

Impact of E-mobility Transition on Jobs

A Case Study of Jaipur, Rajasthan



Impact of E-mobility Transition on Jobs

A Case Study of Jaipur, Rajasthan

Published by



Consumer Unity & Trust Society

D-217, Bhaskar Marg, Bani Park, Jaipur 302016, India

Tel: +91.141.2282821, Fax: +91.141.2282485

Email: cuts@cuts.org, Web site: www.cuts-international.org

Citation

CUTS International (2020), Impact of E-mobility Transition on Jobs:
A Case Study of Jaipur, Rajasthan

Supported by:



Authors



Sarthak Shukla
Assistant Policy Analyst
ssk@cuts.org
CUTS International



Trinayani Sen
Senior Research Associate
tns@cuts.org
CUTS International



Aman Raj
Research Associate
amr@cuts.org
CUTS International

Cover Picture Courtesy: www.dreamstime.com

This report has been published under the project entitled, 'Exploring the Impact of E-mobility Transition on the Jobs Ecosystem in Jaipur, Rajasthan'. The material in this publication may be reproduced in whole or in part and in any form for education or non-profit uses, without special permission from the copyright holders, provided acknowledgment of the source is made. The publishers would appreciate receiving a copy of any publication, which uses this publication as a source.

CONTENTS

<i>Reflections</i>	5
<i>Acknowledgement</i>	6
<i>Abbreviations</i>	7
<i>Foreword</i>	8
<i>Executive Summary</i>	9
1. Introduction	13
2. Literature Review	17
Futuristic Transport: India's EV Vision	18
Linkages between Mobility and the Jobs Ecosystem	18
The E-mobility Jobs Ecosystem	19
EV and the Workforce: Potential Job Losses and Gains and their Attributes	21
3. Approach and Methodology	23
Literature Review	24
Stakeholder Mapping and Development of Interview Guides	24
Tools and Methods of Data Collection: KIIs and Field Inquiries	24
Ethical Considerations	26
Limitations of the Study	26
4. Key Findings and Analysis	27
From Source to Sink: Mapping the Automotive Value Chain	28
Mapping Stakeholder Perceptions: Building the Dynamic Automotive Ecosystem	29
The Process-Stakeholder Grid	34
Exploring the Potential of EVs: Trends, Targets and Carbon Footprint	35
Linking Emissions and EVs on the Road	39
Linking E-mobility with Jobs: Estimation of Impact on Jobs in Jaipur City	44
Impact of Electric Mobility Transition on Facets of Jobs in Jaipur, Rajasthan	50
5. Way Forward	57
Annexure I: Emission Calculator	61
Annexure II: Data Tables for Vehicles and Jobs related Estimations	67
Endnotes	68



List of Figures and Tables

Figures

1. Key Findings: Quantum of Potential Job Losses and Gains Due to E-Mobility Transition in Jaipur	10
2. Key Findings: Emerging roles and roles that will be phased out due to transition from ICE to EV	11
3. Automotive Ecosystem	19
4. Components of an EV Ecosystem	19
5. Process flow in an Automotive Value Chain: ICE Vehicle and EV	28
6. Automotive Ecosystem from the perspective of Manufacturers	30
7. Automotive Ecosystem from the perspective of Dealerships	30
8. Automotive Ecosystem from the perspective of Charging Infrastructure Providers	31
9. Automotive Ecosystem from the perspective of Fleet Aggregators	31
10. Automotive Ecosystem from the perspective of Driver's Union	32
11. Automotive Ecosystem from the perspective of Industry Associations	32
12. Automotive Ecosystem from the perspective of Mobility Research Organisations	33
13. Process-Stakeholder Grid	34
14. ICE Vehicle Registration in India	35
15. Electric Vehicle Registration in India	36
16. Transport Sector Emissions: Current and Projected Trends	37
17. Potential Trend of EVs for achieving state EV targets: Uttar Pradesh	38
18. Potential Trend of EVs for achieving state EV targets: Kerala	39
19. Potential Trend of E-buses for achieving EV targets: Delhi	39
20. Scenario-wise Number of EVs Required in India	42
21. Segment-wise ICE to EV conversion required in Jaipur: INDC Scenario	44
22. Employment Estimates in Pre-Manufacturing Process	45
23. Employment Estimates in 2-W Auto Manufacturing Process	46
24. Employment Estimates in 3-W Auto Manufacturing Process	47
25. Employment Estimates in 4-W Auto Manufacturing Process	48
26. Employment Estimate due to Fuel Pumps Transition	49
27. Net Employment Estimates for EV Transition in Jaipur City by 2030	49
28. Engine of Growth	50
29. Comparison of Labour Costs	51
30. Share of Labour Cost for Electric 3-W (Estimation by Interviews)	51
31. Women Workforce in Indian Automotive OEMs	54

Tables

1. Category-wise Breakup of the key stakeholder Interactions	25
2. State Level EV Targets	38
3. Results of the Emission-linked EV Targets	41
4. Scenario-wise Comparison of EV Vehicles Required (India)	42
5. Segment-wise ICE to EV conversion required in Jaipur: INDC Scenario	43

REFLECTIONS

The biggest opportunity for emerging economies is to seize opportunities for sustainable development such as electrified and digitised transport, to deliver BETTER services. However, that poses a challenge for employment too. Managing both is a governance issue, which I am sure such evidence-based studies as conducted by CUTS International, will help policy makers to balance in a sustainable manner.

Suresh Prabhu

*India's Sherpa to the G7 and G20 Summit and
Hon'ble Member of Parliament, Rajya Sabha*

CUTS International is a crucial partner of Friedrich-Ebert-Stiftung (FES) India's work on energy transformation. They bring a 360-degree view on the issue tying up global, national and local debates. The present study by CUTS deals intelligently, comprehensively and understandably with the many and varied problems that are associated with the transition to e-mobility. This means not only a technological lane change, but e-mobility also means deep cuts in the current socio-economic structures. With this research study, the FES and CUTS make an important contribution to the socio-political discussion on future environmental design with the associated implications in the areas of economy, technology, the world of labour and gender.

Wulf Lapins

Resident Representative, Friedrich-Ebert-Stiftung, India Office

There is a global call for recognising the need for and acting on sustainable growth and development. The Auto sector is fit for the purpose which is looking at an electrified and connected future. However, there is much speculation on how greening the economy may affect jobs in the years to come. Thus, the CUTS research report on identifying and creating localised jobs by fostering E-mobility at a city level (Jaipur, Rajasthan) is a torchbearer of this unified path of economic inclusivity and environmental sustainability.

Nitin Desai

President, Governing Council, CUTS Institute for Regulation & Competition

Technology can be an enabler, as also a disruptor. With technological advancements, traditional ways give way to new systems and techniques: this also calls for re-skilling and up-skilling, as new jobs are created. Uber too has used disruptive technology as an effective enabler, and has committed to become a fully zero-emission platform by 2040. This study by CUTS International offers insights into positive spin-offs of e-mobility in terms of new livelihood opportunities, and augurs well for both environment and economy.

Rajiv Aggarwal

Head of Public Policy, India SA, Uber



ACKNOWLEDGEMENT

This report is a result of the ideas, efforts and support of several people. Involvements in the form of direct inputs, brainstorming sessions, continuous guidance and encouragement and timely reviews have been crucial in the development of this report.

First and foremost, CUTS International acknowledges the contribution of all the stakeholders who have provided critical inputs which have shaped the study and the report.

We would also like to thank Aditya Ramji, Senior Manager – Economist, Mahindra and Mahindra Ltd, Mandvi Kulshreshtha, Program Adviser – Economy of Tomorrow, Friedrich Ebert Stiftung (FES) India, Anurag Shanker, Program Manager – Economy of Tomorrow, Friedrich Ebert Stiftung (FES) India, Radha Krishna Tripathy, Senior Fellow, CUTS Institute for Regulation & Competition (CIRC), Arpit Tiwari, Assistant Policy Analyst, CUTS International for their guidance in shaping the research methodology.

We would like to thank Arvind Mayaram, Economic Advisor to Chief Minister & Vice Chairman, Chief Minister's Rajasthan Economic Transformation Advisory Council, for writing an excellent foreword for the report.

We would also like to extend our heartfelt gratitude to Suresh Prabhu, India's Sherpa to the G7 and G20 Summit and Hon'ble Member of Parliament, Rajya Sabha, Nitin Desai, President, Governing Council, CUTS Institute for Regulation & Competition, Wulf Lapins, Resident Representative, Friedrich Ebert Stiftung (FES) India, and Rajiv Aggarwal, Head of Public Policy, India SA, Uber for providing encouraging endorsements for our report.

We are immensely grateful to Pradeep S Mehta, Secretary General, CUTS International, Bipul Chatterjee, Executive Director, CUTS International and Udai S Mehta, Deputy Executive Director, CUTS International for their continuous guidance and encouragement throughout the course of this study.

We also appreciate the efforts of Madhuri Vasnani for editing, Rajkumar Trivedi and Mukesh Tyagi for preparing the layout of this report. Akshay Sharma deserves special mention for his contribution towards coordinating the information dissemination activities.

Lastly, we are grateful to Friedrich Ebert Stiftung (FES) India, for their valued support to this study.

Finally, any error that may have remained is solely ours.

CUTS International



ABBREVIATIONS

ACMA	Automotive Component Manufacturers Association
AI	Artificial Intelligence
ARAI	Automotive Research Association of India
ASDC	Automotive Skill Development Council
CAGR	Compounded Annual Growth Rate
CEEW	Council on Energy, Environment and Water
EMBE	Electric Mobility Business Ecosystem
ET	Economic Times
EU	European Union
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of Electric Vehicles
GDP	Gross Domestic Product
IBEF	India Brand Equity Foundation
ICE	Internal Combustion Engine
ICT	Information and Communication Technologies
IEA	International Energy Agency
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contributions
IoT	Internet of Things
IT	Information Technology
MoP	Ministry of Power
NBFC	Non-Banking Financial Company
NCR	National Capital Region
NGO	Non-Government Organisations
NMT	Non-Motorised Transport
OEM	Original Equipment Manufacturer
PCS	Public Charging Station
PEV	Plug-in Electric Vehicle
RTO	Regional Transport Office
SIAM	Society of Indian Automobile Manufacturers
SMEs	Small & Medium Enterprises
SMEV	Society of Manufacturers of Electric Vehicles

FOREWORD

Dr. Arvind Mayaram, I.A.S. (Retd.)
Economic Advisor to Chief Minister &
Vice Chairman,
CM's Rajasthan Economic Transformation Advisory Council



Government of Rajasthan
G-27, Yojana Bhawan, Tilak Marg,
C-Scheme, Jaipur-302005 (Raj.).

Jaipur, dated 10th November, 2020

India is at the brink of a future which will be helmed by lower carbon footprints and increased digital footprints. The transformation is inevitable and already visible across diverse sectors of the economy, especially power and transport, globally. As the transport sector is one of the major contributors to the national carbon emissions, it is imperative for this sector to be one of the cogs on the wheels of transformation.

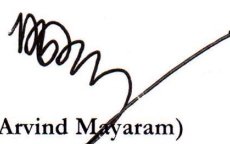
Electric mobility is the buzz word in the sector as different states across the country have formulated policies for promoting production and adoption of Electric Vehicles. Rajasthan, which is attaining newer heights in the clean energy space with initiatives such as the Rajasthan Solar Energy Policy 2019, is also making its headway into E-Mobility by promoting EV manufacturing through its Industrial Policy, 2019. Keeping the 30 percent by 2030 target, endorsed by the Chief Minister of the state, in mind and fast-tracking the coverage of EVs across the state, in my opinion, will place Rajasthan on the global green growth platform.

I feel that this could be achieved through concerted efforts of the state and private stakeholders on the basis of innovative partnerships. Another important stakeholder that needs to be included in this partnership are the owners and the ultimate end-users of EVs who are the actual proponents of the E-mobility revolution. For initiating this linkage, we need to focus on 'Just Transition' in the transport sector wherein E-mobility brings in newer job opportunities not only in auto manufacturing but also in allied sector such as digital technology and gig economy. This linkage between Public, Private and People will have a multiplier effect on employment generation in the state.

A Just Transition will also mean creating opportunities for the existing workforce in the auto sector or enabling them to upgrade their skills for adapting to the changes brought by the technological disruption, i.e. EVs. Skilling, re-skilling and up-skilling of labour for ushering in E-mobility will also be a fitting response for strengthening domestic capacities while remaining a strong multilateral player in the global economy. I can see E-mobility becoming the engine of green economic growth and transformation of the transport sector in the state of Rajasthan.

To this end, the CUTS Research Report, "Impact of E-mobility Transition on Jobs: A Case Study of Jaipur, Rajasthan" is a path breaking and an innovative attempt at linking environmental sustainability and economic inclusivity. It presents a very lucid analysis of how jobs can be created at a city level as we shift from petrol and diesel vehicles towards their electric counterparts.

Being a part of the state government's effort to economically transform the state, I commend Pradeep Mehta, Secretary General and the CUTS team for such path breaking research, which will form a critical input for informed policymaking that will shape the future of Rajasthan.



(Arvind Mayaram)

Tel.: (O) +91-141-2221996
PABX: 0141-2921168 Ext. 21168
E-mail: arvind.mayaram@rajasthan.gov.in

EXECUTIVE SUMMARY

A global transition is underway in the transport sector, as Internal Combustion Engine (ICE) vehicles get replaced by Electric Vehicles (EVs). As a result of the international discourse on sustainable development, the E-mobility transition is poised to open gateways for new business and livelihood opportunities. However, given the unique characteristics of the Indian labour force, it is envisaged that the impact will be different in this case.

The auto sector in India is characterised by a large proportion of informal jobs in medium and small enterprises.¹ A transition will entail losses in jobs across the formal and informal segments of the automotive ecosystem, which are exclusive to the ICE value chain as well as the addition of new roles based on the requirements of the EV value chain. Thus, the transition must be just, sustainable and inclusive.

In an attempt to understand what a just transition would mean in the context of the automotive sector in India, this study aims to explore the impact of E-mobility transition on the quantum of jobs in Jaipur city and their qualitative aspects, such as informality, gendered employment, and skills.

The rationale behind this study is to map the nodal stakeholders in the automotive ecosystem and gauge the job and skill dynamics of the transition from their perspective. To this end, a simultaneous mapping of automotive value chain processes and stakeholders has been carried out. The key processes considered for this study are raw material procurement, automotive component manufacturing, vehicle assembly and manufacturing, sales, operations, and end-of-life management.

It has been found that the ICE and EV value chain are similar to a large extent but have some key differences. Firstly, the manufacturing of EVs

requires 10 times fewer components as compared to ICE vehicles. Currently, most of the EV components are being imported from international suppliers, while the ICE vehicle supply chain is largely localised. Further, a high degree of vertical integration across the different processes of manufacturing is visible in the case of EV manufacturers who are mostly start-ups or small and medium enterprises (SMEs). Secondly, the key difference between the operations of the two kinds of vehicles is the refueling process where ICE vehicles require petrol or diesel and EVs require a power supply.

Based on these processes, seven major categories of stakeholders were identified and interviewed, i.e. manufacturers, dealerships, charging service providers, fleet aggregators, driver's unions, industry associations, and mobility research organisations. An ecosystem consisting of 26 diverse yet interlinked actors has been derived from the perceptions of the interviewed stakeholders. These actors interact directly and indirectly for functional and operational purposes. The juxtaposition of these processes and players leads to the conclusion that EVs should be viewed and treated as a component of the larger automotive ecosystem instead of being treated as an entirely separate and disjointed sector.

Along with stakeholder mapping, this study has also estimated the segment-wise EVs required at Jaipur city-level based on the carbon emission targets for India. The estimation has been carried out using a model calculator² wherein data on per vehicle emissions for ICE vehicles and EVs, transport sector emissions, and power generation mix have been used. Using INDC 2030 targets for carbon emission intensity as a benchmark and considering the current growth trajectory of ICE vehicles, it has been found that on average, 2.1 crore new ICE vehicles will need to be replaced by electric vehicles across India, to achieve the INDC emission target by 2030.



Similarly, for Jaipur city, 18.6 lakhs of new ICE vehicles will have to be replaced by EVs. Further, a comparison with India's current targets of 30 percent EVs by 2030 reveals that meeting the INDC targets by 2030 will require a much steeper trajectory of growth of EVs.

As a forward linkage, this model has also been used to estimate the potential of job creation if the INDC targets are adhered to. A process-wise estimation of potential jobs that can be added and that may be phased out has been made. The rationale behind adopting a process-wise approach is that the impact of EVs will be felt differently across different processes.

It has been found that the net employment generation in Jaipur city, due to the E-mobility transition, is approximately 46,425 jobs across the automotive value chain. At the same time the net employment loss, due to the redundancy or phasing out of various ICE vehicle-related processes, will be approximately 14,408 jobs. Thus, it can be deduced that the E-mobility transition will have a positive connotation on the job scenario at the city level, by generating a net of 32,017 jobs in Jaipur by 2030. (Refer to Figure 1)

Along with the quantum of job creation, the study also outlines the qualitative aspects of the jobs linked to the EV ecosystem (Refer to Figure 2). Stakeholder interactions have revealed that

component manufacturers are set to take a hit as a result of this transition, due to the redundancy of several components and the skills required to manufacture them. A similar fate is also envisaged for the informal repair and maintenance shops. Additionally, automation in vehicle manufacturing may cost certain skilled jobs such as assembly-line roles or painting of vehicles, while generating potential for supervisory roles. At the same time, automation may pave the way for the inclusion of women across different processes in the automotive work-force.

Consumer-interface jobs in dealerships and charging stations are less likely to be impacted by the transition, though they will require reskilling. On the end-user front, the income prospects for EV drivers and fleet aggregators seem optimistic given the low operating costs of the vehicles. However, the high upfront cost continues to remain a deterrent for EV uptake.

The study findings suggest that for a just transition, a focus on five key aspects will be crucial.

- First and foremost, rapid advances in technology will need to be strategically addressed.
- Secondly, the localisation of jobs in the pre-manufacturing and manufacturing processes will be critical for effective employment generation.

Figure 1

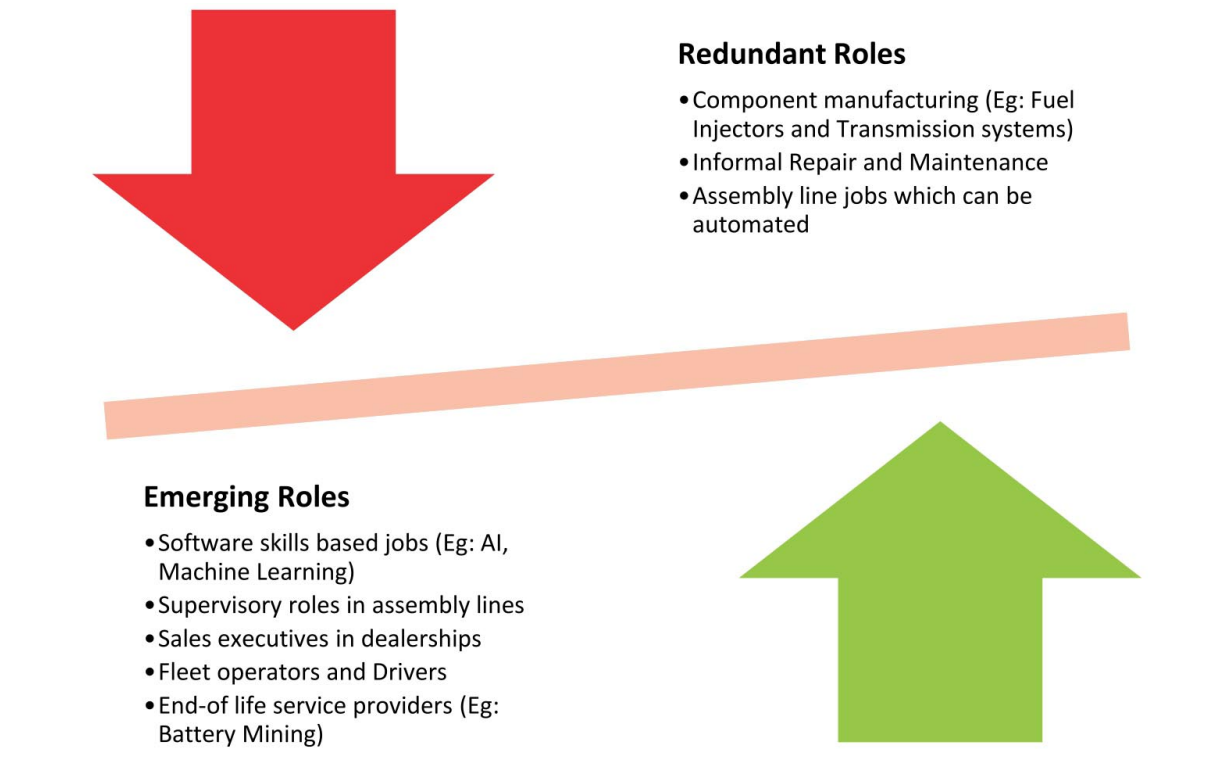
Key Findings: Quantum of Potential Job Losses and Gains Due to E-Mobility Transition in Jaipur





Figure 2

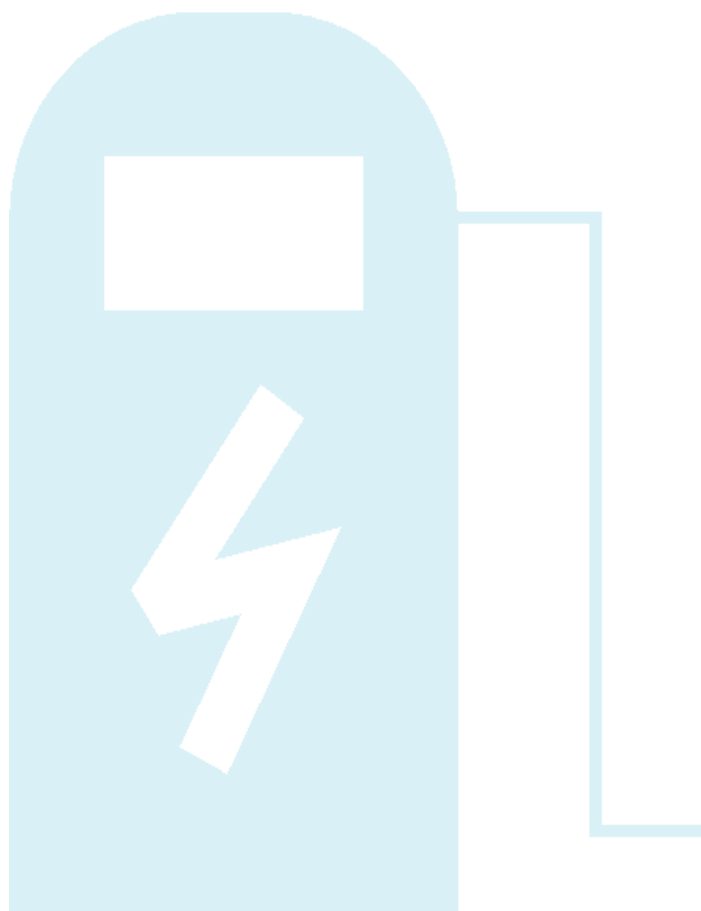
Key Findings – Emerging roles and roles that will be phased out due to transition from ICE to EV



- Thirdly, an enabling environment will need to be created for fostering the production and operation of EVs. This will also be instrumental in the creation of livelihood opportunities in manufacturing, sales, operations, and end-of-life services.
- Fourthly, a match between the jobs created and the workforce will need to be attained through appropriate skilling and reskilling initiatives.
- Finally, reducing gender disparities in the automotive ecosystem will result in a transition that is just and inclusive.



Impact of E-mobility Transition on Jobs – A Case Study of Jaipur, Rajasthan



1

INTRODUCTION





In the times of global discourse on sustainable development, lowering carbon footprints, and greening of the future, the shift to cleaner alternatives in terms of transport is imperative. A paradigm shift is imminent, given the role played by transport in an economy and the plethora of negative externalities on the environment and human health, associated with the use of traditional 'vehicles that operate on fossil fuels.

Electric mobility or e-mobility has been the chosen way forward in most of the developed countries and has also been gaining traction in India, supported by industries and the government. Furthermore, factors such as climate change, developments in renewable energy, rapid urbanisation, battery chemistry, and energy security, etc. have bolstered the adoption and development of EVs.³

This paradigm shift in modes of mobility may open the gateways for new business opportunities such as battery infrastructure, auxiliary service, and multi-modal integrated transport, amongst others. Therefore, it may lead to the creation of a novel job ecosystem.

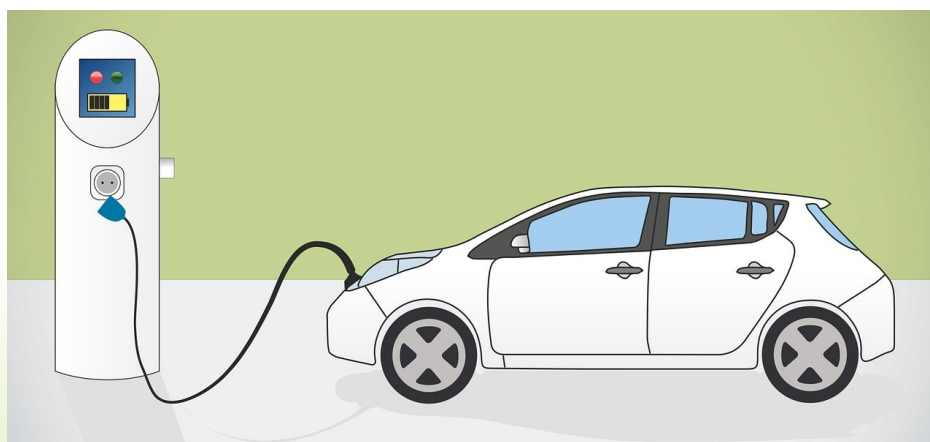
For instance, according to the study done by the European Climate Foundation⁴, with the advent of EV in the global market approximately 5 to 8.5 lakhs jobs would be created by 2030 in research & development. Besides, another study suggests that approximately 2 million jobs would be created in allied sectors, such as after-sales

services, electrical equipment, manufactured fuels, etc. by 2050.⁵

However, the impact of EVs would be different in the Indian job ecosystem – both qualitatively and quantitatively. This is primarily because of the unique characteristics of the Indian labour market, in general, and the auto sector labour force, in particular. The Indian workforce is characterised by a high degree of informality and its impact is prevalent in the auto sector as well. Approximately 50 percent of the workforce in the auto industry is contractual and informal.⁶ Thus, there is a coexistence of some large players and multiple small and medium units in the industry which indicates higher risks and reiterates the need for a just transition.

This report aims to provide an in-depth understanding of the need for just transition in the mobility space. It also aims to highlight the nature and quantum of job losses due to EV integration at the city level and the nature of jobs and skillsets required for an inclusive and just transition. Overall, the study deliberates upon the benefits for India from transitioning to low carbon mobility while discussing its importance in the context of climate change arising from transport infrastructure based on fossil fuels.

This research report is divided into four broad sections. The next section provides an overview of the secondary literature and sets the tone for the research. The section succeeding that details





the approach and methodology adopted for carrying out the research.

Finally, the fourth section discusses the key findings of the research. It is divided into seven subsections, each exploring a separate theme of analysis. The first sub-section focuses on mapping the processes in the automotive value chain. This is followed by the sub-section which attempts to bring out the perceptions of different stakeholders regarding the automotive ecosystem. The third sub-section, a culmination of the first and second sub-sections focuses on integrating the processes and the stakeholders in the ecosystem to provide a holistic picture.

Having defined the ecosystem, the objective of the fourth sub-section is to explore the existing trends and future potential of EVs. Following this, the report moves towards a quantitative analysis as the fifth sub-section projects the EV trends that will be required for India to meet its climate-related targets.

Subsequently, the sixth sub-section attempts to quantify the potential job losses and gains, at the Jaipur city level, which will be affected by a shift to E-mobility. Finally, the seventh sub-section highlights the impact of the E-mobility transition on the quality of jobs in Jaipur city.



2

LITERATURE REVIEW





Futuristic Transport: India's EV Vision

As the world prepares to take up e-mobility in the drive towards a sustainable future, India is also warming up to the idea of the transition. To ease out this transition, the Central Government has taken several initiatives, such as Faster Adoption and Manufacturing of Hybrid and EV (FAME)-I,⁷ FAME-II⁸ schemes and fiscal propositions in the Union Budget⁹ aimed at promoting e-mobility by providing financial incentives to the manufacturing sector and consumers.

Similarly, several state governments have also formulated EV policies¹⁰ out of which some have set up targets for employment generation and investments. For instance, Karnataka has set up a target for 55,000 jobs by 2024 and Tamil Nadu is aiming for 1.5 lakh new jobs due to the rollout of EV policy in the state.¹¹ The recently revamped Delhi EV policy aims to set up World Class Skill Centres (WCSC's) for skill training and facilitate livelihood opportunities through regular recruitment fairs.

Besides, the Central Government initiated the National Electric Mobility Mission Plan in 2013¹² which aimed to infuse approximately 7 million EVs on road by 2020 and convert approximately 30 percent of the total vehicle fleet in the country to electric by 2030. According to government estimates, to achieve such targets, the sector would create 10 million specialised jobs.¹³ The government's Automotive Mission Plan¹⁴ 2016–26 also envisions approximately 65 million direct and indirect employment opportunities to be created in the automotive sector over the next decade.

To give e-mobility a further boost, the Government of India has introduced the National Mission of Transformative Mobility and Battery Storage in March 2019, which will create and implement strategies for transformative mobility. Further, a Phased Manufacturing Programme for EVs and their components will be launched.¹⁵

Linkages between Mobility and the Jobs Ecosystem

The critical difference between an ICE vehicle and an EV lies in the powertrain¹⁶ of the vehicles. The key components of an ICE powertrain are a gas tank, engine, transmission, and driveshaft, while an EV power train, which has 60 percent lesser parts compared to ICE, consists of a motor, a controller, and battery.¹⁷

Thus, the transition from ICE vehicles enabled transport systems to battery-operated EVs is a complex one that involves multiple sectors and stakeholders. One of the crucial aspects of this is the integration of e-mobility into the existing localised transport frameworks, local livelihoods, and job market to smoothen the transition and minimise the impacts on the stakeholders involved.

At the outset, the process requires significant transformations in automobile manufacturing, electricity supply, power electronics, IT, transport infrastructure, transport service providers, and allied sectors. This will lead to a disruption in the existing workforce in these sectors due to the potential redundancy of certain existing jobs and skills and at the same time a need for new jobs and skills to facilitate a holistic transition.

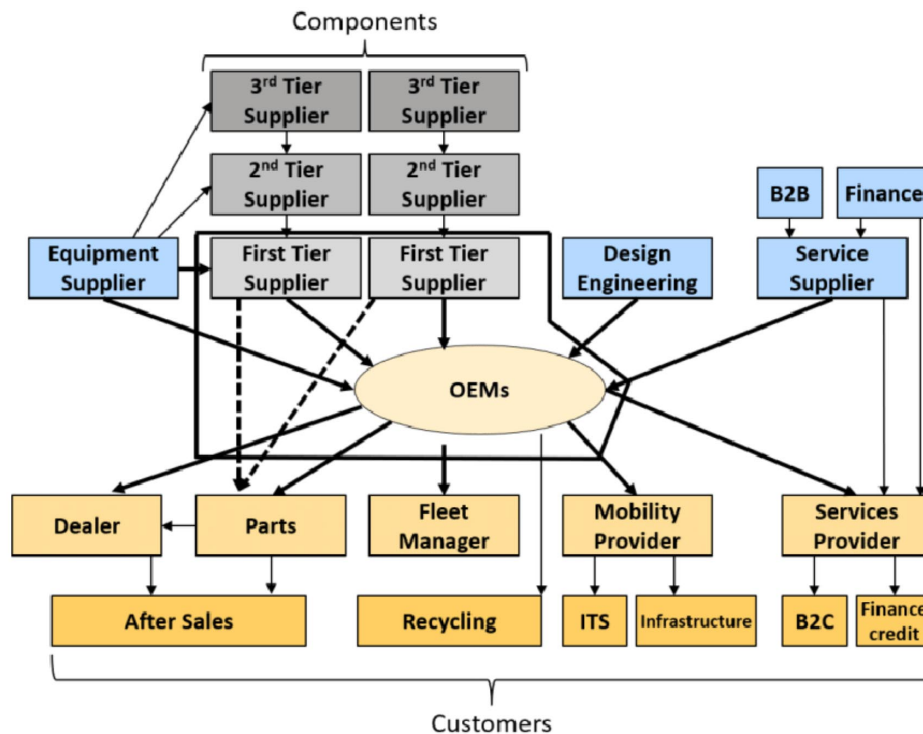
To get a comprehensive understanding of the job dynamics that will occur as a result of the transition to e-mobility it is important to look at what constitutes an e-mobility ecosystem and how different it is from the ICE ecosystem. Figure 3 highlights the broad components of an ICE vehicle that dominates the automotive ecosystem.

The major components of the ICE vehicles ecosystem include manufacturers, dealers, and consumers. Along with that, the ancillary components of the ecosystem include stakeholders that engage in operation and maintenance, production of energy, insurance, mobility services, and recycling and scrapping of



Figure 3

Automotive Ecosystem



Source: Biahmou, A. Majic, T. Stjepandic, J. & Wognum, N. (2019). A Platform-based OEM-Supplier Collaboration Ecosystem Development.¹⁸

vehicles. With infotainment and technological advancements, the ICE vehicles ecosystem is also undergoing a dynamic shift to include more ICT solutions including IoT-based services. (Refer to Figure 3)

- The second is the 'aggregator and provider' who is responsible for developing or aggregating the inputs into comprehensive end products (E.g. EV manufacturers, operation and maintenance providers, e-mobility operators)

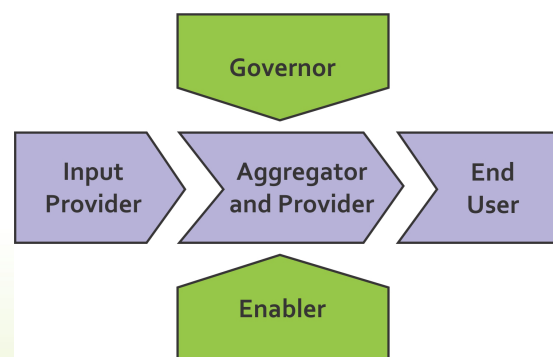
The E-mobility Jobs Ecosystem

On the lines of organisation theory, Raphael Giesecke, in his paper "The Electric Mobility Business Ecosystem: An Initial Agenda for Future Research Needs, Based on Organisation Theory"¹⁹ divides the Electric Mobility Business Ecosystem (EMBE) into five broad components which are interlinked for value creation across the ecosystem. (Refer to Figure 4)

- The first is the 'input provider' who provides the initial hardware and software inputs to the system and are subsequently transformed and aggregated (E.g. EV components manufacturers, electric power generators/producers)

Figure 4

Components of an EV Ecosystem



Source: The Electric Mobility Business Ecosystem: An Initial Agenda for Future Research Needs, Based on Organisation Theory.²⁰



- The third component is the 'enabler' who provides tangible and intangible support to the operations of the ecosystem (E.g. charging services providers, ICT solutions providers, research and development providers)
- The fourth component in this ecosystem is the 'governor' who governs the operations of the ecosystem by setting and implementing rules and standards (E.g. regulatory authorities, user groups, NGOs)
- Finally, the fifth component is the 'end-user' who is the creator of demand for e-mobility, consumer of e-mobility products, and also a feedback linkage for other players in the EMBE (E.g. cab aggregators, mobility service providers). The presence of such a vast and networked business ecosystem highlights the depth and spread of the e-mobility sector, much beyond the automobile industry

While core components of the EV ecosystem, i.e. manufacturing, operation and maintenance, and service provisions remain consistent with the ICE ecosystem, the functions and roles within each of these components become much more diverse, opening up the sector to different job roles and new opportunities. Further, the dynamic nature of each of these roles reveals a tremendous potential for the creation of employment opportunities across the spectrum of e-mobility.

On the lines of Giesecke's model a report by International Energy Agency (IEA) outlines three major value chain components in the EV ecosystem – the EV, the EV charging infrastructure, and the energy value chain.

- The direct components of the EV value chain include raw materials, after-market of the raw materials (including batteries, power electronics, lightweight design and materials, and electric motors), manufacturing, sales, and after-market of the finished product (including maintenance and recycling). The allied sectors of the vehicle value chain are certification, mobility, financing, research

and development, and skill development (education and training)

- In the case of the EV charging value chain, the direct components are manufacturing, installation, operation, service delivery, and a market. The allied components include smart grid and metering along with that of the vehicle value chain
- The energy value chain involves the generation, transmission, and distribution components along with service delivery as direct sectors, while smart grid and metering, research and development, and skill development remain the ancillary components

The interlinking of these three value chains is critical for the facilitation of e-mobility at the local and national level. It is also imminent that the development of the e-mobility sector will have spill-over impacts on the allied sectors in the ecosystem, in terms of enhanced growth and increased employment opportunities.

In the Indian context, a study by Council on Energy, Environment, and Water (CEEW),²¹ divides the EV ecosystem into seven broad categories of stakeholders and creates a distinction between the EV ecosystem and the conventional automobile ecosystem in terms of the value chain of the former being a combination of the automobile value chain along with power electronics and electrochemical components. The stakeholders categories identified in the study are:

- EV manufacturers (which include the component manufacturers, the battery manufacturers, and the vehicle manufacturers)
- Financiers of the EV ecosystem (including banks, NBFCs, venture capitalists, capital markets, and insurance companies)
- Charging infrastructure value chain (including power electronics manufacturers, EV supply equipment manufacturers, and charging service providers)



- Digital technology value chain (ICT solutions provider)
- Customers (including cab aggregators, fleet operators, rental operators, freight and logistics operators, and individual customers)
- After-sales services value chain (including battery swapping, repair and maintenance, and battery and vehicle recycling), and,
- Regulators which govern the ecosystem (including government departments and regulatory bodies)

EV and the Workforce: Potential Job Losses and Gains and their Attributes

The automobile industry is one of the major job creators across the spectrum of employment, in upstream, i.e. core manufacturing areas, mining, automotive parts, etc. as well as downstream for instance, allied services – servicing/repair works, fuel supply, logistics amongst others.

EVs are technologically advanced as compared to ICE vehicles. Thus, a shift from ICE to EV will have a two-pronged impact on upstream and core automobile manufacturing. It will lead to the discontinuation of numerous critical components used in the existing fossil fuel-based vehicles due to the different architecture of the EVs. Secondly, since the standard operating procedure (SOP) of EVs would be different, jobs associated with production will also be affected.

With the growth of the e-mobility sector, the conventional ICE vehicle sector is the one that is set to undergo major disruptions in terms of redistribution of power, markets, skills, and jobs. As the manufacturing processes change the skills required will undergo a subsequent change which will lead to potential job losses in the automotive sector.

However, it will also lead to newer job creation in manufacturing and allied sectors in the e-mobility ecosystem, as newer roles with specific skillsets

come up and the sector gets integrated with telecommunications, transport, and electricity.

Along with a direct impact on employment, the shift is also likely to lead to lower fuel consumption and hence save on the oil import bill, which will lead to a higher gross domestic product (GDP) and eventually create additional jobs in the economy. The impact on employment is expected to be net positive suggests examples from the EU, with about 500,000-850,000 potential jobs estimated to be created by the move. However, in order to that a renewed focus on indigenous manufacturing and reduction in import dependency is needed.²²

On similar lines, a report on the macroeconomic impacts of a shift from ICE or petroleum vehicles to plug-in electric vehicles (PEV), highlights that the petroleum displacement that will occur as a result of the shift to EVs will lead to an annual boost of US\$20bn to economic output. It will also result in considerable annual household savings on fuel costs and provide a boost to the local economy along with generating close to 1.5 lakh jobs.²³

Studies from USA further suggest that a shift to EVs will generate newer jobs in the EV charging value chain and battery manufacturing industry along with employment generation in the EV manufacturing sector. The potential job profiles and skills will vary from unskilled roles to skilled ones. In operation and maintenance, sales, and support services, unskilled job roles will be created, while semi-skilled roles will be created across design and development, manufacturing, operation and maintenance, allied infrastructure development, sales, and support services. Research and development of newer technology for improving the efficiency of vehicles will bring about newer opportunities in the skilled domains of the workforce while their production will add more labour to the factory floor.²⁴

However, the impact of e-mobility on the jobs ecosystem will be extremely different in the Indian scenario, as compared to the impacts in



Europe and the USA. This is because the workforce needed in manufacturing the powertrain in India is approximately 2000-2500, as compared to less than 200 workers needed to do the same in the USA,²⁵ due to a lower degree of automation in the component manufacturing process in India. Besides, auto parts suppliers and labour-intensive workforce engaged in manufacturing processes such as castings, forging, etc. would be severely affected.

To add to the problem of job losses, at present, the existing workforce in India is deficient in the required skills and capacity according to a study by CEEW. Currently, more than two-thirds of the electronic equipment used in Original Equipment Manufacturers (OEM) is being imported from China and European markets. But, at the same time, approximately 25 percent additional core manufacturing jobs may be created, should the set target of 30 percent of EVs production in total passenger segment vehicle production be achieved, assuming different levels of indigenisation of electric car powertrains. While this could be a major area of job creation, the need of the hour is reskilling and capacity building of the existing workforce to achieve the set target of EV mobility in the market.²⁶



The Ministry of Skill Development and Entrepreneurship is in the process of developing a specialised curriculum to ensure an adequate skilled and trained workforce for the electric mobility industry.²⁷ Such a workforce is expected to have expertise in infrastructure, design, testing, battery manufacturing, and allied services amongst others.

Besides, the Automotive Skills Development Council (ASDC) in collaboration with the Automotive Research Association of India (ARAI) is in the process of developing specific occupational standards for EVs along with a training and capacity building framework for technicians, supervisors, and helpers working in allied services.²⁸

3

APPROACH AND METHODOLOGY





The rationale behind this research is to understand the impact of a major transition in the automotive sector, from ICE vehicles to EVs on various stakeholders that operate in the sector. The impact, in this case, is restricted to the job and skill dynamics. To get a comprehensive picture of the transition and identify the nodal points of change a multipronged approach has been used, to capture both the qualitative and quantitative aspects of the employment.

Towards this end, the research has focussed on an extensive review of existing literature in this domain, followed by in-depth interviews with key stakeholders from the sector. The information so collected has also been triangulated using secondary literature and field visits. Following this, innovative methods have been used for analysing the data and preparing a map of potential impacts, jobs, and skills in the automotive ecosystem. The research activities have been carried out over a period of six months. The following sections, sequentially detail out the methodology and approach for each of the components of the research.

Literature Review

A thorough review of relevant national and international literature across diverse themes including, components of the automotive value chain, E-mobility and its impact on the automotive value chain, components of the EV ecosystem, and job dynamics in the EV ecosystem was undertaken. The review was undertaken with a dual-lens of mobility and allied services, as the automotive industry goes much beyond the manufacturing of vehicles. The rationale behind this review was to assess the existing ecosystem, industry players, and relevant prospects.

An extensive review of all national and state-level policies and schemes, as well as Regional Transport Office (RTO)-based regulations related to EVs was also carried out to understand the current discourse and future policy targets for

EVs in India. During the policy review, a special emphasis was laid on the targets and policies specific to job creation and skilling to align it with the overarching objective of this research.

Stakeholder Mapping and Development of Interview Guides

Based on insights from the secondary literature, an extensive map of stakeholders in the automotive industry was created. The rationale behind creating this map was to identify the key stakeholders whose perspectives would need to be represented in the research. The stakeholders were mapped into four broad categories as discussed below:

- The first category of stakeholders includes manufacturers of ICE vehicles and EVs, their components, and allied equipment such as battery chargers amongst others.
- The second category of stakeholders includes supply side operation enablers, i.e., those who provide the necessary support for creating an enabling environment for EV operations such as charging and network service providers.
- The third category focusses on the demand side operation enablers who are responsible for the generation of demand and end-use of EVs.
- Finally, the fourth category comprises research organisations, and industry and workers' associations.

The mapping of stakeholders assisted in designing specific semi-structured interview guides for data collection. The interview guides were peer-reviewed by key industry experts for robustness.

Tools and Methods of Data Collection: KIIs and Field Inquiries

Data collection from primary sources was envisioned through a multi-pronged process comprising of initial scoping visits and detailed



field inquiries. The chosen tools of data collection were Key Informant Interviews (KIIs) and Focused Group Discussions (FGOs) and Stakeholder Consultations. However, due to the COVID-19 pandemic, the field component of the data collection process had to be curtailed and the entire process was carried out through virtual modes.

Thus, the data collection strategy consisted of virtual KIIs with stakeholders from the four identified stakeholder categories. Non-probabilistic purposive sampling²⁹ was initially used for identifying respondents. As the study progressed, snowball sampling was used with the guidance and references from the various industry experts. A total of 26 detailed interactions with key stakeholders. (Refer to Table 1)

The virtual interactions were followed by three physical visits to manufacturing plants (2), dealerships, and workshops (1) to get a more nuanced understanding of the ecosystem. The field visits as well as a simultaneous revisiting of the secondary literature also served the purpose of validating the primary data.

In addition to the primary data collection, quantitative data on EV targets, transport statistics, and carbon emission statistics was collected from several secondary sources including the Ministry of Road Transport and

Highways,³⁰ Society of Manufacturers of Electric Vehicles,³¹ and Carbon Brief Profile: India.³²

• Tools and Methods of Data Analysis

The data analysis component of this study can be divided into two broad categories based on the objective that each has aimed to achieve. The first, is the creation of a dynamic automotive ecosystem that encompasses existing stakeholders of the automotive ecosystem and emerging players of the transition to E-mobility. This feeds into the broad objective of the research to explore the impact of the E-mobility transition on jobs and skills in the automotive ecosystem.

The process of ecosystem mapping is premised on the aforementioned stakeholder mapping exercise. Based on the perceptions of diverse stakeholders in the automotive value chain, a dynamic matrix of the automotive ecosystem has been created. This matrix captures the existing players, jobs, and skills as well as future potential in the context of a just transition to EVs.

The second category of analysis focuses on the creation of a calculator (Refer to Annexure-I) for estimating the segment-wise EV targets based on the carbon-dioxide emission targets for India. As a forward linkage, this model has also been used to estimate the quantum of job creation if these

Table 1: Category-wise Breakup of the key stakeholder Interactions

Category	Number of Stakeholders interviewed
Manufacturers	10
Dealerships	2
Charging Infrastructure Providers	4
Fleet Aggregators	2
Driver's Union	3
Industry Associations	2
Mobility Research Organisations	3



targets are adhered to. The quantitative data analysis is done using a model calculator and based on assumptions. This component of analysis strengthens the arguments put in place by the first component by providing quantitative, target-oriented insights on jobs.

Ethical Considerations

Ethical considerations are critical for conducting social research as this involves interaction with human respondents. For this purpose, at all stages during the conduct of the research ethical codes have been maintained. The ethical codes that have been followed for this study are as follows:

- o **Participation:** The research methodology has taken into account the importance of participation of different stakeholders in the automotive ecosystem and has ensured the same. Further, there has been no discrimination based on gender, class, and any other social construct throughout the conduct of the research activities.
- o **Consent:** The research team has ensured informed consent of all participants to eliminate information asymmetry and ensure participation that is just and responsible.
- o **Confidentiality and Anonymity:** Due to the sensitive nature of the quantitative and qualitative data care has been taken to maintain the confidentiality and anonymity of respondents.

Limitations of the Study

While the research has aimed to provide a comprehensive picture, it has faced several operational challenges that have curtailed its scope. The following are the limitations of the study:

- o COVID-19 has been a major operational challenge for the research proceedings as it curtailed the field visit component and limited the scope of the study to online interviews
- o Though an attempt has been made to cover all stakeholders in the automotive and EV ecosystem, some stakeholders such as auto financiers have not been covered given the scope of the research
- o For quantitative analysis, the scope has been restricted to the passenger vehicle segment due to data constraints.
- o Due to the unavailability of uniform and updated data for each of the data points used, wherever possible, the most consistent datasets have been used which may not always be the most recent. This may have a connotation on the estimates provided by the research
- o The quantitative analysis is restricted to complete conversion of ICE vehicles to EVs and does not take into account hybrid vehicles
- o Due to the limited field component of the study, the qualitative aspects of jobs and skills have not been dealt with in-depth. However, these can be taken up for further study to complement the current findings
- o The scope of the research is limited by the time and resources that were available for this purpose

4

KEY FINDINGS AND ANALYSIS





The research findings have been discussed under three broad themes. The first theme explores the complexities of the multi-faceted automotive value chain and its restructuring due to the incumbents of the E-mobility transition.

Taking this forward, the next theme aims to quantify certain aspects of the automotive industry and their prospects in the context of national emission targets, with the help of trend analyses and a model calculator. The third theme combines the nuances of the first and second to present the prospects of employment with the advent of EVs and highlights the qualitative aspects of a just transition at the Jaipur city level.

From Source to Sink: Mapping the Automotive Value Chain

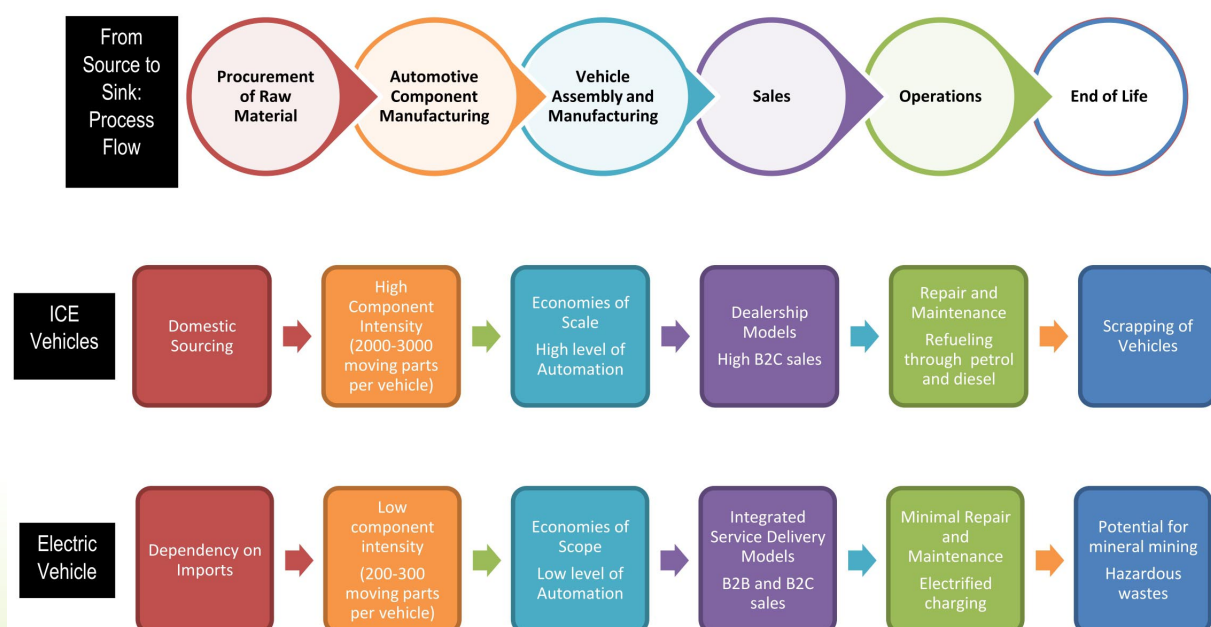
In the first step towards ecosystem building the major processes involved in the automotive value chain have been detailed out in an attempt to

dissect the nuances of an auto value chain and the differences of an EV value chain. Insights from the interactions conducted with diverse stakeholders have revealed that the value chain of a vehicle involves six main processes, procurement of raw material, component manufacturing, vehicle assembly, sale of the vehicle, operations of the vehicle, and its end of life management (Refer to Figure 5).

The first step in the value chain of a vehicle is the procurement of the raw material required to build it. There are multiple stakeholders involved in this process depending on whether the material is being procured indigenously or being imported from international contenders through intermediaries. In the procurement process for ICE vehicles, companies have a localised supply-chain network with the vendors. Whereas, in the case of EV, almost 80 percent of the raw material or the components are imported from foreign countries as this *nouveau* industry has very few Indian manufacturers.³³

Figure 5

Process flow in an Automotive Value Chain: ICE Vehicle and EV



Source: Author



Following the procurement of raw materials, the next step in the value chain is the manufacturing of the automotive components.³⁴ Each of the components has specific manufacturing processes and requires different kinds of raw material and skills. However, there is approximately, a 10 times reduction in the number of components to be manufactured when it comes to an EV. This may lead to the potential redundancy of those job roles which are currently involved in manufacturing the respective ICE components.

The automotive components are assembled by OEMs to create the final product. In this case, some OEMs are vertically integrated and involved in the manufacturing of certain components and vehicle assembly, while other enterprises are only involved in the assembly process. The prevalence of vertically integrated enterprises is higher in the case of the EV value chain which currently has a large share of start-ups and small manufacturing units who prefer to maximise their in-house capabilities for minimising operational costs. Further, in the case of EVs, there is a scope for manual assembly, given its low demand and low scale of production compared to the 'in-demand' ICE vehicles.

A completed vehicle is sold to consumers through dealerships. The vehicles may be sold through two different kinds of modes, i.e. to consumers directly or to businesses and corporates. The latter is more prevalent in the case of fleet aggregators, which is an emerging business in the current scenario. The relevance of B2B sales gains importance when it comes to fostering the adoption of EVs as various state policies set targets and provide incentives for electrification of vehicle fleets.

Once a vehicle is on the road the next step in its value chain is operations. Insights from interactions with EV manufacturers and dealers reveal that the operation and maintenance process of EVs is simpler than that of ICE

vehicles, due to the lesser number of components. However, the key difference between the operations of the two kinds of vehicles is the refueling process where one requires petrol or diesel and the other requires power supply.

The vehicular value chain comes to an end with the scrapping or recycling of its constituent components. In the case of EVs, there is an added process due to the presence of hazardous materials in the batteries. One of the emerging end-of-life uses of EV batteries is mining³⁵ them for the constituent chemicals for the manufacture of new batteries.

Mapping Stakeholder Perceptions: Building the Dynamic Automotive Ecosystem

In addition to the core value chain of a vehicle, several allied processes and stakeholders are linked to its functioning. They are also nodal points for the creation of potential job roles as the mobility ecosystem grows and develops. A combination of these core and allied stakeholders build the complete automotive ecosystem.

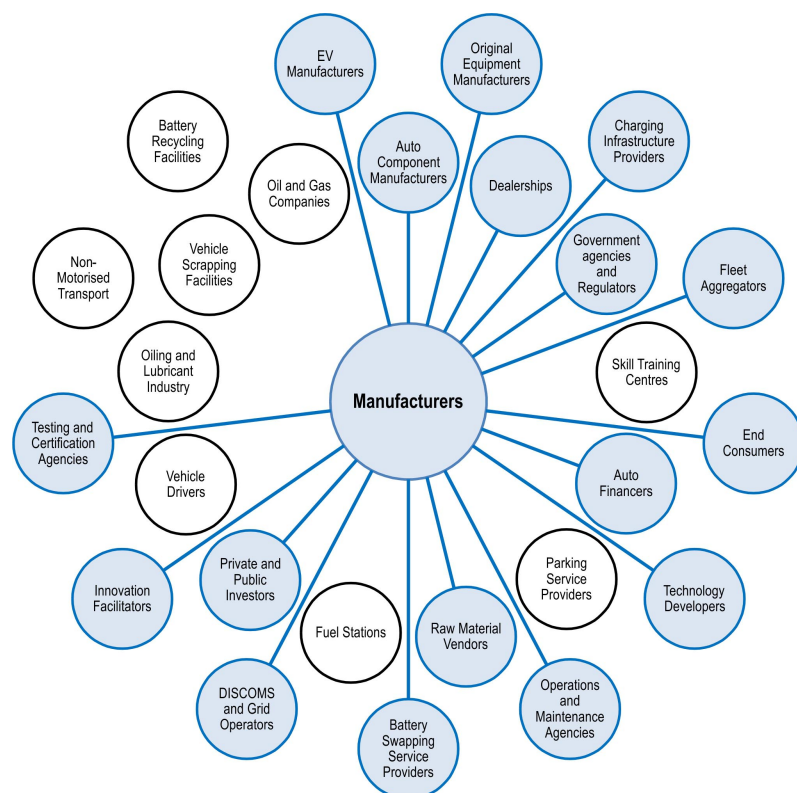
This study adopts a perception-based approach for mapping the network of actors engaged in the automotive ecosystem of ICE vehicles as well as EVs. This section tries to capture the automotive ecosystem and key actors from the eyes of the stakeholders who have been interviewed.

Figures 6-12 represent the key actors operating directly with the interviewed stakeholder and also the actors which are not directly linked with them. Broadly, seven types of stakeholders in the mobility ecosystem were interviewed. These include manufacturers (of components and vehicles for ICE vehicles and EVs), dealerships, charging infrastructure providers, fleet aggregators, industry associations, driver's unions, and mobility research organisations.



Figure 6

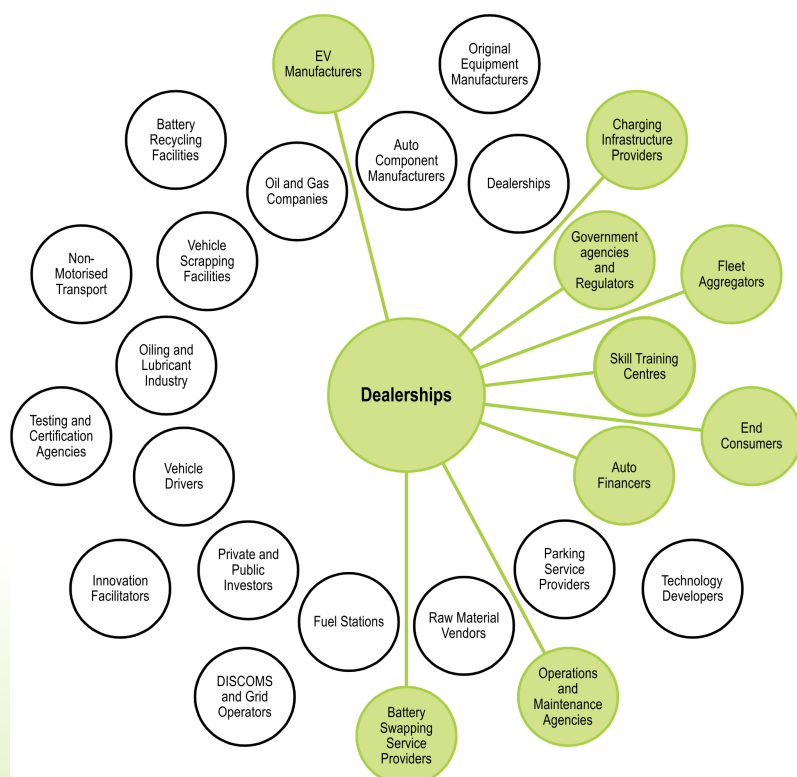
Automotive Ecosystem from the perspective of Manufacturers



Manufacturers include automotive component manufacturers and vehicle manufacturers (ICE vehicles, EVs, retrofitters) across vehicle segments

Figure 7

Automotive Ecosystem from the Perspective of Dealerships



Dealerships include showrooms that facilitate the sale of ICE vehicles and EVs across vehicle segments and are affiliated to one or more OEMs. Some dealerships, especially those selling EVs also include auto repair workshops and charging points



Figure 8

Automotive Ecosystem from the Perspective of Charging Infrastructure Providers

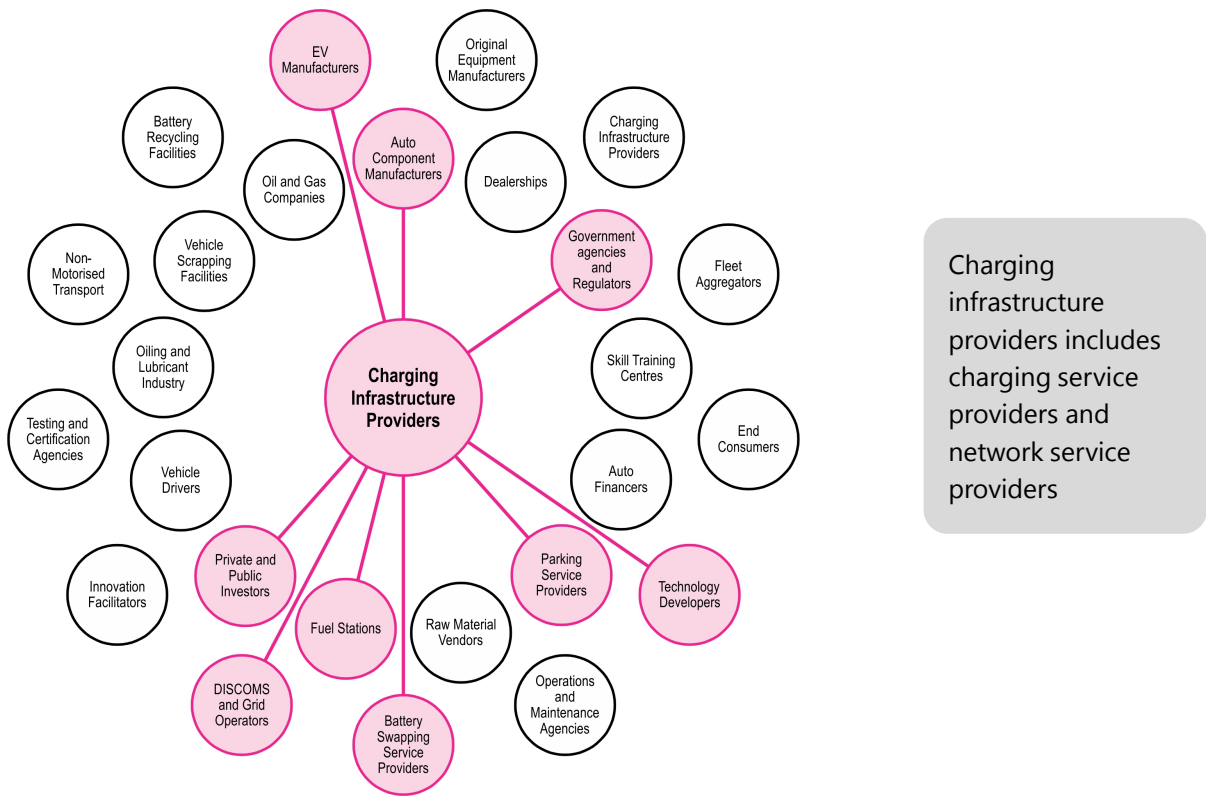


Figure 9

Automotive Ecosystem from the Perspective of Fleet Aggregators

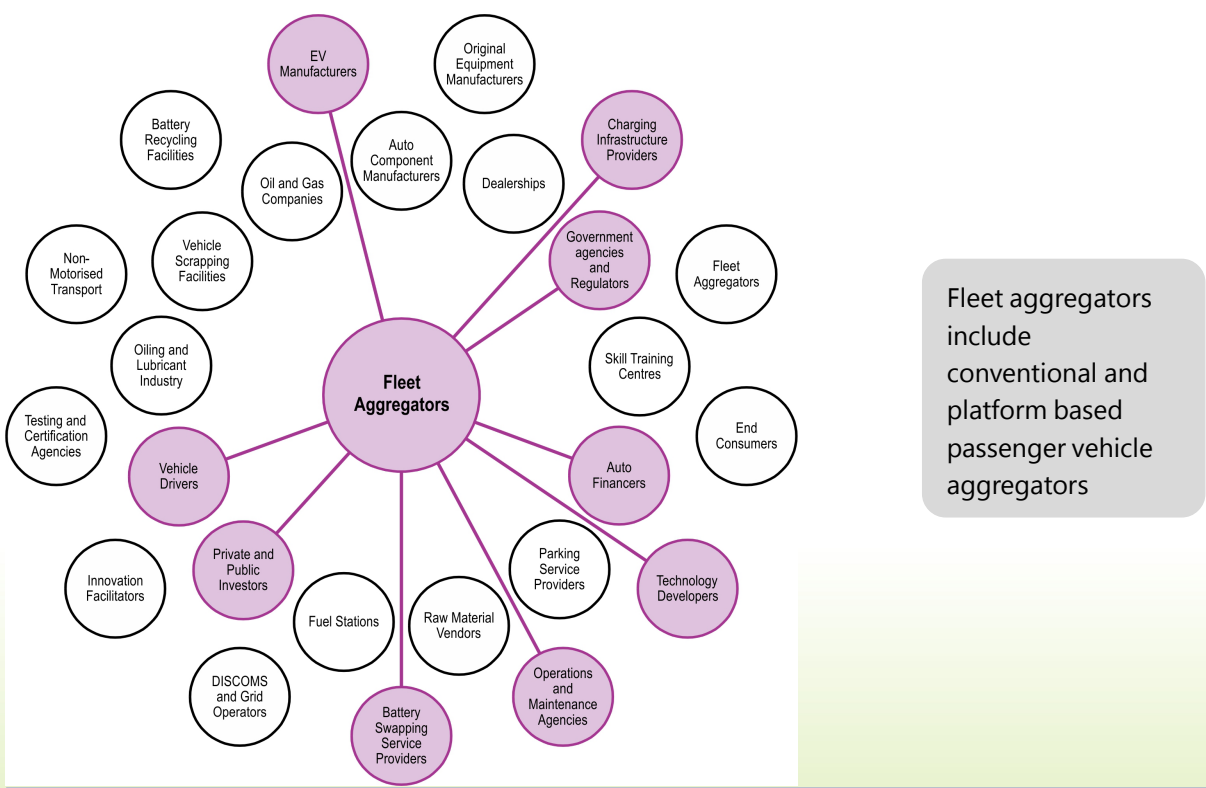




Figure 10

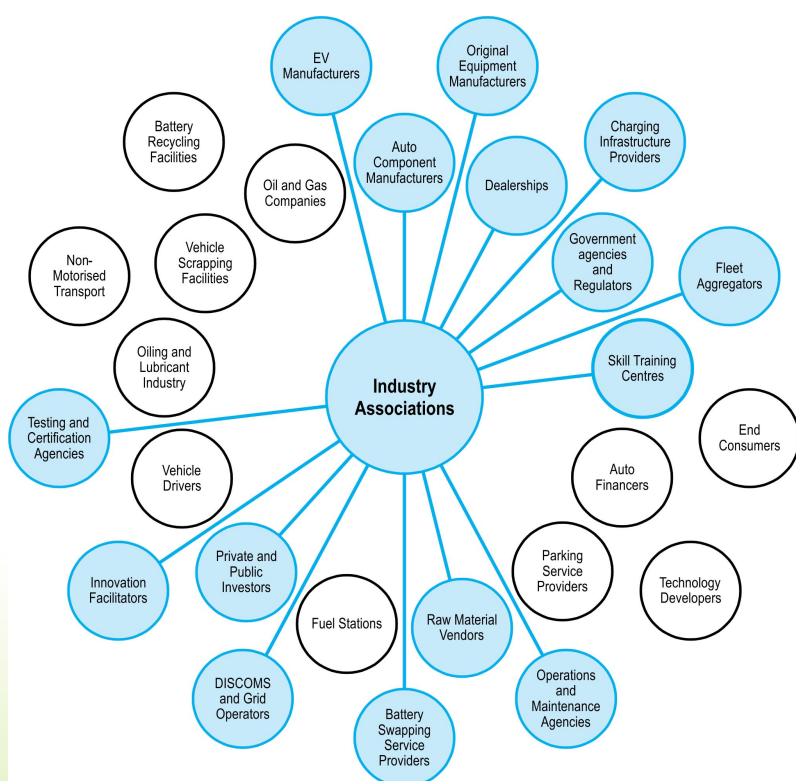
Automotive Ecosystem from the Perspective of Driver's Union



Driver's union includes three-wheeler drivers' unions for conventional and electric three-wheelers

Figure 11

Automotive Ecosystem from the Perspective of Industry Associations

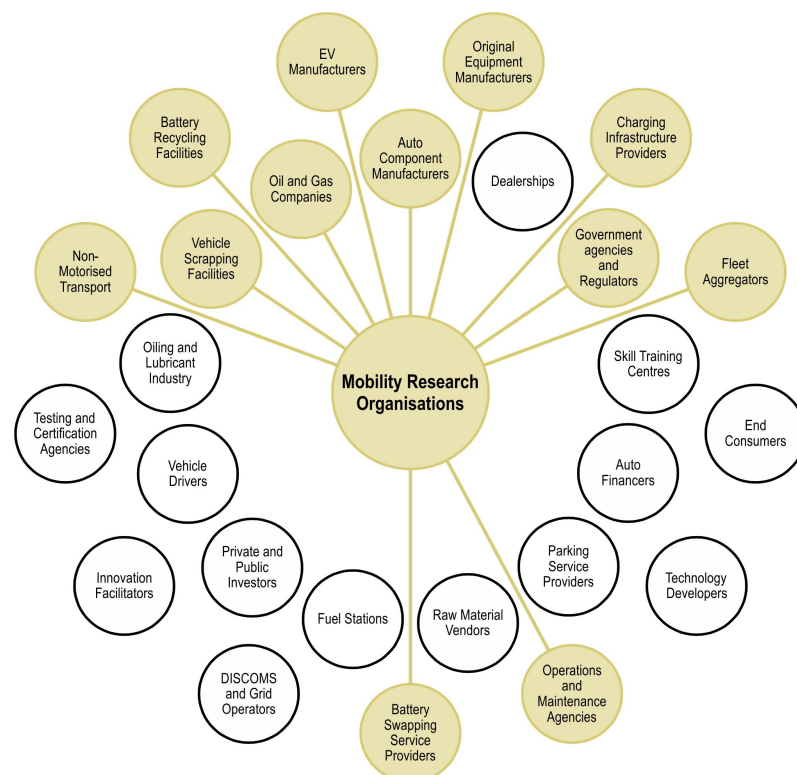


Industry associations includes dealers' associations and manufacturers associations of ICE vehicles and EVs



Figure 12

Automotive Ecosystem from the Perspective of Mobility Research Organisations



Mobility research organisations includes individuals and institutions engaged in mobility related research, in particular EVs

- Firstly, direct interactions take place among actors who are dependent on each other's operations. Thus, the setting in which the ecosystem becomes functional comprises of different actors interacting with each other for functional and operational purposes.
- Secondly, there are certain actors in the ecosystem which are common for the operations of several stakeholders. These represent the dominant actors as perceived by the interviewed stakeholders and include Automotive Component Manufacturers (ICE and EV), Original Equipment Manufacturers (ICE and EV), Charging Infrastructure Providers, Government Agencies and Regulators (transport department and implementing agencies under it, energy department and implementing agencies under it, transport utilities, electricity regulators, municipal corporations, etc.), auto financiers (which provide financial instruments to the purchasers of vehicles), dealerships (for ICE and EVs), operation and maintenance agencies (including workshops, repair shops, etc.) and fuel stations or battery swapping agencies, to name a few.
- Finally, there are certain actors in the ecosystem which are perceived as important players by a few stakeholders only. These include Non-Motorised Transport (NMT) (walking, cycling, paddle rickshaws, etc.), battery recycling facilities, vehicle scrapping facilities, oil and gas companies, and skill training centers, to name a few.

This perception-based analysis highlights a major gap in the functioning of the ecosystem where actors outside the purview of the manufacturing-sales-operations chain are not given the policy and practical importance that is required for the sustainability of the automotive ecosystem.



The Process-Stakeholder Grid

The combination of the processes and related actors detailed out in the preceding sections is used for representing the functional ecosystem of the automotive sector including electric mobility. Figure 13 represents the amalgamation of

processes and players that build the automotive ecosystem. It brings to fore the paradigm that EVs should be viewed and treated as a component of the larger automotive ecosystem instead of being treated as an entirely separate and disjointed sector.

Figure 13

Process-Stakeholder Grid



Source: Author



Thus, an electric mobility ecosystem is deeply engrained into the automotive ecosystem.

Such an intricately interconnected ecosystem reflects the platitude of stakeholders who will be impacted, positively or negatively, by a transition to E-mobility. While some actors, whose skillsets are indispensable to the production and adoption of EVs may benefit from the transition in terms of a significant rise in employment opportunities, some other stakeholders whose skills are indigenous to ICE vehicles may become redundant or require rehabilitation within the ecosystem.

However, the dynamics of the ecosystem are such that the impacts of a transition will not be limited to the core manufacturing processes.

As this complex and multi-faceted ecosystem transitions, it is interesting to analyse the quantum and nature of jobs that will be impacted. However, prior to that, it becomes

imperative to analyse the extent and pace of transformation required for creating a benchmark for the jobs which will be lost or generated.

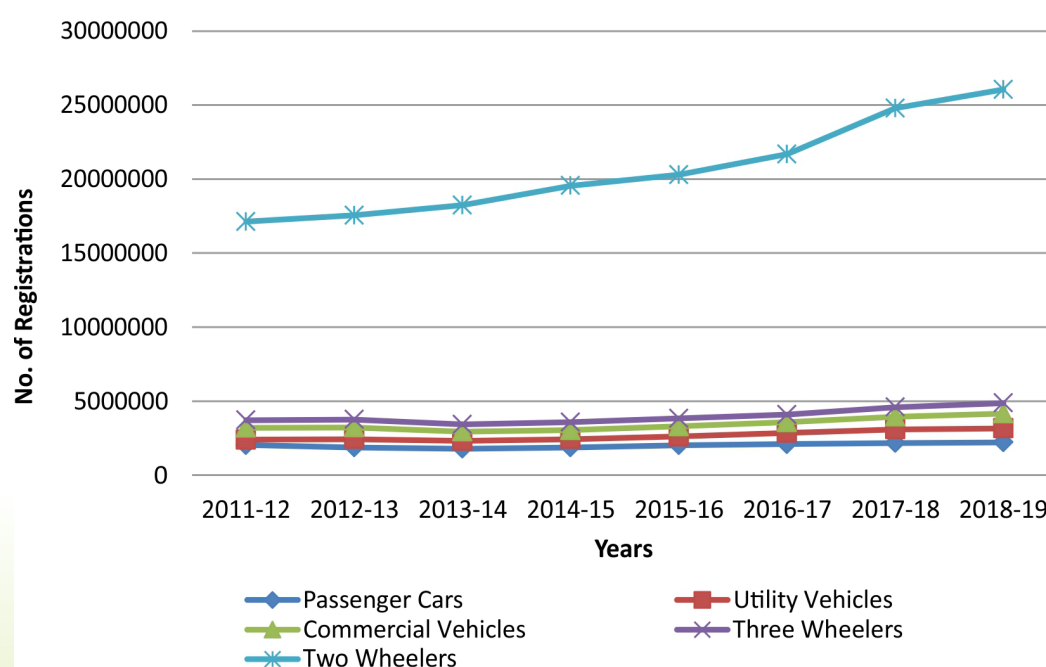
The next section attempts to address this through a target-based approach. It delves into the different modalities for setting up targets of EVs adopted by the Government of India and different state governments till now and explores a climate-linked approach to target setting.

Exploring the Potential of EVs: Trends, Targets and Carbon Footprint

Transportation services play a significant role when it comes to intra- and inter-city mobility. To that end, the automotive industry in India has been on a rise given increased urbanisation and higher demand for vehicles. (Refer to Figure 14) However, in recent years the industry has witnessed major developments in the realm of sustainable mobility.

Figure 14

ICE Vehicle Registration in India (Segment Wise)



Source: Society of Indian Automobile Manufacturers (SIAM)



Since 2013, as the Union Government, through its National Electric Mobility Mission Plan, set targets for transforming 30 percent of vehicles in India to electric by 2030 and introduced policy measures to facilitate the process, electric vehicles trickled into the auto markets. (Refer to Figure 15)

Manufacturing and assembly units were set up by a few large OEMs to initiate a transformation to E-mobility while several start-ups joined the enthusiastic bandwagon. Simultaneously, FAME I was introduced by the Department of Heavy Industries in 2015 as a policy that would fast-track the EV industry by providing subsidies to manufacturers, and infrastructure providers.

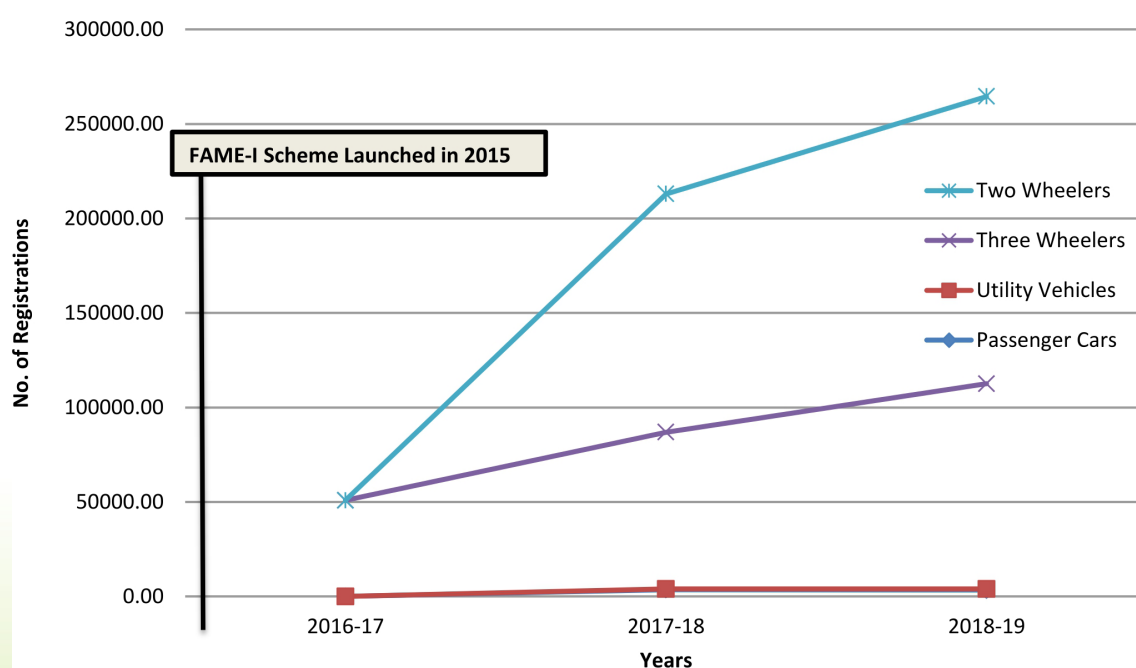
A few years later various states also started coming up with state-level policies for promoting the uptake of EVs. State-wise targets for electrification were set and incentives were provided. In 2019, FAME II was initiated, which shifted the focus to purchase incentives and the development of charging infrastructure.

With a plethora of schemes and policies in place to boost E-mobility, the fledgling industry has been gaining traction in India, albeit slowly. However, the numbers, though rising, are not very promising at the moment. The maximum uptake of EVs has been seen in the two-wheelers and three-wheeler segments where the current shares of EVs in total registered vehicles are as low as 0.54 and 0.36 percent. In the four-wheeler segment, the share is much lower at a meagre 0.02 percent.³⁶

The segment, which has picked up in India is the electric three-wheeler segment which is the chosen mode of transport for last-mile connectivity across the country. The segment looks promising in terms of growth with 108502 EV registrations in 2018-19, more than double the numbers in 2016-17.³⁷ While that is the number of registered E-3 wheelers there are vast numbers of unregistered ones³⁸ (especially in the E-rickshaw category) operating as well which puts the actual E-3 wheelers on the road at a much higher figure.

Figure 15

Electric Vehicle Registration in India (Segment Wise)



Source: Society of Manufacturers of Electric Vehicles (SMEV)



However, to regulate the uncontrolled expansion of E-Rickshaws within city limits and reduce traffic congestions, their registrations have now been restricted through a quota system by RTO's in multiple cities including Delhi and Jaipur. This policy could potentially off-set the growth of E-3Ws. Nevertheless, insights from multiple stakeholders reveal that this segment will be one of the fastest-growing ones within EVs, especially with the introduction of high-speed E-3 wheelers.

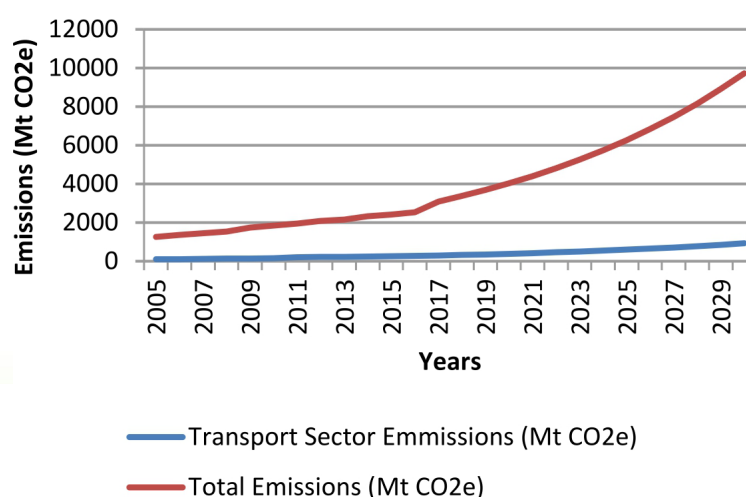
While the EV industry takes baby steps, the ICE vehicles are nowhere close to a reduction in their numbers on the road, making little impact on the emission status and carbon footprint. Though this trend can be attributed to the low availability of EV variants as compared to ICE vehicles, it can also be attributed to consumer preferences and awareness levels. Now, since the grounds for introducing electric vehicles was to reduce the carbon footprint, it may be worthwhile to revisit the impact of the transport sector on emissions and reflect on the current gaps. This reflection gains significance in the context of the Intended Nationally Determined Contributions (INDC) emission targets that have been set and need to be achieved by 2030.

Currently, the transport sector emissions form approximately 10 percent of the total carbon emissions of India. If we consider the current share and growth trajectory, then by 2030 transport sector emissions will rise to 928.61 Mt CO₂e³⁹ which is more than double of what it is today. (Refer to Figure 16)

While that looks like a difficult target to achieve, this is where EVs come in. A vehicle, throughout its operational value chain, emits carbon dioxide. The two broad categories in which the emissions can be divided are manufacturing emissions, which are taking place during the manufacturing of a vehicle, and operational emissions or tail-pipe emissions which occur during its actual on-road operations. Manufacturing emissions depend on the manufacturing processes and have the potential to be reduced with advantages in technology. Similarly, operational emissions, which account for the larger chunk, can be reduced by improving fuel or battery efficiency. While the manufacturing emissions are comparable for ICE vehicles and EVs the difference lies in the operations where the former runs on carbon-intensive and highly polluting fuels, such as petrol or diesel while the latter is refueled using electricity.

Figure 16

Transport Sector Emissions: Current and Projected Trends



Source: Compiled by Authors based on data from Carbon Brief Profile: India



Table 2: State Level EV Targets

State/Union Territory	Targets		
	EVs on the Road	Investment in E-mobility	Job Creation
Delhi	50 percent buses by 2022 and 25 percent vehicles by 2024	Unspecified	Unspecified
Kerala	10 lakh by 2022	Unspecified	Unspecified
Maharashtra	5 lakh vehicles by 2023	INR 25,000 Crore	1,00,000
Telangana	Unspecified	INR 29,000 Crore	1,20,000
Tamil Nadu	Unspecified	INR 50,000 Crore	1,50,000
Andhra Pradesh	100 percent E-buses by 2029	INR 30,000 Crore	60,000
Bihar	100 percent E-Rickshaws by 2022 and 100 percent vehicles by 2030	INR 2,500 Crore	10,000
Karnataka	100 percent vehicles by 2030	INR 31,000 Cr	55,000
Uttar Pradesh	10,00,000 vehicles and 70 percent of public transport by 2030	Unspecified	Unspecified

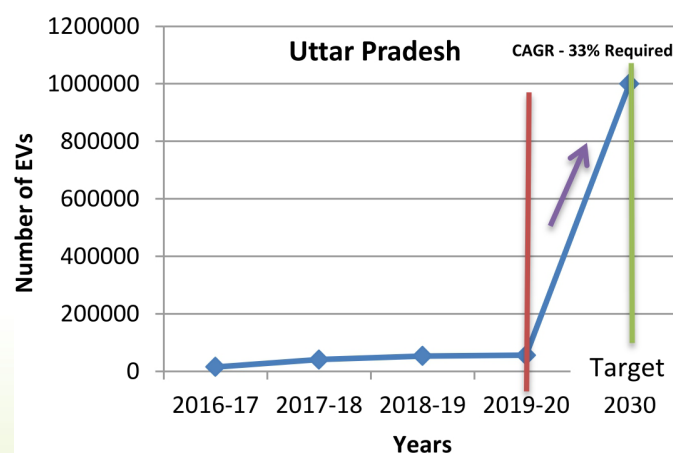
Thus, in the case of the latter tail-pipe emissions are almost negligible, making it green and sustainable. This makes it clear that a shift from an ICE vehicle to an EV is required exactly to significantly reduce operational emissions. It is, for this reason that governments across the country are on a mission-mode to transition to EVs. Some of the major targets set by the EV policies of some states are highlighted in Table 2.

It is interesting to see that each of these states has ambitious targets for electrification, which is often based on the rationale of making the respective state an EV-hub by the end of the policy period. However, the ground realities showcase stark deviations from the targets. Based on these policy targets and the existing state-level EV transport data, the following estimation has been made of the trajectory that will need to be followed for achieving these targets.

For Uttar Pradesh to achieve its target of 10 lakh EVs by 2030 an annual growth rate of 33 percent will be required, based on its current EV scenario. (Refer to Figure 17) Similarly, for Kerala, where there have been a mere 466 new EV registrations in 2019-20, the required growth rate for achieving its target of 10 lakh EVs by 2022, is a

Figure 17

Potential Trend of EVs for Achieving State EV Targets: Uttar Pradesh

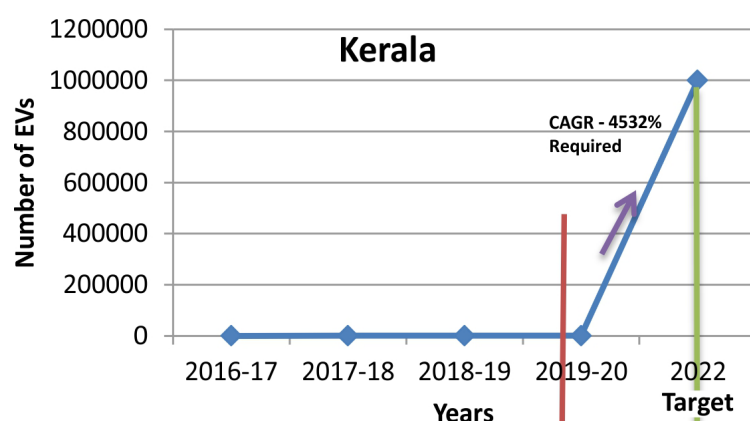


Source: Compiled by Authors based on data from Ministry of Road Transport & Highways, GoI⁴⁰



Figure 18

Potential Trend of EVs for Achieving State EV Targets: Kerala

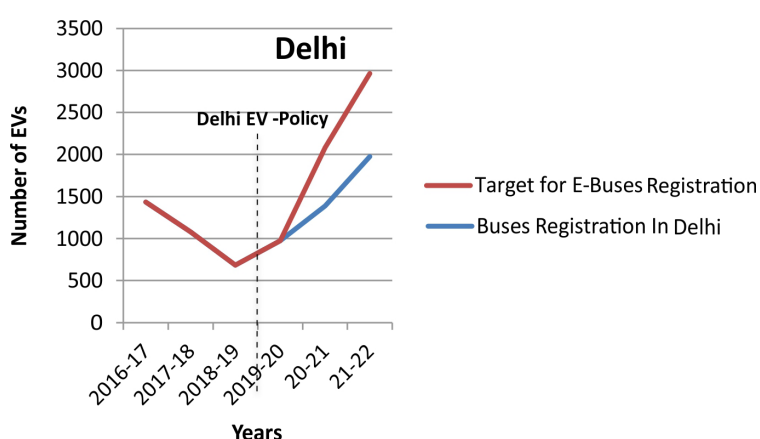


Source: Compiled by Authors based on data from Ministry of Road Transport & Highways, GoI

whopping 4532 percent. (Refer to Figure 18) In the case of Delhi, a similar analysis of its E-bus target reveals that at the current rate of bus registrations, over the next two years it will have to add at least 1682 buses to achieve its policy target. (Refer to Figure 19)

Figure 19

Potential Trend of E-buses for Achieving EV Targets: Delhi



Source: Compiled by Authors based on data from Ministry of Road Transport & Highways, GoI

Linking Emissions and EVs on the Road

While the targets set at the state and national level look promising, achieving them is going to be an uphill task. In such a scenario what can be done to achieve, what may be called 'realistic' targets of electrification of vehicles at the national and

state level? What is missing in the current state or even the national targets is a realistic estimation based on per vehicle emissions and linkages with the ultimate objective of EV uptake, which is emission reduction.

This study aims to address this gap and provide an evidence-backed model of the linkages of EV uptake with emission reduction. The overarching aim of the model is to provide an estimate of the number of EVs required on road to achieve the INDC targets set by India.

The INDC targets set by India are

- Reduction of carbon emission intensity per unit GDP by 33-35 percent of its values in 2005
- Increase of non-fossil fuel-based power generation to 40 percent of the total installed capacity
- Creation of an additional carbon sink of 2.5-3 billion tonnes of CO₂e by increasing carbon stock by 680-870 million tonnes⁴¹

Keeping the 2030 INDC emission targets as the premise the data has been used to analyse the trajectory of transport sector emissions over that period. Subsequently, the data has been used to estimate the potential annual reduction in emission intensity per GDP required for achieving a target of 34 percent⁴² of the emission intensity at 2005 levels.



Along with that, the per-vehicle emission savings for a shift from ICE to EV has been calculated for the different segment of vehicles. The per-vehicle emissions have been calculated as a combination of two types of emissions, i.e. manufacturing and operational emissions. Manufacturing emissions have been calculated by taking into account the carbon intensity of manufacturing of the different types of vehicles. Operational emissions have been calculated by taking into account the travel activity,⁴³ mode share⁴⁴ of each of the segments of vehicles, fuel intensity of operations,⁴⁵ and the carbon emission factor⁴⁶ of each type of vehicle. (two-wheeler, three-wheeler and four-wheeler).

Following that, per-vehicle emission savings has been used to predict the trajectory of replacement of ICE vehicles by electric vehicles required for achieving the INDC targets. This calculation gives a national level scenario for India which is further extrapolated for predicting the trajectory at a city level for Jaipur city.

The starting point for the model was the calculation of manufacturing and operational emissions for an ICE vehicle and an EV. This was used to calculate the emission savings from replacing one ICE E two-wheeler/three-wheeler/ four-wheeler with its electric counterparts.

Key Assumptions of the Model

- Emission related data has been taken from Carbon Brief Profile: India. Since data is available till the year 2016, beyond that all values have been projected based on the existing trajectory/growth rate. All projections have been made by assuming 2005 as the base year.
- For projection of transport sector emissions beyond 2016 it is assumed that the share of its emissions in total emissions remains constant.
- Data related to transport has been taken from SIAM and SMEV on actuals till 2018-19 and all values beyond that have been projected based on the existing trajectory/growth rate. Only those vehicles which are in the passenger vehicle segment of two-wheelers, three-wheelers and four-wheelers have been considered for the purpose of calculation. Further, for two-wheelers and three-wheelers only petrol vehicles have been considered while for four-wheelers both petrol and diesel vehicles have been considered in a 50:50 proportion.
- While the INDC target for carbon emission and power generation has been considered for the projections the INDC target for additional carbon sink has not been taken into account as it is beyond the scope of this study.
- Manufacturing emissions of the different types of vehicles, carbon intensity of petrol and diesel combustion and wall to wheels energy use of an EV has been taken from Shades of Green, a report prepared by Lindsay Wilson for Shrink the Footprint.
- The daily travel activity is considered to be same for an ICE vehicle and an EV. It has been taken from different sources compiled by Centre for Science and Environment.
- Fuel efficiency of ICE vehicles has been calculated on the basis of ranges provided in the literature.
- GDP data at current prices has been taken from IMF World Economic Outlook. GDP at current prices, which has been used for projecting the emission intensity per unit GDP is assumed to grow at the same rate at which it has grown between 2005-2019. (CAGR: 12.2 percent)
- A power mix with 40 percent share of non-fossil fuel-based generation has been considered, 2017 onwards, for the factoring in the greening of the power sector in calculations.



Simultaneously, the transport sector emission trajectory and the GDP trends were calculated to obtain the potential emission intensity per unit of GDP of the transport sector. Additionally, the power sector emission trajectory was calculated based on the INDC targets for non-fossil fuel-based power generation.

Having obtained these data points, the year-on-year emission requirements for the transport was calculated in the context of the INDC 2030 target. Finally, the emission requirement and per vehicle emission savings were combined to calculate the annual number of ICE vehicles that would need to be replaced by electric vehicles, at the national

level, for attaining the target. This was further extrapolated to estimate the same at the Jaipur city level.

The following tables and figures provide a consolidated overview of the analysis and results

Table 3 provides an overview of the projected annual growth in ICE vehicle sales under a business as usual scenario along with the share of those vehicles that will need to be electrified to achieve the INDC targets. According to the model, over the years 32-72 percent of ICE vehicles will need to be electrified progressively, depending on the annual vehicle sales.

Table 3: Results of the Emission-linked EV Targets

Year	ICE Vehicles Sales Projection (India)	Number of new ICE vehicles to be replaced by EVs (India)	Share of ICE fleet to be converted to EV (in percent)
2017	24,789,003	8,011,707	32.32
2018	26,049,730	9,613,519	36.90
2019	27,451,649	12,542,636	45.69
2020	28,929,016	14,104,656	48.76
2021	30,485,890	15,755,163	51.68
2022	32,126,550	17,499,359	54.47
2023	33,855,506	19,342,711	57.13
2024	35,677,509	21,290,952	59.68
2025	37,597,567	23,350,094	62.11
2026	39,620,956	25,526,429	64.43
2027	41,753,239	27,826,536	66.65
2028	44,000,274	30,257,286	68.77
2029	46,368,239	32,825,847	70.79
2030	48,863,640	35,631,315	72.92



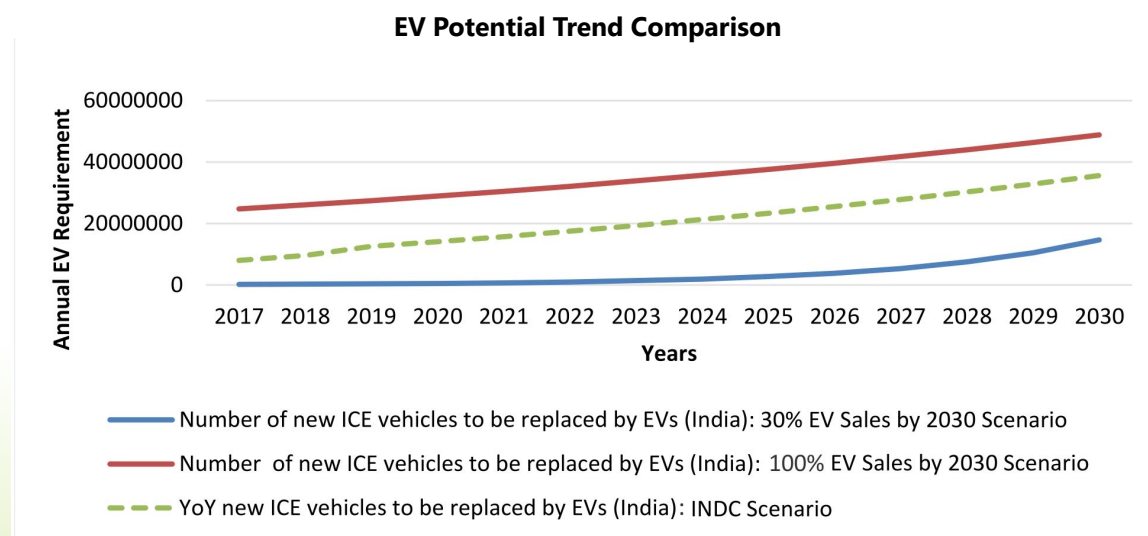
Table 4: Scenario-wise Comparison of EV Required (India)

Year	Number of new ICE vehicles to be replaced by EVs (India): INDC Scenario	Number of new ICE vehicles to be replaced by EVs as per target of 30% EV by 2030	Number of new ICE vehicles to be replaced by EVs as per target of 100% EV by 2030
2017	8,011,707	212,914	24,789,003
2018	9,613,519	264,502	26,049,730
2019	12,542,636	369,603	27,451,649
2020	14,104,656	516,466	28,929,016
2021	15,755,162	721,686	30,485,890
2022	17,499,359	1,008,451	32,126,550
2023	19,342,711	1,409,164	33,855,506
2024	21,290,952	1,969,101	35,677,509
2025	23,350,094	2,751,532	37,597,567
2026	25,526,429	3,844,864	39,620,956
2027	27,826,536	5,372,638	41,753,239
2028	30,257,286	7,507,478	44,000,274
2029	32,825,847	10,490,606	46,368,239
2030	35,631,315	14,659,092	48,863,640

A comparison of the annual electrification trajectory provided by the model with the current government targets of 30 percent of ICE fleet electrification by 2030 or 100 percent of fleet electrification by 2030 was conducted to explore the difference between the policy targets and emission linked targets⁴⁷ (refer to Table 4 and Figure 20).

Figure 20

Scenario-wise Number of EVs Required in India



Source: Author's Analysis

**Table 5: Segment-wise ICE to EV conversion required in Jaipur: INDC Scenario**

Year	Annual Emission Reduction for achieving INDC target (in Mt CO ₂ e)	Number of new ICE vehicles to be replaced by EVs (India)	Number of new ICE vehicles to be replaced by EVs (Jaipur)			
			2W	3W	4W	Total
2017	69	8,011,707	42,249	27,802	1,207	71,258
2018	83	9,613,519	50,696	33,360	1,448	85,505
2019	109	12,542,636	66,142	43,525	1,890	111,557
2020	122	14,104,656	74,379	48,945	2,125	125,450
2021	136	15,755,163	83,083	54,673	2,374	140,130
2022	151	17,499,359	92,281	60,725	2,637	155,643
2023	167	19,342,711	102,002	67,122	2,914	172,038
2024	184	21,290,953	112,276	73,883	3,208	189,366
2025	202	23,350,094	123,134	81,028	3,518	207,681
2026	221	25,526,429	134,611	88,580	3,846	227,037
2027	241	27,826,536	146,740	96,562	4,193	247,495
2028	262	30,257,286	159,559	104,997	4,559	269,114
2029	284	32,825,847	173,104	113,910	4,946	291,960
2030	308	35,631,315	187,898	123,646	5,369	316,912
Average ICE vehicles needed to be converted to EVs		20,969,872.23				186510.33

The comparison reveals that for achieving the INDC target by 2030 the growth trajectory of EVs has to be much steeper than the trajectory expected by the current 30 percent by 2030 targets but flatter than the 100 percent by 2030 targets. Thus, much more aggressive efforts will need to be put in place for boosting EV demand and growth across the country.

Finally, using the model an extrapolation of the national level figures of electrification of the vehicle fleet has been done to predict the potential E-mobility transition levels for Jaipur. This has been done by proportionately reducing the vehicle shares based on the current share of

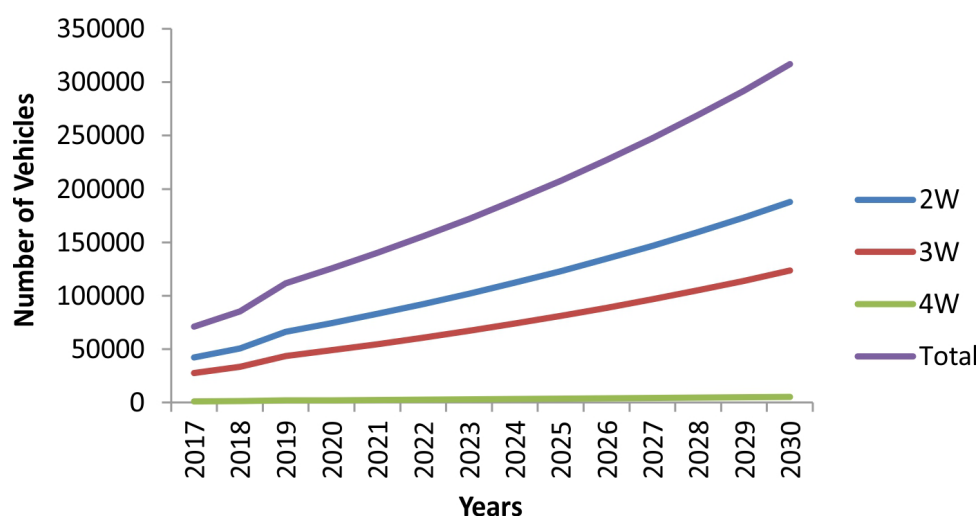
ICE vehicles in Jaipur (refer to Table 5 and Figure 21). The rationale for providing a city level scenario is to address the overarching objective of the project of assessing the impact of E-mobility transition at a city level.

According to the model, given the current trajectory of ICE vehicle growth is maintained, on an average, 2.1 crore new ICE vehicles will need to be replaced by electric vehicles across India, to achieve the INDC emission target. Similarly, for Jaipur city, 18.6 lakhs of new ICE vehicles will have to be replaced by EVs.



Figure 21

Segment-wise ICE to EV conversion required in Jaipur: INDC Scenario



Source: Author's Analysis

Linking E-mobility with Jobs: Estimation of Impact on Jobs in Jaipur City

A substantial increase in the number of EVs must need to be supported by an adequate rise in the personnel involved in various stages of its production and operations. Thus, there is a scope for new job roles and substantial employment generation. At the same time, given the differences in the manufacturing processes of ICE vehicles and EVs and the substantial reduction in the number of components in electric vehicles, it is also imperative that certain job roles may be phased out gradually or lose their employment intensity.

In this section, the report attempts to highlight the potential employment dynamics in the automotive ecosystem which will occur with the advent of E-mobility. **The key assumption here is that the trajectory of EV induction will happen as per the INDC targets, as represented in the previous section.**

The approach adopted for this estimation is a process-based one. A process-wise estimation of

potential jobs that can be added and that may be phased out has been made based on the vehicle estimations made for Jaipur in the previous section. The rationale behind adopting a process-wise approach is that the impact of EVs will be felt differently across different processes. While in some the intensity of loss or gain will be high, in some other processes the scenario will remain somewhat neutral. These nuances can be effectively captured by using a cross-section of processes and job roles.

The key processes that have been considered are pre-manufacturing (i.e. Component manufacturing), Segment-wise vehicle assembly and manufacturing (two-wheeler, three-wheeler and four-wheeler), and Operations (Charging). The following processes have, however, not been considered for calculations due to the underlying reasons.

- Impact on sales has not been considered as it is assumed that dealership and showroom jobs will not become completely redundant due to the transition of ICE to EVs. This is because only the product portfolio will be changing but the workforce required for front end and back end jobs will not change



substantially. It is assumed that with increasing sales of EVs, dealerships will proportionately adopt EVs.

- Impact on end-of-life processes due to EVs has not been considered as these facilities are at a nascent stage in India, both practically and policy-wise.

Component Manufacturing Process

The methodology that has been used for calculating the net job transition in component manufacturing as a result of ICE vehicles being replaced by EVs is as follows

- In the first step, the ratio of the number of workers involved in component manufacturing in India per vehicles manufactured in a year has been computed using industry-level data. This has been used as a multiplier for extrapolating the estimates for Jaipur city.
- Additional jobs in EV Component manufacturing that have the potential to be created are estimated based on benchmarks of employment and production capacity for an EXIDE battery manufacturing plant in India. The six additional parts whose manufacturing will be added to the existing value chain with

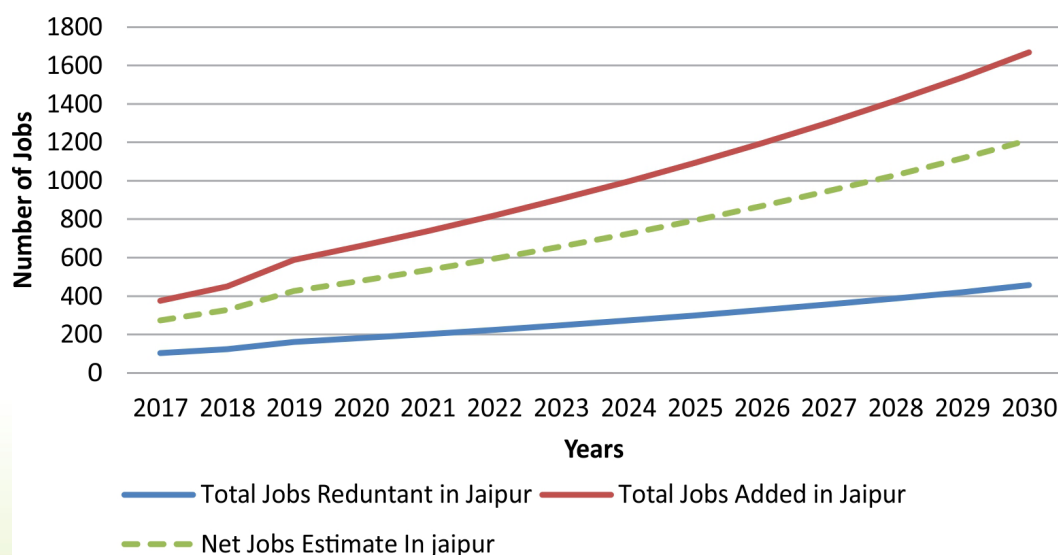
the advent of EVs are electric motors, batteries, inverters, wiring harnesses, microprocessors, and controllers. It is assumed here that the six parts of the powertrain that are to be additionally produced have the same kind of employment intensity.⁴⁸

- Jobs related to ICE component manufacturing which have the potential of becoming redundant are estimated based on benchmarks of employment and production capacity of a model component manufacturing plant for ICE vehicle components wherein the 4 parts engine parts, clutch, radiator, and gears will be phased out with the advent of EVs.⁴⁹

It is observed, that the annual jobs gained will be much higher as compared to the jobs lost in the pre-manufacturing segment as a result of the transition (refer to Figure 22). Further, a large proportion of the jobs are going to remain neutral. Thus, the net impact of the transition on employment in the component manufacturing process is going to be positive though there is a potential of phasing out of those roles which are associated with components that are specific to ICE vehicles.

Figure 22

Employment estimates in Pre-Manufacturing Process



Source: Author's Analysis



However, with appropriate reskilling and upskilling the part of the workforce that has the potential of becoming redundant can be rehabilitated in the new ecosystem through the new jobs being created.

Segment-wise vehicle assembly and manufacturing

In the next step, the job dynamics in vehicle assembly have been calculated. The methodology that has been used for calculating the segment-wise net job transition in vehicle assembly and manufacturing processes as a result of ICE vehicles being replaced by EVs is as follows:

For Two Wheeler (2W) manufacturing

- Estimations for the number of plants and employment required have been made on the basis of enterprise-level benchmarks. It is assumed that a model E-2W manufacturer will have a capacity of producing approximately 1000 vehicles per month and employment intensity of 1 person per 2W manufactured. Additionally, it is also assumed that all such potential 2W manufacturers will be of similar size and capacity.⁵⁰
- For estimating the potential jobs that could be lost in the vehicle manufacturing process the

benchmarks of production and employment have been taken for a model large-sized ICE 2W manufacturing plant employing approximately 8551 persons and producing approximately 7587130 units annually.⁵¹

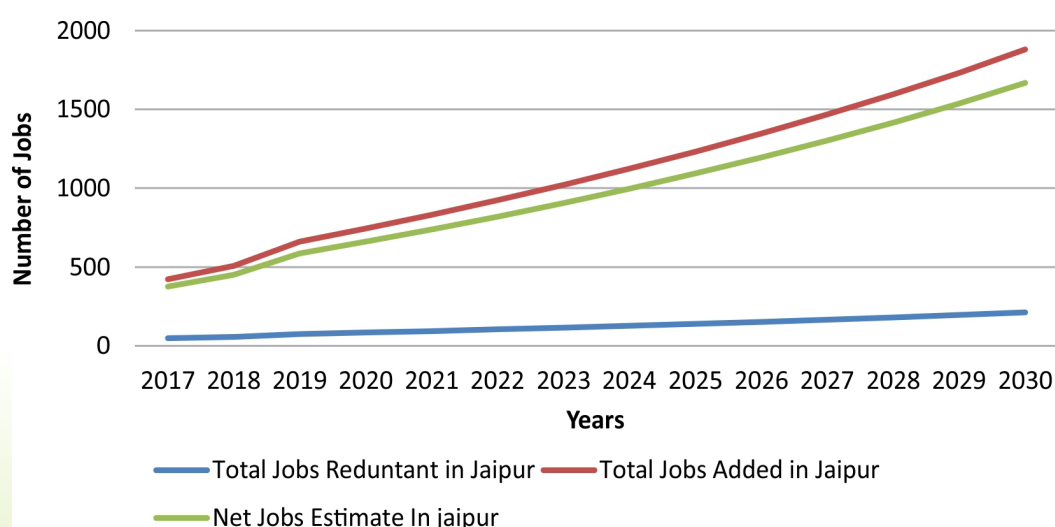
In this case, the required EV manufacturing plants in Jaipur have been calculated based on the number of new ICE vehicles that will need to be replaced by EVs to meet the INDC targets along with the current mode share of E-2W. Based on this trajectory, it can be observed that as in the case of pre-manufacturing the employment generated for additional 2W manufacturing will be much higher than the employment lost due to the transition. (Refer to Figure 23)

For Three-wheeler (3W) manufacturing

- Estimations for the number of plants and employment required have been made based on enterprise-level benchmarks. It is assumed that a model E-3W manufacturer would have a capacity of producing approximately 1500 vehicles per month or 50 vehicles per day and an employment intensity of 1.1 persons per 3W manufactured. Additionally, it is also assumed that all such potential 3W manufacturers will be of similar size and capacity.⁵²

Figure 23

Employment Estimates in 2-W Auto Manufacturing Process



Source: Author's Analysis



- For estimating the potential jobs that will be lost in the vehicle manufacturing process the benchmarks of production and employment have been taken for a model large ICE 3W manufacturing plant in India employing 2419 persons and producing 3 lakh units annually.⁵³

Similar to two wheelers, the required E-3W manufacturing plants in Jaipur have been calculated on the basis of the ICE to EV transition that will be required to meet the INDC targets and the current mode share of E-3W. Along with estimates for total employment gained in setting up additional E-3W manufacturing plants, estimates have also been made for some of the manufacturing processes such as painting, chassis making, boxing, and seat manufacturing for highlighting the different types of skilled employment generation (refer to Annexure II).

Based on this trajectory, it can be observed that as in the case of pre-manufacturing the employment generated for additional three wheeler manufacturing will be marginally higher than the employment lost due to the transition.

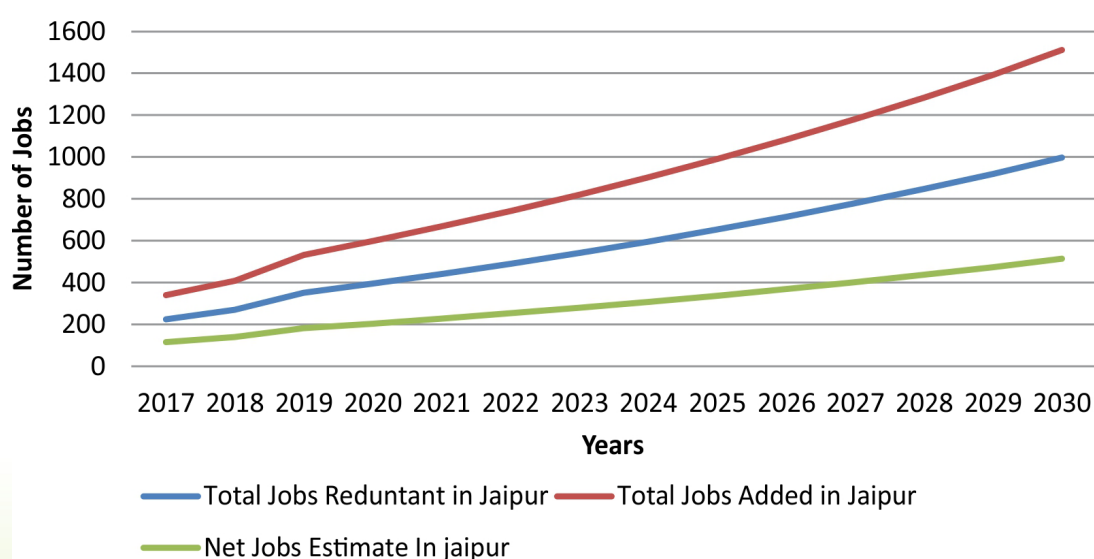
The gap between the jobs lost and jobs gained is much narrower in this case. This could be attributed to the high mode share of ICE 3W and E-3W in comparison with other vehicle segments. (Refer to Figure 24)

For Four wheeler (4W) manufacturing

- Estimations for the number of plants and employment required have been made based on enterprise-level benchmarks. It is assumed that a model E-4W manufacturer would have a capacity of producing approximately 25000 vehicles per month and employ 200 people for carrying out its operations. Additionally, it is also assumed that all such potential 4W manufacturers will be of similar size and capacity.
- For estimating the potential jobs that will be lost in the vehicle manufacturing process for four wheelers the benchmarks of production and employment have been taken for a model large ICE 4W manufacturing plant in India employing 14000 persons and producing 9 lakh units annually.⁵⁴

Figure 24

Employment Estimates in 3-W Auto Manufacturing Process



Source: Author's Analysis



In the case of four wheeler manufacturing, both the employment generation for new EV manufacturing plants and employment redundancy for ICE manufacturing are much lower than those for two wheelers and three wheelers because the scale of manufacturing of four wheelers is higher and several processes are automated. (Refer to Figure 25)

The significant finding, in this case, is that the jobs lost will be higher than the jobs gained because for a plant of higher capacity, a lower scale of production will mean lower labour deployment and hence lesser jobs. This is based on the assumption that the current mode share of four wheelers is maintained. In case the mode share grows the employment dynamics will change accordingly.

Operations

Following manufacturing, the next process in the vehicle value chain is operations. The key difference in operations of EVs and ICE vehicles will be the difference in refueling the vehicles. While EVs will require the setting up of Public Charging Stations (PCS), ICE vehicle operations will need fuel stations.

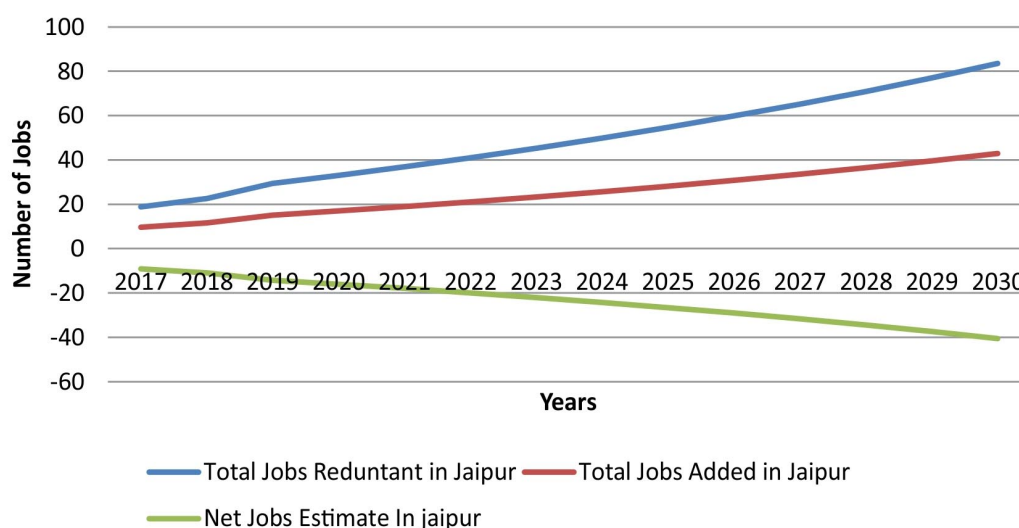
Thus, given the complete contrast in the stakeholders involved in operations, it becomes crucial to gauge the impact of the E-mobility transition in this process. The methodology that has been used for calculating the net jobs lost in vehicle operations as a result of ICE being replaced by EVs is as follows

- Additional employment generation due to the operation of EVs, in terms of operating a PCS, is computed for two scenarios. Under the first scenario, the numbers of PCS to be set up are taken as per the guidelines prescribed by MoP.⁵⁵ In the second scenario, the ratio of on-road vehicles (total) to existing petrol pumps ratio has been used as an optimal reference point for charging stations. Using this ratio the annual requirement of charging stations per number of vehicles under consideration has been calculated.
- In both the scenarios it is assumed that there would be a requirement of 15 people for the operations of each charging station.⁵⁶

Under the first scenario, there will be a cumulative direct employment generation of 810 persons for catering to the 54 new charging stations that will potentially need to be created in

Figure 25

Employment Estimates in 4-W Auto Manufacturing Process

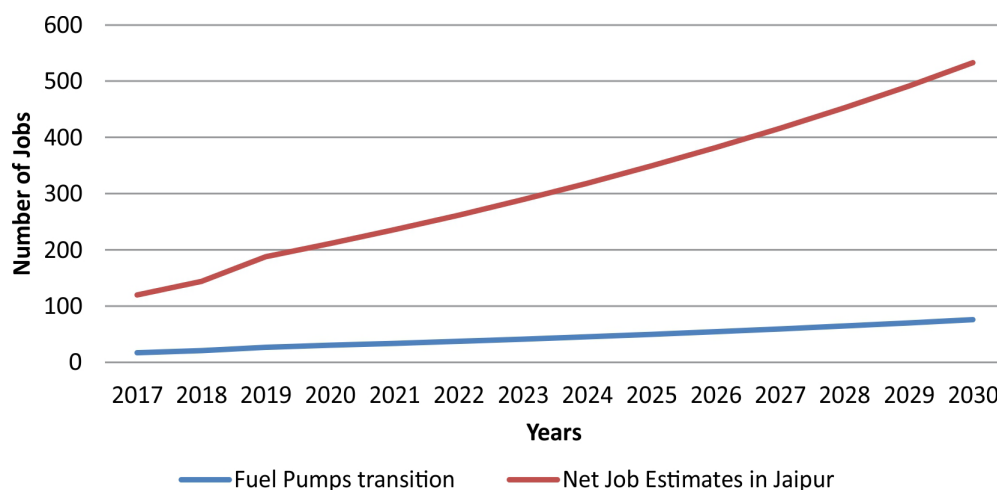


Source: Author's Analysis



Figure 26

Employment Estimate due to Fuel Pumps Transition



Source: Author's Analysis

Jaipur. Under the second scenario, a total of 9412⁵⁷ jobs will be generated in this process/segment by 2030. However, this will involve both rehabilitation of the existing workforce in the fuel stations and the addition of a new workforce. (Refer to Figure 26)

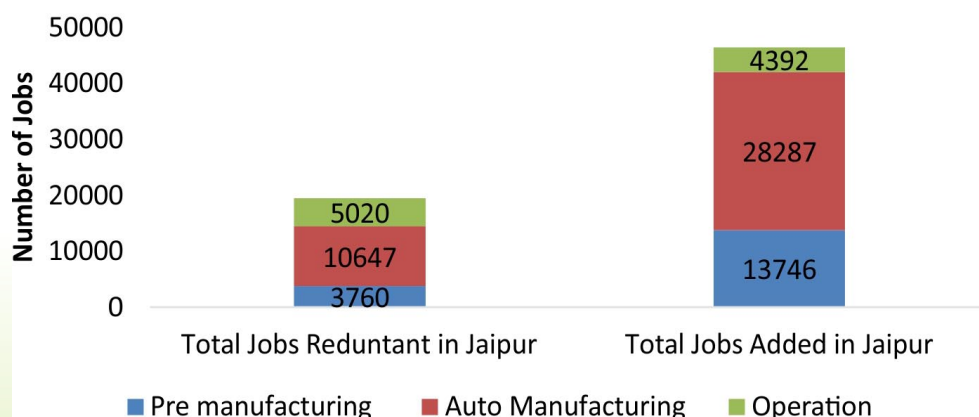
Final Results of Estimation Exercise: After combining the net employment generation for pre-manufacturing, vehicle assembly and manufacturing and operations it can be concluded that approximately 46425 jobs will be added in Jaipur as a result of the new EV additions, out of which 13746 jobs will be

created in pre-manufacturing, 28287 in auto manufacturing and 4392 in operation. Further, approximately 14408 jobs will be lost from the redundancy or phasing out of various ICE vehicle-related processes, out of which 3760 jobs will be created in pre-manufacturing, 10647 in auto manufacturing, and 5020 in operation.

Thus, the net potential employment generation up to 2030 as a result of the E-mobility transition will be 32017 jobs across the spectrum of processes and skillsets. (Refer to Figure 27)

Figure 27

Net Employment Estimates for EV Transition in Jaipur City by 2030



Source: Author's Analysis



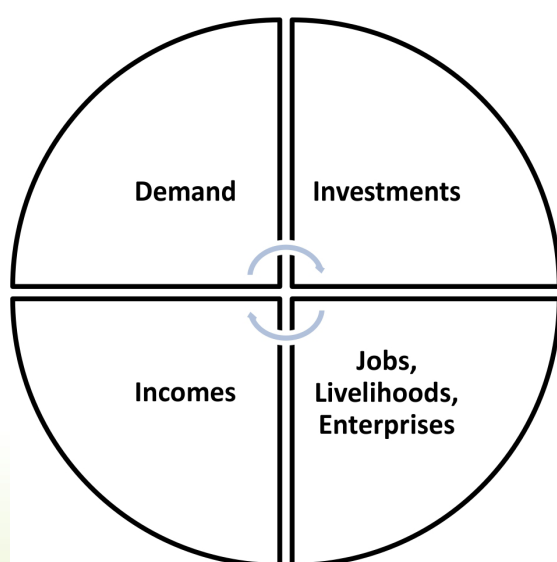
However, the current estimates only cover jobs in the pre-manufacturing, vehicle manufacturing, and operations value chain. Several allied stakeholders are linked to the core automotive ecosystem. As the EV ecosystem develops, substantial jobs will also be created in these indirect but nodal areas, resulting in much higher net employment gains.

Impact of Electric Mobility Transition on Facets of Jobs in Jaipur, Rajasthan

The automobile sector in India, which employs around 32 million workers, is one of the most employment-intensive manufacturing industries.⁵⁸ This section comments on the quality of jobs in the automobile sector and assesses the potential impact of electrification of mobility.

As a preface to the analysis of the qualitative aspects of jobs it is worthwhile to understand the relevance of the quality of jobs from an economic point of view. Figure 28 depicts an engine of growth for any economic sector:

Figure 28
Engine of Growth



Source: A New Industrial Policy for India, CUTS International & Arun Maira⁵⁹

As depicted in the engine of growth, for any enterprise to flourish financially, it needs a constant demand from the market for products it is manufacturing, vehicles in this case. This demand comes from the purchasing power of the consumers which is a direct outcome of their incomes and livelihood.

This implies that an economy with a better-paid consumer-base will potentially have better purchasing power, thus driving the demand for different products. The livelihood of different consumers is also generated by the production facility or enterprise themselves by employing workers and paying them wages. Thus, a better-paying enterprise not only secures demand for different products in any economy but also secures demand for its products. Finally, when such conditions are fulfilled, then only investment inflows grow, thus completing the engine of growth.

A Top-Down View of Labour in the Automobile Sector

The economic contribution of the road transport sector to India's GDP has been a significant 4.8 percent over the last few years. To achieve the national growth targets while ensuring that environmental goals are not compromised, it becomes prudent for the sector to strategically address the structural issues and capture opportunities that come along.

One of these structural issues is the cost of labour borne by these industries in India. A presentation by the India Brand Equity Foundation (IBEF) in the year 2009 pegged India's labour cost and productivity-adjusted labour cost at par with China.⁶⁰

This, as perceived by industry players, is a positive factor aiding domestic manufacturing more competitive in the global world and therefore, making India an investment destination. But when read from a bottom-up manner, this highlights a major concern of workers being paid significantly less as compared to other countries, even after being more productive than the

**Figure 29: Comparison of Labour Costs**

	India	Brazil	China	Thailand
Labour cost (US\$/hour)	0.75	4.3	0.75	0.8
Labour cost (US\$/day)*	6	33.6	6	6.4
Productivity index**	1.0	2.0	1.0	1.2
Productivity adjusted labour cost (US\$/day)	6	16.8	6	5.33

*Assuming eight-hour shift per day

** Gross value added per person employed when compared to India

Source: (IBEF, 2009)

workers in those countries. Figure 29 highlights these statistics as depicted in the presentation by the IBEF.

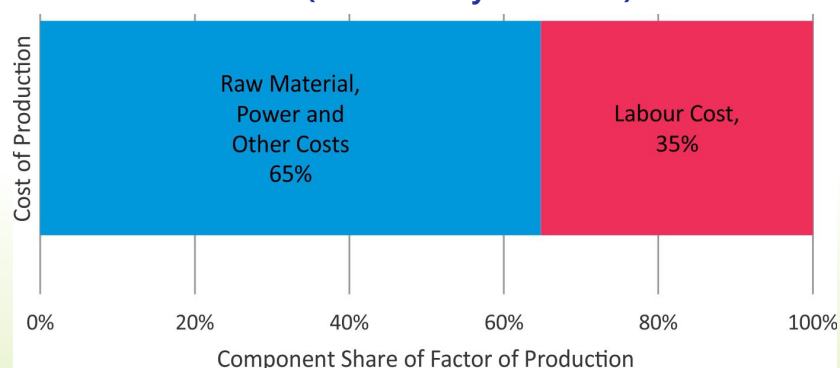
To put this in the current perspective, an analysis by ET Auto⁶¹ has synthesised the proportion of labour costs in the total operating revenue of major OEMs as.

It throws up an interesting insight regarding the gradual fixation of labour costs for automobile manufacturers across the years. For instance, employee cost as a percentage of operating revenue for Mahindra and Mahindra (consolidated) was at a significant 17 percent but has now reduced and saturated at around 10-12 percent. For other players, the proportion has been almost constant across the decade, barring a few jerks. However, there is a vast variation in employee costs as a percentage of operating revenue across the different players. This may be

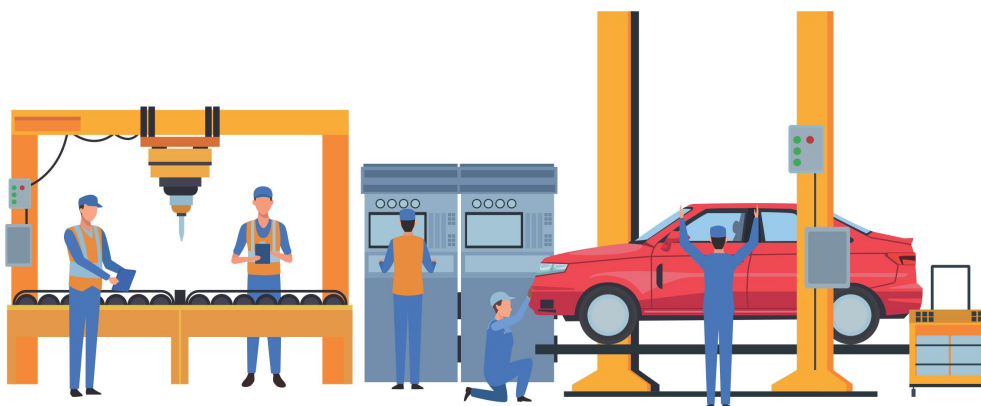
due to different degrees of automation, scale, production capacity, and employment intensities of the respective OEMs.⁶²

For the component manufacturing sector⁶³ which is more than 70 percent informal, the revenue margins are significantly lower which also results in lower wages of the informal and migrant workers engaged in them as well as a higher labour cost burden for the enterprises. The revenue margins for the smaller players in this segment are also lower than the bigger players and significantly lower than the OEMs, as highlighted by a report by ACMA.⁶⁴

For an EV, say an e-rickshaw, the current share of labour cost in the total cost of production is significant owing to manufacturing at a low scale, with low automation and reduced capacity utilisation because of sub-optimal market demand (refer to Figure 30).

Figure 30**Share of Labour Cost for Electric 3-W (Estimation by Interviews)**

Source: Author's Analysis



However, with increasing automation, the trend is likely to follow the ICE trajectory with labour costs shrinking significantly, thus making the workers more precarious and enterprises more dependent on automated technology. Such a scenario has the potential to ultimately lead to a situation with excessive production but low demand owing to low purchasing power of the consumers in the economy, as is explained by the engine of growth. These crucial parameters become a key premise for assessing the nature of jobs in the automobile sector and comparing the jobs to be generated due to the adoption of EVs.

Impact of Electric Vehicles on Quality of Jobs: A Bottom-up View

As highlighted in the previous section, electric mobility at a city level is poised to create a net positive impact on the number of jobs in the sector. While generating new jobs, it will also a dent in the future demand for certain types of jobs that are exclusive to ICE vehicles. Additionally, this transition will make it necessary for certain conventional auto-sector job roles to undergo upskilling for adjusting to newer technologies and the changing nature of production.

To explore the quality of jobs in a bottom-up manner, this section highlights some key qualitative aspects of jobs potentially added, lost, or pushed to margins due to the electric mobility transition in Jaipur, Rajasthan.

1. Informality and Migrant Workers in Component Manufacturing Jobs:

The ICE vehicle manufacturing industry is dependent on a vast network of component manufacturers and suppliers of auto parts. A key attribute of these component manufacturing jobs is the high degree of informality in the production clusters and high dependence on migrant workers to undertake the operations. One of the reasons for lower incomes is the reduced revenue margins on which these suppliers operate.

With a shift to EVs, a major impact will be felt on these domestic component manufacturers as many key components of ICE vehicles will be no longer required for the manufacturing of EVs. The main types of parts required for EVs are currently outsourced from China and bringing those jobs to India and remaining competitive in the market will require structural solutions for reducing the cost of production without harming worker welfare.

2. Automation in Assembly Line Production

Jobs: A major trend in the auto sector is automation, driving the narrative towards a higher scale of production at reduced costs and with minimal error. This implies that the nature of jobs required for automated assembly-line manufacturing would be less machine-oriented and more of operators, observers, and technicians. This, as perceived



by several stakeholders that were interviewed, has a positive impact on the gender ratio of the workforce, as less heavy machinery related jobs can be an avenue for employing more women workers. Thus, with automation, the net jobs on the factory floor will be reduced by a significant extent, and backend jobs of designing, implementing and operating the automated technology will see a hike.

However, the main challenge with the creation of such job roles in India is the cost competitiveness of other countries like China in producing such automated machines for the automobile and other sectors. More importantly, with technology being a major component and driver in EVs the prospects of automating to achieve scale are inherently high, and ensuring that redundant jobs on the manufacturing side are offset by additional domestic jobs in automation and technology becomes crucial.

3. Consumer Interface Jobs in Sales of

Vehicles: In showrooms and dealerships, the impact of the E-mobility transition will not be as significant on the quantum of jobs as it will be on the need for skilling of the employees. The front end and backend office workers in dealerships and showrooms will become the key interface delivering the knowledge, benefits, and other details of the vehicles to make a sale.

With the shifting of vehicle portfolio to EVs, the existing workers' knowledge base of EVs, the different models, financials, efficiency, charging, safety, and other details are of utmost importance for sales. This is even more important in the initial years of EVs, as lack of knowledge remains a major obstruction in enhancing the uptake of EVs in emerging markets.

4. Unorganised Jobs in Repair and

Maintenance Markets: The city landscape of Jaipur is marked by many informal repair and maintenance shops, largely informal,

providing their services to conventional vehicles. With the internal design and components poised to undergo a complete transformation in the EV-scenario, such workers and workshops face the threat of being rendered outdated.

The mechanical and industrial engineering-related repair and maintenance services in ICE vehicles will become more electrical and electronics oriented in the case of EVs, which will require skilling and capacity building of such informal workers. As of now, given the nascent stage of EVs in Jaipur, the manufacturers and different dealerships themselves provide repair and maintenance services but with a greater uptake, there will be a demand for more such facilities across the city.

5. Nature of Hazard in EV-related Jobs: In an EV-dominated market scenario of Jaipur, a significant number of operation-related jobs in repair and maintenance, charging stations, and dealerships will undergo a transformation. This entails that the nature of risks associated with EVs will also need proper attention and capacity-building support.

For instance, if a petrol pump operator starts working on a charging station, he would require expertise regarding handling high-voltage systems, batteries, power supply systems and also take into account the safety aspects of ambient temperature affecting battery charging, amongst others.

Similarly, a conventional vehicle scrappage facility while transforming to a battery scrappage unit will require significant knowledge and training support regarding the handling of battery constituents, chemicals, and hazardous e-waste.

6. Income Aspects of End-user Jobs: EVs, just like conventional ICE vehicles, are a strong case of enhancing the incomes of drivers, especially in a fleet aggregator or a platform-



based aggregator model. Given the overall low operating costs of EVs in the long-run, the prospects of net profits of drivers in an EV fleet increasing with time are also bright, however, it is too soon to comment on the same at this stage.

But, a shift to an aggregator model and that too an EV-based one will require skilling support on various fronts. These include handling technologies like battery health and charge monitoring, Global Positioning System (GPS) Maps, consumer interaction, and communication skills, ensuring passenger safety and satisfaction, amongst others.

Women in the Automotive Ecosystem

The Automotive Industry continues to be one of the least gender-diverse industries across the world, with only eight percent of women holding executive positions in the top 20 Auto companies in Fortune 500. Statistics from the shop floor reveal that female workforce participation is 20 percent in Japan, 23.4 percent in Sweden, 23.6 percent in the USA, and 18.4 percent in Germany.⁶⁵

However, Cut to India, the picture remains grim when it comes to female participation in a male-dominated industry. The key reasons for such a dismal rate of female participation can be attributed to the nature of work, gaps in education, low skill levels, or lack of avenues for skilling and socio-cultural barriers for women.

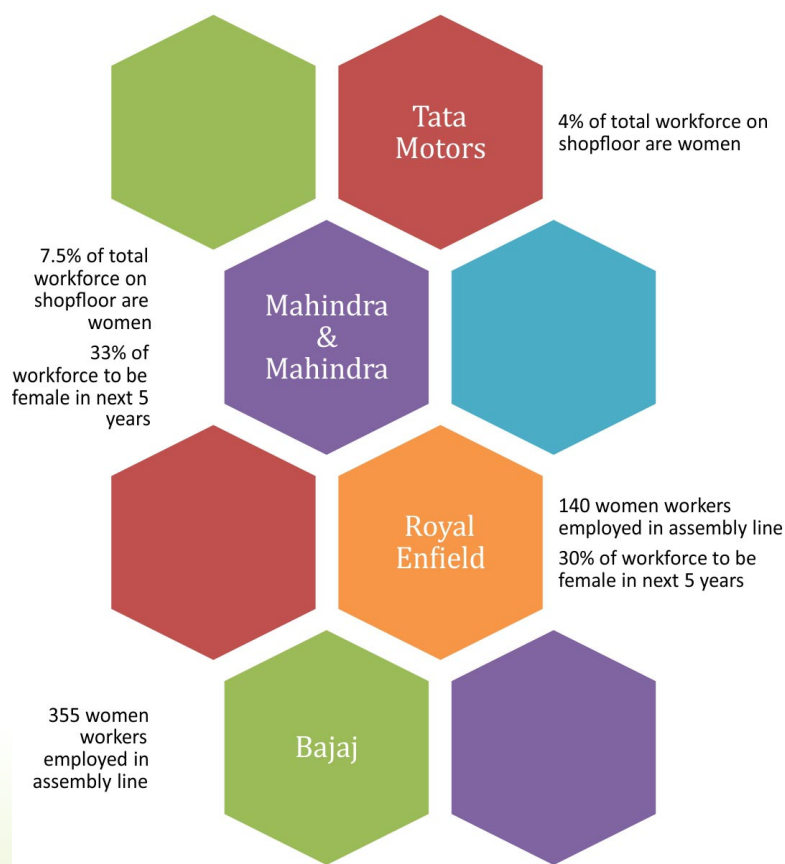
Furthermore, as the industry transforms towards E-mobility, green shoots can also be seen

in this realm. Helmed by the larger OEMs, the industry is opening up to women in manufacturing, with the introduction of exclusive female assembly lines.⁶⁶

Across the pre-manufacturing and manufacturing processes, jobs are mostly on the shop floor where female participation is currently observed to be minimal. However, the advent of automation in manufacturing and assembly processes seems to be a ray of hope for ensuring gender diversity. (Refer to Figure 31) Automation will lead to enhanced operational health and safety in workplaces, which may make it more conducive for women to be hired for and take up these jobs.

Figure 31

Women Workforce in Indian Automotive OEMs



Source: Statements given by OEM representatives to media



Especially in the case of EVs, indigenisation of automated pre-manufacturing and manufacturing processes may lead to more gendered jobs in the realm of artificial intelligence, IoT, and machine learning. Insights from interactions with industry experts revealed internal targets of increasing female participation from the current 10 to 33 percent in manufacturing plants. Female workers are also being encouraged in the Research and Development division of OEMs. The need of the hour, however, is providing women with adequate opportunities for skill development for preparing them for such job roles.

In the case of vehicle sales, the presence of women is visible within dealerships as a mixed workforce is preferred for catering to different kinds of consumer profiles. Given, the rising numbers of female customers, dealerships are gradually increasing the share of women in client-facing jobs for ensuring customer comfort.

Another arena where female participation is emerging is end-user jobs. New models of driving are being increasingly used as an opportunity to increase the share of women workforce in such operations. Pink cabs and e-rickshaws are some

of the experiments already tested in Jaipur, the pink city. However, stereotyping of women-led vehicles as pink vehicles is an exclusionary principle which needs careful revisiting. Many stakeholders who were interviewed provided varying perspectives on this issue, with some advocating for such branding as means to have better coverage and utilisation of women-driven cars while some felt that gender-based stereotyping was a barrier to allow women workers to mix in the general workforce as any other driver would.





5

WAY FORWARD





EVs seem to be bringing with them two kinds of opportunities for the job market. Firstly, they bring with them an opportunity for the current workforce and the sector to upgrade itself for adapting to newer technologies and processes introduced by Industry 4.0, through reskilling and up-skilling.

Secondly, and more importantly, the transition to E-mobility brings with itself an opportunity for an array of new, skilled, job roles in the realm of Artificial Intelligence, Mechatronics, Internet of Things, and allied fields which can be leveraged effectively for motivating India's young workforce towards a newer dimension.

One of the key insights that have emerged from this study is that a transition to E-mobility will lead to a net increase in the number of jobs across the automotive value chain, in pre-manufacturing processes, vehicle assembly and manufacturing processes and operations.

Additionally, new jobs will be created to cater to the end-of-life processes of EVs given the significance of safe disposal and recycling of the hazardous batteries used in them. However, what must be ensured is that this transition occurs in a just manner to ensure social, economic, and environmental sustainability. Thus, as the transition to E-mobility materialises at a city level, state level and national level, a focus on the following aspects will be crucial for ensuring it is a just transition.

Strategically Tackling the Rapidly Advancing Technology

The technology landscape around EVs is rapidly transforming with faster and smarter solutions like Vehicle to Grid, Fast DC Charging, Solar Powered Vehicles, amongst others reaching the market. These enablers of an efficient transition to a clean transportation landscape also have the intrinsic risk of becoming potential disruptors.

For instance, the safety risks owing to fast DC chargers become extremely relevant for a tropical

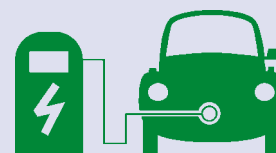
country like India where ambient temperatures can be high enough to make the charging and discharging process thermodynamically unsafe and susceptible to battery explosion.

Similarly, considerations around the stability of the grid and readiness of the ecosystem arise when technological interventions like V2G and V2X (Vehicle to Everything) are planned.

Potential Research Area

Mapping and conducting feasibility analysis of emerging technology-based transformations

occurring in the e-mobility and transportation sector to ensure that such transformations are socio-economically and environmentally just.



Indigenisation as a Means for Job Creation

The COVID-19 pandemic has disrupted global supply chains and brought to light the perils of not having localised value chains from the source to the sink. It has reiterated the need for self-reliance across sectors of the economy and especially in the case of industry. In the case of EVs, India is heavily dependent on imports for vehicle components and largely focuses on assembly.

However, localisation of pre-manufacturing and component manufacturing processes showcases promising potential when it comes to the creation of business and livelihood opportunities. Localisation will lead to the elimination of supply-side distortions as well as create job opportunities across the skill spectrum, at the local level.

Thus, one of the key methods for fostering job creation at the city or state level will be through the promotion of indigenous EV component



manufacturing. This can be facilitated by providing adequate financial and policy support for these initiatives.

Potential Research Area

Evidence-based research, advocacy and capacity-building exercises in the automotive components and allied sectors to ensure that the livelihood potential of e-mobility transition is realised in a resilient manner, particularly in the context of the narrative around self-resilient India (*Atmanirbhar Bharat*).



Creating an Enabling Environment for the EV Life Cycle

For ensuring an effective and efficient transition to EVs, fostering an enabling environment is important for every stage of its life-cycle. While the elimination of supply-side distortions becomes critical for ensuring a smooth-functioning supply chain of vehicles, setting up of a robust charging network and provision of adequate after-sales or repair and maintenance services is imperative for ensuring smooth operations of EVs.

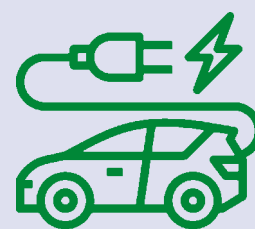
Additionally, to ensure the life-cycle of an EV is sustainably completed, setting up recycling or battery mining units will be the need of the hour.

As each of these nodal players mushroom, so will the livelihood opportunities linked to these. At a city level, setting up charging stations, repair workshops, and recycling units will create opportunities for the formal as well as the informal workforce. It will also provide a platform for rehabilitation of the workforce engaged in other processes of the automotive ecosystem which might get redundant with the transition.

An example would be the replacement of existing petrol pumps with charging stations and reorganisation of jobs accordingly. Thus, going forward, a focus on boosting the allied stakeholders in the EV-automotive ecosystem will have a multiplier effect on jobs in the ecosystem, provided that there is adequate focus and support for them.

Potential Research Area

Evidence-based research, analysis and advocacy project on the action plan required to enable a cradle-to-grave ecosystem for EV-related processes in a particular jurisdiction to enable a circular economy in this sector.



Skilling for the New Workforce and Reskilling for Rehabilitation

The study suggests that the net impact of the E-mobility transition on jobs in the automotive ecosystem will be positive. At the same time, it also suggests that the new job roles will require new or different skillsets.

In the higher-skilled segment, there will be opportunities in artificial intelligence, mechatronics, etc. while in the low-skilled segment there will be a need for basic digital skills and knowledge of batteries and charging system operations, etc. Additionally, automation in manufacturing processes will require skillsets of its own.

Thus, a just transition will require provisions for building these skillsets as well as reskilling of the existing workforce. The first step towards this will be a skill mapping exercise to gauge the current skill levels of the workforce and identify the degree of skill development required.



This should be followed by the setting up of skill training centers and the introduction of relevant courses in the curriculum in educational institutions. Targeted, EV specific vocational courses may also be a means to facilitate this. Additionally, industry players can provide on-the-job training as is prevalent currently.

Thus, as the automotive sector transitions to sustainable alternatives, there is a need for the employment scenario in the sector to transition into a more inclusive one. Automation may be one of the proponents including a higher number of women in the pre-manufacturing and manufacturing processes.

Potential Research Area

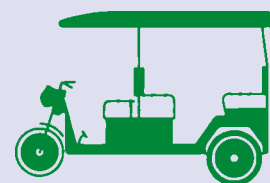
Mapping the skill ecosystem required for a sustainable and just EV ecosystem in a selected jurisdiction and preparing an actionable framework for achieving it through primary research, secondary research and analysis, advocacy, networking, and relevant capacity building exercises.



Alternatively, women may be encouraged for jobs at charging stations or as drivers with fleet aggregators. However, the first step towards this will be necessary skill training for the women to provide them with a level playing field in the male-dominated sector.

Potential Research Area

Evidence-based research and advocacy on gender-related issues in the transportation sector for preparing an actionable framework for enhancing women participation in manufacturing, infrastructure creation, operations, services, and consumer usage domains of the e-mobility ecosystem.



Bridging the Gender Gap

The automotive sector has so far been an alien field for women. However, as the study highlights, small developments are taking place for improving gender diversity in this realm, be it through target setting for female participation on the shop floor or the introduction of female-driven fleets. EVs are no exception to this as reflected during stakeholder interactions.

Annexure

Emission Calculator

Fuel-Efficiency of ICE vehicles

Vehicles Segment	Average Vehicle Efficiency (Km/L)
2W (Petrol)	50.4
3W (Petrol)	33.215
4W Petrol	15.75
4W Diesel	14.65

Travel-Activity

Vehicles Segment	Average Single trip length by per person (Km)	Annual Distance travelled per vehicle (Km)
2W	6	2299.5
3W	7.8	13452.075*
4W	9	3449.25

* Assuming that there are 4.5 passengers per 3W

Mode Share Calculation for various vehicles segments in EVs in India and Jaipur

Vehicle Segments	Percentage Share on India Level
2W	59.29%
3W	39.02%
4W	1.69%
Total	100.00%

Vehicle Segments	Percentage Share on Jaipur city Level
2W	72.89%
3W	1.45%
4W	18.39%
Total	100.00%

Emission Intensity Calculation

The total emission intensity has been calculated by adding manufacturing emission intensity and operational emission intensity. Manufacturing Intensity has been calculated by multiplying the per kilometre emission intensity of manufacturing a petrol/diesel/electric vehicle with the annual travel activity respectively. Operational emission intensity has been calculated by multiplying Travel Activity, Mode Share, Fuel Efficiency/Power efficiency, Carbon Emission Factor for operations.



Annual Emission Intensity of an ICE Vehicle

ICEV	Manufacturing Emissions (in g CO ₂ e)	Operational Emissions (in g CO ₂ e)	Total Emissions (in g CO ₂ e)	Total Emissions (in Mt CO ₂ e)	Difference in Emissions Intensity (in Mt CO ₂ e) per vehicle per year
2W (Petrol)	91980	9167774.106	9259754.106	0.00000925975	0.0000089853
3W (Petrol)	538083	2561020.234	3099103.234	0.00000309910	-0.00000299
4W (Petrol)	137970	2367940.643	2505910.643	0.00000250591	0.0000023723
4W (Diesel)	120723.75	2953497.172	3074220.922	0.00000307422	0.0000029405931
					Total Emission Savings of converting one vehicle from each ICE segment to EV
					8.65575E-06

Annual Emission Intensity of an EV

EV	Manufacturing	Operational	Column1	Total Emissions (in Mt CO ₂ e)	
2W	1.60965E-07	1.13448E-07		0.00000027441	
3W	5.38083E-07	5.54705E-06		0.00000608513	
4W	1.20724E-07	1.2904E-08		0.00000013363	



Transport Emission Projection

The transport emission calculations are available until 2016 and projections in all categories have been made from 2017 to 2030.

Year	Transport Sector Emissions (Mt CO ₂ e)
2005	102.7
2006	112.9
2007	120.7
2008	132.3
2009	148.1
2010	163.2
2011	207.9
2012	220.6
2013	228.2
2014	248.8
2015	257.3
2016	270.6
2017	295.5142721
2018	322.7224132
2019	352.4356209
2020	384.884538
2021	420.3210425
2022	459.0202029
2023	501.2824137
2024	547.4357265
2025	597.8383971
2026	652.8816657
2027	712.9927945
2028	778.6383839
2029	850.3279943
2030	928.6181015



Vehicle Projection

Year	Annual Transport Emission Trajectory if INDC met	Annual Difference in Emission Required for INDC	India ICE-EV Conversion required (INDC)	Percentage Conversion with Avg vehicle conversion value	India ICE Vehicles Projection	Share of ICE fleet to be converted to EV	30% by 30 EV projection	100% by 30 EV projection	Jaipur ICE-EV Conversion required (INDC)
2016	270.6								
2017	236.0709586	69.34733421	8011706.703	84.59344747	24789003	32.32	212914	24789003	71257.75798
2018	205.9478843	83.21222131	9613518.947	80.49938418	26049730	36.90	264502	26049730	85504.60368
2019	179.6685678	108.5659305	12542636.32	76.38838829	27451649	45.69	369603	27451649	111556.7727
2020	156.7425389	122.0863869	14104656.44	72.48733324	28929016	48.76	516466	28929016	125449.6991
2021	136.7419121	136.3727575	15755162.73	68.7855012	30485890	51.68	721686	30485890	140129.6396
2022	119.2934008	151.4700864	17499359.14	65.27271752	32126550	54.47	1008451	32126550	155642.8791
2023	104.0713506	167.4256802	19342711	61.939326	33855506	57.13	1409164	33855506	172038.0276
2024	90.79166113	184.2891737	21290952.64	58.77616689	35677509	59.68	1969101	35677509	189366.0872
2025	79.20648364	202.1125908	23350094.37	55.77454581	37597567	62.11	2751532	37597567	207680.5149
2026	69.09959541	220.9503978	25526428.71	52.92621468	39620956	64.43	3844864	39620956	227037.2776
2027	60.2823641	240.8595492	27826535.61	50.22334251	41753239	66.65	5372638	41753239	247494.8988
2028	52.59022719	261.8995222	30257286.48	47.65850374	44000274	68.77	7507478	44000274	269114.4942
2029	45.87962063	284.1323389	32825846.74	45.22464662	46368239	70.79	10490606	46368239	291959.7945
2030	40.02529942	308.4157755	35631315.38	42.91508416	48863640	72.92	14659092	48863640	316912.2064

Annexure

Data Tables for Vehicles and Jobs related Estimations

Pre Manufacturing

Year	Total Jobs Impacted	EV Component Manufacturing Jobs Gained	ICE component Manufacturing Jobs Lost	Jobs Remaining Neutral
2017	12542	375	103	12439
2018	15050	450	123	14926
2019	19635	587	161	19474
2020	22080	660	181	21900
2021	24664	738	202	24462
2022	27395	819	224	27170
2023	30280	906	248	30033
2024	33330	997	273	33057
2025	36554	1093	299	36255
2026	39961	1195	327	39634
2027	43561	1303	356	43205
2028	47367	1417	388	46979
2029	51388	1537	420	50967
2030	55779	1668	456	55323

2-W

Year	Required 2W manufacturing Plants	Employment generated (2W)	Employment lost for ICE conversion (considering Hero Plant)
2017	14	422	48
2018	17	507	57
2019	22	661	75
2020	25	744	84
2021	28	831	94
2022	31	923	104
2023	34	1020	115
2024	37	1123	127
2025	41	1231	139
2026	45	1346	152
2027	49	1467	165
2028	53	1596	180
2029	58	1731	195
2030	63	1879	212



3W

Year	Required plant 3W manufacturing plants	Total employment gained	Painters	Chassis	Boxing	Seat and Cushion manufacturing	ICE 3W manufacturing jobs lost
2017	6	340	37	56	56	37	224
2018	7	408	44	67	67	44	269
2019	10	532	58	87	87	58	351
2020	11	598	65	98	98	65	395
2021	12	668	73	109	109	73	441
2022	13	742	81	121	121	81	490
2023	15	820	89	134	134	89	541
2024	16	903	99	148	148	99	596
2025	18	990	108	162	162	108	653
2026	20	1083	118	177	177	118	714
2027	21	1180	129	193	193	129	779
2028	23	1283	140	210	210	140	847
2029	25	1392	152	228	228	152	918
2030	27	1511	165	247	247	165	997

4-W

Year	Employment for 4W Electric Vehicle Manufacturing Plant	Employment lost ICE 4W Manufacturing
2017	10	19
2018	12	23
2019	15	29
2020	17	33
2021	19	37
2022	21	41
2023	23	45
2024	26	50
2025	28	55
2026	31	60
2027	34	65
2028	36	71
2029	40	77
2030	43	84



**Charging Stations required in Jaipur City:
Scenario 1 - MoP guidelines**

PCS required	Potential Employment Generation (Cumulative)
54	808

**Charging Stations required in Jaipur City:
Scenario 2 - Petrol Pumps transition**

Year	PCS required	Potential Employment Generation (YoY)
2017	17	257
2018	21	308
2019	27	402
2020	30	452
2021	34	505
2022	37	561
2023	41	620
2024	46	683
2025	50	749
2026	55	818
2027	59	892
2028	65	970
2029	70	1052
2030	76	1142

Endnotes

- 1 https://www.researchgate.net/publication/333096247_Informality_in_the_Indian_Automobile_Industry
- 2 The calculator has been created by the authors using secondary data and based on key assumptions. It uses a model for predicting the trajectory of ICE vehicles that need to be replaced by EVs in order for India to meet its INDC targets. The calculations are premised on the emissions generated by ICE vehicles and EVs during manufacturing and operations and the relevant trajectory of emission reduction and power mix as per India's INDC targets. For further details please refer to page 40 and Annexure I.
- 3 https://niti.gov.in/writereaddata/files/document_publication/EV_report.pdf
- 4 <https://europeanclimate.org/>
- 5 https://www.camecon.com/wp-content/uploads/2018/02/ECF-Fuelling-Europe_EN_web.pdf
- 6 <https://www.cmie.com/kommon/bin/sr.php?kall=warticle&dt=2019-07-30%2010:07:16&msec=766>
- 7 <https://pib.gov.in/newsite/PrintRelease.aspx?relid=191377>
- 8 <https://fame2.heavyindustry.gov.in/>
- 9 <https://www.thehindu.com/business/budget/tax-break-to-rev-up-electric-vehicle-sales/article28298483.ece>, dated July 05, 2019
- 10 <https://inc42.com/features/paving-the-way-for-emobility-state-and-central-government-ev-policies-in-india/>, dated December 31, 2019
- 11 <https://kum.karnataka.gov.in/KUM/PDFS/KEVESPPolicyInsidepagesfinal.pdf&https://www.investingintamilnadu.com/wp-content/uploads/2019/Sep/TN%20E%20Vehicle%20Policy%202019-English.pdf>
- 12 <https://pib.gov.in/newsite/PrintRelease.aspx?relid=191337>
- 13 <https://www.businesstoday.in/current/economy-politics/e-vehicles-industry-electric-mobility-mission-create-10-million-jobs-in-future/story/346804.html>, accessed on 14th April 2020
- 14 <http://www.siam.in/uploads/filemanager/47AUTOMOTIVEMISSIONPLAN.pdf>
- 15 <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1567807>
- 16 Powertrain = Engine Assembly and Gear Assembly
- 17 <https://evreporter.com/ev-powertrain-components/> Accessed on 22nd August, 2020
- 18 <https://research.tudelft.nl/en/publications/a-platform-based-oem-supplier-collaboration-ecosystem-development>
- 19 https://www.researchgate.net/publication/269298965_The_electric_mobility_business_ecosystem
- 20 http://www.ieahev.org/assets/1/7/IEA-HEV_TCP_Task_24_-_Final_Report.pdf
- 21 <https://www.ceew.in/sites/default/files/CEEW-IndiaElectricVehicleTransitionReportPDF26Nov19.pdf>
- 22 <https://www.transportenvironment.org/sites/te/files/publications/Briefing%20-%20How%20will%20electric%20vehicle%20transition%20impact%20EU%20jobs.pdf>
- 23 <https://caletc.com/wp-content/uploads/2019/05/EERA-PEV-Economic-Impacts-and-Employment-Growth.pdf>
- 24 https://www.iedconline.org/clientuploads/Downloads/edrp/IEDC_Electric_Vehicle_Industry.pdf
- 25 <https://www.financialexpress.com/industry/electric-vehicles-will-kill-jobs-see-shocking-emerging-facts/874976/> Accessed on 22nd August, 2020
- 26 <https://www.ceew.in/sites/default/files/CEEW-IndiaElectricVehicleTransitionReportPDF26Nov19.pdf>
- 27 <https://inc42.com/buzz/govt-release-course-meet-skill-shortage-ev-sector/>, dated May 15, 2019
- 28 <https://www.businesstoday.in/current/economy-politics/e-vehicles-industry-electric-mobility-mission-create-10-million-jobs-in-future/story/346804.html>, dated May 15, 2019



- 29 The main goal of purposive sampling is to focus on particular characteristics of a population that are of interest, suitable to answer research questions. The sample being studied is not representative of the population, but it is a choice, depending upon the need for the research.
- 30 <https://morth.nic.in/>
- 31 <https://www.smev.in/>
- 32 <https://www.carbonbrief.org/the-carbon-brief-profile-india>
- 33 Excerpts from interaction with industry experts
- 34 Automotive components refer to the various parts of a vehicle which are later on assembled to build it.
- 35 Battery Mining refers to the extraction of metals such as Lithium and Cobalt from used batteries for reuse.
- 36 Data from SMEV <https://www.smev.in/>
- 37 Data from SMEV <https://www.smev.in/>
- 38 Currently two categories of sale are prevalent in E-2W and E-3W segments. The first category is the Non-RTO one which includes low speed and do not require registration or licenses for operations. The second category includes the higher speed variants which need to be registered with the RTO and require necessary licenses and permits for operations
- 39 Data extrapolated from Carbon Brief Profile: India. Retrieved from <https://www.carbonbrief.org/the-carbon-brief-profile-india>
- 40 <https://vahan.parivahan.gov.in/vahan/vahan/ui/login/login.xhtml>
- 41 <http://moef.gov.in/wp-content/uploads/2018/04/revised-PPT-Press-Conference-INDC-v5.pdf>
- 42 INDC targets are in the range of 33-35%. Thus the average target has been considered.
- 43 Segment-wise annual distance travelled by one vehicle
- 44 Share of vehicle segment in total vehicles (ICE+EV)
- 45 Amount of fuel utilised for 1 Km (Eg: Petrol, Diesel, Electricity)
- 46 Carbon intensity of fuel used to run the vehicle (Eg: Petrol, Diesel, Electricity)
- 47 <https://www.financialexpress.com/auto/car-news/government-finally-wakes-up-sets-a-realistic-goal-of-30-electric-vehicles-by-2030-from-existing-100-target/1091075/>, Accessed on 22nd August, 2020
- 48 <https://www.exideindustries.com/about/manufacturing-facilities.aspx>
- 49 https://www.business-standard.com/article/news-ians/bosch-s-14th-manufacturing-plant-in-india-inaugurated-115082701036_1.html Accessed on August 22, 2020
- 50 Based on the estimates provided by BattRE during interview
- 51 Hero MotoCorp Annual Report 2018-19
- 52 Based on the estimates provided by Kuku Automotives during interview
- 53 <https://auto.economictimes.indiatimes.com/company/piaggio-vehicles-private-limited> Accessed on August 22, 2020
- 54 <https://www.financialexpress.com/auto/car-news/hyundai-ramps-up-production-to-1000-cars-daily-demand-creta-venue-verna-rises-lockdown-unlock-1-0/1985537/>
#:~:text=Hyundai%20Motor%20India%20(HMIL)%20has,in%20the%20know%20told%20FE. Accessed on 22nd August, 2020
- 55 1 PCS in 3*3 sq km for the total area of Jaipur (484.6 sq km) means approximately 53 charging stations will be required to cater to the entire city in total.
- 56 According to CUTS's Analysis, A charging station operating at 20 hours a day in 2 shifts of 10 hours will require 10 Employees (5*2 shifts) for 5 charging points (5 types of charging points), 2 technician (1*2 shifts), 2 Site maintenance staff (1*2 shifts) and 1 helper.



- 57 Assuming that 24 charging stations will be required for every 1 lakh EVs on the road based on current vehicle intensity of petrol pumps in India.
- 58 <https://auto.economictimes.indiatimes.com/news/industry/an-anatomy-of-the-indian-auto-industry/75709891> Accessed on 22nd August, 2020
- 59 https://www.cuts-ccier.org/pdf/A_NEW_INDUSTRIAL_POLICY_FOR_INDIA.pdf
- 60 https://www.ibef.org/download/Auto_Component_171109.pdf
- 61 <https://auto.economictimes.indiatimes.com/slide-shows/46041005/financial-analysis-of-key-auto-cos-fy09-fy2019/75731663>
- 62 <https://auto.economictimes.indiatimes.com/news/industry/an-anatomy-of-the-indian-auto-industry/75709891> Accessed on 22nd August, 2020
- 63 Component manufacturing clusters in India include Delhi-NCR (including Gurgaon, Manesar, Faridabad, and Greater Noida), Pune (including Chakan, Talegaon, and Ranjangaon) in Maharashtra, Mysore in Karnataka, and Sriperumbudur and Hosur in Tamil Nadu serve the Indian OEM markets by supplying the major input parts.
- 64 <https://auto.economictimes.indiatimes.com/news/industry/an-anatomy-of-the-indian-auto-industry/75709891> Accessed on 22nd August, 2020
- 65 <https://www.catalyst.org/research/women-in-the-automotive-industry/>
- 66 <https://cis-india.org/internet-governance/future-of-work-in-automotive-sector.pdf>

About the Project

In the times of a global discourse on sustainable development and lowering carbon footprints, the shift to cleaner alternatives in terms of transport is critical. A paradigm shift is imminent, given the role played by transport in an economy and the plethora of negative externalities on the environment and human health, associated with the use of traditional vehicles that operate on combustion of fossil fuels. Electric mobility has been the chosen way forward in most of the developed countries and has also been gaining traction in India, aided by enthusiasm from the businesses and the government.

This paradigm shift in mobility may open the gateways for new business opportunities and lead to the creation of a novel job ecosystem. Thus, a just transition would require a fair assessment of livelihood opportunities being affected and potential opportunities being generated.

This project aims to explore the nature and quantum of job losses due to Electric Vehicle integration at a city level & also the nature of new jobs & skills required due to it. This will help inform the pathways to a just transition which is socially, economically, environmentally and politically acceptable and viable.

For more information, please visit:

<https://cuts-ccier.org/exploring-the-impact-of-electric-mobility-on-the-jobs-ecosystem/>

CUTS International

Established in 1983, CUTS International (Consumer Unity & Trust Society) is a non-governmental organisation, with its Mission: Consumer Sovereignty in the Framework of Social Justice and Economic Equality and Environmental Balance, within and across Borders.

For details, please visit:

<http://www.cuts-international.org>



D-217, Bhaskar Marg, Bani Park, Jaipur 302 016, India

Ph: 91.141.228 2821, Fax: 91.141.228 2485

Email: cuts@cuts.org, Website: www.cuts-international.org

Also at Delhi, Kolkata and Chittorgarh (India); Lusaka (Zambia); Nairobi (Kenya); Accra (Ghana); Hanoi (Vietnam); Geneva (Switzerland) and Washington DC (USA).