahore to allow us all facilities and support for this report and for the IECE sustainable green technology Initiative since 2020.



The SDG and green sustainable development initiatives at the University of Lahore have been developed under the leadership of Awais Rauf, the chairman of the board of Governors of the University of Lahore and Ibadat education trust, a not for profit organisation promoting leadership and education in Pakistan. This initiative has been a major reason for the development of IECE, the consortium and the development of this study and we thank him for this opportunity.

We would like to show our extreme gratitude to Mushtaq Gaadi Sahib, country head of Tara for his support, encouragement, and reviews of the work all the way. Also, for the Tara group of partners that have been very welcoming and supporting. Mustafa Amjad and Zain Maulvi with the ACJCE group.

The policy evaluation was helped dearly by Dr Amin Khan, distinguished Professor at Government College University, and president of Madrasatul Binat and the SDG group of Government college Lahore for their valuable input.

We would also like to acknowledge the efforts Nauman Ahmad Zaffar, project Director national Incubation Centre and LUMS, and Dr Naveed Arshad, of the Energy Institute of LUMS, for the arduous work they have done over the years to promote renewable energy and EV systems and for letting us be part of a scoping study conducted LUMS under the USAID program.




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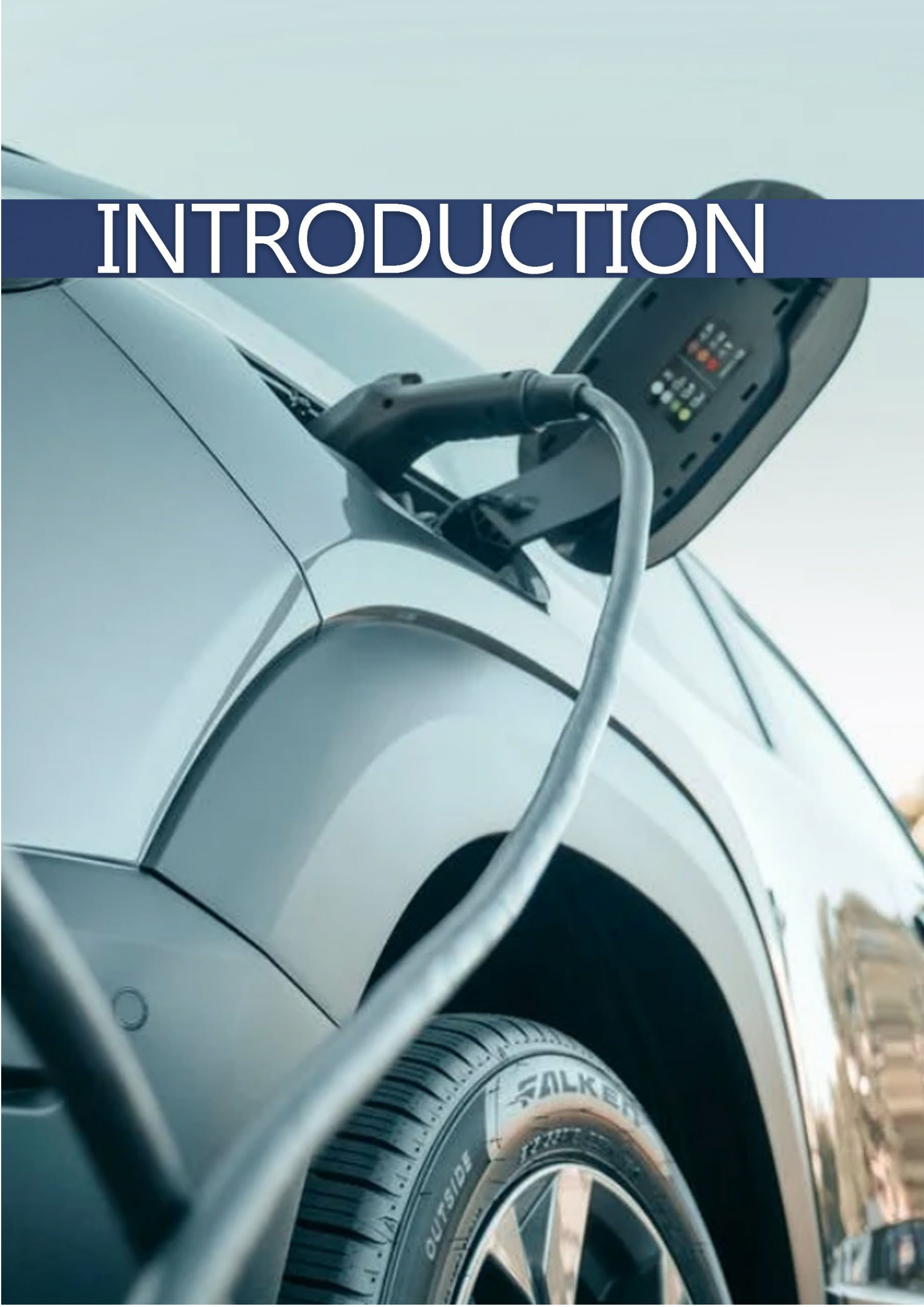
# INTRODUCTION

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# 2 INTRODUCTION

## 2 1 THE NATIONAL ELECTRIC VEHICLE POLICY 2019

The National Electric Vehicle Policy, rolled out by the Ministry of Climate Change in December 2020, Pakistan has set aims and recommendations to leverage the potential of EVs against the dangers of climate change.

Despite being the premier and seminal work on Electric Vehicles in Pakistan, this policy document, is fragmented in nature, and leaves the practitioners and implementation professionals with a lot of unanswered questions and gaps between implementation recommendations and actual KPI numbers. For example, questions have arisen on how can financing institutions and banks support the EV market in Pakistan, how can the government departments working on EVs (Engineering Development Board, Ministry of Climate Change, Ministry of Industries and Production, etc.) be bought on the same page to the same KPI goals, and how can the targets stipulated in the EV policy be met, etc.

This leaves the policy with some critical issues completely unaddressed, unchained, or not defined enough to be able to be assessed accurately as a key performance indicator (KPI). For example, secondary and tertiary stakeholders such as an ecosystem of local tier suppliers, spare parts industries, and mechanics are unaddressed in the equation which will be barrier to the adaption of implementation plan. The effect on the end users and groups are tackled on an economic standpoint Ignoring the social Impact of the adaption of these emerging disruptive EV technologies in Pakistan. More importantly, the effects on carbon emissions are not quantified in policy Implementation; a holistic intervention is required to reduce the detrimental impacts of air pollution in Pakistan, which causes annual socioeconomic losses of PKR 62-65 Billion.

The integrated Engineering Centre of Excellence (IECE), at the University of Lahore, has been tasked with an EV scoping study that not only identifies these gaps and barriers, but also proposes the leading the scope towards an ecosystem as a panacea to these issues by suggesting various evidence-based policy measures related to EV manufacturing, financing, regulations, and legislations. Being cognizant of its societal responsibilities, the scoping study endeavour to develop a cohort of CSOs / NGOs to further the agenda of clean and sustainable transportation.

The IECE team believes that the proposed scoping study would provide a foreground for evidence-based policy interventions in EVs, lead towards an EV ecosystem that can be developed to further pave way for future interventions with regards to technological, financial, and regulatory mechanisms related to EVs; thereby not only achieving climate friendly transportation, but also increasing social mobility and catalysing economic empowerment.

## 2 2 DEVELOPMENT OF THE EV SCOPING FRAMEWORK

A gap analysis of the National Electric Vehicles Policy was not enough for the development of this scoping study as there are several key issues including all stakeholders unaddressed.

The figure below shows the methodology framework that was followed for the scoping study. This framework has been developed using approaches for designing evaluation



research using methodologies from the handbook of environmental policy evaluation[1]. There is a context, input, process, and product (CIPP) evaluation design and empowerment, assessment evaluation designs (that empowers stakeholders to be able to review the policy in a capacity of being to recommend policy change in the future. There are three distinct phases created in this study:

### *2 2 1 Phase I*

This phase (In blue) concentrates on the Policy document itself. It addresses a policy evaluation methodology (in conjunction with Government College University and Madrasatul-Binat) and to carry out a gap analysis on the document including targets, incentives, and actions recommended by the Policy document.

A desk review for EV technical layer scoping evaluation is added to this section which was unaddressed mainly by the document. Initial Policy actions and recommendations are made throughout this section.

Phase II

(in red) Is related to the development of the field survey that would cater to the stakeholders such as the end users including the market and social layer. This is conducted for the two main markets, which is the two and three wheeled markets. A financial institute layer is also added to this Phase to stake the interest in the EV industry. Policy recommendations are made through this Phase as well.

Phase III

Is related to the development of a sustainable transportation stakeholders alliance to add to dissemination and lobby the intricacies of the EV market that would lead to a complete ecosystem developed for EVs as medium-term goals.

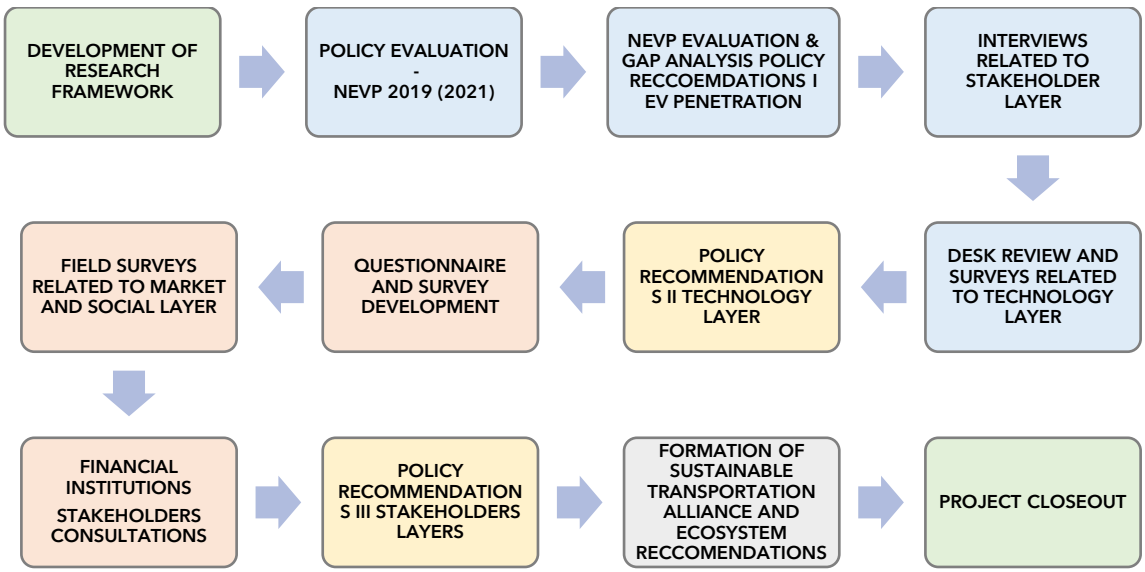
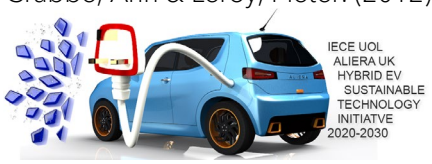



Figure 1 Methodology of the Scoping Analysis

[1] Crabbé, Ann & Leroy, Pieter. (2012). The Handbook of Environmental Policy Evaluation.





# POLICY EVALUATION & GAP ANALYSIS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# 3 POLICY GAP EVALUATION – NEVP 2019

## 3 1 POLICY EVALUATION PROCESS BACKGROUND

To understand the context, development mindset and approach, and to be able to evaluate the policy using methodologies already developed, the first step was to understand policy document itself. In cooperation with Dr Amin U Khan, Professor Govt College Lahore, Director Lahore Botanical Gardens (BGGC) and President Anjuman Madarastul Binat, a discussion group was developed for environment policy evaluations. The Department of Sustainable development study centre of Government College University in Lahore graciously provided its PhD course team in environmental sciences and allowed discussions in their policy evaluation classes.

Emphasis on the study was given to the following topics:

1. The emphasis on Environment, social impact, and regulation (and lack thereof) of any quantitative data to justify EVs in Pakistan.
2. The evaluation design approach that would be good to give the best analysis for future changes to the policy; is the CIPP model useful with the data that is currently available, empowerment evaluation so that the stakeholders can be assisted to evaluation developing the policy, or should we keep it to a deliberative democratic evaluation as this is still a young document and should be treated as fragile. (Any approach other than these of course might be better)
3. The emphasis on how this policy should be used so that the common man can understand the impact of the Policy on his day-to-day life.
4. Are the target goals in this policy valid and achievable? (This can be seen in conjunction with the other documents attached with this email that are
5. Is the quantitative data that is in the policy well laid out?

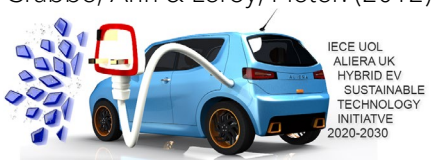
10 evaluation reports were submitted by the group which included representatives of EPB, EDB, private consulting and analysis groups and the SDG group GCU itself. A consensus of the evaluation is summarised in this section.

## 3 2 POLICY EVALUATION RATIONALE

Crabbé and Leroy 2012[2] have shown the process of policy evaluation must take into consideration, the rationale behind the policy that was developed. There is a clear approach towards economic and businesses in the creation of the NEVP document; the policy goals described emphasis market penetration, rational of savings and earnings, and cost benefits of mainly manufacturers, developers and distributers and its implications on tax and duties. This leads to three different contradictory evaluation criteria, and therefore need to be evaluate using all three Judicial, Economic, and Political/social approaches. This can be seen in Figure 2. This policy therefore has been evaluated and analysed inclusive of Political-social

[2] Crabbé, Ann & Leroy, Pieter. (2012). The Handbook of Environmental Policy Evaluation.





approaches on different stakeholders, and the implementation of incentives not just economically, but as legislative aspects protecting EVs strategically.

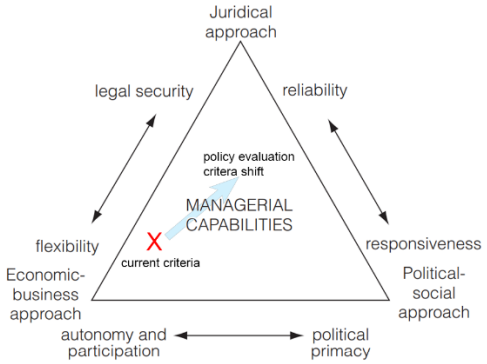



*Figure 2 Policy JEP localization triangle for the NEVP, modified from [1]*

## 3 3 Policy Evaluation Approach

There are different program evaluation methods that can be applied; needs analysis, programme theory evaluation, case study evaluation, experiment and quasi-experiment, formative/developmental evaluation, goal-free evaluation, impact assessment (social, environmental, and regulatory impact assessments) cost-benefit analysis and cost-effectiveness analysis, log-frame method, multi-criteria analysis, and realistic evaluation.

When it comes to the NEVP, there are certain quantifiable goals and actions that have been included. That allows us to go quantitative based analysis approaches (which still trying to justify if a methodology is implemented or justified. The formative developmental method of evaluation identifies strengths, weaknesses, opportunities, and threats and make suggestions for a better policy implementation. It follows a participatory approach in which stakeholders take part in the evaluation of the policy. This would be another good approach to evaluate the electric vehicle policy. A quasi-experimental approach is also used to see if there is a causality between policy intervention and presumed effect. Finally with doing our own field work and desk reviews, the NEVP was approached through impact assessments, if the NEVP will have effects on different stakeholders. While other policy documents are available as seen in the next section of all documents reviewed, only the NEVP was evaluated with the gaps or policy changes reviewed from the other policies; the NEVP only policy that is encompassing of EVs, and not only either the vehicles, or charging, or energy requirements as the other policies are.

## 3 4 Framework Design Approach

While the evaluation approaches are mentioned in the earlier section, the framework design has been based on design approach methodologies. The CIPP (Context, Input, Process &Product) model applies to policy programmes with the focus on improving rather than proving. The benefit is that the evaluation is conducted using detailed criteria which is useful in carrying systematic and structure evaluations.

*Context Evaluation*: The mission, vision, value, goals, and objectives are identified and analysed. The judgment of experts and stakeholders can be utilized (for e.g., the goal of the electric vehicle policy is unclear).



*Input Evaluation:* Evaluation of data bases, internal and external stakeholders' interests and assessment of SWOT is conducted. Determining the resources availability, time, and funding requirements.

*Process Evaluation:* The evaluator provides information regarding discrepancies and related defects.

*Product Evaluation:* The analysis of the policy outcome (pre and post).

During the study

Empowerment Evaluation approach used to empower future stakeholders in evaluating policy documents (especially for environment related policies) entwined with democratic evaluation.

## 3 5 Initial Analysis of the Policy by the Evaluation Group

The reviews of the assessment group were taken in consideration; the group was given a copy of this studies assessment to make their judgement on their evaluation, as well as our assessments. The 6 major outcomes of the group include:

- The NEVP Targets are not realistic – from 40K a year to 100,000K just for electric vehicles new cars sold after 2025 needs to be revisited or quantified.
- Correct value of emission reduction not created – no dollar value assigned – The actual impact on the environment needs to be quantified in the policy document as well. The KPI should be on emissions reduced rather than no. of vehicles added to the system.
- A charging infrastructure is not created in the policy, and it does not go far enough to suggest one. Table 2 of the policy where it suggests the amount of savings / earnings from EV needs to be completely revisited
- 37% renewable energy may not be a valid statement – many studies and organisations do not consider hydroelectric as renewable / the ecological implications of hydroelectric are quite high. The addition of a further half a million plus vehicles is not quantified as realistic by 2025 in the current scenario of high peaks of electricity demands during some months in Pakistan.
- Incentives only in import CKDs CBUs etc. none for the actual buyer (note these now have been completely overturned as well)
- Incentives for manufactures also on Import values. No actual value given
- No program defined for disseminating this information to the public – cannot make their own opinions on the system

It was also determined by the group that the policy was more goal oriented rather than goal seeking. Which, at this infancy stage of the EV industry, is more difficult to develop as there is no clear problem definition to a complete holistic encompassing solution strategy. Goal seeking policies tend to allow policy processes to move forward and involve more stakeholders within the process. During goal seeking policies, the process of development of the policy itself is important to assess, which in the case of the NEVP, cannot be implemented as it has clear goal definitions

Policymaking is a multisector and multilevel phenomenon. The political actors have their own goals and intentions. Though it's a good initiative to start with, the policy lacks coherence, consistency, and congruence. The goal is not clear and well stated. If this is the case, the designed policy outcomes cannot be achieved. The interrelation between policy



goals and instruments is necessary to effectively achieve intended outcomes. Moreover, the policy lacks data congruity and appropriateness. A legally designed policy institute is the prerequisite for policy setting. The stakeholder consultation and policy expert's involvement is the basic agenda towards a successful policy formation.

The good point is the tax exemptions on manufacturing equipment's.

## 3 6 Lifecycle Costs and Consumer Concern

Economic feasibility is the main driving force empowering the decision of the people especially when they have low purchasing power. The acquisition costs and operational costs cannot be assumed as simple. Keeping in view the perspective of the consumer, a comparison should have been discussed among the electric vehicles and conventional cars on the following grounds.

- Costs of generating electricity
- Transmission and distribution losses of the electric grid
- Availability of charging stations
- The financing cost of High up-front price, long payback periods and uncertain demand
- Higher insurance costs due to Li-ion-batteries, which are expensive to replace if
- damaged
- End-of-life costs

Life cycle costing is a versatile tool, that presents an overall impression of the benefits that electric vehicles may provide.

1. The lack of awareness about electric vehicle technology makes the user reluctant to shift from internal combustion engine vehicles. The users are more concerned about the safety, reliability, short circuits during heavy rain or flood and power consumption in traffic jams. If such comprehensive information is not given, then a bundle of incentives proposed by the government will not be fruitful.

2. The users are more concerned about the range of electric vehicles. The ones who must travel longer distances will not be interested in spending much time charging the vehicles.

3. There is a limited market for used electric vehicles and batteries. The consumer pays a high initial cost to buy but is not aware of the selling price. The consumer is unable to forecast the future valuation of their electric vehicle.

All these concerns should have been discussed.

## 3 7 Environmental Impact

1. If local manufacturing is employed, the key component in the vehicle design would be the battery. Larger Lithium-ion batteries will require more raw materials and input and supply more energy storage, resulting in higher environmental impacts. Alternatively, if lighter materials are used in the construction, this would result in higher production impact and lower recyclability of materials.

2. The Adoption of electric vehicles will result in copious amounts of battery waste leading to a concerning environmental issue.



### 3 8 RECOMMENDATIONS

i. The "vehicle-to-grid" technology will enable car batteries to provide electricity back to the grid, allowing electric vehicles to become an important source of distributed energy storage.

ii. The academic and research institutions should contribute to electric vehicle market expansion by building an understanding of how they are used.

iii. Laws, regulations and standard codes should have been mentioned in the policy.

iv. For the market expansion such reliefs can be provided.

- Electric vehicle owners can use toll lanes without paying toll charges
- Car dealers should include the cost of electric vehicle charging equipment within electric vehicle purchase financing, making it easier for electric vehicle purchasers to get in-home charger installations.

v. The different schemes/programs for incentives and funding should be discussed at all scales.

vi. If local governments do not have funding to deploy electric vehicle infrastructure, they can still work on selecting prime locations for charging stations and work with private site hosts, who may be interested in electric vehicle charger installations.

vii Local governments should examine their land use mix and determine zoning areas for charging stations.

viii. Utilizing solar power to directly charge vehicles may be a cost-effective option, with the added benefit of further reducing greenhouse gas (GHG) emissions. If solar panels have been installed before an electric vehicle charging station, the solar project could still be sized to accommodate electric vehicle charging.

ix. The inclusion of low-carbon electricity sources across all the life stages of the electric vehicle; raw material extraction, manufacturing and production should be prioritized.

x. Research on carbon composites reuse and recycling is required.

xi. Phase-out fuel and hybrid vehicles by increasing taxes on them

# 4 GAP ANALYSIS

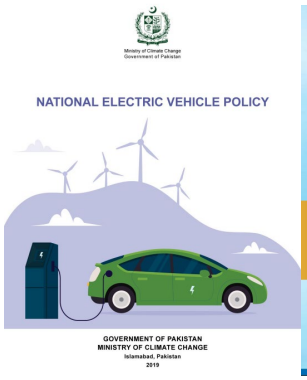
## 4 1 THE NEVP & OTHER DOCUMENTS CONSULTED

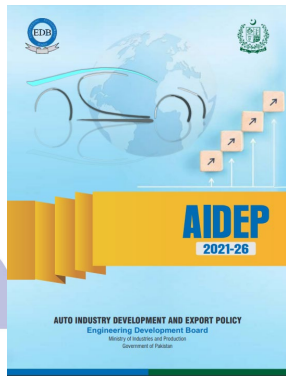
The NEVP, drafted in 2019, was released in December 2020. That one-and-a-half-year delay was the result of public consultation, but also as the policy was passed through other ministries including industries, and science and technology that left the policy dead in the water with precedence given to other policies such as the AIDEP Policy document. The public consultation was limited to certain research institutes and several identified potential manufacturers. All other policy documents, and recommendation documents from the consultations have been made part of this study and included in the analysis of the NEVP. The documents included are listed as below.

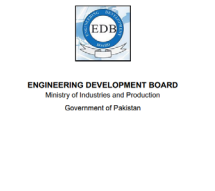
- NEVP – The National Electric Vehicle Policy of Pakistan 2019

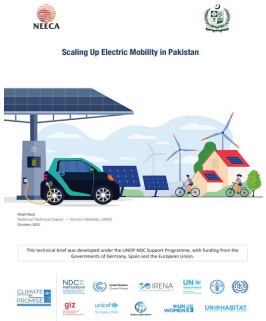


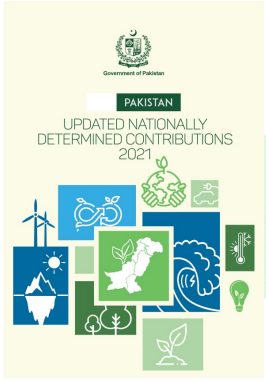
  - Ministry of Climate Change of Pakistan (MoCC) – Ministry of Industries & Production, Ministry of Science & Technology
  - Drafted 2019 – Released 2020
- AIDEP – Auto Industry Development and Export Policy. 2021-2026 released by the Engineering development board, Ministry of Industries and Production in December 2021.
  - This is the document that supersedes the NEVP including some of the policies of NEVP. It however also adds and emphasises the addition of Hybrid Vehicles after an incentives package promised to Toyota in September.
- AIDEP INCENTIVES
  - (Summary of all the incentives to vehicles from the AIDEP Policy)
- NEECA Scaling up Electric vehicle charging and spread recommendations.
  - This is much more comprehensive and is useful to identify the drawbacks of the NEVP policy.
- 3-wheeled survey of Pakistan - IECE (2022) on the market requirements of 3Wheeler vehicles.
- USAID electric vehicles and batteries market analysis 2021.
- USAID Policy Brief (of the NEVP) 2020
- iea global EV outlook
- All other documents referenced are in the footnotes of this document

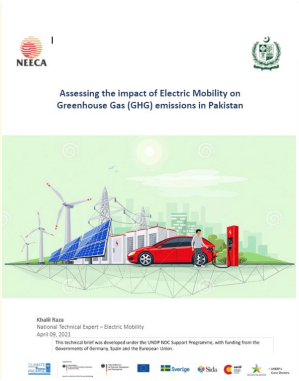


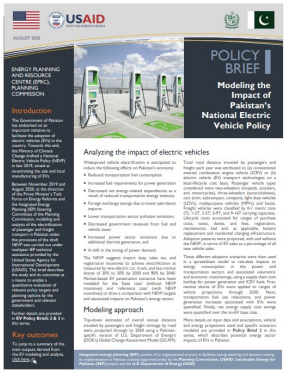







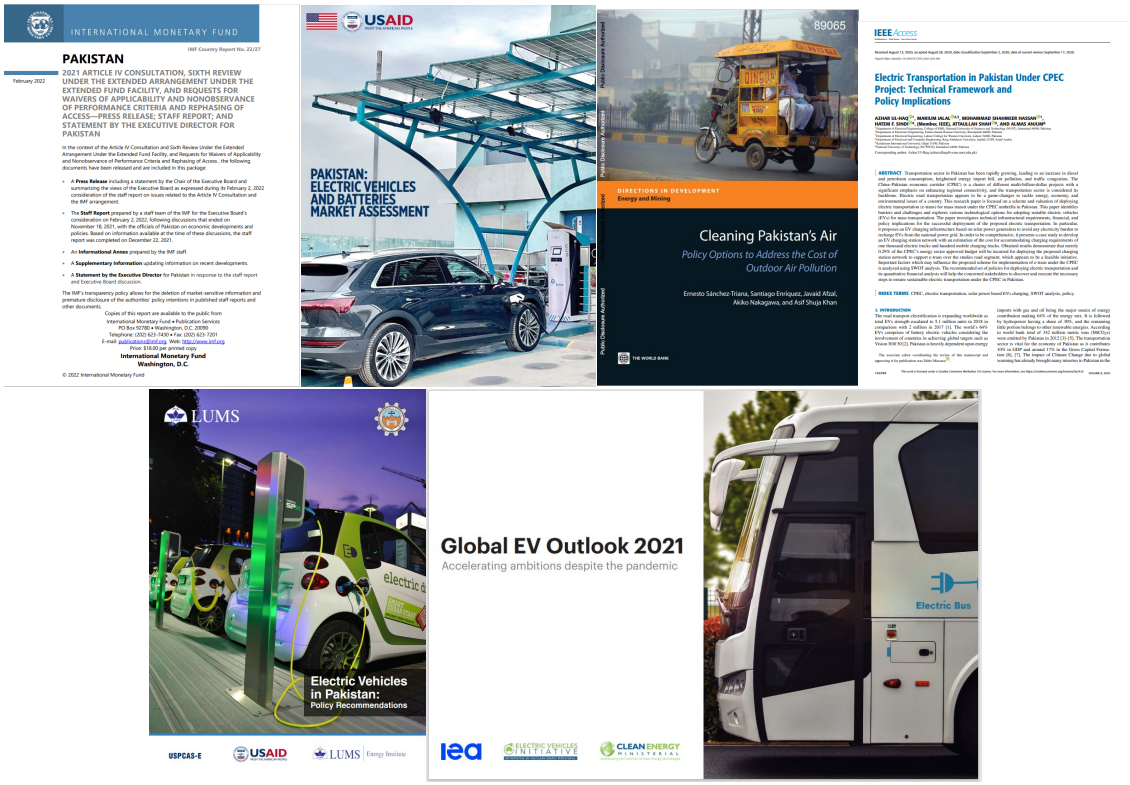



*Figure 3 Documents referred to evaluate the NEVP directly*

## 4 2 THE NEVP DOCUMENT

The NEVP 2019 is a document that is not timestamped for its policies other than three phases. It is an open-ended document which has its deadlines based only on certain goals set (such as EV market penetration). So, the analysis can only take under consideration these values. During the policy study, we have determined that many facts and numbers added in the NEVP do not have credible sources, or do not compute correctly. For GAP analysis, we must assume the figures as accurate and correct for the NEVP. All other documents coming after the NEVP including the AIDEP document must be part of the GAP analysis of things that have been updated or redacted.

## 4 3 NEVP PHASES – A GENERAL DISCUSSION

Phase I: Market development and public awareness through incentives and subsidies on EVs especially for the companies willing to set up EV related industry in Pakistan. (Years 1 and 2)

### *4 3 1 Awareness*

we are at the in the middle of the second year of this Phase I, and there has not only not been any market development and awareness campaign other than the initial reaction, but there have also been negative campaigns that have been run.

EDB Board – The AIDEP: With the AIDEP document redacting several incentives given to manufacturers, the NEVP has been negatively portrayed.

*"One reason for the delay is that the policy prepared by the Ministry of Climate Change (MoCC) has been set aside and the policy prepared by the Engineering Development Board*



*(EDB) has been approved in which all the facilities provided to the manufacturers have been abolished"* [3]

According to Shaukat Qureshi, general secretary at Pakistan Electric Vehicles and Parts Manufacturers and Traders Association (PEVPMTA), the policy from EBD not only abolished tax relief but also revoked the import permit that allowed 100 vehicles to be imported. Instead, the policy allowed the import of only 10 vehicles that discouraged many investors from making further investments into promoting electric vehicles in Pakistan.

*"The Engineering Development Board does not include a single person with the knowledge of electric vehicles. Instead, the board has representatives [from big automobile manufacturers in Pakistan] who will not allow EV policy to be implemented until the big auto companies start making electric vehicles,"*[3]

Importing EVs:

*"The problems start and end with the strenuous processes of taxation, releasing and registering the vehicles at the port. "The process is complex, even if all the FBR rules and regulations and the fee structure are met," Asim Jalandhari*[3]

The taxation of these vehicles (import duty) has varied between 25%, to 50%, to complete bans (currently since May, 2022, all CBUs are banned)

REGISTRATION OF EVs: is indeed an onerous undertaking and a survey conducted by Profit[3] revealed that many electric vehicles owners have expressed their concerns and complained to the government of the stressful car registration process. ("Importing & Registering EVs Remains Strenuous For Pakistani Consumers")

*"Consequently, Excise, Taxation and Narcotics (ET&NC) department charge different registration amounts from different individuals. In my case, ET&NC Lahore told me that for registration of my vehicle, I was required to pay Rs975,000." Aamir Shakeel, an Audi e-Tron customer*

Registration of these vehicles were supposed to be free under the NEVP and AIDEP policies. (See update on budget in section 5 8)

Negative Campaign Toyota Indus:

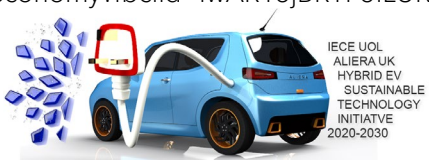
According to The Express Tribune[4], June 1, 2022, under the title of "EVs to adversely impact economy" the current statement was made by the CEO of Toyota:

*"The promotion of electric vehicles (EVs) will have a negative impact on the local auto industry and the national economy, remarked Indus Motor Company (IMC) Chief Executive Officer Ali Asghar Jamali."*

His statement continues with the fact that the highest vehicle electrification rate was in Europe and EU electricity generation was mostly based on renewable and nuclear; in Pakistan, electricity generation was based on fossil fuels with 25% line-losses.

[3]https://profit.pakistantoday.com.pk/2021/04/17/despite-an-ambitious-policy-importing-and-registering-electric-vehicles-remains-strenuous-for-pakistani-consumers/
[4]https://tribune.com.pk/story/2359460/evs-to-adversely-impact-economy?fbclid=IwAR13jBRTF3ILURU3QCc8gfA7icykbmnHmNeVEWneZRCOUcOacD2M88xNagg





Pakistan Auto Sector Campaign:

> *"We were informed by government authorities that an electric vehicle policy was under consideration and stakeholders would be consulted before its finalisation," said Hyundai Nishat Motor Chief Financial Officer Norez Abdullah while talking to The Express Tribune.*[5]

> *"Until yet, we have not collected even a single rupee out of our investments," he said. "The overall scenario of the local automobile industry is not encouraging, and the government has introduced a new policy."*

Industries Minister Negative Comments:

In an article titled Poor Response to Electric Vehicles Policy, the Industries ministry attributes lack of interest to limited market for Electric Vehicles[6]

> *The government had announced a very attractive electric vehicle policy; however, the manufacturers did not show any interest due to the limited market of such vehicles.*

This is reaching as Phase II and Phase III of the policy have not been implemented yet which address these issues

PHASE II: Fuel import bill substitution through targeted penetration of EVs through local assembly and manufacturing. (Years 3 and 4)

Note: Foreign Direct Investment (FDI) is the solution to this problem, for example Volkswagen invest completely in complete setup with local manufacturing and tier suppliers without a local partner as part of the OEM, can overcome a lot of issues of CKD assembly / localisation issues.

PHASE III: Reasonable local adoption and export of electric vehicles and their components through indigenous research, development, assembling and manufacturing (years 5 and beyond)

### *4 3 2 Subsidies*

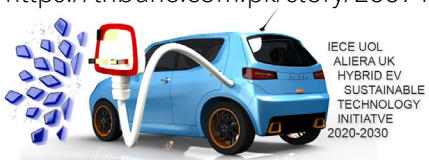
Almost all subsidies have not been implemented towards the EV market yet. The 100 limits on Imports of CBDs has been revoked early 2022 to 0. (Which should be the other way around to increase the growth of Electric Vehicles in Pakistan over the next 5 years) CKD imports have been banned mid-2022.

IMF Regulations

Till recently, because of IMF requirements in a bit to increase taxation, the Pakistan government increased taxes and duties not only Electric vehicles, but on renewable energy as well. The GST on solar panels has been reduced, however it is still valid on EVs Progress has been made on these issues however there is still a consensus that there is more to be done by the IMF to remove their contradictions. Figure 4 shows the development concerns, observations and demands that the TARA partners group and the Alliance for Climate Justice and Clean Energy (ACIJCE)

[5] https://tribune.com.pk/story/2094992/pakistans-auto-sector-hits-pti-govts-ev-policy
[6] https://tribune.com.pk/story/2337165/poor-response-to-electric-vehicles-policy





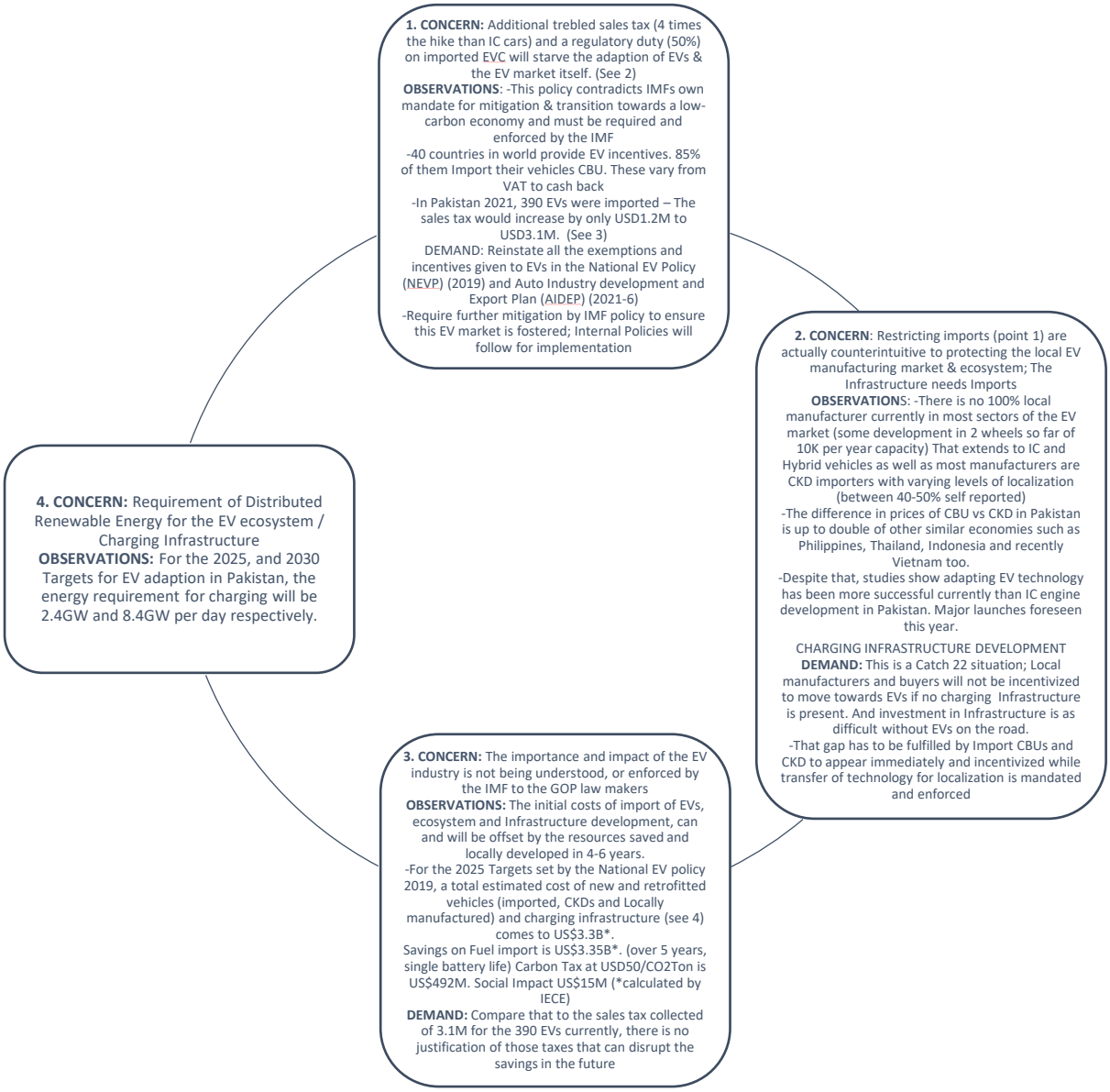



*Figure 4 Concerns observations and demands for IMF by the ACIJCE*

## 4 4 Policy Objectives

The main objectives of the EV policy include:

1. Mitigate climate change through a reduction in emissions from transport sector.
2. Create a pivot to industrial growth in Pakistan and encourage auto and related industry to move towards local EV manufacturing
3. Forge links with the global EV value chain for export potential of EVs and their parts.
4. Meet the objective of generating employment through Green Economy initiatives.
5. Reduce oil import bill.
6. Use electricity in off-peak times for useful purposes.
7. Develop affiliated industry such as battery manufacturing, charging infrastructure, etc.



# EV MARKET PENETRATION TARGET


IECE UOL
ALIERA UK
HYBRID EV
SUSTAINABLE
TECHNOLOGY
INITIATVE
2020-2030

# 5 EV MARKET PENETRATION TARGETS:

*Table 1 EV market penetration targets*

| *EV Penetration Targets* | *Medium Term Targets (5 Years) Cumulative* | *Long Term Targets (2030)* | *Ultimate Targets (2040)* |
|---|---|---|---|
| Cars (including Vans, Jeeps, and small Trucks) | 100,000 | 30% of New Sales (Approx. 60,000) | 90% of New Sales |
| Two and Three Wheelers Four Wheelers UNECE 'L' Category | 500,000 | 50% of New Sales | 90% of New Sales |
| Buses | 1,000 | 50% of New Sales | 90% of New Sales |
| Trucks | 1,000 | 30% of New Sales | 90% of New Sales |

The NEVP proposes minimum mandated targets for guiding EV penetration within the country. These values have been given as a conservative estimate for market penetration and benefits to Pakistan. The breakdown of the medium-term targets are given over a cumulative of 5 years. Phase II in the previous article is an important outcome of the targets as actual penetration figures allow the substitution of Fuel bill substitution. With one and a half years passing since the release of the Policy in December 2020, we can establish an understanding of the current situation, and the likely hood of reaching targets in the future.

To be able to predict if we will reach the targets, we can use two methods. One, is to use the average number of vehicles that need to be sold over each year over 5 years and compare current figures to those required. This method however does not take into consideration growth or drop in EV numbers from year to year (Same value for each year). A more accurate assessment is CAGR (Cumulative Annual Growth rate) which is indictive of the EV market globally, in Asia Pacific, and even Europe and North America. The different predictions that have been made can be seen in the table below. These values are mainly between 21% and 33% with varying time frames and start date (beginning volumes) used for assessment.

*Table 2 CAGR EV growth values Globally*

| *Geographical Loc.* | *Source* | *CAGR* | *TIME (years)* | *From year* |
|---|---|---|---|---|
| Global | Bloomberg | 33.6% | 6 | 2020 |
| Global | EMobilty+ | 21.7% | 8 | 2022 |
| Global | Fortune Business Insight | 24.3% | 8 | 2021 |
| Global | Allied Market Research | 18.2% | 10 | 2020 |
| Global | Markets And Markets | 21.7% | 8 | 2022 |
| US focused | Globe News Wire | 24.5% | 7 | 2021 |
| North America | Statista | 28.5% | 10 | 2016 |
| North America | Grand View Research | 37.1% | 7 | 2021 |
| North America | Meticulous Research | 39.4% | 8 | 2022 |
| Asia Pacific | Market Data Forecast | 29.9% | 5 | 2021 |



| | | | | |
|---|---|---|---|---|
| Asia Pacific | Statista | 29.5% | 10 | 2016 |
| Asia Pacific | Mordor Intelligence | 25.2% | 5 | 2019 |
| Asia Pacific | Market Watch | 19.0% | 9 | 2020 |
| Asia Pacific | Triton Market Research | 21.7% | 8 | 2019 |
| Global & Asia Pacific | Business Wire | 21.9% | 8 | 2021 |
| Asia Pacific | Inkwood Research | 21.0% | 7 | 2020 |
| Europe | Statista | 23.2% | 10 | 2016 |
| Europe | Business Wire | 29.1% | 6 | 2021 |
| Europe | Market Watch | 29.4% | 9 | 2021 |
| Europe | Allied Market Research | 25.4% | 6 | 2020 |

CAGR calculations are made using the formula seen below:

$$CAGR = \left(\frac{V_{final}}{V_{begin}}\right)^{\frac{1}{t}} - 1$$

Where:
*CAGR* = Cumulative Annual Growth Rate
$V_{final}$ = The number of vehicles sold the last year
$V_{begin}$ = The number of vehicles sold first year
*t* = Time period in years

Therefore, the second method is to find the beginning value *($V_{begin}$)* which needs to be attained at the end of 2021 to be able to grow to the target figure at the end of 2025 at an accurate enough CAGR. The same formula can be used at the end of each year over the period of 2021-2024 at the same CAGR value as well. Using the NEVP target figures for end of year 5 as ($V_{final}$) from the above table, we can apply the following formula to find the required penetration values at each year between 2021 and 2024 as.

$$V_{begin} = \frac{V_{final}}{(CAGR + 1)^t}$$

For Pakistan, a high CAGR (exceedingly high growth rate for Pakistan) of 34% is used to attain the most conservative starting values of number of EVs that need to be sold over the 5 years as that is an assumption set by the NEVP. The graphs below show the values of each target over the 5 years.

Note: as the name suggests, CAGR is cumulative growth over a certain time-period; the growth never is simple constant over the 5 years as seen in the graph below. It is an outlier for the starting values and the end value. It caters for gains as well as loss in growth over a time-period, and the variance shows how stable the growth is. The graphs following however show the values over the middle years just as an outlier to better see the variance in CAGR and actual growth.



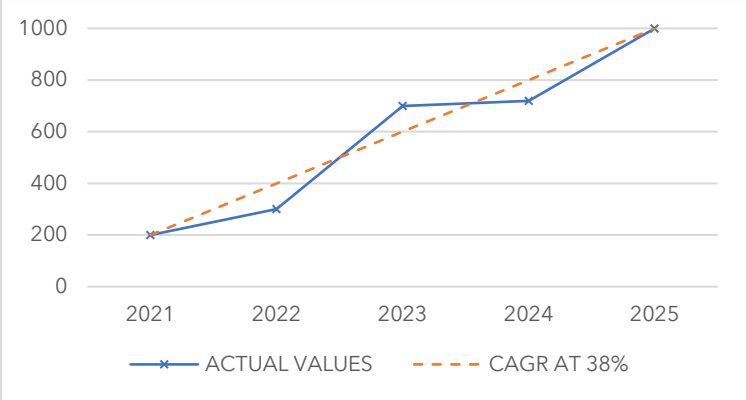



*Figure 5 Example of an CAGR vs an actual growth curve*

The graphs show that the values for each of the actual ending sales in 2021 should be close to those of a realistically high CAGR of 34% to have a fair chance to come to the NEVP predicted figures. When we add the actual figures from end 2021, we see the values for Pakistan falling well short and require unrealistic high CAGRs to make it back on track.

*Table 3 Comparison of EV penetration Targets – Actual vs Required for a CAGR of 34%*

| *EV Penetration Targets* | *2021 Required values for a CAGR of 34%* | *End 2021 Actual values* |
|---|---|---|
| *Cars (including Vans, Jeeps, & small Trucks)* | 31505 | 2000 |
| *2 & 3 Wheelers Four-Wheeler of UNECE 'L' Category* | 155078 | 10320 |
| *Buses* | 310 | 40 |
| *Trucks* | 310 | 0 |

The breakdown of all market penetrations so far can be summarised as follow:

### *5 1 1 2 & 3 Wheeled Market*

Jolta, one the main motorcycle manufacturers of Pakistan, have claimed to have sold 10,000 motorcycles in Pakistan in 2021[7] reported March 16th, 2022. This was with an initial 500 motorcycles that required battery replacements individually due to issues with the batteries. The total number of EV motorcycles built by all other EV motorcycle developers and 3-wheeler Electric rickshaws made by a few manufacturers can only be estimated to nearly 320.

The UNECE L category for 4 wheeled vehicles is not well defined in the NEVP document. The L category is split into L 6e and L7e which is 5 different versions of the vehicles. An image can be seen for these vehicles[8]:

[7] https://propakistani.pk/2022/03/16/pakistans-jolta-electric-sold-10000-bikes-in-2021/
[8] https://unece.org/



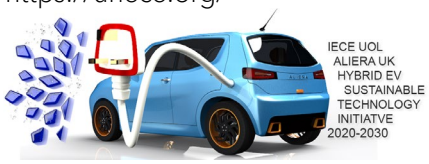


*Table 4 Category L electric vehicles classification*

| | | |
|---|---|---|
| L6e, Light quadricycle | L6Ae Light quad |  |
| | L6Be Light mini car |  |
| L7e, Heavy quadricycle | L7Ae On-road quad |  |
| | L7Be All Terrain Vehicles |  |
| | L7Be Heavy mini car |  |

There is no current information available for all category L electric vehicles. Hobby quads are not registrable so are not road legal, hence cannot be part of these numbers.

From this start (end of 2021), we would need a CAGR of 164% to come up to the predicted NEVP figures of half a million in 2025. At the global average CAGR, 2025 would yield only 33275 vehicles.

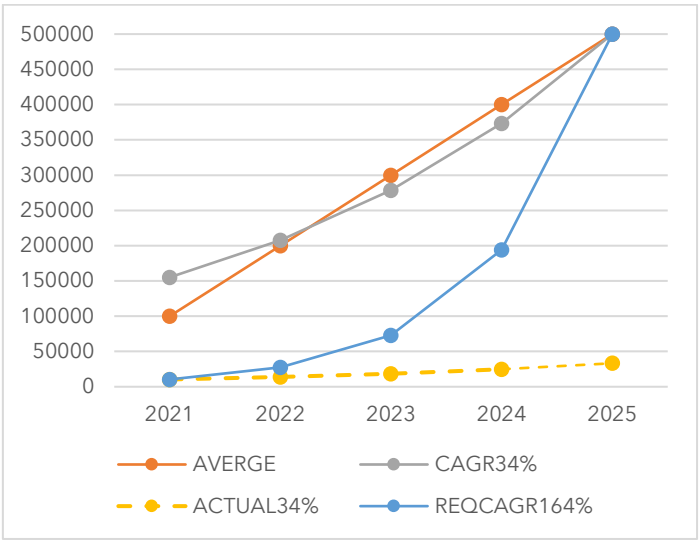



*Figure 6 Cumulative Sales – 2 & 3 Wheeled Vehicles*

### *5 1 2 Cars*

There is no cumulative sales information on EV cars entering the market in 2021, however there are no EVs currently built either indigenously, or CKD in Pakistan either. From varying data records available, there is conflicting reports on how many 4 wheeled EVs are currently on the roads in Pakistan (CBU) to be between 1400 and 2000. This has not been verified but we shall add the value of 2000, which is again way below the required to kickstart the program for 100000 by 2025. A high CAGR of 166%, like that of 2 and 3 wheelers, is required to reach the target.



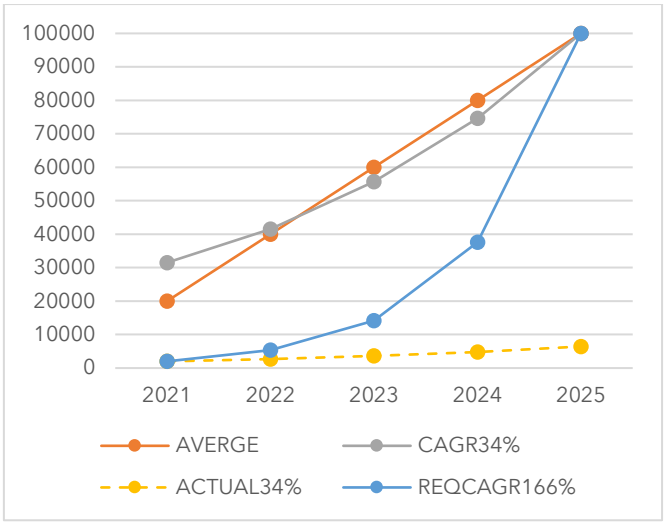



*Figure 7 Cumulative Sales - EV Cars*

### *5 1 3 Buses*

By 2021, 40 electric buses have been imported as the Green Line Rapid Transit system, purchased to be implemented in Karachi. The first one being run on March the 1st, and the rest of the buses imported in September 2022.

250 buses have been further approved for Karachi over the year. With 100 buses coming in by June 20th, 2022.

29 Electric buses are planned for Islamabad which should be operational in 2022.

With the values for 2022, the value for buses is well underway to reach the predicted numbers for 2025 due to the high CAGR growth from 2021 to 2022 in actual terms.

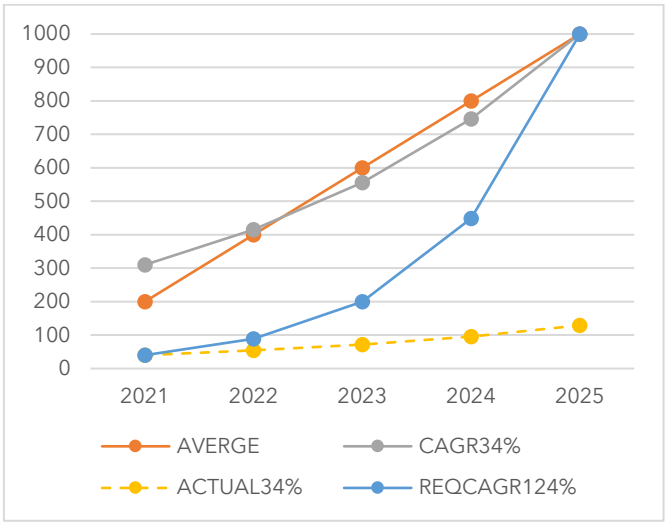



*Figure 8 Cumulative Sales - Buses*

### 5 1 4 *Trucks*

There is no report of any electric truck entering the market (imported, manufactured, or operational) in Pakistan till now. There is prediction for trucks due to that reason.

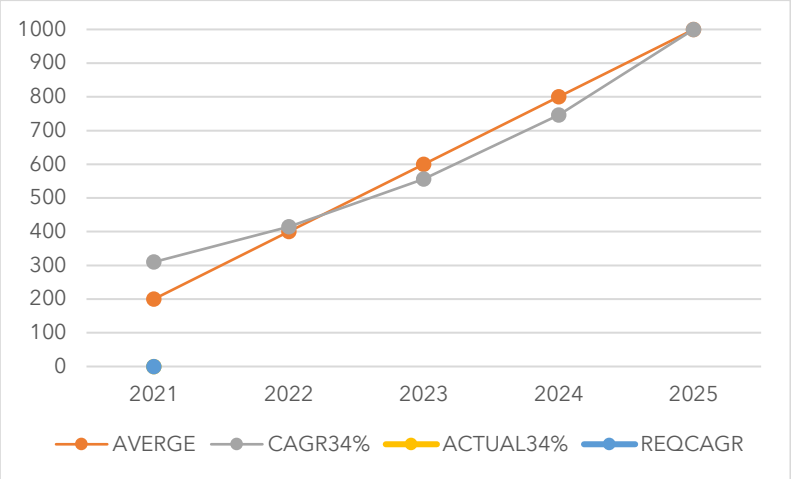



*Figure 9 Cumulative Sales – Trucks*

## 5 2 ACTION PLAN

All graphs are showing the requirement for extreme growth in Electric Vehicles over the next 4 year (or 3.5 years at the current point) which might be possible only with the extreme introduction of policies, or prediction targets be re-evaluated.

### 5 2 1 *Increase the EV CAGR I: Increase Market Size for all Phases of the NEVP*

A higher CAGR can be used with introduction of policies that will actively inject EV systems into the market rather than just incentives for natural growth. The emphasis is given to Climate change, but the document itself does not give an action plan on how to achieve that. One requirement is to incentivise import of both CBU and CKD EV to create a market size of EVs that can incentivise people to invest in charging stations.

### 5 2 2 *Increase EV CAGR II: Reduce New Market Size*

One plan which is described in a bit more details in the future work section, is to induct retrofitting vehicles already into the market rather than concentrate on new vehicles itself. This means increasing the market share of EVs without requiring a higher cost of increasing the market size.

For the Car figures:

Currently, the %age of EVs (plugin) globally accounts for 1% of all vehicles. (At the end of 2020)[9] Pure electric accounts for 0.75% (2/3 of all EVs)

Of new sales, EVs accounted for 9% of all new vehicles (4-wheel cars) in 2021. Up from 4.6% in 2020 and 2.5% in 2019. in 71.29%

[9] https://www.iea.org/reports/global-ev-outlook-2021

For a market penetration of 100000 vehicles in Pakistan in 2021, the total number of New EVs had to be 31505 (CAGR 34%) out of 242886 cars sold in Pakistan in 2021. This is already a high number of 12.9% of all cars to be sold needed to be EVs without having an CKD assembler, or manufacturer in Pakistan. (Incentives to import have already been severely limited as will be seen in following sections)

Retrofitting a car cost between 10-30% of a new vehicle with kits, that are developed in Pakistan by groups such as IECE. If half of the vehicles were retrofitted with EV in 2021, the new vehicles sales required would go down to 15752 or 6% which is closer to representative global sales figures of EVs. The cost goes down to 60%

This figure goes down when it comes to GHG emissions costs. Each new EV vehicle costs 8.8Ton $CO_2$ (of which 43% is from battery production)[10] For 15752, 57% of 8.8 Ton, or 71.831KTon of $CO_2$ is saved over buying new EVs.

## 5 3 Estimate of Yearly Income & Savings from EVs – 5 Year Penetration

The NEVP gives an estimate of yearly income and savings from EV with 5 years of penetration. These goals cannot be quantified without the actual penetration of Vehicles within the Pakistan market. However, the values can be quantified including key comments from the NEVP document.

### *5 3 1 Charging of the Vehicles*

> *"EVs will also use the idle capacity available in the national electricity grid due to intra-day and seasonal variations. On one hand this will reduce the idle capacity payments and on the other hand this will generate extra revenue from using electricity that otherwise may not be sold altogether"*

> *"The effective tailpipe emissions will reduce by 65% from EVs. Part of this reduction comes from efficient electricity generation plants and part from the fact that Pakistan has around 37% renewable sources of generating electricity."*

This statement can only hold true if the pattern of charging vehicles can be controlled and maintained. The document recommends smart charging is possible through smart metering, time-of-use pricing and through other innovative mechanisms that can be controlled through public charging stations, but more difficult at home with Level 1 and Level 2 charging. Emissions oriented charging has been recommended[11] with blocks of charging controlled during high and low emission times.

[10] https://www.zemo.org.uk/work-with-us/collaborative-initiatives/projects/2020-lifecycle-emissions-policy-integration.htm

[11] Chen, Xiao & Tan, Chin-Woo & Kiliccote, Sila & Rajagopal, Ram. (2019). Electric vehicle charging during the day or at night? A perspective on carbon emissions. 1-5. 10.1109/PESGM40551.2019.8973578.



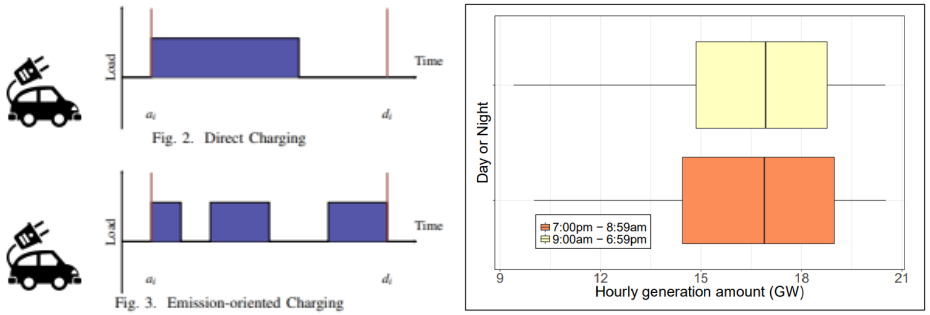



*Figure 10 Ref Chen, Xiao & Tan, Chin-Woo & Kiliccote, Sila & Rajagopal, Ram. (2019). Electric vehicle charging during the day or at night? A perspective on carbon emissions. 1-5.*

The same could be implemented for time when electricity is readily available. However, driving patterns can be unpredictable and not controlled with the availability of free electricity. According to the same paper, the mean of daytime hourly generation is higher than that of night-time hourly generation. There is higher charging vehicle during the day when it is required rather than at night when the vehicle is not required.

Energy Shortfall – Renewable Energy

The predicted energy production and demand up to 2025 over the year is seen to be positive from the NEPRA report in 2018.

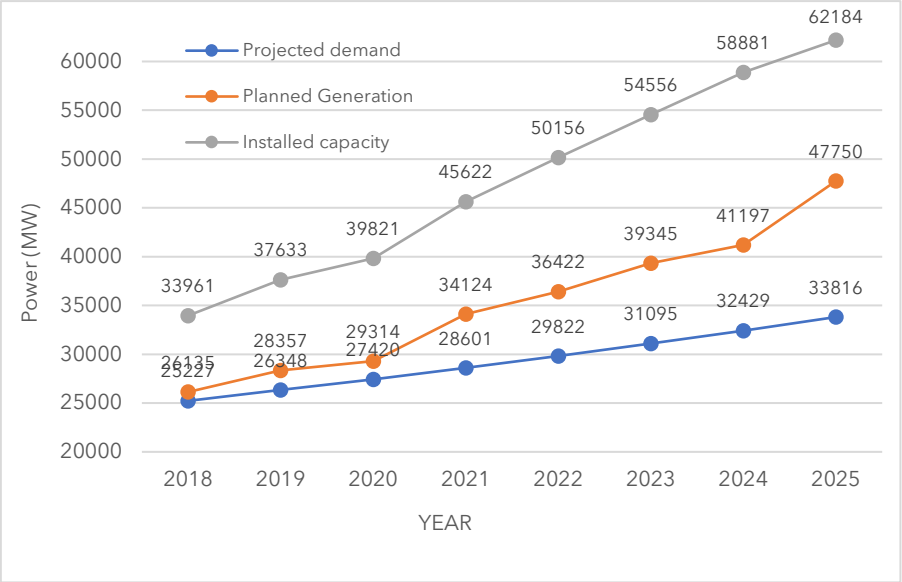



*Figure 11 Projected Demand, Planned Generation, and Installed Capacity Prediction*[12]

From calculations made by this study, the total energy requirement to cater for all EV vehicles targets of 2025, would be 2.8GWh (Table 6) every day (required if all vehicles are charged 300 days a year). That would be needed to be incorporated within the system. **Error! Reference source not found.** and **Error! Reference source not found.** show the results of these calculations.

[12]https://nepra.org.pk/publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202020.pdf



The electric units required per day are calculated from drive cycles which IECE has developed and tested at the University of Lahore. The total distances travelled by the vehicles is also based on the drive cycles and field surveys conducted by IECE.

*Table 5 Vehicle Fuel savings *The breakdown ratio of the .5M 3 Wheel to 2 Wheel is not set in NEVP*

| Vehicle Type | Fuel Type | Fuel Average (km/litre) | Daily Usage (hours) | Average Daily Km Driven | Fuel Consumed Daily | Fuel (L) Consumed in 300 days | No. of Vehicles (2025 Target) | Fuel saved - import cost/Yr | Fuel Saved over 2021-2025 duration at CAGR 34% |
|---|---|---|---|---|---|---|---|---|---|
| Cars | Gasoline | 10 | 4 | 80 | 8 | 2,400 | 100,000 | $248,316,832 | $759,849,505 |
| Motorcycles | Gasoline | 40 | 10 | 60 | 1.5 | 450 | 380,000* | $176,925,743 | $541,392,772 |
| Trucks | Diesel | 5 | 16 | 400 | 80 | 24,000 | 1,000 | $24,831,683 | $75,984,950 |
| Buses | Diesel | 5 | 12 | 300 | 60 | 18,000 | 1,000 | $18,623,762 | $56,988,713 |
| Rickshaw | CNG/LPG | 15 | 10 | 150 | 10 | 3,000 | 120,000* | $372,475,248 | $1,139,774,257 |
| Totals | | | | | 159.5 | 47,850 | | $841,173,267 | $2,573,990,198 |

From the calculations, the study predicts a fuel saving of US$2.5B over the 2021-2025 period. It is a shame to see this money go to waste over non-action of all organizations. The energy required can be seen in Table 6. This is a cost that the NEVP has added as earning for Pakistan. But it is a negative cost, nevertheless.

*Table 6 Energy calculation costs on and off grid 2021-25*

| Vehicle Type | Efficiency Wh/km (Calculated from drive cycles) | Total Electric Units required per day per vehicle | Required UNITS during the duration of the Pilot Project at CAGR34% | Total Cost of Electricity for pilot period: 50% On grid; 50% off grid distributed renewable | EXTRA KWh Load required to cater for 2025 level of EVs | Total Cost of Electricity from Grid costing to Pakistan |
|---|---|---|---|---|---|---|
| Cars | 147 | 11.76 | 1,079,568,000 | $64,132,752 | 1,176,000,000 | |
| Motorcycles | 24 | 1.44 | 502,329,600 | $14,920,681 | 547,200,000 | |
| Trucks | 320 | 128 | 117,504,000 | $6,980,436 | 128,000,000 | |
| Buses | 335 | 134 | 77,387,400 | $4,597,271 | 84,300,000 | |
| Rickshaw | 281 | 84.3 | 859,248,000 | $29,775,921 | 936,000,000 | |
| TOTAL: | | 375.1 | 2,636,037,000 | $120,407,061 | 2,871,500,000 | $57,483,876 |

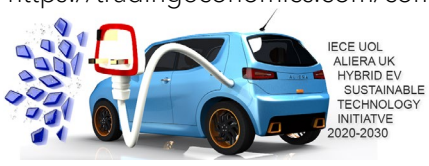
To cater for the missing data of actual GHG calculations, the following table summarizes calculations for the 2025 target figures and assigns a value to it updated to 2022.[13] This is an extra US$356M

*Table 7 GHG Calculations for EV Vehicles*

| Vehicle Type | Fuel Type | Fuel Consumed (L) in 300 days | Energy Consumed Daily (Mega-Joules) | Energy used in 300 days (Tera-Joules) | CO2 Emissions (kg-CO2)/TJ | kg-CO2 Emissions for 300 days | CH4 Emissions (kg-CH4)/TJ | kg-CH4 Emissions for 300 days | N2O Emissions (kg-N2O)/TJ | kg-N2O Emissions for 300 days |
|---|---|---|---|---|---|---|---|---|---|---|
| Cars | Gasoline | 2,400 | 256.3 | 0.076 | 69,300 | 5,328.8 | 30.0 | 2.306 | 5.0 | 0.384 |
| Motorcycles | Gasoline | 450 | 48.0 | 0.014 | 69,300 | 999.1 | 30.0 | 0.432 | 5.0 | 0.072 |
| Trucks | Diesel | 24,000 | 2,880.0 | 0.864 | 74,100 | 64,022.4 | 3.9 | 3.369 | 3.9 | 3.369 |

[13]https://tradingeconomics.com/commodity/carbon





| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Buses | Diesel | 18,000 | 2,160.0 | 0.648 | 74,100 | 48,016.8 | 3.9 | 2.527 | 3.9 | 2.527 |
| Rickshaw | CNG / LPG | 3,000 | 316.8 | 0.095 | 56,100 | 5,331.7 | | | | |
| TOTALS | | 47,850 | 5,661.1 | 1.698 | 342,900 | 123,69 | 67.8 | 8.636 | 17.8 | 6.353 |

*Table 8 GHG Calculations Continued*

| Vehicle Type | No. of Vehicles (for 2025 OBJECTIVES) | Total (tonnes-CO2 emissions) for 300 days | Total (tonnes-CH4 emissions) for 300 days | Total (tonnes-N2O emissions) for 300 days | COST OF EMISSIONS SAVED PER YEAR | COST OF EMISSIONS SAVED FOR THE DURATION OF 5 YEAR |
|---|---|---|---|---|---|---|
| Cars | 100,000 | 532,889 | 230.688 | 38.44800 | $37,302,250 | $114,144,884 |
| Motorcycles | 380,000 | 379,684 | 164.3652 | 27.39420 | $26,577,853 | $81,328,230 |
| Trucks | 1,000 | 64,022 | 3.3696 | 3.36960 | $4,481,568 | $13,713,598 |
| Buses | 1,000 | 48,017 | 2.5272 | 2.52720 | $3,361,176 | $10,285,199 |
| Rickshaw | 120,000 | 639,809 | | | $44,786,650 | $137,047,148 |
| TOTALS | 602,000 | 1,664,421 | 401 | 71.73900 | $116,509,496 | $356,519,058 |

The total cost / savings of implementing EV market, must be calculated with other factors to be added eventually which include, but not limited to: (+ve is a saving -ve is a cost)

- - Cost of Electric Vehicles
- - Cost of Charging infrastructure
- + GHG Carbon Credit
- + Fuel Savings from Import
- + GHG Emissions savings of producing fuel
- - Cost of electricity generation (which is not renewable or idle electricity)
- + Emissions cost of producing electricity
- + Reduction cost of social impact of air pollution

When it comes to the statement of idle energy, the ground reality is however different when it comes to high demand peaks during the summer and need to be catered and not meeting the planned generation due to several issues including shortage of coal and oil.

The energy shortfall currently in Pakistan exceeds 7GW according to power division sources to the News[14] as of May 31st, 2022. Current supply is 21.2MW with demand surging to 28.2MW. The breakdown for production is:

- Hydropower 4635 MW (or 22%)
- Govt Thermal power plants 1060 MW (or 5%)
- IPPs 9677 MW from (or 46%)
- Other (renewable and nuclear) sources 5838 MW (or 28%)

A further breakdown can be seen in April figures[15]

- Hydropower 3674 MW from Hydropower (or 20%)
- Govt Thermal Power Plants 786 MW (4%)
- IPPs 9526 MW (53%)
- Wind 487 MW (3%)

[14]https://www.thenews.com.pk/latest/962248-energy-crisis-deepens-as-electricity-shortfall-widens-to-7000mw

[15] https://www.geo.tv/latest/413660-pakistans-power-crisis-continues-to-get-worse



- Solar 104 MW (1%)
- Biogas 141 MW (1%)
- Atomic power plants 3312 MW (18%)

For a total of 18031 MW. The total demand was 25500 MW

### *5 3 2 Action Plan: Distributed Energy Sources.*

These figures are important for two factors. To overcome these peaks, the study proposes distributed renewable energy sources in the interim while we still have high load peaks. This is not only to reduce the load, but to cater to the second part of the statement about Pakistan having 37% renewable energy sources. Accordingly, Hydropower is not considered a renewable source[16] mainly due to several factors: Hydro plants need a consistent supply of water and a large amount of land; poorly planned hydropower causes more damage to the climate than it prevents. Its effects are seen on through the flooding of plants and other organic matter. This material decays over time, releasing greenhouse gases like carbon dioxide and methane. Studies that have been conducted have found huge differences in emissions from reservoir to reservoir. Large dams also effect migrating fish patterns, impact flows, temperatures and silt loads of rivers and streams[17].

### *5 3 3 Charging Stations*

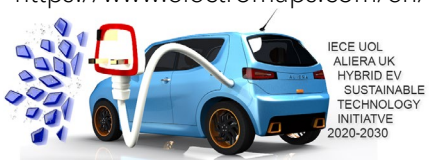
Another key discussion requirement for distributed the development of charging stations itself. While there are 85 locations on motorways identified for EV charging, in a study from January 2022, there currently are only 6 chargers, concentrated at Islamabad, Lahore and the M2 motorway, deployed over Pakistan, as of the 8th of June 2022[18].


*Figure 12 Current Charging stations in Pakistan[18]*

Those 6 themselves are distributed over 4 distinct types of connecter systems which breaks down this charging system even more. There is requirement of a consortium of

[16] https://climate.mit.edu/ask-mit/why-arent-we-looking-more-hydropower
[17]https://www.governing.com/archive/gov-hydropower-renewable-energy.html#:~:text=The%20water%20itself%20is%20not,not%20considered%20renewable%20by%20everyone.
[18] https://www.electromaps.com/en/charging-stations/pakistan





manufacturers that come up with a standard plug charging system within a single ecosystem (or a distribution of standard plug systems).

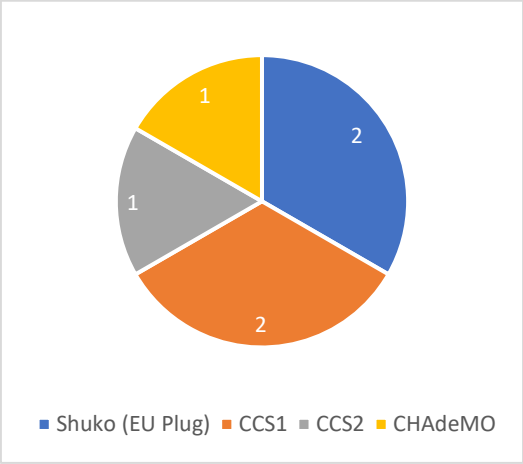



*Figure 13 Distribution of connecter systems from charging stations in Pakistan*

Part of the action plan is to develop a distributed renewable energy system (mainly on Solar, or wind) that can be deployed varying with the amount of EVs that are injected within the market. Each EV should be able to bring its own energy renewing source with it. That alleviate the requirement of having a large upfront cost of creating charging stations. A breakdown of the requirements for charging Electric cars, 2, wheelers, 3 wheelers and bus and trucks will be part of the future of implementing retrofitting.

## 5 4 Establishment of National EV Centres

There is a comprehensive plan to develop national centres in Pakistan in the Policy plan which has not been started just yet. The objectives of these national centres are to:

1. Evaluate EVs (two-three wheelers, cars, buses, and trucks) for Pakistan's unique environment e.g., temperature variations, altitude variations, unpaved roads, and fragile electric grids.
2. Jumpstart network of charging infrastructure for EVs.
3. Collect and evaluate data from testing on EVs under various conditions in Pakistan.
4. Establish opportunities for maximum indigenous production of EV parts and possibly ensure that 80% of the total EVs on roads are locally assembled with significant indigenization by 2023.
5. Work on standards, specifications, and possible regulation support for electric mobility.
6. Train a work force on high tech EV value chain.
7. Develop business models to attract local and international investment, both in manufacturing as well as in operations.
8. Identify upcoming and futuristic opportunities in the EV value chain and encourage local industry to harness it.
9. This centre will be established by a consortium of leading universities of the country to maximize the conceptualization to commercialization of EVs, components and related infrastructure.

The proposal is to develop a stakeholder's group that would develop and run such national centres that have been working on the EV market to bring it together. There are three



organisations under the University of Lahore, LUMS, and NUST that have been developing strategies, policies, and technologies for Electric vehicles that would cater to these points above.

### *5 4 1 Action Plan: Testing*

Testing must be conducted for Pakistan specific cases and must be conducted through an authority developed by Pakistan.

24. Weather testing of the vehicle for its running in extreme conditions. We can have a minimum of -25°C and maximum of 60°C. However, in the presence of direct sunshine later can easily increase and at components level with heat generated by systems, harshness tolerance levels are to be redefined for fitness to automotive applications. Standardization of IP (Ingress Protection) code/rating required for various electrification components to promote local RTD (research and technology development) and import of safe and robust components. Electric fire is a major hazard for electric vehicles.

25. Standardize range based on suitable driving cycles for each vehicle type. Development and standardization of driving cycles representing local driving patterns for each vehicle category is critical and need to be employed by OEMs for vehicle range and efficiency (km/kWh) specification to empower the buyer. For light duty vehicles, cycles like NEDC (New European Driving Cycle) and WLTC (Worldwide harmonized Light vehicles Test Cycles) can be used as a starting point.

26. Charging time measurement for each vehicle type based on different chargers will be conducted with standard chargers available to the customer as well (special equipment that is not sold to the consumer will not be allowed)

27. Safety requirements with respect to the electric power train of road vehicles of categories M and N (1), with a maximum design speed exceeding 25 km/h, equipped with one or more traction motor(s) operated by electric power, and not permanently connected to the grid, as well as their high voltage components and systems which are galvanically connected to the high voltage bus of the electric power train. ("EV Safety (Standard Regulation) Whole Vehicle Safety Testing")

28. Regulations covering post-crash safety requirements of road vehicles.

29. Safety requirements with respect to the Rechargeable Energy Storage System (REESS), of road vehicles of categories M and N equipped with one or more traction motors operated by electric power and not permanently connected to the grid. ("EUR-Lex - 42015X0331(01) - EN - EUR-Lex")

### *5 4 2 Homologation*

30. To promote RTD and technology-based SMEs developing high-tech mobility solutions adding value proposition to EVs, Individual approval certificate (IVC) should be registered because of Individual vehicle approval (IVA) for a production capacity of less than 300/month.

31. Certification Bodies like those mentioned below can be created and developed over time. IECE has the capability to function as a as hub of National Centre on Electric Vehicles and as approving body for Privately Owned Test Facilities (POTFs).

32. Vehicle Certification Agency (VCA)



33. National Type Approval (NTA)

34. Driver and Vehicle Safety Agency (DVSA)

35. IECE certified safety inspectors.

36. Development of the regulations such as the one given below.

37. Regulation No 100 of the Economic Commission for Europe of the United Nations (UNECE) – Uniform provisions concerning the approval of vehicles regarding specific requirements for the electric power train [2015/505] ("EU 2015/ECE100 - 2015-03-31 - Beuth.de")

a. Arrangements of the approval marks

b. Protection against direct contacts of parts under voltage

c. Isolation resistance measurement method for vehicle-based tests

d. Isolation resistance measurement method for component-based tests of a REESS

e. Confirmation method for function of on-board isolation resistance monitoring system

f. Essential characteristics of road vehicles or systems

g. Essential characteristics of REESS

h. Essential characteristics of road vehicles or systems with chassis connected to electrical circuits ("InterRegs: Regulation No. 136-00 | ECE - United Nations")

i. Determination of hydrogen emissions during the charge procedures of the REESS

j. REESS test procedures: Vibration test, Thermal shock and cycling test, Mechanical shock, Mechanical integrity, Fire resistance, External short circuit protection, Overcharge protection, Over-discharge protection, Over-temperature protection.

38. Conformity of production

## 5 5 NEVP Policy Incentives:

The promotion of Electric vehicle use, sales, and development to impact climate action by the Pakistan government is not as straightforward when looking at it holistically in the past one year with the number of actions taken including the new budget supplement under consideration, the impact of the IMF discussions, and the new government change. We have argued that the Import of Electric vehicles in CBU and other formats is a necessity to increase the CAGR of the EV market and must be equally protected in the short and medium term as that of local manufacturers, as it is necessary for the transfer of technology, the development of the local EV industry, standards, regulations, and charging infrastructure equally. An incentive to the end user to adapt EVs over time is required for the EV industry to develop in Pakistan, and that can only be achieved through a slow transfer from CBUs to local manufacturing, and not an abrupt switch. This statement agrees and accordance to the National EV policy approved recommendations as well.

### *5 5 1 Sales Tax Targeting EVs*

The increase in sales tax for imported electric vehicles has been increased by 12% (which is 3 times that of both IC (4.5% increase) and Hybrid engine (4% increase) vehicles) appears to be severely targeting Electric vehicles in particular. This will be detrimental to the medium



to long term local EVs market as well without proper transfer of technologies being promoted as will be seen in the following headings.

This negates the EV policy recommendations; Exemption of Sales tax and VAT on imports, and 1% sales tax on sales, CBU imports at 0% VAT on imports, 1% Withholding tax, and Exemption of 4-wheel EVs from Federal excise duty.

Hybrid Vehicles have been given extra preferential treatment with the overall sales tax at 12.5% compared to 17% of Electric vehicles; this is in line with the advent of Toyota's investment of USD100M in Pakistan. This needs to be made possible for EV manufacturers as stated in the EV policy recommendations.

### *5 5 2 CBU Imports – Increase in 50% Tariff and Ban*

While it seems that through the AIDEP (Auto industry Development and Export Policy 21-26) there has been a significant decrease in the Custom Duty of CBUs (completely built units) from 25% down to 10%, the banning complete CBUs till June 2022 negated that entirely in the short term.

The reasoning of banning CBUs for 6 months was justified by the fact that the import restrictions of 100 of CBUs have been alleged to be ignored and misused by known Pakistani assemblers increasing the CAD (current account deficit) and leading to less manufacturers importing CKDs or locally manufacturing vehicles in Pakistan with local components.

That however cannot be implemented onto the EV market, as Pakistan still hasn't kickstarted its local manufacturing (using CKDs or locally available components) as those aren't ready developed yet for the EV market. The National EV policy is still only one year old; local and European research and policy analysis groups still haven't been able to evaluate the full impact of the policy let alone local manufacturers and foreign investors being able to implement an action plan based on it to develop the local manufacturing market. The banning of EV CBUs would be detrimental to approximately 90% of the EV market in the short and medium term restricting the transfer of technology.

### *5 5 3 Overturning CBU Import ban – Implementation of 50% Regulatory Duty*

As WTO regulations do not allow banning of imports, the ban has been overturned and a regulatory duty of 50% imposed on EVs, Hybrids and IC vehicles. This again has been justified by the reduction of CD as mentioned above but the figures do not add up. This again targets the EV industry as it loses any protection status when compared with IC and Hybrid vehicles, and as mentioned above, will affect 90% of the EV industry. Unfortunately, a further proposed Federal excise duty on local manufacturers to 10%, again shows the policy not being completely justified about the protection of local EV market.

Hence, while Sales taxes (1%) and custom duty on components for locally manufactured 2,3 and heavy vehicles (1%) is being promoted to help the EV industry, the effect on the entire EV sector as it stands right now, is miniscule and restricting development locally. This is giving the IC and HEV the advantage and negating the promotion of climate action change.

As of May 2022, the ban has been reinstated on all CBUs (EV and regular)



### 5 5 4 *Infrastructure*

The National EV policy prescribes NEPRA (national electric power regulatory authority) to develop a regulatory framework EV charging stations and tariffs. This regulation itself has been distributed on the 5th of January 2022. This framework is developed on safety standards, regulations, vehicle requirements, that are still in the development stages, and need to be implemented fully. The recommendations including using standards and regulations developed outside of Pakistan, which are implemented on EVs that are being imported within Pakistan. Therefore, these imports are important for the development of this regulation and standardization framework.

### 5 5 5 *Crude Oil Import*

With sales tax of 0% currently implemented in recommendations, The Pakistan oil refinery policy recommended 0% duties and sales tax on the import of crude oil. This again further incentivizes the continued adaption of IC engines and is detrimental to clean green technology adaption as required by the National EV policy. Sustainability of Oil refinery and use needs to be equalized with the incentives for sustaining the EV policy.

### 5 5 6 *Restriction on Local Manufacturers*

To tangle the situation for local manufacturing further, a statement from the ministry of industries and production stating "Poor response to electric vehicles policy attributed to the limited market for environmentally friendly vehicles" The statement includes "The adviser to prime minister on commerce and investment recommended that no new licenses should be issued as already 15 manufacturers were present in the country and no new vehicle models should be allowed as well."

This therefore negates any sales taxes and custom duties promotion for local manufacturers when it is being stated that none of it is being taken up by manufacturers and restricting further manufacturers by appearing in Pakistan. The increased FED does not help in this situation.

The Electric vehicle import, in CBU, CKD, and components alike must be protected in the short and medium term to be able to survive in the long term locally for Pakistan.

## 5 6 Fiscal Barriers that Need to be Remedied:

- Sales tax increased to 17% on imported EVs
  - 12% rise from previous tax
  - 3 time the rise in sales tax on IC and Hybrid vehicles (4% and 4.5%)
  - Hybrid increased to 12.5% has been reduced to 8.5%

This needs to go back to no sales tax to promote EVs over other vehicles. At least down to previous levels or even to Hybrid Levels. Without imported vehicles, an infrastructure cannot be created that quick.

- Duty on Import CBUs: higher on EV cars than Hybrid cars and still high for 2-3 wheelers
  - Custom duty imposed on CBU cars: Started from 25% then reduced to 10% however New 50% regulatory duty imposed (on cars)
  - Compare that to regulatory duty of 15% on hybrid over 1800cc and 0% for under 1800cc (Which covers all Toyotas to be brought into Pakistan)



- CBU duty at 50% duty (even though restricted in numbers) on 2-3 wheelers
- Bike CBU restricted to 10 per variant (200 per company)
    - Car CBU restricted to 100 CBU

This custom duty on CBU needs to be revised to be back to lower values of 10% (or 25%, but without the regulatory tax) The AIDEP still shows CD as 10% but does not regard the new regulatory duty) and have a higher limit on EV CBU till more CKD assemblers or local manufacturers can be established – give it a 5-year limit. As in the previous point, we need to develop an infrastructure before local manufacturers and assemblers can get running.

- CKD kits for 2-3 wheelers have been brought to 1% custom duty and 0% sales tax (for 5 years ending 2025), however that does not get applied for 4-wheeler cars

CKD for all electric vehicles should be at 1% CSD and 0% ST so that more local assemblers start bringing in Electric Vehicles instead of IC engine vehicles. This limit should be further moved to 2030.

NOTE: CBU Vs CKD

CKD kits are still taxed much cheaper which makes CBUs awfully expensive. Considering we do not have a CKD for Electric Vehicles just yet; we should not restrict it; CKD kits have new incentivized reduction of sales tax, custom duty, Withholding tax, and Federal excise duty. This is good for IC cars, but not for EVs.

This makes the local three assembler vehicles cheaper than any EV vehicles, even though both are imported from the same countries. In countries such as Vietnam, Philippines Thailand, the difference in CKD and CBU is very marginal. In Pakistan it is nearly 2-3 times.

- With sales tax of 0% currently implemented in recommendations, The Pakistan oil refinery policy recommended 0% duties and sales tax on the import of crude oil.

This must be equalized. A recommendation is that instead of losing money incentivizing fossil fuels, this same amount can be put into EV vehicles. A calculation on how much money is saved on fossil fuels, Carbon Tax, $CO_2$ emissions from production of Fuel etc. can be shown to favour EVs vastly even overcoming the initial cost of EVs.

## 5 7 Regulation Barriers that need to be Remedied:

- Restriction on local manufacturers due to perceived small market for EVs

A statement from the ministry of industries and production stating "Poor response to electric vehicles policy attributed to the limited market for environmentally friendly vehicles" The statement includes "The adviser to prime minister on commerce and investment recommended that no new licenses should be issued as already 15 manufacturers were present in the country and no new vehicle models should be allowed as well."

- WP-29 Regulation:
    - Pakistan has opted for 17 safety regulations for brakes, steering, tires, lighting, safety belts, seats, airbags, collision, safety glazing, mirrors and cameras, antitheft devices for cars and heavy commercial vehicles. According to AIDEP: In case of local manufacturing, certificate by the OEM's/principal or third-party certification for compliance of desired safety regulations will be required by the EDB before issuance of manufacturing certificate for any model. The compliance to

shortlisted WP29 Regulations will be applicable to all new models of vehicles being manufactured in Pakistan.

This has been given a deadline for Jun 2022, extendable by one year each, max to June 2025. This must be evaluated based on the capabilities of the local market rather than a timeline imposed by the EDB. We need to make sure this is achievable by manufacturers.

This is not imposed on CKD or CBU (at least not mentioned inside the AIDEP policy) so it is concerning if this will be a requirement only for local manufacturers that will impede EV manufacturers the most.

Secondly, WP-29 are on passenger cars and Vans, commercial vehicles, and busses. We need to ensure 2 and 3 wheelers are accurately appreciated within these criteria.

- No clear definition of electric vehicle testing, standardization, or homologation in all the policies

Clearly mention specifications that are required for EVs, to make them comparable to other vehicles.

- Make the approval for new vehicles easier.

The current approval mechanism requires around 25 points that need to be conducted according to the EDB (and AIDEP) policy. This is not technically a problem; however, it is time consuming. A requirement of having registrable vehicle evaluated and, on the road, must be fast tracked over CKD and CBU assemblers and importers.

## 5 8 Update to Incentives – Budget 2022-23

As of June 12th, 2022, with the continuing trend of volatile policy decision changes, the 100 CBU vehicle imports to evaluate the market remains banned by the government. Affects most luxury EV vehicles, BMW, Audi, Mercedes and Porsche. However, CKD systems were also banned on May the 20th with a reversal in order on the 20nd with exceedingly high import duties levied as an alternate. A new directive by the State Bank of Pakistan through EPD circular No. 09 of 2022, requiring prior approvals on transactions including:

- Import of several goods for Issuance
- Enhancement
- Amendment for Letter of Credit
- Registration
- Amendment of Contract
- Advance Payment
- Authorizing Transactions on Open Account or Collections Basis

Affecting import of CKDs rendering all of Pakistan's automotive sector very volatile[19] and adversely affect the CAGR growth of EVs in the market down to halt.

The Budget 2022-23 has made the following changes to the policy once again.

[19]https://www.globalvillagespace.com/pakistans-auto-industry-faces-a-huge-business-risk-over-sbps-new-directives/



Advance tax rise has been doubled to PKR150K on vehicles between 1600-1800cc, PKR200K between 1800-2000cc, PKR300K between 2000-2500cc, PKR400K between 2500-3000cc, and PKR500K for above 3000cc vehicles.

The implication on EV is higher as an advanced tax has been added to 2% (which was suggested to be 0% in the policy papers). As an example, An Audi e-Tron tax (value of US$65,000) would come up to an additional PKR265K to the cost. This would add to the registration fees.

An advance tax on non-filers has gone to 2% for all vehicles. While the impact has said to not affect the vehicles market[20] all additional taxes on EVs are unsustainable.

The Federal Government has suggested a petroleum levy in the budget for the fiscal year 2022-23[21] to take it up to PKR750B[22]. This should have made EVs cheaper in Pakistan albeit without any EV able to replace FFV vehicles. This has been predicted to be between Rs 50 per litre levy[23] and a sales tax of 17%[23] to between PKR25-30[24] that would have an impact on the difference in the cost of running vehicles between Electric and FFV vehicles.

In total, the government has reduced total subsidies by 54% which is affecting all subsidized projects so a subsidized plan for the EV market is not on the cards currently.

ACTION PLAN: Again, as several sections in this study point out, the suggested action is to have the government specifically target EVs to be taken out of this blanket CKD and CBU bans / rises, tax rises and plans and be given its own status. The reliance on Fuel import seen in the earlier sections is seen to be exceedingly high and can be countered with this. In case, this is not possible, then an active action in developing Electric vehicle retrofitting systems needs to be vitalised as recommended in the future actions part of this document.

Update to Action Plan: The senate standing committee on finance, in a meeting held on the 17th of June 2022, rejected the increase in sales tax on electric vehicles from 12.5pc from 17pc, while Senator Naik suggested an exemption for small electric vehicles[25]. This is a positive step towards promoting the EV industry. Further action is needed to further break the EV industry away from the regular automotive industry.

# 6 POLICY RECOMMENDATIONS TECHNOLOGY LAYER

## 6 1 ELECTRIC VEHICLE TECHNOLOGY (DESK SURVEY REQUIREMENTS)

Vehicle homologation, specifications and certification have been investigated the section on national EV centres action plan. To ensure these are implementable, technical vehicle

[20] https://www.brecorder.com/news/40179274
[21]https://www.incpak.com/national/govt-considering-to-restore-petroleum-levy-in-upcoming-budget-2022-23/
[22]https://profit.pakistantoday.com.pk/2022/06/11/govt-to-collect-rs750bn-petroleum-levy-in-the-next-fiscal-year-2022-23/
[23] https://tribune.com.pk/story/2360927/govt-unveils-rs95-trillion-federal-budget-for-2022-23
[24] https://www.dawn.com/news/1694211
[25]https://www.dawn.com/news/1695096/budget-2022-23-tax-relief-to-salaried-class-sacrificed-at-imf-altar

specifications must be given priority within the policy document to ensure that local developers and manufacturers are able to provide the same specifications as importers and assemblers. Policy points pertaining to the actual vehicles are given below. These are based on a desk survey of regulation specifications that have been conducted in other next 11 developing countries. This is to ensure that not only tougher WP-29 are regulated, but a local Pakistan oriented specifications list is developed.

### *6 1 1 Specifications*

These are specifications that must be achieved by EVs and should be included in documentation. Type approval of selected the systems can be conducted locally using data available.

1. All imported and developed vehicles alike must have at least four airbags, and in case the of three-wheelers, the safety features need to be articulated. For an electric vehicle passive safety is extremely important and ensures that impact does not start a fire at vulnerable components such as the battery system, controllers, and wiring systems. With 3 wheelers being extremely specific to developing countries, Pakistan needs to develop its own safety standards and tests. In absence of such, safety can be provided by regulatory structural features and parametric constraints.

2. Appropriate cut-off systems (both manual and automatic) must be available in electric drivetrains for crashworthiness of electric vehicles. Shut down of controller systems, battery systems, and motor and braking systems must be monitored. The wheels must remain free after a major crash to allow removal. A manual override system in case of minor crashes also must be available to allow the vehicle to be operatable again.

3. Development of a system for availability of spare parts and a transfer of technology (ToT) to local SMEs to develop the products to avoid failure due to unreliable supply chain and quality of components. This ToT must be available even when components are imported to allow a free market allowing local vendors to develop the technology while its being imported.

4. Two-way vehicle charging especially in PHEVs (Plug in Hybrid Vehicles) could help in electricity shortfall and would allow grid load management in case of BEVs (Battery Electric Vehicles). Therefore, PHEVs should still be promoted till Pakistan is capable of 1.5 times the actual capacity required by EVs and local requirements.

5. Promote vehicle to vehicle (V2V) charging as an innovative technology for range extension.

6. Smart Home EV chargers to be programmable to let EV charge itself during off-peak hours when electricity is cheaper.

7. Electric vehicles registration must include place to be mainly charged (in case of on grid charging) to identify hotspots of Energy used.

8. Smart home EV chargers must be type approved, and registered for grid development

9. Standardised symbols and system indicators for the HMI (human machine interface) such as the dashboard, lights, and warning signs) should be type approved for the ease of use and adaptability.



10. All vehicles imported and developed in Pakistan must have the following standardised and type approved systems EV specific indicators:

11. Charge left and distance that can be travelled till the battery is depleted

12. Warning indicators over-heating, sudden stop, electrical circuit malfunction of the system

13. Clear warnings that the system is operational (Electric vehicles do not give noise when stationary) so the person must be made aware through warning systems. These are especially required for open 2 & 3-wheel vehicles.

14. Speed of the vehicle

15. Mode of vehicle in case of hybrid vehicles and range on both electric and fuel systems

16. Placement of the battery systems in the front of the vehicle (where head on impact will have a direct affect) will require a crush zone around the battery system. This can follow standards safety approval as those of ICE (internal combustion engine) vehicles.

17. Even in case of regenerative braking, there must be a physical brake present on each imported or developed vehicle for emergency braking, parking brakes, and locking systems.

18. Auxiliary systems of the vehicle must have a redundant backup battery system that cannot be used to propel the vehicle to have operational systems in case of complete battery depletion.

19. There must be a locking system on every vehicle that does not allow unintentional staring of the system. This is particularly important for 2-wheel vehicles.

### *6 1 2 Documentation*

1. Each of the monitoring systems on the vehicle dashboard including warning lights, switches and numbers should be type approved and included in documentation with ergonomics in mind.

2. Each of the vehicle specifications on sheet must mention the vehicle charging time based on different charger types and wattage provided.

3. The range for automobiles must be specified in the EV Policy draft, so that there is a minimum performance qualification criterion for the battery systems. These must be indicated in the documentation (both marketing material and user manual) of the vehicle as well.

4. These type approvals will be part of Homologation and testing regimes within Pakistan, for Pakistan standards.

### *6 1 3 Conversion Technology Incentive*

1. Retrofitting of older vehicles must be incentivised and mandated for infractions. Even if 50% or more of all cars sold by 2040 should be electric, there will still be 80% older cars on the road that will be ICE based.

2. Mandated regulation for conversion will be based on testing and homologation systems for older than a certain age vehicle starting from industrial and heavy vehicles, then implemented on all road vehicles. A United Kingdom type MOT (ministry of transport) test can be implemented on a point-based system. IECE organisations can develop these points



systems and train an authorised tester network and a secure online certification system offered.

3. Vehicles that cross the marked threshold of emissions either pay fines or convert their vehicle into an EV or PHEVs directly by mandate.

4. The tests will be also required for conversions. A vehicle that does not pass safety standards (such as suspension systems or other auxiliary operations) will need to be fixed before they can be allowed for conversion. A vehicle that could fail after conversion should not be converted.

5. Voluntary conversions will allow drivers to bypass emissions tests.



# FIELD SURVEY THREE-WHEELER


IECE UOL
ALIERA UK
HYBRID EV
SUSTAINABLE
TECHNOLOGY
INITIATVE
2020-2030

# 7 FIELD SURVEY – MARKET AND SOCIAL LAYER

## 7 1 SUMMARY OF THE FIELD SURVEY

Developing countries around the world face a complex problem that is layered in nature, which exhorts that economic and environmental performances of the country should be given equal importance. With the looming danger of climate change, it is imperative to reduce the GHG emissions and regulate the sectors that contribute the most to pollution. Transportation sector is one of the major contributors to GHG emissions, and it is essential to investigate the role of electric vehicles in economic and environmental performance of developing countries. ("(PDF) Consumer attitudes towards battery electric vehicles: A large ...") This study seeks to investigate the usage pattern of three-wheeler vehicle by taking a Pakistan-based survey approach and analysing the responses from various three-wheeler drivers across the country. The survey results indicate that the adoption of hybrid and electric three-wheelers in Pakistan would be welcomed by the users due to increased economic benefits, despite having a high initial capital cost. On an average basis, the regular three-wheeler is run for more than 7 days a week, 101-150 kms daily across more than 10 hours and enables the owner to make around PKR 20,000-25,000 after approximately PKR 15,000 is spent every month on fuel and maintenance. "The adoption of hybrid or electric three-wheelers can easily improve the monthly earnings by 50%." ("Clean and sustainable transportation through electric vehicles – a user ...") In addition to this, the GHG emissions from the transportation sector will be considerably lowered around 3-6 tons of $CO_2$ emissions per year per three-wheeler. At an investment return period of 13-16 months, the electric three-wheeler is a highly lucrative opportunity. This study suggests that government should introduce policies that promote indigenous technology development, offer easy loans to three-wheeler drivers, and introduce easily available charging stations to achieve holistic sustainability.

## 7 2 INTRODUCTION

Three-wheeler vehicles are a common mode of transportation in the MENA, South Asian, Southeast Asian and some Central American countries, carrying their own titles in local vernaculars suited to intra-city transport over short distances but are less feasible for longer routes due to the limitation of speed, vehicle comfort, stability, and overall aerodynamics of the vehicle. Used predominantly by the lower and middle class of Pakistan for daily commute, a survey by PBIT (2017) concurred that it offers the most economical means of transportation for the social stratum in the user base. Statistics show that 73,477 units were produced in 2017 across Pakistan, and the market has shown a compound annual growth rate of 18%.



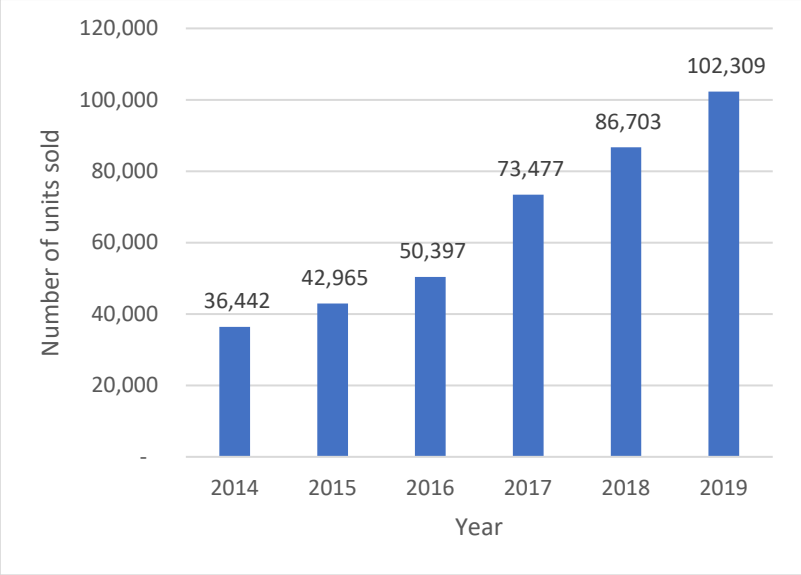



*Figure 14 Number of three-wheelers sold in Pakistan from 2014-2019*

The data shown in Figure 14 concurs with the 2010 survey conducted by the Pakistan government which suggested that the number of rickshaws on the road touched the hundred thousand mark, and it can be safely assumed that the number has increased by at least 2 times over the past decade. With 400,000 three-wheelers running, it is imperative to gauge their climate change potential and the fuel economics to identify the caveats.

## 7 3 SURVEY

A survey was administered from the local three-wheeler drivers in the metropolitan city of Lahore, Karachi, and Peshawar, whereas the cities of Jhelum and Mirpur were also taken into the account. A questionnaire was designed which was subjected to a pilot study first by considering the responses from field experts. After a few minor corrections, the questionnaire was finalized, and the data was collected from rickshaw drivers across Pakistan. Close ended questions were utilized that were extremely simple in nature and related to the daily routine of the rickshaw drivers, the fuel consumption, and the monthly fuel expenditures. The survey included both yes/no and polytomous-score based questions which helped in gathering relevant information and observing the general perception of the drivers.[26] In addition to this, a Lickert scale was used based questionnaires that helped in gauging the sustainability implications of three-wheeler adoption.

[26] *Clean and sustainable transportation through electric vehicles – a user …*, https://link.springer.com/article/10.1007/s11356-022-19060-x.



*Table 9 Questionnaire Format*

| |
|---|
| NAME: |
| CONTACT NUMBER: |
| VEHICLE MAKE AND MODEL: |
| REGISTRATION YEAR: |
| THE CITY IN WHICH YOU DRIVE YOUR VEHICLE: |
| CAN WE CONTACT YOU LATER, ON PHONE FOR ANY FOLLOW UP QUESTIONS? |

| | *QUESTION* | *RESPONSE* |
|---|---|---|
| *1* | For how much did you buy the rickshaw? | |
| *2* | Are you its owner? | |
| *3* | How many days a week do you typically use it? | |
| *4* | How many hours a day your vehicle is used? | |
| *5* | Total kilometres clocked each day? | |
| *6* | For how many hours each day the vehicle is present at your home or its parking location (to estimate hours it can be charged)? | |
| *7* | If it is parked at some parking location, for instance filling station or public overnight parking, then for how many hours the vehicle is left there? (to estimate feasibility of plugin charging stations at those locations) | |
| *8* | Roughly how many trips a day you make? | |
| *9* | Typical longest trip in a day? | |
| *10* | Typical shortest trip in a day? | |
| *11* | Maximum number of people carried? | |
| *12* | Average number of persons carried in a trip? | |
| *13* | How much you generally earn in a month excluding maintenance? | |
| *14* | How much you spend on maintenance? | |
| *15* | How much you spend on fuel in a month? | |
| | a) Money spent on Gasoline | |
| | b) Money spent on CNG | |
| | c) Money spent on LPG | |
| *16* | If the vehicle is on rent, then how much you pay to the owner in a month? | |
| *17* | Suppose that you needed to pay 50K to buy your vehicle, then how much saving a day or a month it must make to justify the additional cost? (For instance, Rs 3000/month, Rs 6000/month or Rs 9000/month OR more) | |
| *18* | Will you pay Rs 50,000 every 2 years to replace the battery? | |
| *19* | If not, then will you pay Rs 30,000 every 2 years to replace the battery? | |
| *20* | If not, then what is the figure you would be comfortable at? | |
| *21* | Will you be willing to buy the vehicle for Rs. 450,000 if gives saving in fuel? | |
| *22* | If not, then what is the figure you would be comfortable at? | |
| *23* | What is the average speed you normally drive at? | |
| *24* | What maximum speed you go at and how often? | |
| *25* | Time in seconds to reach speed of 60 km/h? | |
| *26* | Are you literate in basic English for using the user interface? | |



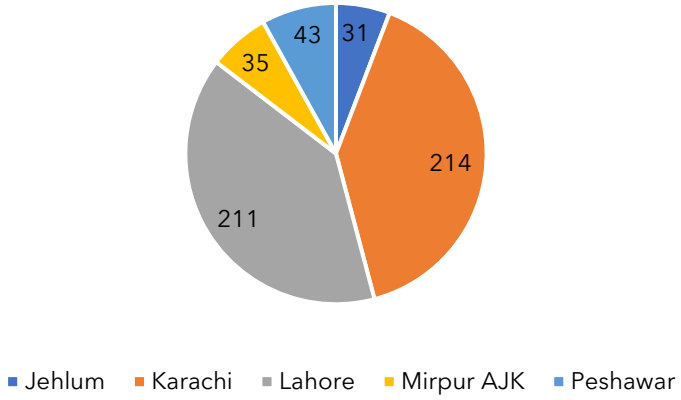



*Figure 15 City-wise distribution of the survey results*

It was generally observed that the closed three-wheeler/rickshaw was mostly used in metropolitan cities, whereas the non-metropolitan cities of Jhelum and Mirpur saw open rickshaws, colloquially known as Chingchis, running on the roads due to various sociocultural factors. The respondents from the aforesaid cities maintained that the female populace preferred to commute in an open rickshaw or Chingchi as they felt safe, whereas the female populace in the metropolitan cities preferred a closed rickshaw for privacy reasons; thus, the lower number of responses from the cities of Jhelum and Mirpur. Out of the 534 surveys conducted, 489 responses were received which shows a response rate of 91.7%. Karachi, being the largest city of the country, had the greatest number of responses at 196, followed closely by Lahore with 194 responses as shown in Figure 15.

As shown in Figure 16, most of the rickshaw drivers belong to a lower socioeconomic stratum and this is evident from the figure below that a whopping 40% of the responses had no formal education whatsoever. Approximately 43% of the respondents had acquired basic formal education, out of which 28% had studied up to Grade 5, whereas up to 23% cleared their 10$^{th}$ grade examination.

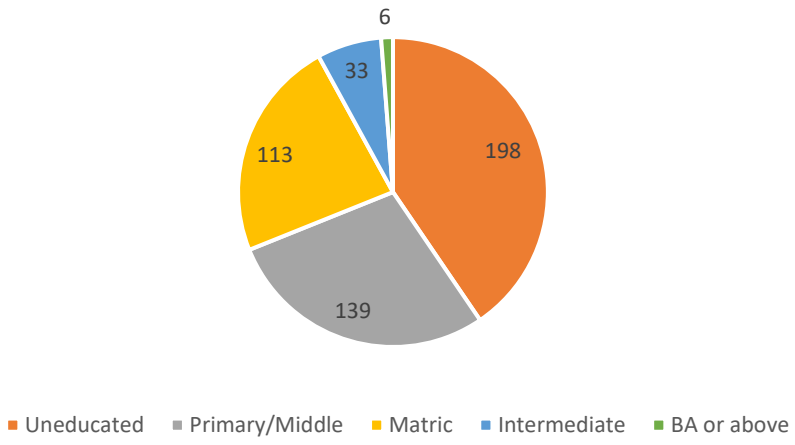



*Figure 16 Qualification of the rickshaw drivers*



Out of the 489 filled results, 76% of the users owned a rickshaw whereas remaining 24% were paying the monthly rent to some individual, AOP or an instalment company. This suggests that there is a trend of owning the rickshaw (Figure 17), rather than renting it and this is a strong indicator that upon the arrival of electric rickshaws, the consensus would be to own it.

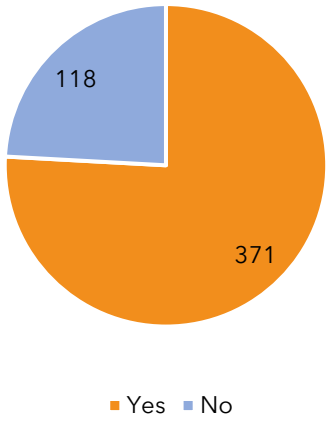



*Figure 17 Rickshaw ownership statistics*

## 7 4 Usage Pattern

### *7 4 1 Duration*

It was observed that approximately 70% of the rickshaw drivers started this business within the past 10 years. The increase in population has merited an increase in the means of transport, which is agile and compact, thus addressing traffic congestion. This is manifested in the growing number of rickshaw drivers in the past 10 years, given in Figure 18.

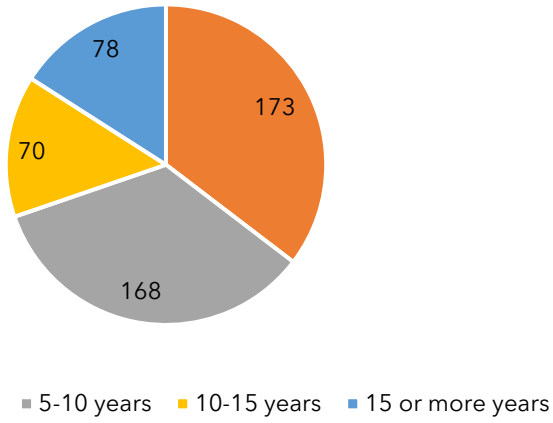



*Figure 18 Duration of driving the rickshaw*

### *7 4 2 Rickshaw cost*

Regarding the cost of rickshaw, a remarkably interesting pattern was seen in the responses (Figure 19). The survey results from Karachi showed that the general consensus was to buy a used rickshaw that costed below PKR 100,000 and then the drivers spent PKR 15,000-

20,000 of their own funds in the repair and refurbishment of the rickshaw. However, this trend manifested itself in a different manner in other cities and the holistic results indicate that the median value of rickshaw lies between PKR 100,001-150,000, as the users prefer a second-hand/used rickshaw as a regular brand-new rickshaw has a starting price of PKR 225,000. This is evident from the fact that only 8% of the rickshaw drivers had a rickshaw costing more than PKR 200,000.

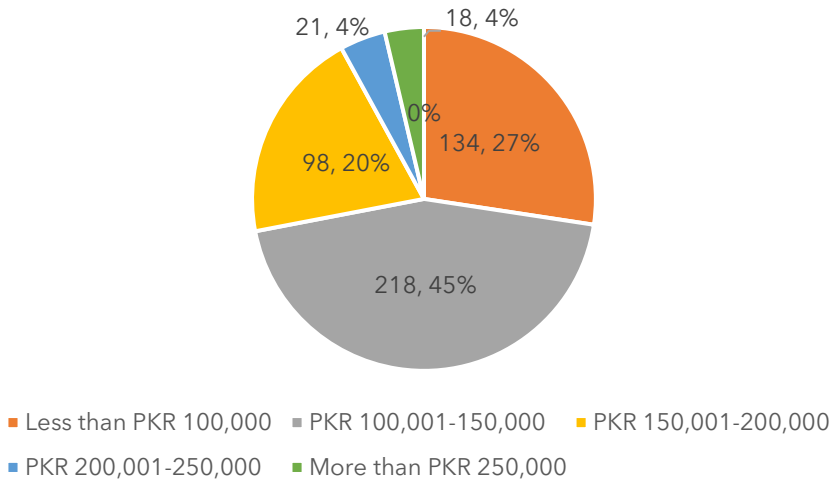



*Figure 19 Rikshaw cost statistics*

### *7 4 3 Usage Statistics*

One of the most useful results of the study was the weekly-use statistics of the rickshaw (Figure 20) as a whopping 54% of the users drive the rickshaw the whole 7 days a week, whereas a meagre 9% of the respondents drive the rickshaw less than 4 days a week. This suggests that the rickshaw use is strong among the residents and people are willing to spend their weekends driving the rickshaw as 76% of the respondents drive the rickshaw for 6 or 7 days a week.

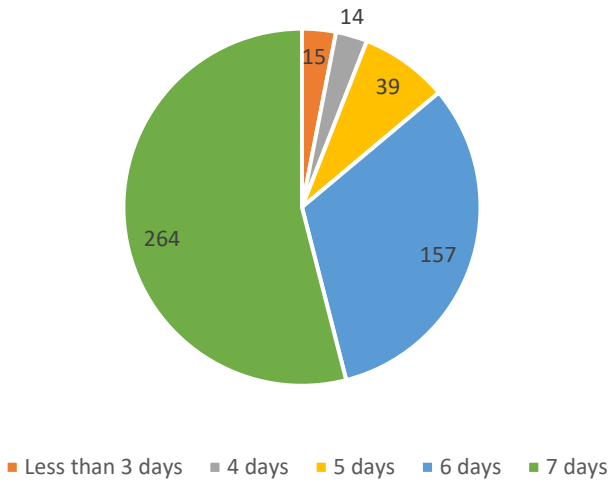



*Figure 20 Weekly usage statistics*

In line with the usage statistics, the driving statistics suggest that the median populace drives the rickshaw for more than 10 hours a day, whereas 30% of the respondents suggested that



the rickshaw was driven for 8-10 hours. This suggests that the economic benefits of an electric rickshaw would be immense, if driven for more than 10 hours as the fuel charges are minimal. The statistics given in Figure 21 are extremely important in infrastructure development for charging stations.

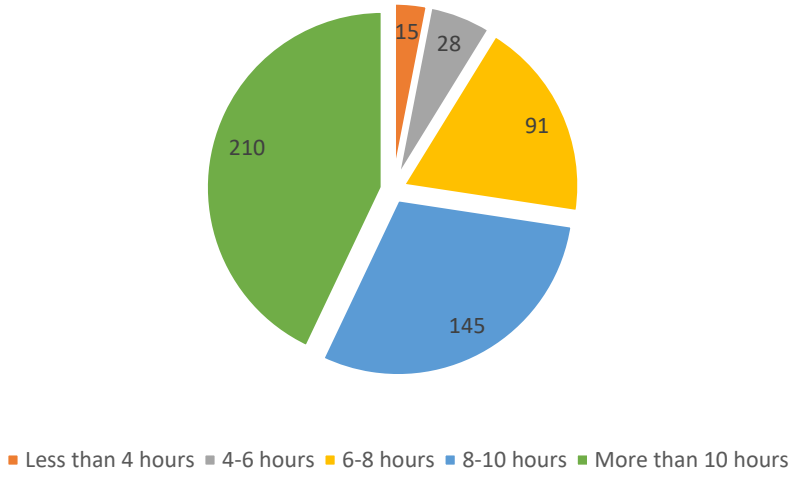



*Figure 21 Daily usage statistics*

The daily commute statistics are given in Figure 22 where out of the 489 respondents, 48% drove 101-150 kilometres a day, whereas 24% drove 151-200 kms a day. As the running rickshaws cause a lot of air pollution, the long hours and the extensive travels indicate that there needs to be a conscious effort to regulate the emissions of these rickshaws; and the introduction of electric rickshaws can be a panacea to these ills.

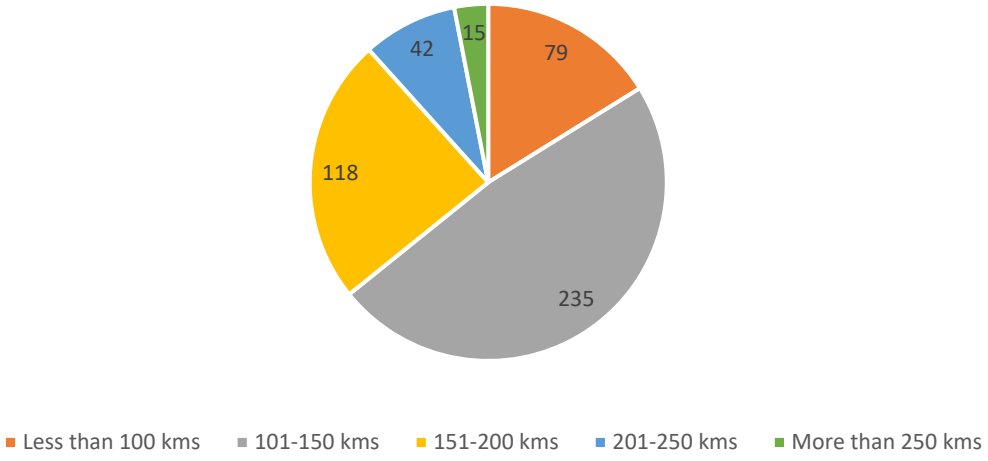



*Figure 22 Daily driving statistics*

### *7 4 4 Expenditures & Earnings*

The median expenditure on rickshaw's monthly maintenance came out be PKR 2,000 – 3,000 (Figure 23). In addition to this, 44% of the users suggested that the monthly expenditure on the maintenance activities exceeded PKR 3,000. The introduction of electric rickshaws can



bring about a considerable reduction in these expenditures, as the skyrocketing prices of lubricants and amenities indicate that this figure will go upwards.

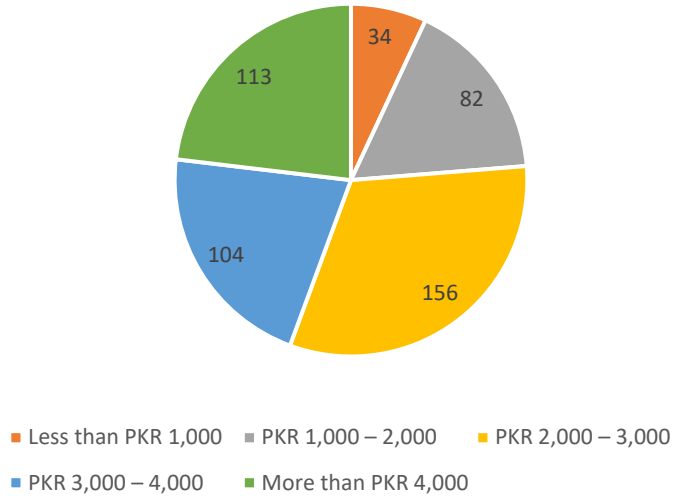



*Figure 23 Monthly maintenance expenditure*

The most interesting finding of the survey suggests that more than half of the respondents spend more than PKR 12,000 on fuel every month (Figure 24), which is almost 40% of their monthly earnings, whereas 29% of the respondents indicated that their monthly fuel expenditure ranged between PKR 9,000 to PKR 12,000. This huge economic burden can easily be reduced by the introduction of electric rickshaws.

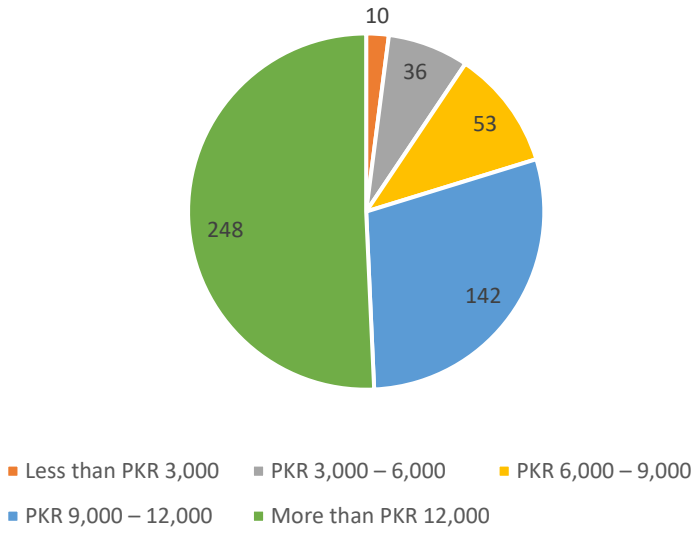



*Figure 24 Monthly fuel expenditure*

The survey results in Figure 25 suggest that the median income of the respondents ranges from PKR 20,000 to PKR 25,000 per month, whereas one-quarter of the respondents make PKR 25,000 – 30,000 per month. These figures can easily observe an increase of 50% with the introduction of electric rickshaws as the maintenance and fuel expenditure will be minimized.

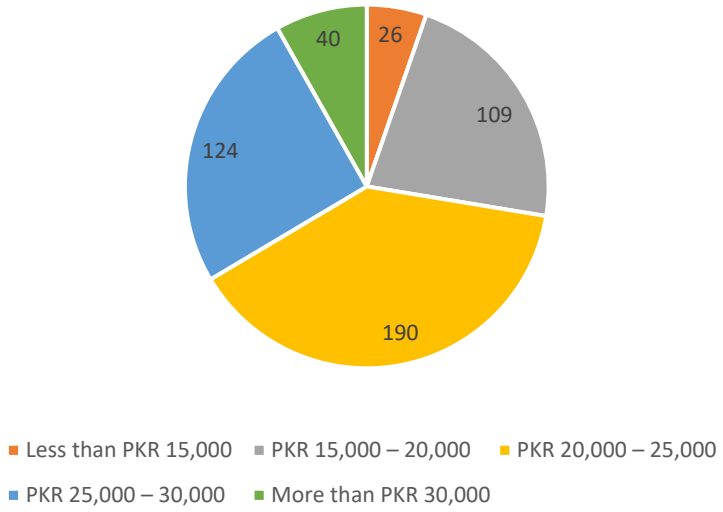



*Figure 25 Monthly earning of the rickshaw drivers*

The usage pattern results indicate that there is a general trend of owning the three-wheeler in Pakistan, and with a median driving of 101-150 kms per day for 6-7 days a week and clocking more than 10 hours daily, the drivers are making PKR 20,000 – PKR 25,000 every month, which barely makes the ends meet. The introduction of electric rickshaws can increase this figure by 50% by considerably reducing the maintenance and fuel expenditures, whilst reducing the emissions at the same time. This will not only act as a strong lever for economic development but will help in attaining environmental sustainability.

## 7 5 Sustainability Analysis

After the usage pattern analysis, the responses to the adoption to electric three wheelers were collected. Out of the 534 surveys conducted, 423 responses were received which shows a response rate of 79.2%. 170 responses were collected from Lahore whereas 163 responses were collected from Karachi.

The scoring results of the whole sample sorted from highest to lowest average score are given below in Table 10. Despite belonging to a lower socioeconomic stratum, the respondents were very much in favour of government imposing fines on the rickshaws with uncontrolled emissions, with climate change being the second most important aspect. It was seen that the respondents were more willing to buy an electric rickshaw from government run easy-loan scheme rather than spending a sum of 1.5-2 times the average price of a regular rickshaw. The variable of increased economic opportunities for women did not perform well, and this can have two major explanations: (a)100% of the respondents were men and belonged to a stratum where there is lack of awareness regarding gender equality; and (b) a lot of women from lower social strata work as housemaids in relatively affluent households, and their driving a rickshaw becomes more of a safety issue.

*Table 10 Ranked statistics of the responses based on average score*

| Sustainability Question | Mean | Std. Deviation | Rank |
|---|---|---|---|
| Support of government on imposing fines | 4.26 | 1.205 | 1 |
| Importance of climate change | 4.06 | 1.04 | 2 |
| Importance of regular maintenance for emissions check | 3.89 | 0.976 | 3 |
| Willingness to buy from government scheme | 3.88 | 1.287 | 4 |
| Chances of increased economic opportunities | 3.64 | 0.946 | 5 |
| Relationship of charging stations with electric rickshaws | 3.62 | 0.995 | 6 |
| Likelihood of success | 3.53 | 1.034 | 7 |
| Chances that Pakistani rickshaw is reliable | 3.41 | 1.019 | 8 |
| Chances to spend more on rickshaw | 3.25 | 1.174 | 9 |
| Willingness to spend bi-annually on batteries | 3.22 | 1.19 | 10 |
| Women Jobs | 2.84 | 1.049 | 11 |

## 7 6 POLICY RECOMMENDATIONS

Considering that the tentative price of an electric or hybrid three-wheeler would be 1.5-2 times the cost of a commercially available rickshaw, more than 50% of the respondents were willing to spend that sum, provided it offered reduced fuel and maintenance costs. Therefore, it is incumbent upon the government to take active measures in the introduction and promotion of electric three-wheelers. Approximately 68% of the respondents were of the view that the success of electric three-wheelers is dependent upon the availability of charging stations throughout the city. 56% of the respondents were satisfied with the indigenously developed three-wheeler in Pakistan and only 19% were of the view that a locally developed three-wheeler would not be durable and reliable. However, the bi-annual expenditure on batteries seemed a difficult proposition. This can be countered by the governmental loan schemes as 68% of the respondents were very much willing to acquire an electric three-wheeler through government schemes. Another welcoming narrative is the response of 64% respondents that an electric rickshaw is likely to succeed in Pakistan. 81% of the respondents were aware of the problems that arise due to climate change and showed cognizance regarding this pressing issue, despite belonging to a lower socioeconomic stratum; and 65% strongly supported the government to impose fines on the vehicles that are major sources of GHG emissions. 66% of the respondents suggested that the adoption of electric three-wheelers would result in increased economic opportunities and would help improving the standard of living. Despite these positive responses, only 21% of the respondents suggested that the adoption of electric rickshaws would help creating economic opportunities for women. To achieve holistic sustainability through the adoption of three-wheeler vehicle; the following policy considerations should be made by the governments of developing countries to achieve the sustainable development goals stipulated by the UN.



### 7 6 1 *Reduced GHG emissions for environmental sustainability*

Besides the economic challenges faced by the country, the environmental issues are of a grave concern. It has been projected by Lin and Raza (2019)[27] that by year 2035, the $CO_2$ emissions will reach 277.9 MT and conclude that the increase in transport related emissions is directly related to increase in the population. In this scenario, it is incumbent upon the government to reduce the usage of fossil fuels and transport sector accounts for 29% of the $CO_2$ emissions (Rehman et al., 2020)[28]. A paradigm shift towards cleaner fuels is necessary and at the same time, conscious efforts are needed to reduce the dependence on fossil fuels for transportation. Despite being a country that is highly susceptible to climate change, Pakistan is still ranked 33 among the petroleum product consumers with 151,200 barrels of fuel imported on daily basis (Saleh et al., 2017)[29]. 21% of the imported fuel is used in the transportation sector, which accounts for 22.69% of the GHG emissions produced annually, amounting to 37.7 Tg of $CO_2$ (Mir et al., 2017)[30]. Out of all the transport related emissions, the road transport produced 34.4 Tg $CO_2$eq, which is a whopping 92% share.

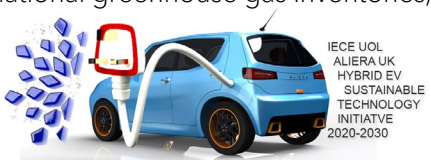
The commercially available three-wheeler rickshaws in Pakistan mostly use either Compressed Natural Gas (CNG) or Liquified Petroleum Gas (LPG) as main sources of fuel. As per the general statistics observed from the survey, protocols stipulated by Eggleston et al. (2006)[31] were used to calculate the minimum and maximum emissions from the three-wheelers for the median distance travelled. The emissions produced by the CNG, and LPG consumption are calculated using the given formula.

$$Emission = \sum_{a} Fuel_a \times EF_a \qquad (1)$$

Where a is the type of fuel, Fuel is the fuel sold in TJ, i.e., LPG or CNG and $EF_a$ is the emission factor in kg/TJ. In case of LPG and CNG, the default rate is 56,100kg/TJ for $CO_2$ emissions. In case of road transportation emissions, the default emission factor for $CH_4$ is 92 kg/TJ for CNG and 62 kg/TJ for LPG. Similarly, the default emission factor for $N_2O$ is 3 kg/TJ for CNG and 0.2 kg/TJ for LPG. These statistics require extensive knowledge of the three-wheeler engine and performance parameters, therefore the emission factors in mg/km for light duty vehicles are convenient from a generalizability perspective. The $N_2O$ and $CH_4$ emission factors for CNG are 27-70mg/km and 215-725 mg/km respectively, whereas for LPG the stats are at 5mg/km and 24mg/km (Eggleston et al., 2006)[12]. Using the figure of 98 g emission of

[27] LIN, B. & RAZA, M. Y. 2019. Analysis of energy related CO2 emissions in Pakistan. Journal of Cleaner Production, 219, 981-993.
[28] ASGHAR, R., REHMAN, F., ULLAH, Z., QAMAR, A., ULLAH, K., IQBAL, K., AMAN, A. & NAWAZ, A. A. 2020. Electric vehicles and key adaptation challenges and prospects in Pakistan: a comprehensive review. Journal of Cleaner Production, 123375.
[29] SALEH, N., MUSHTAQ, K., ZAIDI, A., ABBASOGLU, S. & AHMED, S. F. 2017. Design and performance analysis of a solar powered hybrid rickshaw for commercial use in Pakistan. Journal of Environmental Science and Technology, 9, 472-480.
[30] MIR, K. A., PUROHIT, P. & MEHMOOD, S. 2017. Sectoral assessment of greenhouse gas emissions in Pakistan. Environmental Science and pollution research, 24, 27345-27355.
[31] EGGLESTON, S., BUENDIA, L., MIWA, K., NGARA, T. & TANABE, K. 2006. 2006 IPCC guidelines for national greenhouse gas inventories, Institute for Global Environmental Strategies Hayama, Japan.





$CO_2$ per kilometre for a 4-stroke rickshaw that has been utilized by Reynolds et al. (2011)[32] for Delhi, the annual emission statistics for the rickshaw clocking a median distance 101-150 kms a day for 6 days a week, are given in Table 11.

*Table 11 Minimum and maximum GHG emissions in tonnes from CNG and LPG run three-wheelers, driven 101-150 kms a day for 6 days a week throughout the year*

| | CNG 3 Wheel Minimum | CNG 3 Wheel Maximum | LPG 3 Wheel Minimum | LPG 3 Wheel Maximum |
|---|---|---|---|---|
| kg-$CO_2$ Emission | 945.36 | 7,768.8 | 3,088.176 | 4,586.4 |
| kg-$CH_4$ Emission | 6.77508 | 33.93 | 0.756288 | 1.1232 |
| kg-$N_2O$ Emission | 0.850824 | 3.276 | 0.15756 | 0.234 |

These emissions can easily be curtailed by the adoption of electric or hybrid three-wheeler vehicles and can have a significant impact in improving the air-quality index of the metropolitan cities. Moreover, the noise pollution levels would be considerably reduced as well.

### *7 6 2 Development of Indigenous Technology*

The government should focus on promoting indigenous technology in Pakistan regarding the manufacturing and development of hybrid or electric three-wheelers. Tax incentives should be given to the organizations that are ready to develop such technologies and assemblies in Pakistan, and it is suggested that the general sales tax be reduced to 5% from the existing 17% for these industries. In addition to this, these manufacturers should be exempted from the withholding tax as well. In addition to manufacturing and assembly of three wheelers, conscious efforts should be made to develop chargeable batteries within the country, so that the import bill is considerably reduced. Therefore, it is incumbent upon the government to provide subsidy on the purchase of electric vehicles and they should be at the same level as that of commercially available three-wheeler vehicle. Prime focus should be made on PHEVs as they offer flexibility to the user, and then gradual progression can be made towards BEVs. Efforts should be made to locally develop motors, batteries and powertrains to achieve economic and social sustainability goals.

### *7 6 3 Government Easy Loan Scheme*

The results suggest that one of the decisive factors in the success of electric three-wheelers would be the availability of easy loans that are offered by the government. The price point of electric three-wheelers is almost 1.5-2 times as that of a commercially available petrol/gas run three-wheeler, however the economic benefits offered by the electric or hybrid rickshaw makes it a very lucrative option for the users. At present, the users are forced to buy rickshaws on instalments via various private investors who charge high markup rates. Once government loan scheme is introduced, these markup rates would be considerably lower. It is suggested that the markup rates should be at maximum around 7-8% for the buyers.

[32] REHMAN, E., IKRAM, M., FENG, M. T. & REHMAN, S. 2020. Sectoral-based CO2 emissions of Pakistan: a novel Grey Relation Analysis (GRA) approach. ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH.



### 7 6 4 *Poverty amelioration for economic sustainability*

It is evident from the survey results that median income is between PKR 20,000 and PKR 25,000 and the users spend more than PKR 12,000 per month on fuel and maintenance of their three-wheelers. This extra economic burden can easily be reduced by a considerable margin and the median income can see a substantial increase of 40-50%, thus increasing the spending power and the standard of living. Against an initial investment of PKR 450,000, the user can get a full return on their investment by the 13$^{th}$ month. In case the user opts for a 3-year loan scheme offered at 8% per annum, the return would be possible by the 16$^{th}$ month. Therefore, the business model is highly lucrative and sustainable for the socioeconomic strata, as they will also experience an increase in the monthly earnings due to minimal fuel and maintenance related expenses.

*Table 12 Economic feasibility of electric three-wheeler*

| Description | Upfront Payment | Government Loan Scheme @ 8% for 3 years |
|---|---|---|
| Electric Three-Wheeler Price | PKR 450,000 | PKR 558, 000 |
| Annual Charging Cost for 2kW Battery | PKR 840 | PKR 840 |
| Annual Maintenance Cost | PKR 1,500 | PKR 1.500 |
| Total Expenditure | PKR 452,340 | PKR 560,340 |
| Annual Median Income | PKR 420,000 | |
| Return on Investment | 13 months | 16 months |

### 7 6 5 *Easily Available Charging Stations*

Keeping in view that the three-wheeler drivers belong to a social stratum that resides in the underprivileged neighbourhoods, the charging stations should be integrated with the readily available gas stations. This would have dual functionality (a) –ensuring the user that their household electricity bill will not increase and (b) - providing peace of mind that the vehicle will not face range issues. In this scenario, the government should focus on PHEVs and once the vehicles are fully adopted by the market, BEVs can be introduced as it is posited that the existing infrastructure will be upgraded by the time BEVs come into the equation. As per a 2016 report, there were 7560 petrol pumps operating throughout Pakistan (Ali, 2016)[33]. Since most of these petrol pumps are already being used by the three-wheeler drivers to park their vehicles at night, these petrol pumps can be equipped with charging stations as the consensus among the respondents suggested that the ease of availability of charging stations is essential for the success of electric three-wheelers. The government should work with the electricity companies and regulatory authorities to check the extra grid load that is offered by the charging stations and how it can be distributed. In case the establishment of charging stations becomes an uphill task, government can introduce small solar panels and battery bank in the three-wheeler package so that the three-wheelers can be charged at home, and the rest of the time, the solar panels are used to run other domestic electrical appliances which would considerably reduce the electricity bill.

[33]https://en.dailypakistan.com.pk/24-Feb-2016/do-you-know-how-many-petrol-pumps-are-operating-in-pakistan



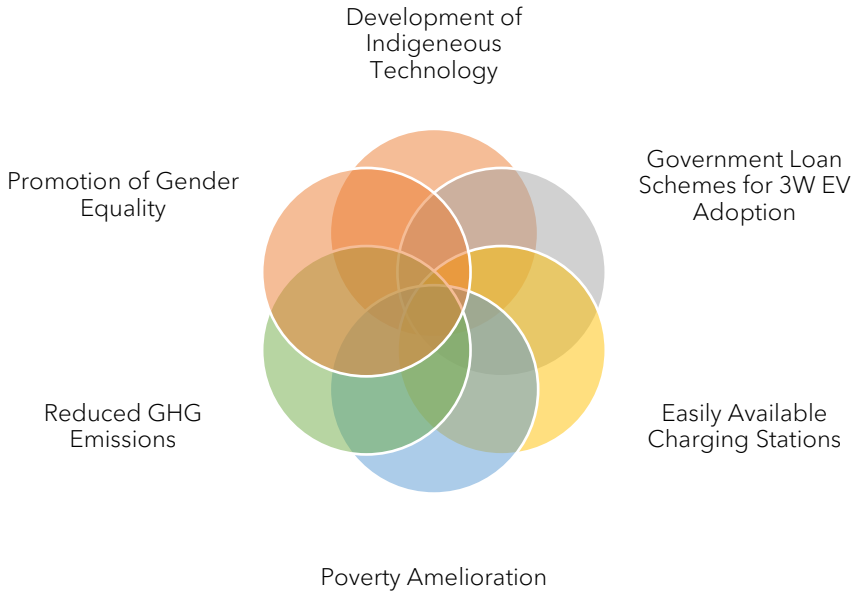



*Figure 26 Electric Three-Wheeler Policy Recommendations*

### *7 6 6 Promoting Gender Equality*

Even though the results do not indicate that the adoption of electric three-wheelers would help in lowering gender disparity, literature suggests that that specific portion of the questionnaire can be treated as edumetric measure as it investigates the level of awareness regarding the narrative of gender equality. A whopping 40% of the responses had no formal education whatsoever. Approximately 43% of the respondents had acquired basic formal education, out of which 28% had studied up to Grade 5; thus, it is understandable as to why the correlation of three-wheeler adoption and creation of economic opportunities for women was considered weak. Therefore, it is incumbent upon the government to introduce national campaigns on gender equality and promote inclusion of women in the macroeconomics to achieve economic sustainability. In addition to women, the marginalized handicapped individuals can earn a decent wage as well.

## 7 7 Conclusion, Limitations & Future Prospects

This research work has sought to understand the usage pattern of three-wheeler vehicles and the consensus on the adoption of electric three-wheelers. Using a survey-based approach, data from 534 three-wheeler drivers were collected from the major metropolitan cities of Pakistan and it was observed that there exists an opportunity to introduce electric three-wheelers to achieve holistic sustainability. A number of researchers have discussed the importance of adoption of electric vehicles and their economic benefits however the case of three-wheelers from driver/owner viewpoint has remained an unexplored avenue. This is. quite possibly. the first study that describes the usage pattern of three-wheelers and performs the sustainability analysis of adoption of three-wheeler vehicles in Pakistan, and it can be said with confidence that the results can be extended to other countries with similarity in socioeconomic demography. The main findings of this study are given as follows:

- On an average basis, the regular three-wheeler is run for more than 7 days a week, 101-150 kms daily across more than 10 hours and enables the owner to make around PKR 20,000-25,000 after approximately PKR 15,000 is spent every month on fuel and maintenance. The adoption of hybrid or electric three-wheelers can easily improve the monthly earnings by 50%
- The user survey indicates that rickshaw drivers have shown extreme willingness towards adoption of an electric rickshaw, even if it costs 1.5-2 times than a regular rickshaw. However, this process can be accelerated through a government funded loan-scheme. However, the success of electric three-wheelers is incumbent upon the availability of charging stations, as this will address the range anxiety issues
- The higher price point of the electric or hybrid three-wheeler will not affect the buyer as the investment can easily be recouped within 13 months if the three-wheeler is bought on lumpsum basis, whereas the return period is 16 months if the electric or hybrid three-wheeler is bought through a government loan scheme
- The adoption of electric three-wheelers will result in improved environmental performance as on average 3-6 tonnes of $CO_2$ emissions are produced from a single three-wheeler throughout the year at a driving cycle of 101-150 kms a day for 6 days a week. With more than 100,000 three-wheelers running across the country, the environmental benefits will be substantial
- The government needs to educate the masses regarding gender disparity and the electric three-wheelers can serve as a great tool to integrate women in the economic stream by providing them with a lucrative financial opportunity

The policy recommendations are given in Figure 26 and the results indicate that despite the higher capital costs, the three-wheeler drivers are more than willing to buy them due to added economic and environmental benefits. However, this study does not reflect the existing performance parameters of conventional three-wheelers and the benefits offered by an electric or hybrid three-wheeler. Moreover, the emission stats were taken from the IPCC guidelines and there needs to be a conscious effort to investigate the real-time $CO_X$, $NO_X$, $SO_X$ and noise emissions. In addition to this, the power load on the grid introduced because of adoption of electric three-wheelers needs to be investigated as well. Further research needs to be conducted on the standards, codes, and manufacturing policies for the electric three-wheeler vehicles so that there are stringent protocols in place for accreditation, minimum design requirements and large-scale production. Moreover, a country-specific urban driving cycle can be developed as a benchmark to monitor and test the vehicular performance.

## 7 8 Update to the Field Study

The Integrated Engineering centre of excellence with Aliera ltd in the UK has conducted a complete development plan for retrofitting 3 Wheeled vehicles for both Electric and Hybrid versions to verify the field study. These vehicles have been taken up to commercially workable levels and will be launched on the platform in Q4 of this year.



## 7 9 THEME: STAKEHOLDERS

These are Policy points that affect and can be implemented for different stakeholders in the current EV ecosystem are given below.

### *7 9 1 Importers*

44. Keep the same import duties with deferred implementation. Impose them as soon as EVs are developed in Pakistan. Incentivise the transfer of technologies of systems ensuring the requirement of royalties do not harm the local developers and is not used to suppress technologies with the design rights within Pakistan. Those technologies must be given priority and funding to develop and distribute further.

### *7 9 2 Pakistani Developers*

1. Promote local industry, technology companies and SMEs over importing of EVs through RTD funding, Individual Vehicle Approval (IVA), various tax reliefs as given below, preferred rates in financing, representation in regulatory bodies, development of government funded experts' forums to influence development of future EV frameworks.

2. Tax reliefs could include these in any combination: vehicle registration fee, annual tax, toll taxes, parking fee, custom duties regarding components not locally produced.

3. Establishment of National Centre for Electric Vehicles as already mentioned before.

4. Incentivise development of design ecosystems by automotive design companies such as those in this group to share the ecosystems to smaller OEM manufacturers to allow better homologation of vehicles developed in Pakistan

5. IP protection of these institutes and companies must be protected for this work.

### *7 9 3 Financing Institutes*

1. To help finance incentives and subsidies related to EVs, government can add "environment levy" on per litre of Gasoline sold. This levy is to be avoided for Diesel to control inflation.

2. EV schemes must be incentivised to financial institutes to fund them more often with guarantees.

3. 10% subsidy on purchase price of EVs.

4. Lower interest rates on leasing of EVs.

5. Lower insurance premium negotiated by government with insurance companies. It should be certain percent less than their regular rates with an upper cap.

6. Better tracking and control systems must be implemented on vehicle technologies that allow financial institutes protect investment and keep location on systems thus reducing risk.

7. OEMs can also lease battery pack to buyers when they purchase EV and financial institutes to provide a mechanism for this.

### *7 9 4 Buyers*

1. Vehicle specifications to be regulated to contain certain parameters related to vehicle performance, energy efficiency and active and passive safety to help buyers make an



informed decision and to promote healthy competition. Certifications to be obtained for various parameters through the network of testing centres.

2. On the model of NCAP (New Car Assessment Program), New Electric Vehicle Assessment (NEVA) program could be initiated on voluntary basis, conducted by testing centres, to provide detailed performance and safety assessment to the buyer. In absence of advanced and expensive testing methods and reservations regarding destructive tests, initially, assessment could be qualitative and are to be performed by certified experts.

3. An EV owner when registered with electricity distribution company, should get certain rebate or discounted rate per unit (kWh) of electricity consumed at his/her domestic electricity connection.

4. EV owner to get a "Friend of Environment" or "Environment Loyalty/Commitment" card providing credit points earned against various measurable low carbon footprint actions, environment friendly promotions by financial institutions and other government initiatives and promotions. These credit points can be used to provide various facilitations, for instance, discounted or free units at public charging stations.

5. Various incentives and tax concessions provided on purchase and use of an EV.

### *7 9 5 Environment*

1. How it really should affect environment - Including AQI policies, mapping of traffic etc. Such policies developed after detailed study by MoCC are bound to recommend restriction to improve air quality; EVs would be promoted through exemption from these restrictions.

2. Marking of environmentally vulnerable areas and allow access of EVs to such zones. These Zones are created with AQI policies requirements

3. Marking of congestion zones in major cities with toll access of standard vehicles. EVs to be exempted from this.

4. Use of renewable energies to produce Electricity, that can be on or off grid specifically for EVs.

### *7 9 6 Energy*

1. The points that affect the Energy sector includes:

a) How it really will be affected through EV use and reduction of use of fuel for ICE vehicles.

b) how will the grid take care of charging? Creating a smart network of charging stations

c) Promotion of mobile charging systems, and solar policy (one panel pack per vehicle incentivised or mandated).

2. Two-way EV charging will facilitate load management.

## 7 10 Theme: Future Studies Required

Continuing efforts in the form of research and technical studies are required by research centres and leading technology-based companies in collaboration with MoCC to help in policy making.



### *7 10 1AQI Monitoring*

1. Research and monitor the pattern which emerges. This will require dynamic research efforts and consequential recommendations would essentially be dynamic in nature. They could be in the form of making EV only zones, protecting ecology and environment etc.

### *7 10 2Behavioural Patterns*

1. Research into usage patterns would provide recommendations on locations of charging stations.

2. These usage pattern could provide insight into future urban planning.

3. Also, through infrastructure planning, certain desired behavioural/usage pattern can be induced for the benefit of environment and urban control.

### *7 10 3Smart Monitoring*

1. Have a monitoring system for on and off the grid usage to point out hotspots.

2. V2V charging and two-way charging.

### *7 10 4Trucking Industry & Logistics*

1. EV policy can provide a window to development of a detailed national environmental protection policy regarding trucking industry and logistics. Such policy is critical, and recommendations can be provided to systematically reduce the emission by first collecting relevant data, then employing various technological measure in logistic operations to improve efficiency (systemic improvements) and reduce energy per tonne kilometre (litre/tkm), implementation of various onboard informatics in vehicle to encourage optimal operations, near-term vehicle efficiency measures, hybrid electric powertrain and finally battery operated fully electric powertrain. Thus, detailed EV policy regarding trucking industry and logistics can be a subset of this environment protection policy regarding freight transportation and will facilitate targets highlighted for heavy duty trucks in EV policy.

2. This policy can soon be developed and is not foreseen to have practical constraints. Its initial adaptation could be voluntary to minimize disruption.

## 7 11 Theme: New stakeholders

Following stakeholders would need to be brought in the EV ecosystem.

### *7 11 1Trucking Industry*

1. Recommendations to be prepared as part of environment protection policy regarding freight transportation with a focus to data analysis, systemic improvements, and electrification of drivetrain.

### *7 11 2Logistics*

2. Recommendations to be prepared as part of environment protection policy regarding freight transportation with a focus to data analysis, systemic improvements, and electrification of drivetrain.



### *7 11 3Services*

1. Conversion of Police / fire / ambulance / cleaning vehicles etc Either new EV or conversions of them

### *7 11 4Manufacturers*

2. 17% GST and 4-4.5% WHT must be brought down to 4% and 1% respectively

### *7 11 5Special Vehicle Categories*

1. Special vehicle system for personal carriers for the disabled and elderly must be investigated to provide registration to be operational in public areas where there are other people either pedestrian, or in vehicles

## 7 12 GLOBAL EV OUTLOOK REPORT

### *7 12 1Policy Insights*

1. Policy needs for a timely and sustainable transition to electric mobility require a wide array of measures and supporting actions. They must be adapted to specific market contexts. Plus, they must be adaptable as markets evolve to mass adoption of electric vehicles.

2. In the preliminary stages of EV deployment and diffusion, public procurement schemes (for instance, buses and municipal vehicles) have the double benefit of demonstrating the technology to the public and providing the opportunity for public authorities to lead by example. Importantly, they also allow the industry to produce and deliver bulk orders and initiate economies of scale.

3. Taxes that reflect the $CO_2$ content are important to ensure that the policy environment is conductive to increased EV uptake.

4. Fiscal incentives at vehicle purchase, as well as complementary measures that enhance the value proposition of driving electric daily (e.g., preferential parking rates,

5. road toll rebates and low emission zones) are pivotal to attract consumers and businesses to electric vehicles.

6. More comprehensive policies are critical to lay the foundation for a transition to electrification and to assuage stakeholders' uncertainties.

7. Increasingly stringent, technology-neutral regulations on tailpipe $CO_2$ emissions and mandates requiring that automakers sell a minimum share of zero- or low-emission vehicles are well suited for this purpose.

8. Policymakers will also need to set appropriate signals for charging infrastructure and grid service businesses to enable viable business models to emerge and to facilitate a smooth integration of EVs in power grid operations.

9. Approaches should be designed to reap maximum benefits from the available synergies of transport electrification with increasing supplies of variable renewables.

10. Changes in the regulations governing grid operations, such as allowing non-utility stakeholders to enter the charging services market (which is currently not permitted in several countries), can easily lift key barriers to innovation and investment.



11. National or local regulations targeting new or renovated buildings are also a prime resource to expand the EV-readiness of the building stock and to facilitate consumer EV adoption.

12. Foregone revenues from fuel taxation will call for alternative tax approaches. Taxation based on vehicle activity (e.g., distance-based pricing) is well suited to recover funds needed for investments and maintenance of transport infrastructure, to give a price to the emission of local pollutants – based on their impact on health and the environment, and to reduce traffic congestion.

13. The uptake and widespread diffusion of EVs does not come without long-term social, sustainability and natural resource implications.

14. Clearly defined and respected norms and requirements for traceability are needed across the battery supply chain.

15. Regulators can play a significant role in setting minimum standards related to labour and environmental conditions, and in developing effective instruments to ensure that they are properly enforced. Regulatory frameworks shall not only be targeting the EV battery materials supply chain, but also the end-of-life and material recycling processes, with the aim to facilitate cost reductions for battery recycling and to maximise the residual value of batteries at the end of their useful life.

## 7 13 Theme: Trucking Industry and Logistics

The increase in oil demand and $CO_2$ emissions means that the importance of road freight transport for key energy policy goals, such as energy security and environmental protection, is likely to grow moving forward. Reducing future growth of oil demand from road freight vehicles is a challenging, but possible task.

1. Systemic improvements in road freight operations and logistics can reduce growth in road freight trucking activity and improve the on-road efficiency of truck operations. Near-term examples include using Global Positioning System to optimise truck routing.

2. Driver training and the use of on-board, real-time feedback devices that monitor the on-road fuel economy of trucks.

3. Adopting a wide range of measures to improve the utilisation of vehicles to maximise load.

4. Other measures, including autonomous trucks or the "physical Internet" – an open, shared, and modular system wherein all physical assets used in goods delivery are shared across companies – could transform the road freight operations entirely, but face higher barriers to implementation.

5. Similarly, many vehicle efficiency technologies pay back their higher capital costs through fuel savings within only a few years.

6. For the existing stock of trucks, aerodynamic retrofits can reduce the drag coefficient and lead to reductions in road load; and low rolling resistance tyres can translate into immediate improvements in fuel economy.

7. For new trucks, additional technologies exist for reducing idling and for improving vehicle efficiency, such as the use of lightweight materials and improvements to truck engines,



transmissions, and drivetrains. However, some of these opportunities have longer payback times than operators tend to consider when purchasing new trucks.

8. Finally, the use of alternative fuels and alternative fuel trucks could help achieve key energy and environmental policy goals, such as diversifying the fuel supply of road freight and reducing $CO_2$ and air pollutant emissions. Natural gas, biofuels, electricity, and hydrogen are the main alternatives to oil, but they differ in the extent to which they can contribute to policy objectives.

Three key enablers that present opportunities from an energy policy perspective, one for each category of potential improvements:

a. Adopting policies targeting vehicle efficiency, including fuel economy standards and differentiated taxes on vehicle purchase. The two policies complement each other: the former regulatory policy ensures that all new truck sales achieve minimum efficiency performance, and the latter fiscal measure favours the best performing models, pushing further improvements. For Medium Freight Trucks (MFTs) and Heavy Freight Trucks (HFTs) taken together, the fuel use per kilometre of new vehicle registrations needs to be progressively reduced by 35%, compared to a 2015 baseline, by 2035. Once heavy-duty fuel economy policies are in place, their stringency needs to be successively raised, accounting for cost reductions delivered by technological progress.

b. Supporting widespread data collection and information sharing: Data gathering, and information sharing are key prerequisites to realising some of the potential that underlies systemic improvements of freight logistics, including the sharing of assets and services. Policy makers should take a proactive role in supporting data collection and sharing platforms by promoting closer collaboration among all stakeholders, including government, citizen groups and corporate actors operating across the supply chain. Toward these ends, public policy can be built.

c. Promoting the deployment of alternative fuels and the vehicles that use them: The use of alternative fuels requires different policy involvement, depending on the fuel in question (natural gas, biofuels, electricity, or hydrogen) and the state of technological maturity. Their deployment typically requires support across four areas: RT&D, market uptake of alternative fuel vehicles, adequate access to charging or refuelling infrastructure and the availability of alternative fuels.

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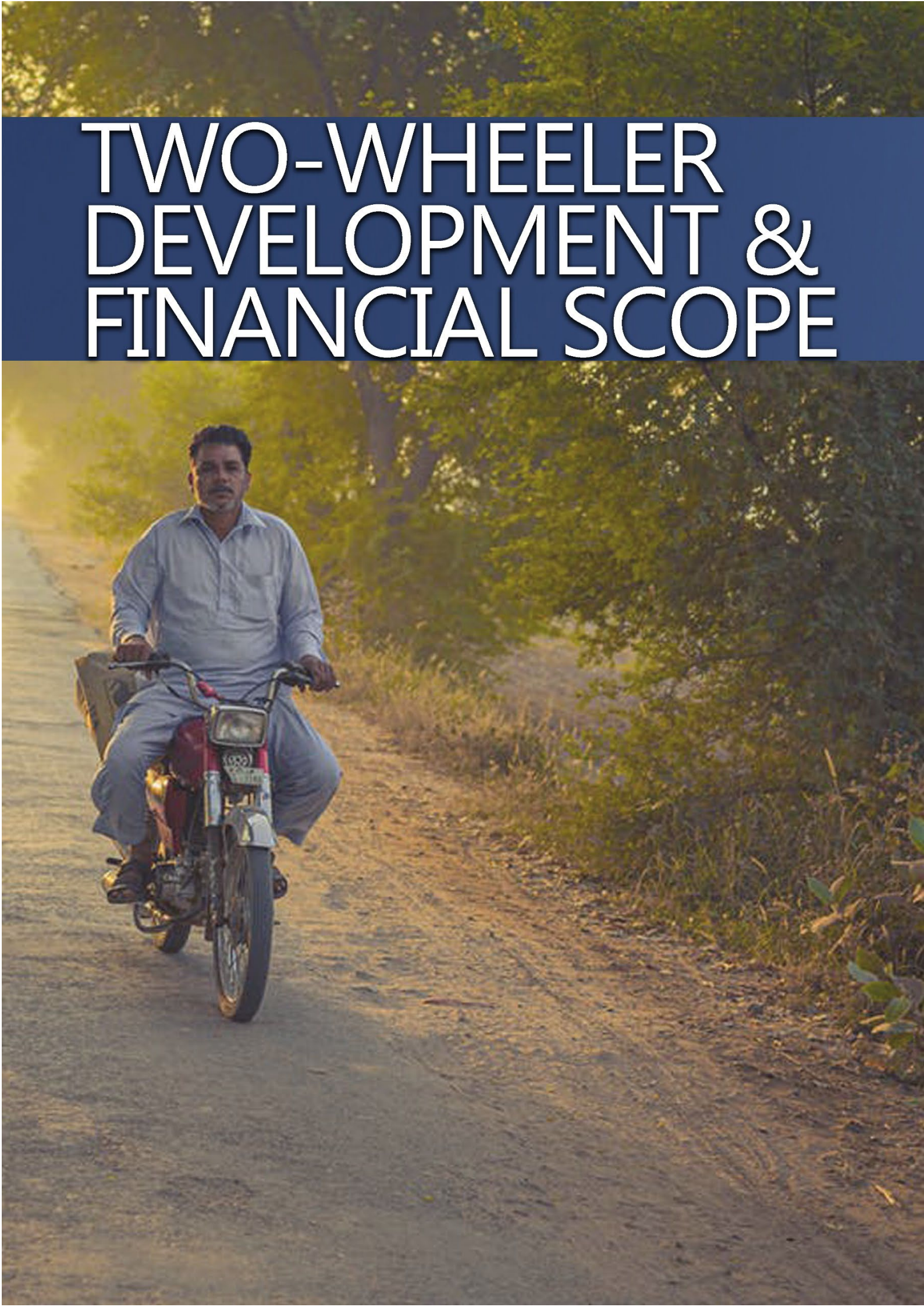
# TWO-WHEELER DEVELOPMENT & FINANCIAL SCOPE

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2020-2030

# 8 FINANCIAL INSTITUTES – SCOPING 2-WHEELED NEW AND RETROFITTED VERSIONS

## 8 1 BACKGROUND – EV 2-WHEELER DEVELOPMENT

As part of the scoping study, action on financial subsidies, incentives, and financing of EVs was a key topic to be discussed with financial institutes. This was not just conducted with banks, but with private investment groups and governmental officials. Some of which are mentioned in the list in the next section.

To drive home the concept, a complete study on 2 wheeled EVs was conducted (both for BEV and HYBRID variants) for new vehicles, conversion retrofitting kits, and running the vehicles.

This project/study has been an Integrated Engineering Centre of Excellence, University of Lahore, and Aliera ltd (UK) funded and collaborated effort with initial research funding given to the University of Lahore from the Higher Education Institute

The main outcome from the complete project have been the list below that has been broken down into three layers: 1. Market perception and survey from different types of motorcycle end users. 2. Scoping with Financial institutes on the potential to fund leasing of motorcycles, and its impact. 3. Technical development, and development costs, barriers for manufacturers, importers, logistics and government incentives (if any).

1. MARKET PERCEPTION AND SURVEY
    - Average motorcycle ride per day (in Lahore) distributed over type of rider
    - Acceptance of Electric or Hybrid Motorcycles
    - Show to potential users and asked their opinion on the specifications of the vehicle (is it fast enough, strong enough etc)
    - Show EV kits and vehicles to potential users and ask for an opinion on the price they are willing to pay for the vehicle. (This is a similar questionnaire as that for the field survey of the 3-wheeler)
2. FINANCIAL INSTITUTE SCOPING
    - Cost savings of running a motorcycle – Leasing EV / Hybrid motorcycles. A plan on financing EV vehicles
    - Specification requirements that would help in financing vehicles
3. TECHNICAL BARRIERS
    - Cost of Development of vehicles in Pakistan
    - Importing costs – Battery packs etc
    - Difficulty in importing components (even with the incentive of 1% duty for local manufacturers)
    - Development time
    - Specifications that can be developed within Pakistan.
    - Help if any, from the government in incentives
    - Development of a local manufacturing facility in Pakistan
    - Price of the actual retrofitted kit that is sustainable in Pakistan



- Development of all technical components in Pakistan to reduce import requirements and their costs

## 8 2 MARKET PERCEPTION

To understand the market segment, a survey was conducted with over a hundred motorcycle owners to find out information regarding the type of work they do, the milage they travel, and the main purpose of travel. This market was segmented into a classification that has been developed on that developed by the Pakistan Bureau of Statistics (PBS).[34]

*Table 13 Claimed Milage over market segment of 2 Wheeled vehicles*

| Profile (Extended from PSLM[34] classification | Examples of type | %age of total (Estimated) | Claimed milage per day (km) | Main reason for travel |
|---|---|---|---|---|
| Professionals | managers, college professors. | 4.3% | 40 | work trip / social |
| Students | Students | 10.0% | 60 | trip to College / Social |
| Assoc Professionals | nurses, schoolteachers, trade brokers | 4.7% | 50 | work trip / social |
| Clerks Sales | office clerks, cashiers, restaurant workers, shop salesperson. | 14.0% | 70 | work trip / social |
| Skilled Workers | killed Agri and fishery workers, craftsmen, mechanics, factory plant and machine operators | 28.8% | 60 | work trip / social |
| Unskilled Workers | labour, street vendors, building caretakers, janitorial workers | 16.8% | 80 | work site / equipment purchase |
| Logistics | Delivery / Transport service | 5.6% | 120 | logistics |
| Traders | Shop vendors and small shop owners | 15.2% | 80 | Shop Logistics |
| non-professional travel | Enthusiast | 0.6% | 20 | road trip / social |

A breakdown percentage of the segments was verified by that of the PBS statics[35]. That was used to develop the example operating conditions of 80km (in point 1.) previously.

To ask about opinion on the specifications, two motorcycle prototypes (one electric and one hybrid) were developed by IECE and shown to motorcycle riding public on the streets.

*Figure 27 Electric and Hybrid Bikes used for Scoping Study developed by IECE*

[34] https://www.pbs.gov.pk/content/labour-force-statistics
[35] Ghani, Jawaid. (2014). The Emerging Middle Class in Pakistan: How it Consumes, Earns, and Saves. KSBL Working Paper.

The following graphs show the perception of several specification areas such as performance and top speed, ride and handling being better, same, or worse than that of current Petrol Engine vehicles (Honda CD 70 which is the host vehicle for the Kits) We can see from the graphs that both EV and Hybrid vehicles had the same or better performance perception when it came to specifications.

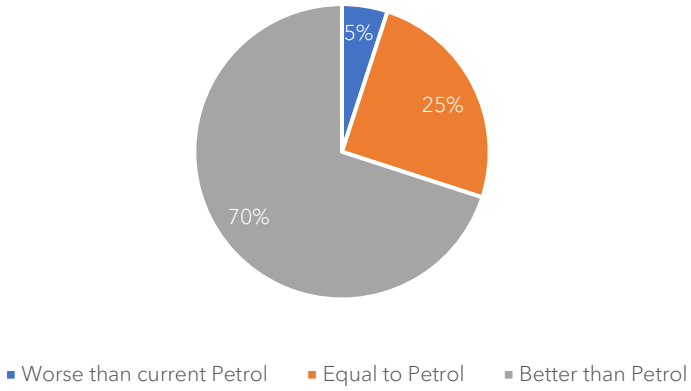


*Figure 28 EV - Performance Acceleration / top speed*

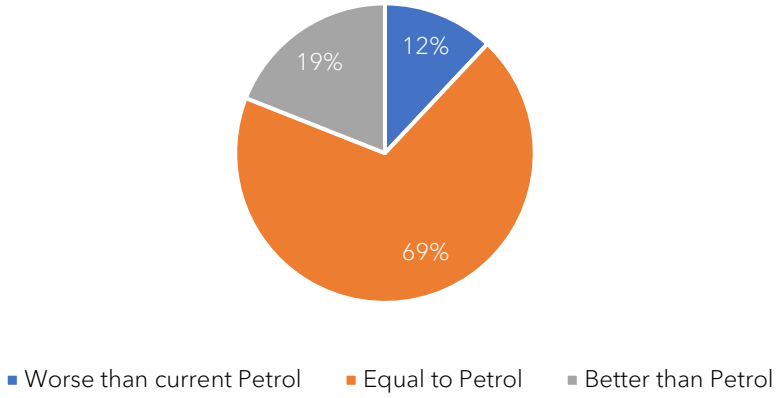


*Figure 29 Hybrid - Performance Acceleration / top speed - petrol mode*

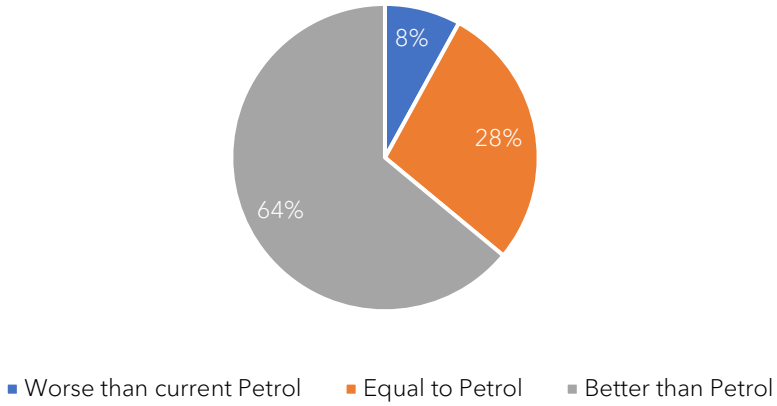


*Figure 30 Hybrid - Performance Acceleration / top speed - charging mode*



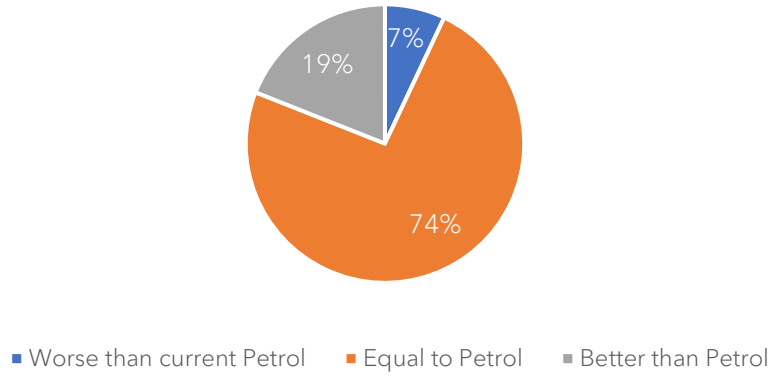


*Figure 31 Electric - Ride and Handling perception*

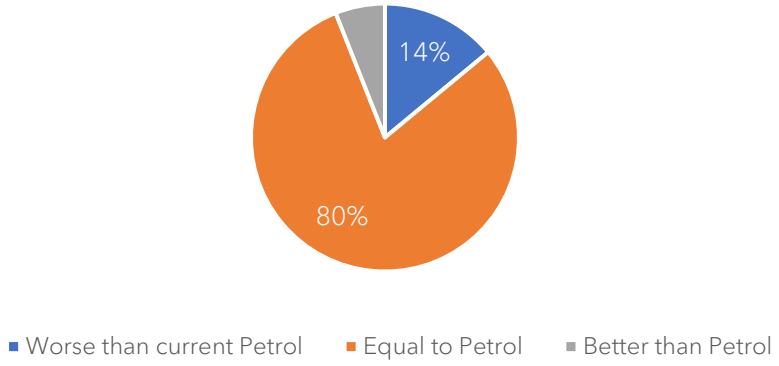


*Figure 32 Hybrid - Ride and Handling perception*

The price points were also scoped by the participants. They were told the upfront cost of the kit and explained the savings. The need to pay an upfront cost is daunting in the current climate even when the savings are explained to them. 64% and 72% participants claimed the upfront cost too high, and not affordable. The future savings was not factor into the decision.

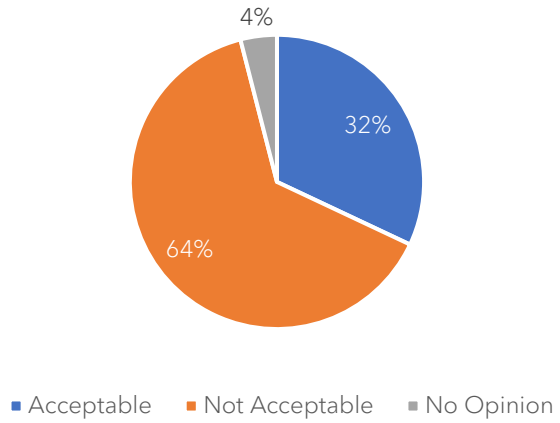


*Figure 33 EV Kit Price Point (as an upfront cost)*



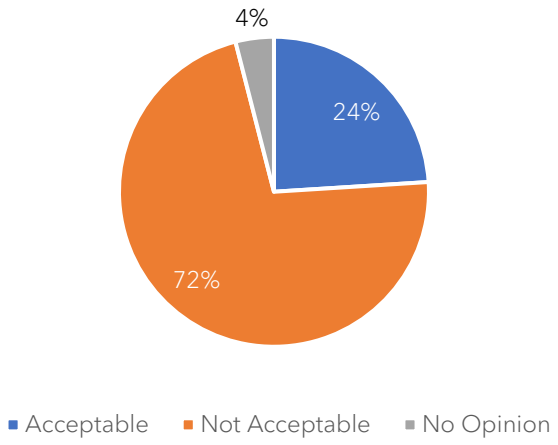


*Figure 34 Hybrid Kit Price Point (as an upfront cost)*

On a leasing plan, It was explained that the total cost per month would be nearly half that of petrol, basically having the kit pay itself back right from day 1. This was seen more favorable and acceptable to convert to Electric rather than staying on Petrol. The figures can be seen in the next section.

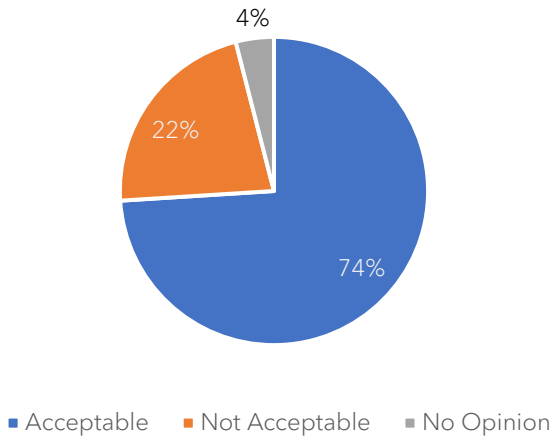


*Figure 35 EV Kit price point leased (less than running costs)*

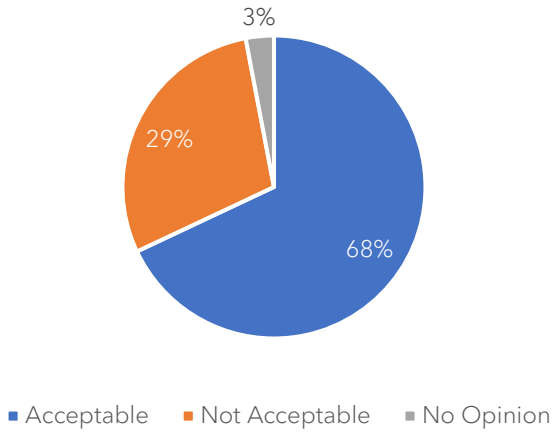


*Figure 36 price point Hybrid Kit leased (less than running costs)*



For the acceptance of the vehicles on how it looks, or its acceptability in public, the perception of Hybrid and Electric bikes were very different. The Hybrid vehicle looks exactly like a Petrol motorcycle as all extra components are well hidden; the EV has been modified in renders (as seen in the image below) to cater for the larger battery size and thus has a better acceptance amongst the younger sector of professionals, students, associate professionals, enthusiast, and skilled workers.

*Figure 37 Hybrid completely hidden design vs Electric Vehicle highly Stylized Design*

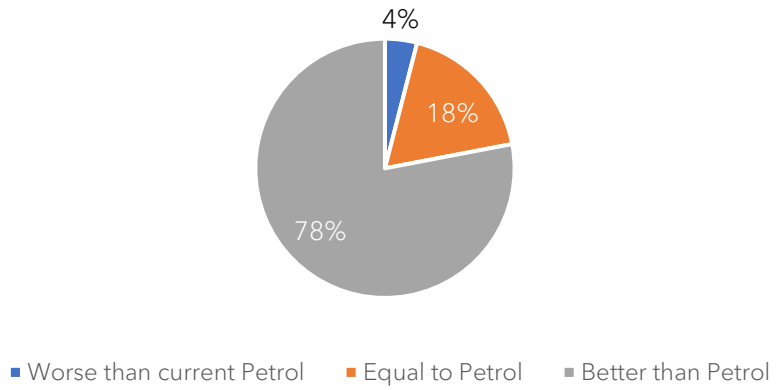


*Figure 38 Electric - Acceptance / Social acceptance*

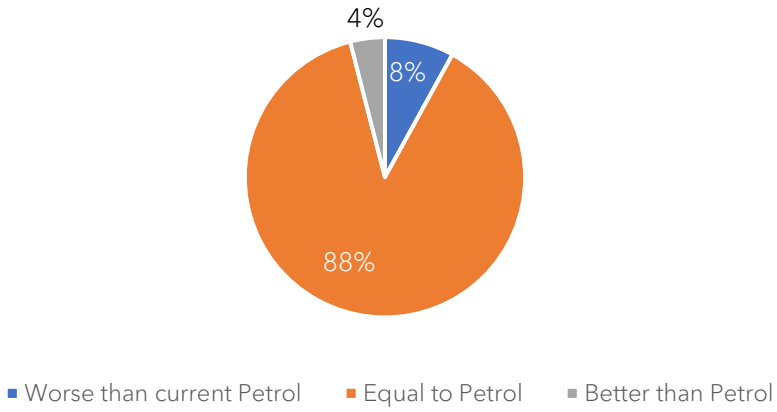


*Figure 39 Hybrid - Acceptance / Social acceptance*



The study acknowledges that quite a sizeable number of motorcycles buyers are the emerging M-Class (emerging middle class & Lower middle class) motorcyclists. The average income in Pakistan has increased from Rs3,862 per earning person per month in 1999 to Rs18,136 per earning person per month in 2019, which represents a growth rate average of 8.0% per year; with an inflation rate of 7.4% per year, the inflation-adjusted growth is 0.6% per year for the past two decades[36] They will go with the second-hand motorcycle market and are more accepting of kit systems rather than new motorcycles. The rest of the market buys motorcycles which is around a 1.2 million market every year in Pakistan.

## 8 3 FINANCIAL INSTITUTE SCOPING

The second segment of scoping was one to one discussion with financial institutes, (investment banks, venture capitals, startup accelerators and policy makers) on the general acceptance of EVs on a leasing platform. The list of the institutes talked to are listed in the section 9. A summary of a particular leasing plan is given as below in the two tables. (This is modified as of June 12th, 2022, to add in the increased cost of petrol at PKR209, the increased cost of electricity on-grid, solar panel systems, of the components, and all taxes and import duties required) that covers the costs, potential price plans and specifications. This is based on the 80km running range. Two scenarios are seen where just the vehicle is leased, or the vehicle is leased with a complete charging kit (with an extra battery)

*Table 14 Operating conditions / specifications*

| | | | |
|---|---|---|---|
| Total distance travelled per day | 80 | Km | |
| Cost of electric Units | Rs 9.68 | per unit† | † 1 Electric Unit is 1KWh |
| Monthly cycle | 30 | days | |
| Current petrol price | Rs 209.00 | per litre | As of June 12th, 2022 |
| Fuel efficiency - petrol engine | 55 | Km/L | (CD 70 Specifications) |
| motorcycle financing rate | 18% | ‡ | ‡ Rate 3 above Kibor rate (June 12th) |
| Deposit Requirement | 15% | § | § Set by the Bank. Aim is to get this to Zero with Govt Initiative guarantees |
| Financing period | 3 | years | |

*Table 15 Petrol vs Hybrid vs Electric Motorcycle Costing*

| | PETROL | HYBRID | ELECTRIC | units |
|---|---|---|---|---|
| Range Per Charge | - | 54 | 80 | Km |
| Total Cost of Plug-in charging per day | - | Rs 8.71 | Rs 17.42 | per day |
| Cost of Fuel Required per day (for charge or running) | Rs 304.00 | Rs 34.58 | - | per day |
| Total cost of maintenance (engine plus engine running) per month | Rs 1,397.52 | 678.24 | - | per month |
| Total cost per month plus maintenance | Rs 10,517.52 | Rs 1,977.00 | Rs 522.72 | per month |
| Total Savings per month over petrol | Rs 0.00 | Rs 8,540.52 | Rs 9,994.80 | per month |
| loan payment of kit per month (3 years) | - | Rs 3,511.95 | Rs 4,444.43 | per month |
| Total cost per month (plus kit repayment) | Rs 10,517.52 | Rs 5,488.95 | Rs 4,967.15 | per month |
| Total Savings per month over petrol including the cost of the kit | Rs 0.00 | Rs 5,028.57 | Rs 5,550.37 | per month |
| Cost of kit plus extra battery and solar powered charging at home | Rs 10,517.52 | Rs 6,404.62 | Rs 7,289.41 | per month |

[36]https://profit.pakistantoday.com.pk/2020/09/19/how-big-is-the-pakistani-middle-class/#:~:text=Let%20us%20start%20off%20with,average%20of%208.0%25%20per%20year.



| | | | | |
|---|---|---|---|---|
| Cost saving of charging household appliances on solar (hours averaged over Pakistan daylight) when not charging battery | - | Rs 464.64 | Rs 766.66 | per month |
| Total Savings per month over petrol including repayment of kit, and charging kit | Rs 0.00 | Rs 4,577.54 | Rs 3,994.77 | per month |
| Time taken to recover cost of kit | | 11.9 | 12.6 | months |
| Time taken to recover cost of kit and charging kit | | 14.6 | 16.6 | Months |
| Total Cost per month (when charging with charging kit at home) | Rs 10517.52 | Rs 572.76 | -Rs 766.66[37] | Per month |

In both scenarios, for both EV and Hybrid motorcycles, at the high-cost point of petrol, not only the cost of leasing the vehicle, but of the charging can come within the cost of petrol spent per month. The time it takes to recover the cost of the kit is around 1 year as a standalone, and less than 16 months with the charging kit as well. Ultimately after ownership of the kit, the total cost for the Hybrid will be Rs572 per month for Hybrid, and in fact, will create electricity worth Rs766 for Electric. (The total time for battery charging is 4 hours. The rest of the 4 hours can be used to run a household burden of 660W.

### *8 3 1 Update in the Petrol Price*

Currently, the subsidies on petrol have been removed and the current price of petrol has been increased to PKR233.89 starting 16th of June 2022.[38]

Under this scenario, the total cost for riding the FFV motorcycle at 80km goes up by PKR1100 per month widening the gap between running costs of petrol and EV and Hybrid Vehicles.

*Table 16 Updated Petrol vs Hybrid vs Electric motorcycle costing (17th June)*

| | PETROL | HYBRID | ELECTRIC | units |
|---|---|---|---|---|
| Total cost per month Plus maintenance | Rs 11,603.63 | Rs 2,100.54 | Rs 522.72 | per month |
| Total Savings per month over petrol | - | Rs 9,503.08 | Rs 11080.91 | per month |
| Total Savings per month over petrol including the cost of the kit | - | Rs 5,991.14 | Rs 6,636.48 | per month |
| Total Savings per month over petrol including repayment of kit, and charging kit | - | Rs 5,540.10 | Rs 5,080.88 | per month |

The main outcome of the survey with financial institutes was positive on having a policy that is constant and would not restrict the influx of EV and Hybrid Motorcycles. Part of the discussion was on the feasibility of motorcycles being based on the value-added requirements in the EV / Hybrid systems. The following requirements are a major part of both EV and Hybrid vehicles:

- A system that would have complete aftersales diagnosis, service, parts replacement, all within Pakistan without fluctuation in the import market
- A system that can track trouble / problems
- A system that would be able to make the average distances travelled on a single charge, with the opportunity to travel even further with both charging / swappable batteries.
- A system that can be trackable, and traced for the financial entity to be able to retrieve its asset

[37] Money is net positive, so saving from household bill as well due to solar charging
[38] https://www.geo.tv/latest/422643-petrol-price-reaches-record-high-of-rs23389-in-pakistan



- A distributed network that makes it easy to acquire / service / charge these vehicles.
- A distributed for sharing battery systems that can be swappable / charged

## 8 4 TECHNICAL BARRIERS

These specifications, including the cost of the vehicle, its development and suitability of being built in Pakistan have been scoped by IECE's technical development team under commercial scenarios. Jolta has already been able to sell 10,000 motorcycles in 2021 under similar conditions. The cost of EV retrofitting was developed by the IECE technical development team for EV kit development.

The main outcome of this complete survey will be published as a separate scoping paper as part of future work.




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# NATIONAL EV STAKEHOLDERS ALLIANCE


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# 9 DEVELOPMENT OF A NATIONAL ALLIANCE

Several one-on-one consultations and three EV demonstrative seminars have been conducted over the duration of the study to scope interest in the EV industry, and confirmation of data developed during the NEVP analysis. IECE has developed a program to induct all members into a stakeholder's club or alliance. There are 21 sessions of questions on the current situation on Electric vehicles, policy, and the automotive and energy sectors in general. Most of the members in the list below of all the stakeholders that were consulted, have pledged to be part of a Stakeholders club / National Alliance. With two former PAPAAM Chairmen on board, major 3 and 2 Wheel EV OEMs, the next phases would be to disseminate the concept of collaborative development and placement within an EV ecosystem. Some of the meetings and seminars can be seen within the collage below.


*Figure 40 Workshop on Environmental Policy Analysis with GCU Sustainability Group at the Botanical Gardens*


*Figure 41Main Stakeholders Club Launch by IECE (Technical teams called GLISTAR)*

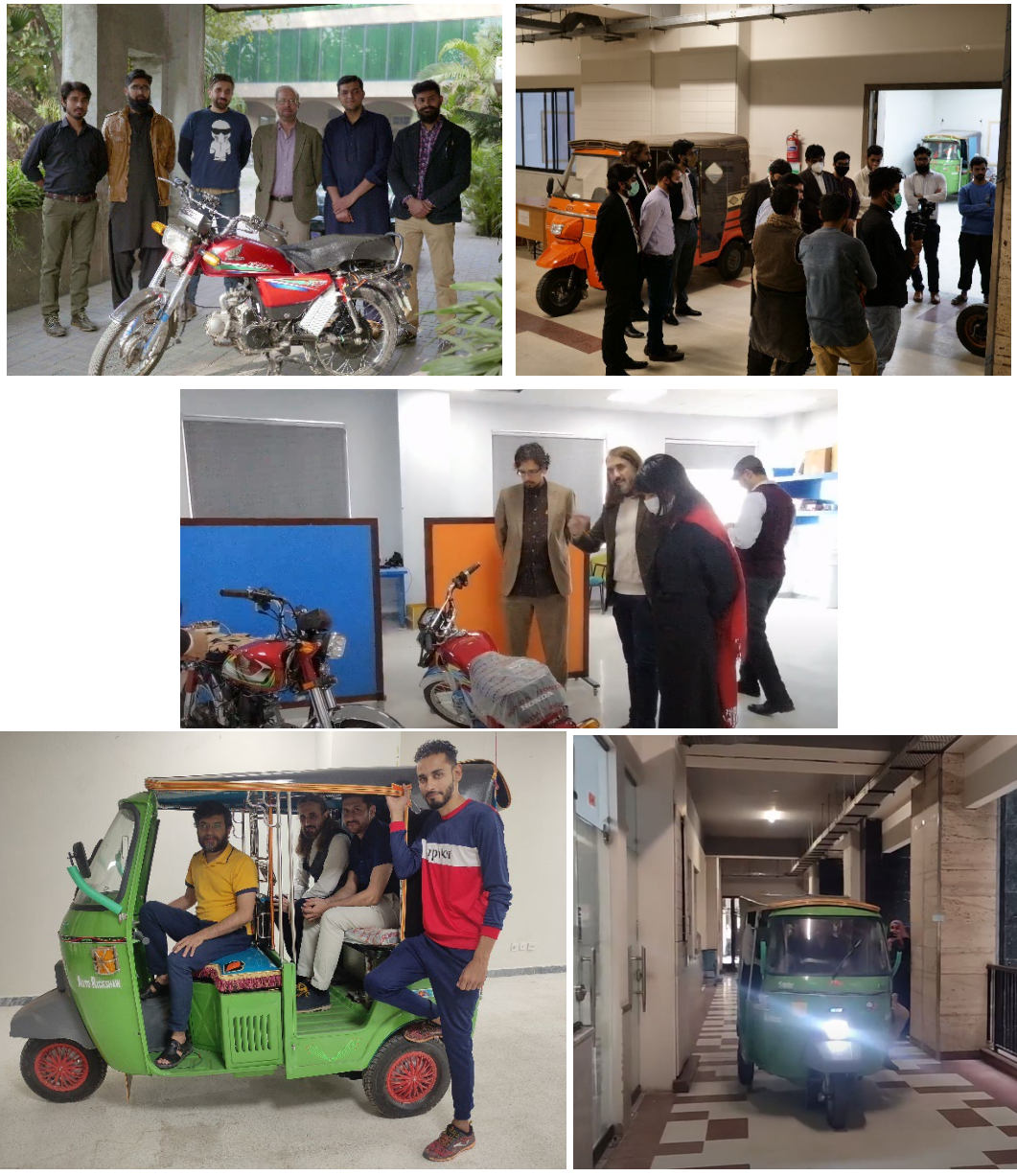

*Figure 42 Various Demonstrators / Meetings with stakeholders (with 2 and 3 wheelers)*

*Figure 43 Seminars where Hybrid Vehicles were presented*



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*Table 17 List of Stakeholders contacted for the Scoping*

| No. | NAME | AFFILIATION | MAIN PLAYER |
|---|---|---|---|
| 1 | Abdul Razzak | CEO Infinity Engineering | Tier Supplier |
| 2 | Abdul Wahid | CEO Pak China Motors | OEM |
| 3 | Adil Mansoor | Chairman Excel Engineering | Tier Supplier |
| 4 | Ali Irfan Najam | 47 Ventures | Investment / Banking |
| 5 | Atif Hassan | Dev Manager Ford Motor Company, USA | OEM |
| 6 | Ashfaq Khokhar | Manager Sandberg LLP UK | Technology Developer Supplier |
| 7 | Brig. Dr. Nauman | Heavy Industries Taxila | OEM |
| 8 | Col Aqil Ahmed Khan | Colonel Pakistan Army | Networking |
| 9 | Dr Abdul Sattar | UofL Dean Engineering | Research And Development |
| 10 | Dr Amin U Khan | Prof GCU Sustainability Centre | Policy Development |
| 11 | Dr Faiz Ul Hassan | Prof University Of Central Punjab | Technology Developer Supplier |
| 12 | Dr Ishtiaq Hussain | UofL Director Oric | Networking |
| 13 | Dr Kamran Ali Chatha | Strategic Sector Research LUMS | Policy Development |
| 14 | Dr Khizar Hayat | Assoc Professor UofL | Research And Development |
| 15 | Dr Noor Sheikh | Electrical Engineering, GCU Lhr | Networking |
| 16 | Dr Zeeshan Rafique | UofL Industry 4.0 | Research And Development |
| 17 | Firoz Khan | CEO Omer Jiban Ex PAPAAM Chair | OEM |
| 18 | Ghulam Hussain | New Asia | OEM |
| 19 | Haroon Mehmood | Senior Executive Volta Battery | Tier Supplier |
| 20 | Imran Mughal | Asst Prof UofL Automobile Design | Research And Development |
| 21 | Issam Khan | Investment banking Habib Bank | Investment / Banking |
| 22 | Irfan Chaudhry | Jolta, Director Marketing | OEM |
| 23 | Khurram Zafar | Executive 47 Ventures | Investment / Banking |
| 24 | Mumshad Ali | MD Rk Gears – Ex Chairman PAPAAM | Research And Development |
| 25 | Nadeem Ahmed Malik | GM Pakistan Ordinance Factory | Tier Supplier |
| 26 | Nadeem Dar | Imperial College, London | Research And Development |
| 27 | Nauman Ahmad Zafar | Executive Director NeuCel / LUMS | Research And Development |
| 28 | Naeem Abbas | Greenery Ltd UK | Tier Supplier |
| 29 | Nasir Mahmood | UofL - Pro Rector Academics | Policy Development |
| 30 | Rehan Sheikh | NESCOM | Technology Developer |
| 31 | Saad Amjad | University of South Florida | Policy Development |
| 32 | Salman Gaba | 47 Ventures | Investment / Banking |
| 33 | Sher Azam | EVMotorcycle | OEM |
| 34 | Simon Tyler | Centurion Electronics UK | Tier Supplier |
| 35 | Tauseef Riaz | MashKraft Canada | Investment / Banking |
| 36 | Umer Zafar Ullah | Lahore | Policy Development |



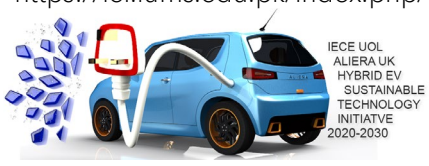
| | | | |
|---|---|---|---|
| 37 | Waheed Sohail | KAPKO | Tier Supplier |
| 38 | Ejaz Minhas | C100 Think Tank | Policy Development |
| 39 | Umer Ayub | Transaction Network Services UK | Investment / Banking |
| 40 | Zain Qureshi | C100 Think Tank | Policy Development |
| 41 | Zain Maulvi | Alternative Law Collective | Policy Development |

A second group on a mailing list worked on the USAID panel (of which IECE was also part) this has been created by LUM. This group has been meticulously developed and contacted by Dr Naveed Ashraf and Nauman Zaffar of the LUMS Energy and policy group for the Pakistan: Electric vehicles and batteries market Assessment study sponsored by USAID[39]. A complete list of this group is listed below are all EV stakeholders which will be invited to the National EV alliance group

| Contact Name, Organisation, Weblink |
|---|
| 1 Shaaf A. Mehboob Adaptive Technologies https://adaptive-tec.com/about/ |
| 2 Shahab Raza Raja AEI-Tek http://www.aei-co.com/ |
| 3 Tauqir Lodhi AGL Supply Chain (Pvt) Ltd www.agl-sc.com |
| 4 Ashar Afzal Ahmed Fine Weaving http://www.ahmedfine.com/mv.html |
| 5 Abdul Manan AMZ Internationals https://amzinternational.com/ |
| 6 Ali Ahmad Minhas Army Welfare Trust https://www.awt.com.pk |
| 7 Mian Shaukat Shafi Asian Development Bank https://www.adb.org/ |
| 8 Rizwan Majeed Ather Technology http://www.athertechnologies.com/ |
| 9 Mansoor Jamil Atlas Battery Ltd. http://www.atlasbattery.com.pk/ |
| 10 Sadullah Ejaz Atlas Honda Limited https://www.atlashonda.com.pk/ |
| 11 M. Faisal ur Rehman AUTOCOM https://autocom.com.pk/ |
| 12 Mansoor Lashari Barq Box https://barqbox.com/ |
| 13 Ahmad Khan Cheetay https://cheetay.pk |
| 14 Dr. Aazir Khan Cyber Drive/IECE https://uol.edu.pk/iece/ |
| 15 Benjamin Brink DEG https://www.deginvest.de/International-financing/DEG/ |
| 16 Awais Jalai Designit http://designit.com.pk/ |
| 17 Almas Haider EDB http://engineeringpakistan.com/ |
| 18 Muffi Ghadiali Electriphi https://www.electriphi.ai/ |
| 19 Rana Tauseef Iqbal Electrum Motors |
| 20 Omer Mukhtar Energi by Matra https://www.energi.com.pk/ |
| 21 Adnan Nasir Euro Oil Limited https://www.euro.com.pk/ |
| 22 Tauqeer Hassan Khan FFC https://www.ffc.com.pk/ |
| 23 Bakhtiar Agha Fuel Motion Inc. http://fuelmotioninc.com/ |
| 24 Nabeel Ilyas GFC Fans https://www.gfcfans.com/ |
| 25 Muhammad Ayaz Green Wheels Pvt. Ltd |
| 26 Waqas Moosa Hadron Solar (Pvt) Ltd. https://www.hadronsolar.pk/ |
| 27 Feroz Arshad Hills Enterprise |
| 28 Jahanzaib Burana Hoopoe https://myhoopoe.com/ |
| 29 Tanzeel ur Rehman Indus Electric https://induselectric.com.pk/ |
| 30 Murtaza Zaidi INER-Z https://iner-z.com/ |
| 31 Michael Grundke Inventus Power https://inventuspower.com/ |
| 32 Munir Raza Waris IRTIKAZ Solutions http://irtikaz.com/ |
| 33 Omer Ayub Izhar Izhar Group https://izhar.com/ |
| 34 Shiomi Masahiro JICA https://www.jica.go.jp/pakistan/english/index.html |

[39] https://lei.lums.edu.pk/index.php/pakistan-electric-vehicles-and-batteries-market-assessment/





35 Omer Khokar JOLTA Electric https://www.joltaelectric.com/
36 M. Khalid Mushtaq KAN Energy https://kanenergy.com/
37 Majir Munir Karakorum Capital Partners
38 Hassan Daud Butt KP-BoIT http://kpboit.kp.gov.pk/#sthash.phUR6fvF.dpuf
39 Pervaiz Iqbal LESCO http://www.lesco.gov.pk/
40 M. Ali Lotia Lotia Engineering https://lotiaeng.com/
41 Atiq Qasim MAQ International https://www.maqint.com/
42 Shakeel Ahmed Meer Mega Electric https://megabikes.pk/step-1-mega-bikes
43 Ahmad Majeeb Khan Mentor Graphis Pakistan https://www.mentor.com/company/
44 Ammar Khalid MG Motors https://mgmotors.com.pk/
45 Malik Amin Aslam MoCC http://mocc.gov.pk/
46 Shibli Faraz MoST https://most.gov.pk/
47 Nauman Saeed MTI http://www.mtilimited.com/
48 Saad Bin Hammad n4business https://n4business.com/index.html
49 Sardar Mohazzam NEECA https://neeca.gov.pk/index
50 Tauseef Farooqi NEPRA https://www.nepra.org.pk/
51 Muhammad Salman NeuBolt http://neubolt.com
52 Khurram Ali Ilyas NeuWat http://neuwat.com
53 Khawaja Haris Nadeem OptoElec
54 Sajjad Nasim Orient Energy System https://www.orient-power.com/
55 Suneel Surfarz Manj Pakwheels https://www.pakwheels.com/
56 Mashood Khan PAPAAM https://www.paapam.com/
57 Sohail Qadri PBIT http://www.pbit.gop.pk/
58 Syed Kazmi PEPSICO https://www.pepsico.com/
59 Tariq Khan Piranha Company http://www.piranhacompany.com/
60 Shah Alam PLUM Qingqi Motors http://qingqi.com.pk/
61 Talha Gorsi QUALCOMM https://www.qualcomm.com/
62 Fahad Iqbal Ravi Motors http://www.raviautomobile.com/
63 Naveed Nazir SabzTek http://sabztek.com/
64 Bilal Juadet Ahmed Sapphire-BYD https://www.sapphiremills.com/sapphire-group
65 Zubair Aamir Sazgar Engineering Works http://www.sazgarautos.com/
66 Moiz A. Khan SB- Entrack/SyedBhais http://entrack-sb.com/
67 Farman Lodhi Solis Energy Solution https://solis-energy.com/
68 Sajid Ali K. Tareen SoluNox https://solunox.com.pk/
69 Adeel Gohar Sunra EV http://sunraev.pk/
70 Shaukat Qureshi SZS's EV Auto Division https://www.zias.com.pk/
71 Mohyuddin Khan Teleport https://teleport.com.pk/
72 Dr. Afnan Ullah Khan TELSEC CORP http://www.telseccorp.com/
73 Aamir Hussain Tesla Industries (pvt) Ltd. http://tesla-pv.com/
74 Mehmet CelePoglu Total Parc Pakistan http://www.totalparco.com.pk/
75 Syed Shahryar Ali Treet Group https://treetgroup.com/
76 Usman Manzoor UNDP https://www.undp.org/
77 Bilal Hussain VISCELERATE Mobility
78 Badar ur Rehman Volvo Pakistan http://vpl.com.pk/
79 Dr. Bilal Siddique Woot Tech https://woot-tech.com/
80 Said Dahdah World Bank https://www.worldbank.org
81 Rehan Aslam ZOX Cell https://www.zoxcell.com/
82 M. Faheem Ashraf ZUES Energy https://www.zeus.com.pk



The stakeholders' group from table 16 has been categorised into 7 diverse groups that can be seen below. Together, these groups create the new ecosystem for Electric vehicles to develop and promote the EV industry. A complete breakdown of these roles at various levels is part of future studies tying them to the different layers which include a policy layer, Economics Layer, Social layer, Regulatory Layer and Environment layer (explained in the next section)

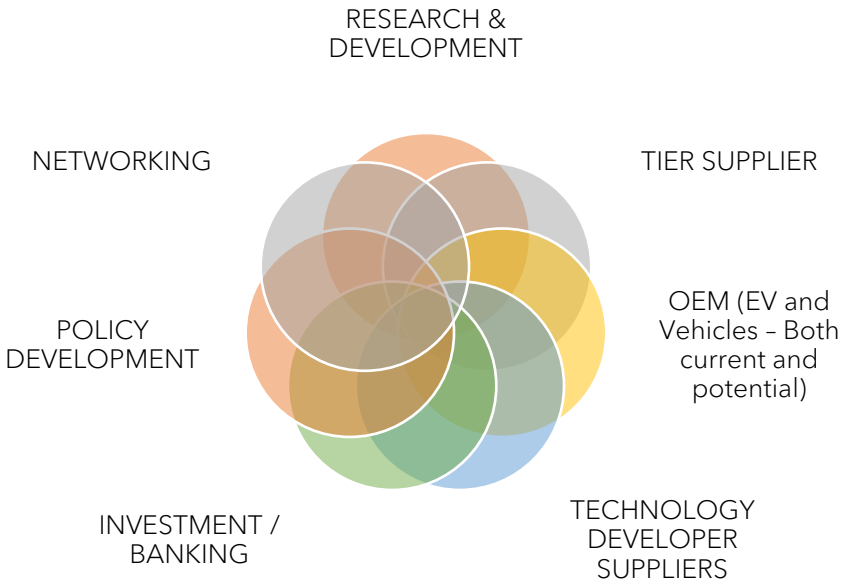
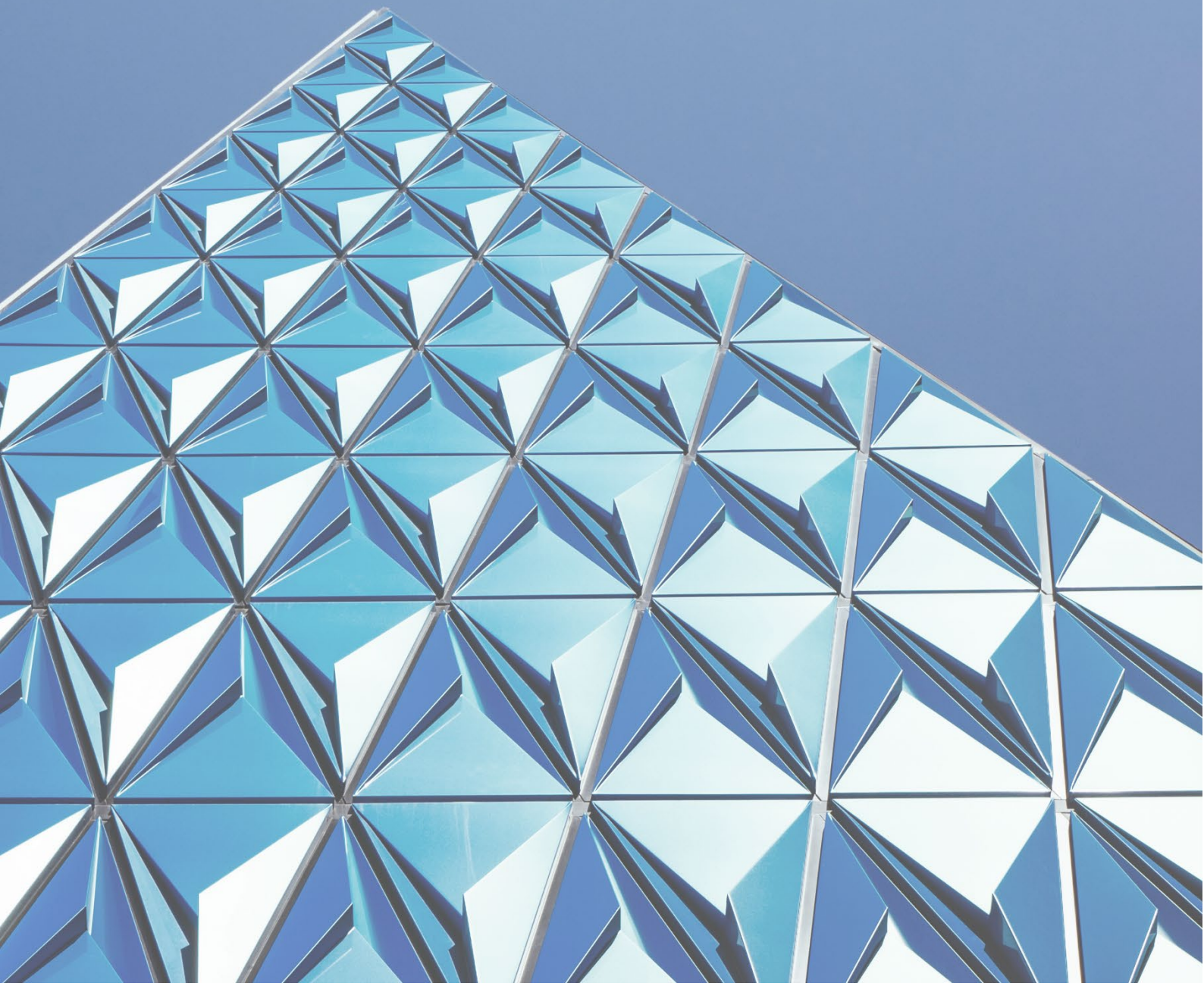



*Figure 44 EV Stakeholders collaboration as an ECO-SYSTEM*

# FUTURE STEPS 2-3 YEARS

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# 10 FUTURE STEPS 2-3 YEARS TIMELINE

## 10 1 Ecosystem Development & Stakeholder Placement

There is a need to develop a holistic electric vehicles ecosystem that is divided into policy layer, vehicle specifications layer, economics layer and auxiliary infrastructure layer. The next steps proposes the development of an electric-vehicles ecosystem (hereafter called the EV ecosystem), with the following components.

### *10 1 1Policy layer*

We emphasise the addition of stakeholders other than just importers and assemblers to include local developers, financing institutes, buyers, and the environment and energy sectors. Furthermore, new stake holders will be affected by the addition of Electric vehicle polices include industries that are reliant on transportation, logistics and essential services. Therefore, the following propositions are made:

Formation of an EV Department which oversees the technical, financial, and regulatory mechanisms related to the imported, locally assembled and indigenously manufactured electric vehicles and electric vehicles technologies

Promoting indigenous technology development in Pakistan through academic-industrial linkages which will not only improve the socioeconomic status of the public, but also lead to the realization of green jobs

Development of environmental standards for vehicles through formulation of a Pakistan-focused Urban drive cycle against which vehicles can be tested

### *10 1 2Economics Layer*

The cost of electric vehicles, specifically cars, is currently quite high, which leads to affordability issues faced by the middle-income social strata. Therefore, financing facilities are required if electric vehicles are to be promoted. The following interventions can take place:

Our research on three-wheeler vehicles suggest that users are willing to buy it through a financing mechanism, usually independent corporations, and private lending institutions, even if the cost of the vehicle is twice as that of regular vehicle. This owes to the fact that the fuel and maintenance cost of three-wheelers takes up to 45% of the total monthly earnings; therefore, a mechanism can be devised that not only provides financing at concessional rates, but also gives away solar panels and charging kits.

The retrofitting of existing vehicles with electrical systems can be a novel exercise for Pakistan in which the old and eco-burdening engines can be retired. The carbon emissions saved through this exercise can be used to gain carbon credits, which is an untapped opportunity for Pakistan.

Tax rebates have already been put in place; however, they need to be articulated further from a buyer's perspective. Over half of the states in the United States are using rebates, tax exemptions, and tax credits to motivate EV purchases. For instance, California offers rebates to light-duty zero emission vehicles and plug-in hybrid electric vehicles (PHEVs); low-income



families are eligible for an extra $2,000. Washington and New Jersey exempt EVs from motor vehicle sales and use taxes. Louisiana and Maryland provide tax credits of up to $2,500 and $3,000 per vehicle, respectively.

Pakistan can also follow the Chinese model of dual-credit policy, in which the vehicle manufacturers are assessed in terms of fuel consumption and EV production to qualify for new energy credits. To obtain these new energy credits, manufacturers will need to produce a minimum number of EVs, and the number of credits they receive will be based on factors such as driving range and EV weight.

### *10 1 3Environment Layer*

The environmental burden of transportation sector merits a holistic technologically intensive approach to identify the hotspots with the maximum contribution to GHG emissions. There are antecedent IOT based commercial and research Air Quality Index monitoring systems which have been operational with data that is available over a period of 5 years or more. This data can be correlated with weather conditions, seasons, and large-scale events. Through regression analysis we can create patterns and predict certain changes in the AQI index over a large scale (such as seasonal or event based) but we are no closer to pinpointing the actual controlling factors and numerics of regional AQI behaviour; the breakdown of precise contributing factors, the dynamics of the system and its controlling mathematical model and predicting models that can controlled through special control points that can be added to the model.

In this regard, the air quality monitoring system can be devised in which only electric vehicles are allowed to enter environmental hotspots.

### *10 1 4Regulatory Layer*

The regulations for electric vehicles must be developed for the case of Pakistan, and the following recommendations are proposed:

For an electric vehicle passive safety is extremely important and ensures that impact does not start a fire at vulnerable components such as the battery system, controllers, and wiring systems. With 3 wheelers being extremely specific to developing countries, Pakistan needs to develop its own safety standards and tests. In absence of such, safety can be provided by regulatory structural features and parametric constraints.

Appropriate cut-off systems (both manual and automatic) must be available in electric drivetrains for crashworthiness of electric vehicles. Shut down of controller systems, battery systems, and motor and braking systems must be monitored. The wheels must remain free after a major crash to allow removal. A manual override system in case of minor crashes also must be available to allow the vehicle to be operatable again.

Development of a system for availability of spare parts and a transfer of technology (ToT) to local SMEs to develop the products to avoid failure due to unreliable supply chain and quality of components. This ToT must be available even when components are imported to allow a free market allowing local vendors to develop the technology while its being imported.

Weather testing of the vehicle for its running in extreme conditions. We can have a minimum of -25°C and maximum of 60°C. However, in the presence of direct sunshine later can easily



increase and at components level with heat generated by systems, harshness tolerance levels are to be redefined for fitness to automotive applications. Standardization of IP (Ingress Protection) code/rating required for various electrification components to promote local RTD (research and technology development) and import of safe and robust components. Electric fire is a major hazard for electric vehicles.

Standardize range based on suitable driving cycles for each vehicle type. Development and standardization of driving cycles representing local each vehicle type. Development and standardization of driving cycles representing local

driving patterns for each vehicle category is critical and need to be employed by OEMs for vehicle range and efficiency (km/kWh) specification to empower the buyer. For light duty vehicles, cycles like NEDC (New European Driving Cycle) and WLTC (Worldwide harmonized Light vehicles Test Cycles) can be used as a starting point.

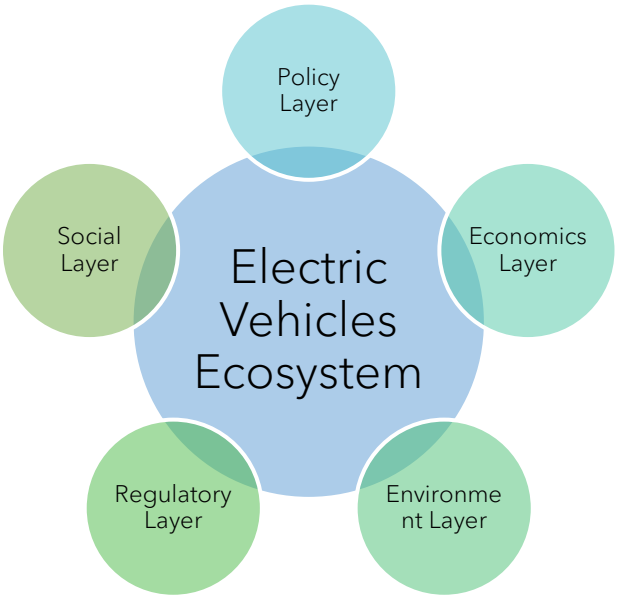


*Figure 45 Electric vehicles Ecosystem*

## 10 2 Retrofitting Technology with Emphasis on Networked Distributed Ecosystem

Against a backdrop of ever-increasing number of vehicles on roads and the environmental burden these vehicles carry, it is imperative to introduce interventions that lead to a sustainable transportation system. In this regard, retrofitting of existing vehicles with electric motors and electric systems is a terrific opportunity that needs to be explored.

As mentioned in previous sections, not only to increase the number of new cars sold to be zero emissions, but to increase the percentage of market penetration of EVs in total in Pakistan.

In 2019, there were 23,588,268 vehicles in Pakistan. The average annual growth rate since 2004 is 4.8%. To achieve 30% EVs by 2030, 11.85M electric vehicles must be sold vs 4.06M

IC vehicles. (74% electric to 26% IC), a near impossible task. By retrofitting old vehicles, the distribution changes to 11.85M retrofitted to 15.98M IC sold (42% retrofitted vs 58% IC sold) which is achievable at a much lower cost (retrofitting at average 25% cost of a new vehicle). Adding new OEM EVs to the mix, a 10.06M(46%) IC, 5.92M(27%) EV and 5.92M(27%) retrofitted distribution can be achieved.

The technologies required for the development of retrofitting vehicle systems are based on new vehicle technologies developed over the past 20 years. This is a combination of EU funded research and technology developed in the UK, Italy, Germany and the US, and HEC funded Hybrid and Electric vehicle technology development in Pakistan These include the following headers:

1. The electronics technology:
    a. PCB and PLC based electronic control systems, drivers, battery management system, power splitting systems and vehicle control which have been developed specially for Pakistan by a consortium of University of Lahore, Integrated Engineering Centre of Excellence, CyberDrive Pvt and Aliera UK) These have been funded by HEC, UOL, and Aliera to the tune of $1.5M
    b. Controllers for vehicle Air quality index monitors, developed at UOL, IECE through UOL and Aliera sponsored engineering projects also monitored by the Ministry of Climate change, GIZ, UNDP and IOT, GPS, tracking and interconnectivity developed by Imperial College London and SAAB (PhD research project) at $480K.
2. An AI based supervisory controller system that supervises the on-vehicle controllers, and the networked infrastructure. This system was developed first through an EU consortium, Ayton Willow, DENSO (Germany), Cranfield U, Kings College London worth $3.2M and an AI framework control developed at Technical University Hamburg with Air Bus, and BMW.
3. Vehicle hardware implementation for design of modular vehicle systems through EU projects PICAV ($3.0M) vFeather ($3.2M) and EcoVolve ($230K) at the University of Genova (Italy) with INRIA (France) and Dublin City University funded by enterprise Ireland.
4. Development of a hybrid RPM7 system developed by Aliera UK and IECE, that incorporates an automotive project development plan, (Developed by Centurion Electronics UK), advanced product quality planning (Developed by Ford Motor company (Detroit) US, Volvo Sweden) Mercedes (Germany) and OEM development network programs. (Ford Motor company APQP PPAP systems were lectured, and an implementation plan was given to the University of Lahore in 2019 by Ford development team members)
5. An automotive CE and UNC certification-based testing plan and test facilities developed by Nokia (Finland) and Centurion Electronics (UK) These testing facilities are being developed at UOL and IECE.
6. Environment Policies, EV vehicle policies sustainability

The interconnectivity of all these systems can be seen in the figure. All OVA and VHS technologies are implemented directly on the vehicle, and all IFC and ONDP technologies are part of interconnectivity of the vehicles and collecting data, analysis, regulation, policy, and final dissemination.



All these technologies are under development in Pakistan; with the help of the consortiums at various stages of development they will be part of an implementation plan for the Pilot project. A larger consortium of members with advisors and consultants from the Ministry of Climate Change, Energy, Transportation, Science and Technology will be involved, and stake holders such OEM developers, Universities and research organisations will be part of the structure, some already mentioned above, and some developed through newer MOUs.

Level 1 development includes self-imposed policy development aspects, regulation, and standardisation on the project, and the stake holders. Level 2 Also includes project and implementation planning, KPI development and data collection, analysis, intervention, and dissemination. Level three is pure developmental aspects including those of lower-level project planning. Each stakeholder will know its exacting role in the pilot project.