International Copper Association India
Copper Alliance

Alliance for an Energy Efficient Economy

CATALYSING THE MARKET TRANSFORMATION OF ELECTRIC TWO-WHEELERS IN INDIA

June 2022

CATALYSING THE MARKET TRANSFORMATION OF ELECTRIC TWO-WHEELERS IN INDIA

Jointly prepared by: International Copper Association India (ICA) and Alliance for an Energy Efficient Economy (AEEE). AEEE supports policy implementation and is an energy efficiency market enabler with a not-for-profit motive.

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Suggested citation:

Natarajan, B., Sasidharan, C., Patil, A., Varun, B. R., Dhupar A., & Kumar H. (2022). Catalysing the Market Transformation of Electric Two-Wheelers in India. New Delhi: Alliance for an Energy Efficient Economy

Disclaimer:

This report is based on the best available information in the public domain. Every attempt has been made to ensure the correctness of data. However, AEEE and ICA do not accept responsibility for the consequences of the use of such data.

ACKNOWLEDGEMENTS

The authors would like to thank Mayur Kamarkar from International Copper Association India for his support and insights.

We would like to thank Satish Kumar, President, AEEE for his valuable guidance and feedback in improving the report.

The authors would also like to acknowledge the valuable inputs from the Climate Trends consumer survey on Triggers and Barriers of Adoption for Electric Vehicles (Module 2: Deep Dive into 2-Wheelers) and extend our gratitude to Aarti Khosla and Madhulika Verma, Climate Trends.

Further, we would like to express our gratitude to a long list of stakeholders who participated in the stakeholder consultation sessions and one-on-one discussions, which were synthesised into the key takeaways presented in the report. The full list of key persons who participated in the stakeholder discussions is shared at the end of this report.

We are also grateful to Shri N Mohan, CESL, Shri Randheer Singh, Advisor, NITI Aayog and Shri Anand A. Deshpande, ARAI for their inputs in finalising the study's recommendations.

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LIST OF ABBREVIATIONS

°C	Degree Celsius
ACC	Advanced Chemistry Cell
AEEE	Alliance for an Energy Efficient Economy
AIS	Automotive Industry Standard
ARAI	Automotive Research Association of India
BIS	Bureau of Indian Standards
BMS	Battery Management System
BOO	Build, Own, and Operate
BOV	Battery Operated Vehicle
CESL	Convergence Energy Services Limited
CMVR	Central Motor Vehicle Rules
CO_2	Carbon Dioxide
COVID-19	Coronavirus Disease 2019
CPCB	Central Pollution Control Board
CPO	Charge Point Operator
CSTEP	Centre for Study of Science, Technology and Policy
DISCOM	Electricity Distribution Company
e-AMRIT	Accelerated e-Mobility Revolution for India's Transportation
EMI	Equated Monthly Instalment
EOI	Expression of Interest
EPR	Extended Producer Responsibility
EV	Electric Vehicle
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FI	Financial Institution
FY	Fiscal Year
GHG	Greenhouse Gas
GWh	Gigawatt-Hour
GST	Goods & Services Tax
HEV	Hybrid Electric Vehicle
ICA	International Copper Association
ICCT	International Council on Clean Transportation
ICE	Internal Combustion Engine
ICRIER	Indian Council for Research on International Economic Relations
IEC	Information, Education, & Communication

IT	Information Technology
km	Kilometre
kW	Kilowatt
kWh	Kilowatt-Hour
LEV	Light Electric Vehicle
LFP	Lithium Iron Phosphate
LTV	Loan to Value
MBBL	Model Building Bye-Laws
MHI	Ministry of Heavy Industries
MoEFCC	Ministry of Environment, Forest and Climate Change
MoP	Ministry of Power
MoRTH	Ministry of Road Transport and Highways
MSEs	Micro and Small Enterprises
NBFC	Non-Banking Financial Company
NCR	National Capital Region
NMC	Lithium Nickel Manganese Cobalt Oxide
OEM	Original Equipment Manufacturer
PLI	Production Linked Incentive
PSE	Public Sector Enterprise
PSL	Priority Sector Lending
R&D	Research and Development
RBI	Reserve Bank of India
RFP	Request for Proposals
RTO	Regional Transport Office
RVSF	Registered Vehicle Scrappage Facility
RWA	Resident Welfare Association
SMEV	Society Of Manufacturers Of Electric Vehicles
SPCB	State Pollution Control Board
URDPFI	Urban and Regional Development Plans Formulation and Implementation
UT	Union Territory

EXECUTIVE SUMMARY

Electric two-wheelers are poised to become the primary clean mobility alternative, and efforts to facilitate their adoption must be prioritised. There is an imminent need to address the key barriers in their value chains. International Copper Association (ICA) and Alliance for an Energy Efficient Economy (AEEE) have collaborated on this whitepaper to identify the key issues for facilitating increased adoption of electric two-wheelers in India. The objective of the proposed whitepaper is to identify pathways to pave the way for a market transformation for electric two-wheelers in India.

For the whitepaper, a consumer survey was conducted with electric vehicle (EV) users and internal combustion engine (ICE) vehicle owners, as well as an overview of electric two-wheeler technology classification and, review of national and state level policies and schemes. AEEE also carried out stakeholder consultations on a range of topics impacting electric two-wheeler adoption. Chapter 2 provides an overview of the electric two-wheeler models available in the Indian market and the current trends in the electric two-wheeler segment in terms of vehicle category (L1 and L2), battery chemistry, and capacity. Chapter 3 presents the main findings from the consumer survey, which was designed to identify the key challenges, concerns, and expectations of consumers related to electric two-wheelers in India. Chapter 4 provides an overview of the schemes and policies related to electric vehicles at the national level. In addition, the chapter reviews the provisions for electric two-wheelers in state EV policies and provides a summary of the developments of tenders and proposals and other efforts such as the Accelerated e-Mobility Revolution for India's Transportation (e-AMRIT) portal. Chapter 5 presents the summaries of and key takeaways from the stakeholder sessions conducted as part of this research. Chapter 6 provides recommendations aimed at addressing the barriers to electric two-wheeler adoption in India.

The recommendations presented in the whitepaper focus on topics ranging from consumer perceptions and demand incentives to addressing product issues such as awareness, servicing, safety, and other related areas. The recommendations comprise important aspects of the EV ecosystem, such as batteries, charging, financing, and manufacturing, as well as addressing the shortcomings in existing schemes and policies for original equipment manufacturers (OEMs) and servicing entities. The market transformation for electric two-wheelers in India will require the stakeholders in the EV ecosystem to further deliberate and implement strategies in line with the recommendations presented in the whitepaper.

1

Introduction

1.1 Electric two-wheelers: A low-hanging fruit to achieve climate goals

The electrification of the transport sector is poised to play a critical role in enabling India to ensure a low carbon and sustainable future. The transport sector is the third-largest greenhouse gas (GHG) emitting sector in India[1], accounting for approximately 13% of carbon dioxide (CO_2) emissions in 2018 [1] of which road transport accounts for 90%. In this sector, electrification of two-wheelers is recognised as the low-hanging fruit for clean mobility in India. In the vehicular transport segment, two-wheelers are the most preferred mode of transport, comprising 80% of total vehicle sales between 2015 and 2021, as shown in Figure 1. Two-wheelers are seen by consumers as an ideal choice for the daily commute in both urban and rural India.

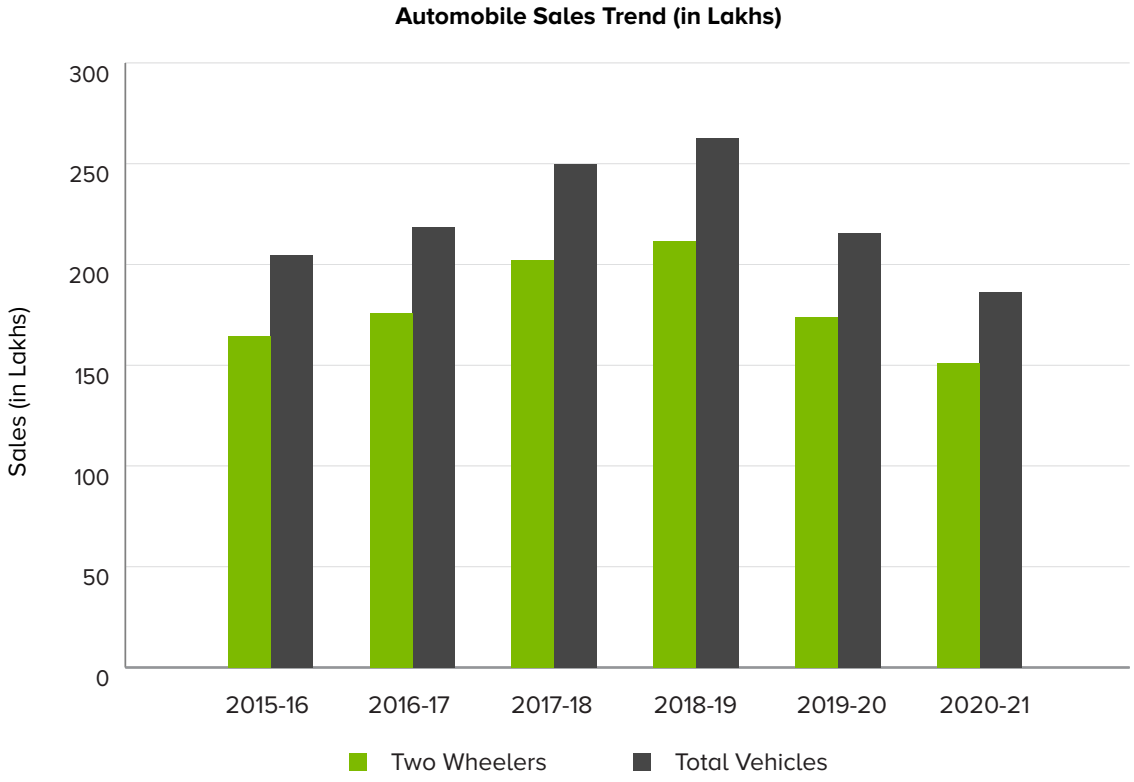


Figure 1: Domestic two-wheeler sales trends

Source: [2]

In 2018, Alliance for an Energy Efficient Economy (AEEE) research on nudging the transport sector towards a more efficient and cleaner future revealed that two-wheelers are responsible for over 50% of petrol sales in India [3]. Two-wheelers are used in commercial applications such as logistics fleets for food and groceries, parcel and courier services, and passenger transport-related services. Two-wheelers that can easily navigate traffic are also being tested for first and last-mile connectivity through shared rides and bike taxi services. AEEE research identified these segments as the early adopters of electric two-wheelers. There is some on-ground traction for electrifying commercial two-wheeler fleets due to their low operating costs [4].

1.2 Current status of India's electric two-wheeler market

Although the market for electric two-wheelers is growing, it is not growing as quickly as the overall two-wheeler market. In 2020, the ratio of internal combustion engine (ICE) two-wheelers to electric two-wheelers stood at around 110:1, i.e. for every 110 units of ICEs sold, only 1 unit of EV was sold. The

1 https://unfccc.int/sites/default/files/resource/INDIA%20SECOND%20BUR%20High%20Res.pdf

coronavirus disease 2019 (COVID-19) pandemic had a disruptive effect across all sectors and segments; electric two-wheelers sales declined marginally by 5.4% as a result, from 152,000 units in fiscal year (FY) 2019-20 to 143,837 units in FY 2020-21.

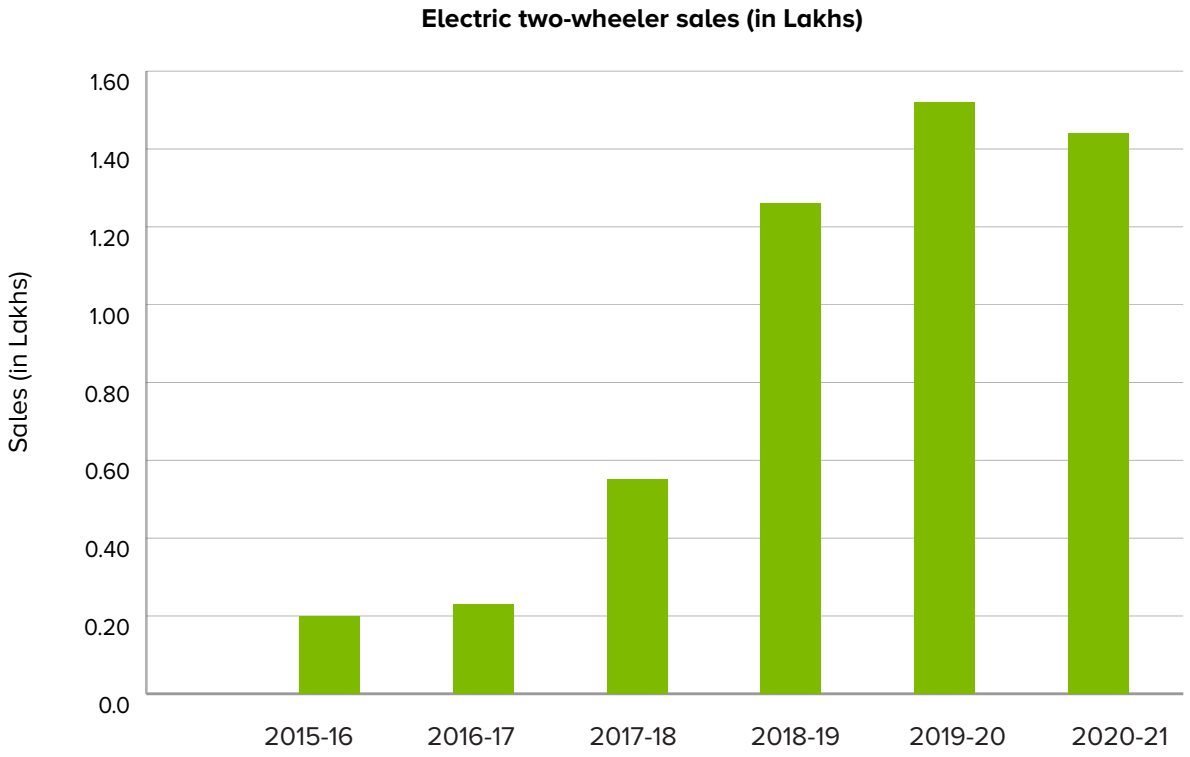


Figure 2: Electric two-wheeler sales

Source: [5] [6]

Electric two-wheeler sales are expected to reach a 24% share of total two-wheeler sales in 2024, a sharp increase from the current <1% sales penetration. The NITI Aayog and RMI report on India's Electric Mobility Transformation also states that electric two-wheeler sales penetration in India could reach 80% of two-wheelers by 2030, provided that Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) Phase II and other measures are successful [7].

In the context of greenhouse gas (GHG) abatement, India has recently made two important commitments to be met by 2030. One is to reduce the total projected carbon emissions by one billion tonnes, and the second is to lower the carbon intensity of the Indian economy by 45 percent. India has also set targets to derive 50% of its energy needs from renewable energy sources by 2030. The transport sector, with the third-highest contribution to carbon emissions in India, is a critical area that needs a clean energy transition. The transition to clean mobility options will facilitate in reaching this goal. In 2020-21, the Indian two-wheeler segment accounted for 81.2% of all domestic vehicles sold that year [8]. Electric two-wheelers therefore have the potential to become the primary clean mobility alternative, and efforts to facilitate their adoption must be prioritised.

Thus, there is an imminent need to address the key barriers in electric two-wheeler value chains. International Copper Association (ICA) and AEEE have collaborated on this whitepaper to facilitate the increased adoption of electric two-wheelers in India. The objective of the whitepaper is to identify pathways to pave the way for a market transformation for electric two-wheelers in India.

2

Electric Two-Wheeler Technologies in India

2.1 Technology classification

This chapter provides an overview of the electric two-wheeler models available on the Indian market. The important features of electric two-wheeler models, such as battery type & capacity, motor capacity, range, top speed, charging time, and fuel economy are presented.

The electric two-wheeler market is dominated by new start-ups that are competing with established ICE vehicle manufacturers. A few of the ICE vehicle manufacturers also offer a range of electric variants. A list of electric two-wheelers that are FAME-approved models has been obtained from the models' webpage by the National Automotive Board, Ministry of Heavy Industries. Table 1 shows the 51 models approved by FAME-II according to the manufacturer and vehicle category[2].

Table 1: FAME-approved models

S.No	OEM name	Two-wheelers	
		L1	L2
1	Ampere Vehicles Private Limited	7	
2	Ather Energy Pvt. Ltd.		2
3	Bajaj Auto Ltd.		3
4	Benling India Energy and Technology Private Limited	1	
5	Hero Electric Vehicles Private Limited	11	
6	Jitendra New EV Tech Pvt. Ltd.	5	
7	Kabira Mobility Llp	3	
8	Li-ions Elektrik Solutions Pvt. Ltd.	1	
9	M/s Tunwal E-motors Pvt. Ltd.	5	
10	Microcon I2i Private Limited	1	
11	Okinawa Autotech Private Limited	4	
12	Revolt Intellicorp Pvt. Ltd.	2	
13	TVS Motor Company Limited		1
14	Ola Electric Technologies Private Limited		2
15	Lectrix Ev Pvt.ltd.	2	
16	Booma Innovative Transport Solutions Pvt Ltd	1	
Total		43	8

Source - [9], Accessed 1 February 2022

In addition, data on new product launches has been collected from JMK Monthly EV Updates for the period January 2020-November 2021. Further, the additional models from the top 10 selling manufacturers, according to the Q3 2021 India EV Update by JMK Research, have been added to the list of models. The additional information has been collected from sources such as manufacturers' websites and other portals such as Bikewale, BikeDekho, Zigwheels, and Bikes4Sale, among others.

The assessment of electric two-wheeler models in India covers 92 models from 31 manufacturers[3]. Table 2 presents the descriptive statistics for the key specifications of the different models.

2 There are two types of electric two-wheelers on the Indian market, classified based on their maximum speed and motor power - L1 and L2. An L1 vehicle is defined as a two-wheeler with a maximum speed not exceeding 45 kilometres per hour (km/h) and motor power not exceeding 0.5 kilowatts (kW) if fitted with an electric motor. The L2 vehicle category comprises two-wheelers other than those in the L1 category.

3 Our research identified 129 models, and complete data on price, battery specifications, and fuel economy was available for 92 models from 31 manufacturers.

Table 2: Descriptive statistics for key electric two-wheeler model specifications

Descriptive statistics	Average ex-showroom price (INR)	Battery capacity (kWh)	Motor capacity (W)	Range (km)	Max. speed (km/h)	Fuel economy (km/kWh)	Charging time (hours)
Mean	74,093	2.23	1,700	98	47	51.53	4.5
Median	67,440	1.8	1,000	86.	42	50	4
Min	19,999	0.5	250	50	25	12.2	1.08
Max	1,58,887	8.2	12,000	236	120	124.21	9
Range	1,38,888	7.7	11,750	186	95	112.02	7.92
Standard deviation	23,982	1.36	2,008	36	26	19.26	1.81

Note - Fuel economy = range / battery capacity

The vehicle category for FAME-II approved models has been obtained from the National Automotive Board, Ministry of Heavy Industries website. The remaining models have been classified using the definition provided by VAHAN. According to these sources, there are 60 L1 category models and 32 L2 category models.

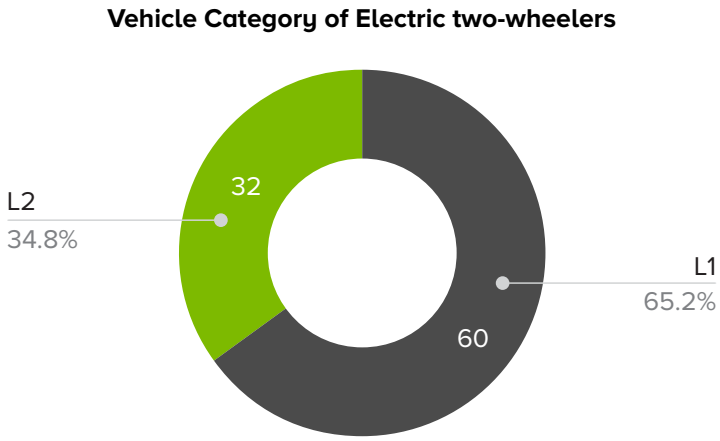


Figure 3: Vehicle category of electric two-wheeler models

Low-speed electric two-wheelers represented 90% of all electric two-wheelers in FY 2020[4]. These electric two-wheelers are popular, as they are exempted from regional transport office (RTO) registration and driving licence requirements. The low-speed models are not eligible for subsidies under the FAME-II scheme. In terms of sales, a reversal of market trends has been observed during the pandemic; the sales of low-speed models decreased, whereas the sales of high-speed models increased [5]. In 2021, electric two-wheeler sales increased over twofold, at 2,33,971 units compared to 1,00,736 units in 2020, driven by the sale of highspeed scooters [10]. According to the Society Of Manufacturers Of Electric Vehicles (SMEV), highspeed electric two-wheelers (L2) registered a whopping 425% increase in sales, at 1,42,829 units in 2021 vs. 27,206 units in 2020. At the same time, low-speed electric two-wheeler (L1) sales only grew by 24% last year, at 91,142 units vs. 73,529 units sold in 2020.

4 The electric two-wheelers models with <25KMPH & <250W motor are referred to as low-speed.

Table 3 presents the electric two-wheeler battery types. The penetration of lithium-based battery chemistries is increasing in the electric two-wheeler segment.

Table 3: Battery type

Battery type	Number of models
Lithium-ion	65
Lead-acid	7
Lithium iron phosphate	10
Li-ion (nickel manganese cobalt)	5
Advanced Li-ion	1
Lithium nickel cobalt aluminium oxide	2
Detachable battery with locking mechanism	2
Total	92

Figure 4 depicts the forecasted net battery pack capacity by year for electric two-wheeler categories such as e-bike, low-speed (2WLS), commuter segment (2WCS), and high performance (2WHP) [11].

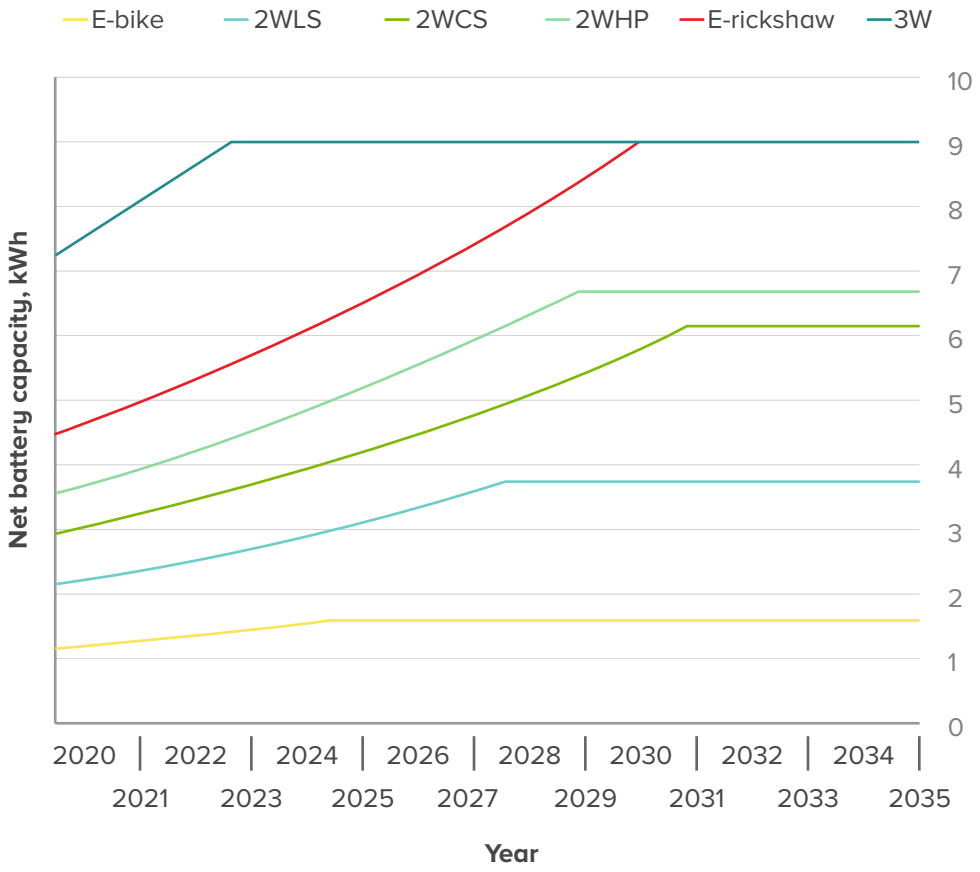


Figure 4: Forecasted net battery pack capacity

Source – [11]

The electric two-wheeler segment is projected to contribute around 27% to the cumulative battery capacity requirement by 2035 in the 30@30 scenario[5] [11]. In addition, a technical report by the Centre for Study of Science, Technology and Policy (CSTEP) recommends that battery chemistries such as

5 30@30 is one of the transport electrification scenarios created using ICCT's India Emissions Model (IEM). In the 30@30 scenario, 30% of new automotive sales are electric by 2030.

lithium nickel manganese cobalt oxide (NMC) and lithium iron phosphate (LFP) to be given priority. These batteries have high-performance capabilities. Among the available chemistries, NMC battery systems are the cheapest, and LFP batteries are the safest. The report concludes that manufacturing both of these battery technologies will be crucial to effectively managing any shortage of critical materials such as cobalt and nickel, as LFP does not require these metals [12].

The performance analysis in the ASC Energy Letters study (2019) shows that typical electric two-wheelers have a mileage of 22–25 W/km and require a battery pack of around 2.5 kilowatt-hours (kWh) for a range of 100 km. Given this battery requirement, the cost of batteries is a critical bottleneck to attaining cost parity with equivalent ICE two-wheelers. The target battery pack price range of INR 11,000-16,000/kWh and a corresponding battery pack-to-vehicle cost ratio between 0.4 and 0.6 to attain cost parity with the ICE two-wheelers. The local manufacturing and sourcing of raw materials are important to meet this battery pack cost target [13].

3

Insights from Consumer Survey

In market transformation research on electric two-wheelers in India, it is critical to consider the consumers' perspective and behavioural aspects concerning electric mobility. To investigate this, a survey was designed to identify the key challenges, concerns, and expectations of consumers regarding electric two-wheelers in India. The primary objective of the survey was to find out what motivates riders to buy electric variants and where they find value in their experience. Further, for the unwilling consumer base, it aimed to identify the key barriers that are inhibiting their transition to EVs. The overall goal was to collect information to help design innovative policies and programmes, refine new offerings, and move the market forward.

Survey analysis and results

Respondent demographics

A total of 358 responses were received, and data on respondent gender, age, location, and monthly household income were collected. As seen in Figure 5, a majority of the respondents (64%) were 25-40 years old. While a majority of the respondents belonged to Tier 1 cities, the survey also saw a significant response from consumers belonging to Tier 2 cities and beyond. To gauge the purchasing power of participating consumers, data on monthly household income was collected, with a majority of the respondents disclosing a monthly income exceeding 1 lakh rupees.

Two-wheeler ownership status and type: Among the respondents, 67.3% owned a two-wheeler. A majority of the two-wheelers owned (87.6%) were ICE vehicles, with only 12.4% owning an electric two-wheeler. While the survey saw a higher response from men, secondary research reveals that in the context of electric two-wheelers, the owners are more likely to be female [14].

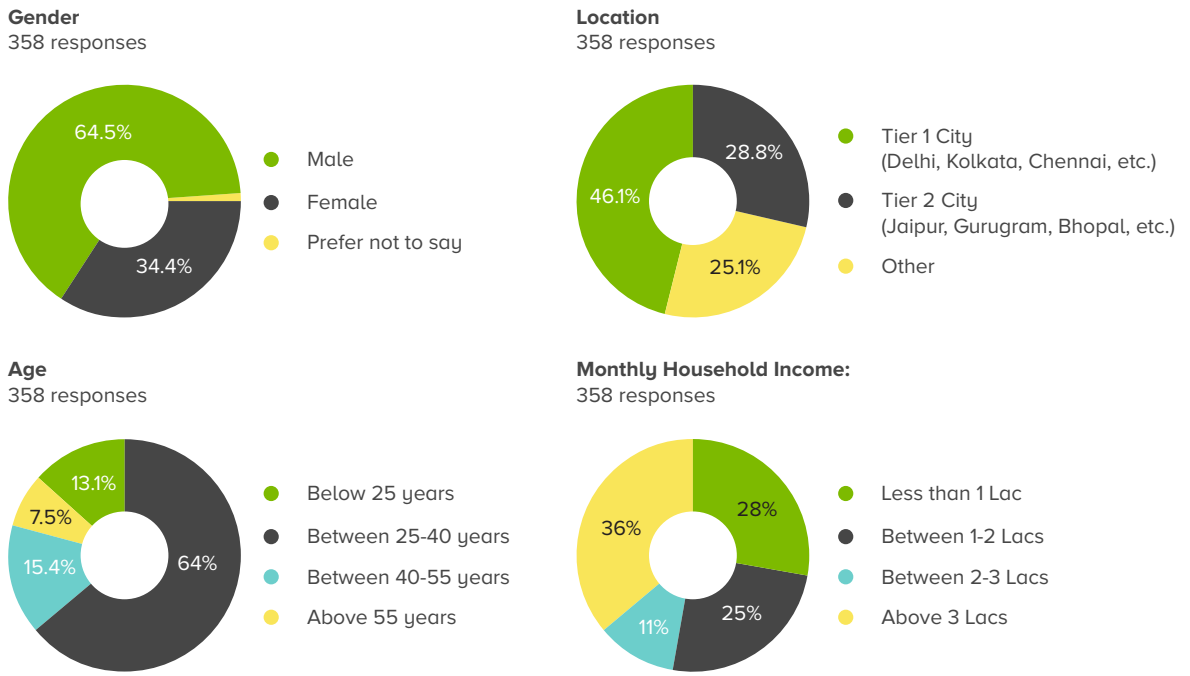


Figure 5: Survey respondent demographics

Views of ICE vehicle owners

ICE vehicle owners are the majority vehicle owning class, and their views are critical to understanding the necessary steps to catalyse an EV market transformation. Details concerning their daily vehicle usage

and vehicle age were captured, as shown in Figure 6, to gauge their vehicle expectations and tentative timeline of their next purchase. Nearly half of the users had usage of fewer than 10 km per day, while 43% used their two-wheelers for a range of 10-30 km per day. Usage of above 30 km per day was only reported by 10% of users.

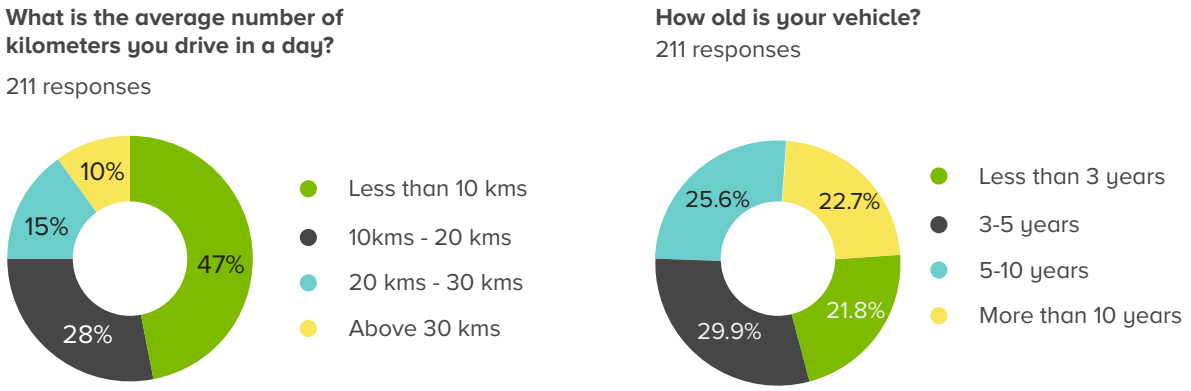


Figure 6: ICE vehicle owner profile

A majority of ICE vehicle owners (88.6%) acknowledged the benefits of owning an EV as opposed to their conventional choice. 78.7% of the respondents also confirmed their willingness to switch to an electric two-wheeler in the near future. Details concerning the timeframe and budget of their next vehicle purchase are summarised in Figure 7.

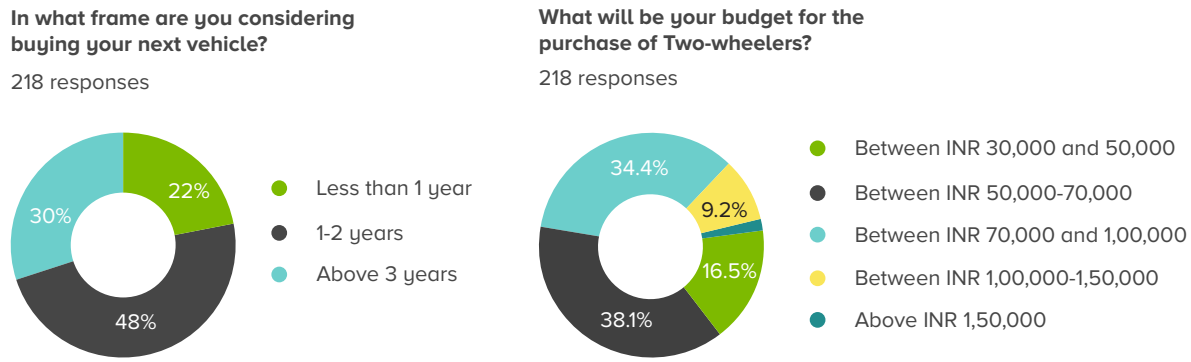


Figure 7: Budget and timeframe for prospective electric two-wheeler purchases

The primary motivations for their shift towards an electric two-wheeler were also recorded, as shown in Figure 8. Environmental and cost-saving factors stood as the top factors. A large number of respondents were also interested in the silent ride aspect of EVs.

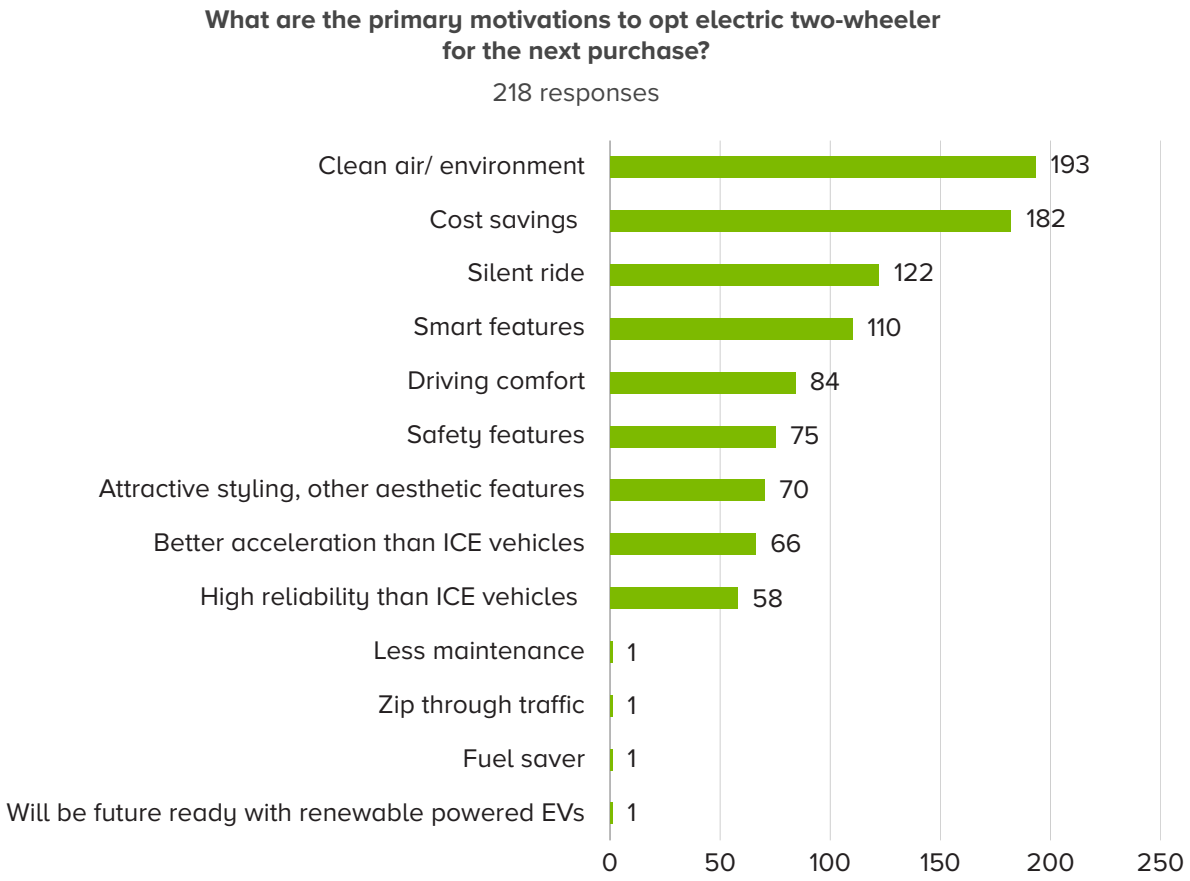


Figure 8: Motivations driving electric two-wheeler purchases

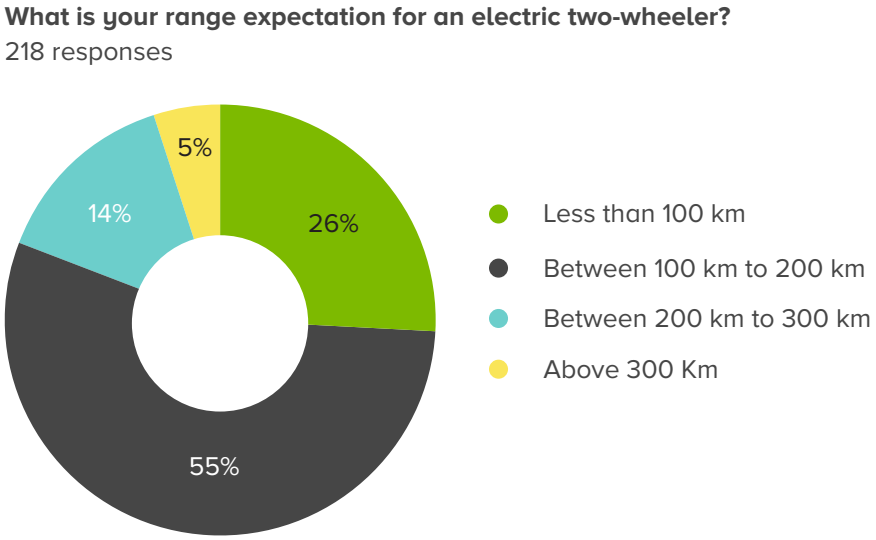


Figure 9: Range expectation of prospective consumers for electric two-wheelers

Among the factors that deter ICE owners from purchasing an EV, lack of resale value stands out as a disincentive, and studies indicate that a significant portion of consumers prefer ICE vehicles over EVs due to this [14].

Views of EV owners

In an attempt to understand the profile of current EV owners, key parameters such as vehicle price, daily usage, location of charging points, and range expectations were recoded, as depicted in Figure 10. Key takeaways include the following:

- A majority of vehicle charging is done at home (86.7% of respondents).
- A majority of vehicles possess a removable battery (63.3%).
- The profile of the EV owners from the survey depicts that the lower range of vehicles (INR 30,000 – 70,000) have nearly the same market share as the higher range of electric two-wheelers (INR 70,000 - 150,000).
- While the respondents had varied daily usage requirements ranging from less than 10 km to over 30 km, a majority of them (56.7%) preferred a range of 100-200 km.

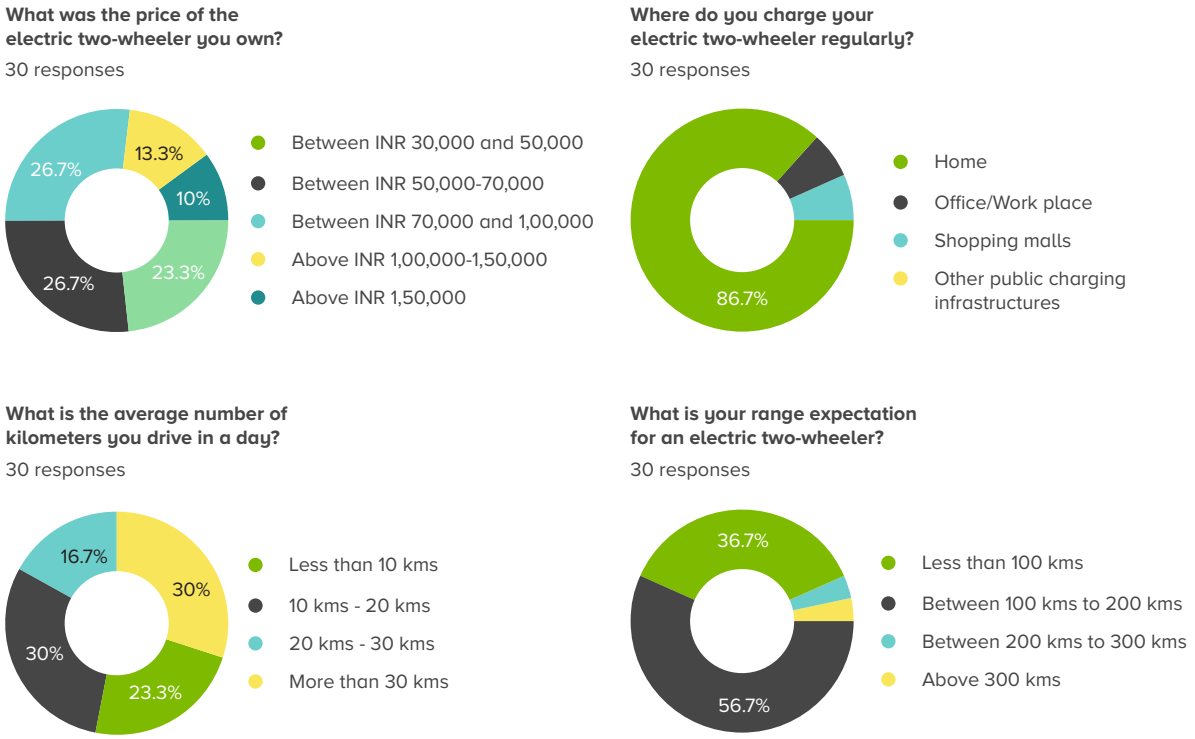
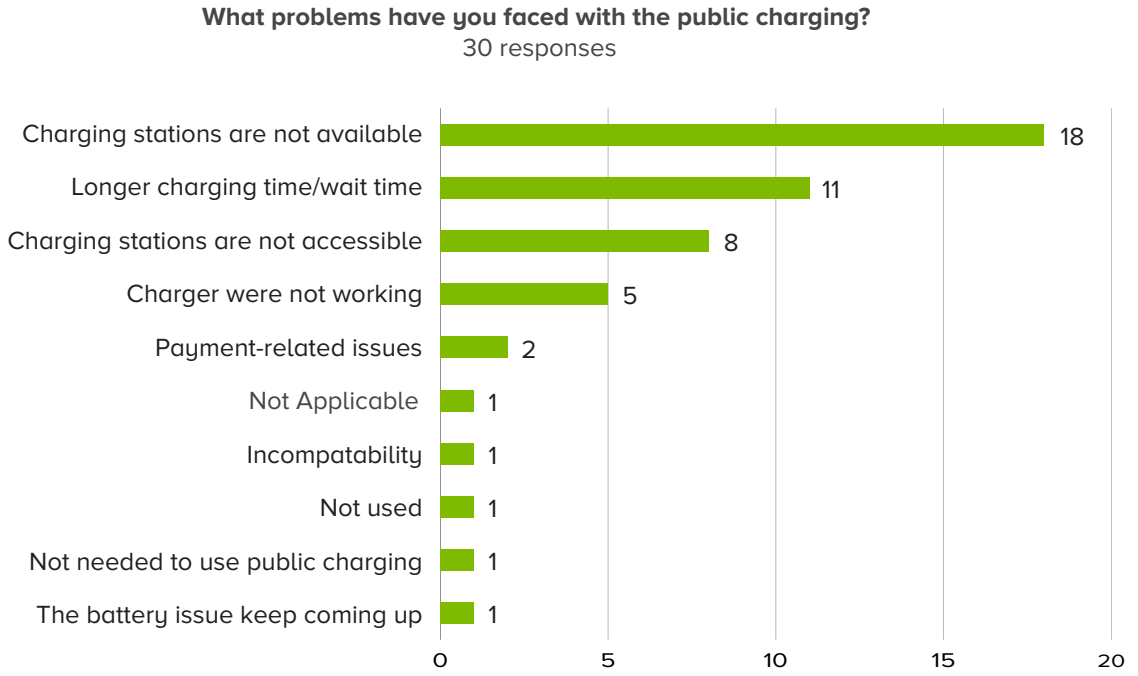


Figure 10: EV owner profile

Further, the survey attempted to understand the experiences and challenges associated with EV ownership, as summarised in Figure 11. Feedback on public charging facilities and issues concerning vehicle servicing and repair were recorded. The inadequate availability of EV charging stations and long charging time were the primary challenges associated with public charging. Despite the shortcomings associated with EV ownership, studies indicate that a significant majority of EV owners would recommend the purchase of an EV.



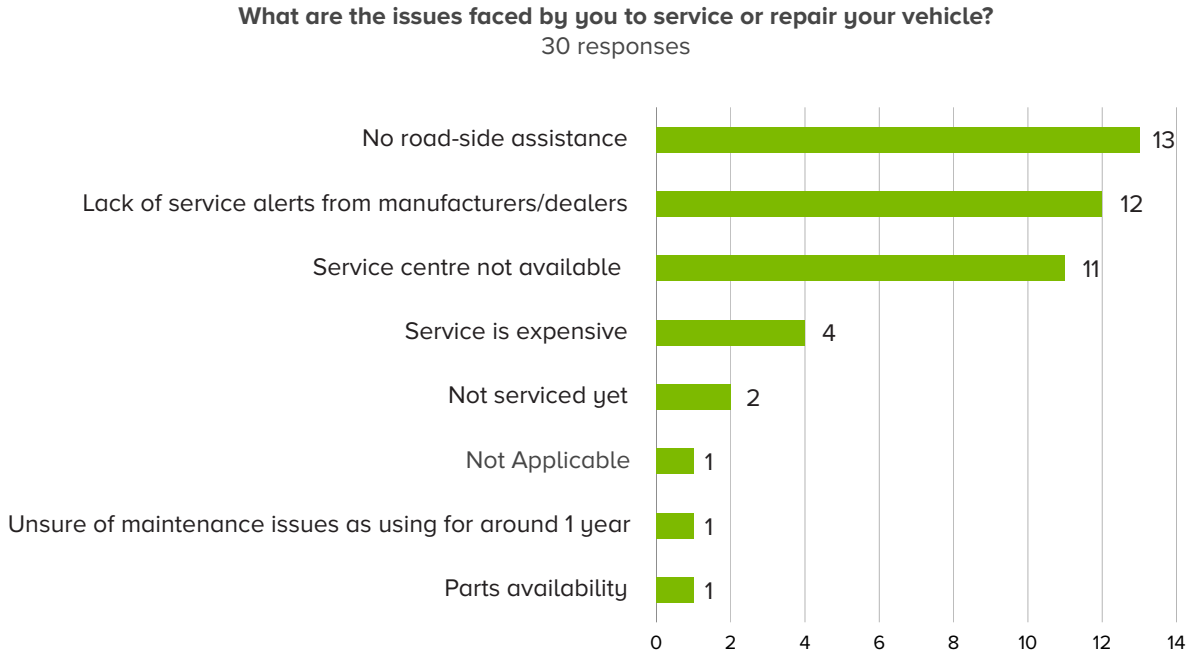
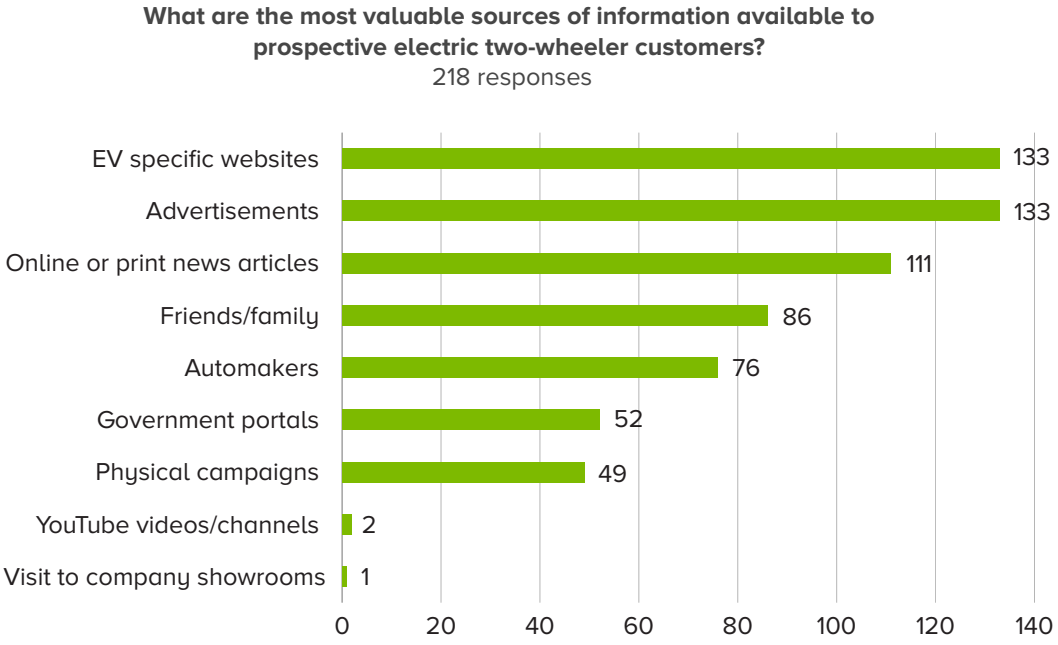


Figure 11: Challenges faced by EV owners

Preferences of prospective EV owners

This section of the survey was created to identify the areas to be targeted to push for greater EV adoption by penetrating a larger consumer base. Details regarding the consumers' trusted source of EV information and vehicle expectations were recorded, as illustrated in Figure 12. It is observed that EV-specific websites are useful to the consumer and function as one of the top EV information sources, apart from manufacturer advertisements. While fuel economy and range are the top criteria sought in an EV, a significant number of consumers are also swayed by the smart controls unique to EV models. Consumers also perceive EVs to possess better handling capability, which is viewed as a positive.



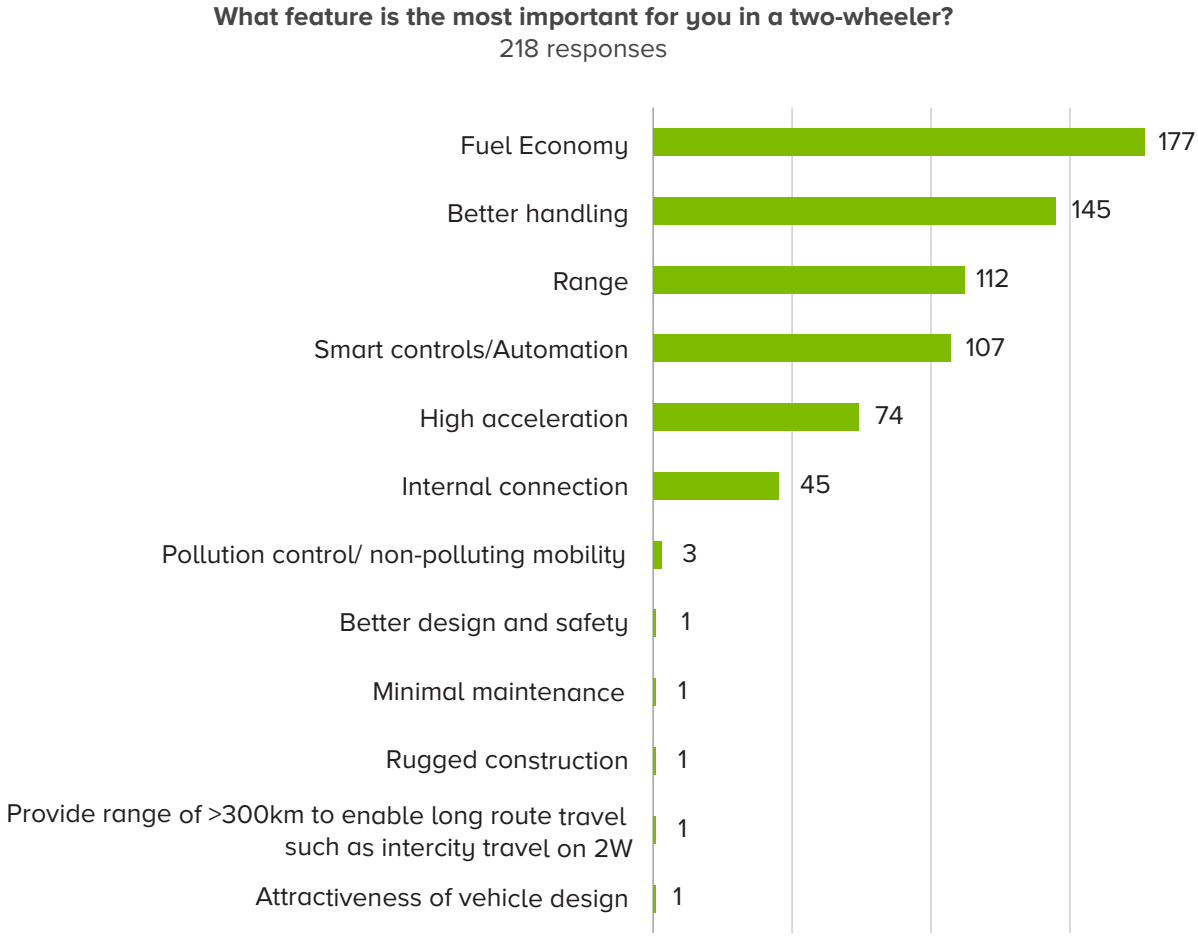


Figure 12: Preferences of prospective EV owners

4

Overview of India's Plans to Roll Out Electric Two-Wheelers

This chapter provides an overview of the national EV-related schemes and policies. In addition, there is a brief review of the provisions for electric two-wheelers in state EV policies. The chapter also provides a summary of the development of tenders and proposals and other efforts such as the Accelerated e-Mobility Revolution for India's Transportation (e-AMRIT) portal.

4.1 National policies/programmes

Scheme for Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India Phase II

FAME-II is being implemented through the following verticals:

- Demand incentives – Electric two-wheelers (including privately owned registered electric two-wheelers) are eligible for demand incentives. Currently, the incentives for electric two-wheelers are based on battery capacity. The cost of a battery is a key barrier that contributes to the high upfront vehicle cost. Recently, the specific demand incentive under FAME-II for electric two-wheelers increased from INR 10,000/kWh to INR 15,000/kWh. FAME-II includes a significant budgetary allocation[6] for demand incentives for electric two-wheelers. It is important to note that only a limited share of electric two-wheeler models available on the market satisfy the eligibility criteria for the FAME-II subsidy. For instance, only vehicles that are registered as "motor vehicles" as per the Central Motor Vehicle Rules (CMVR) and vehicles fitted with advanced batteries satisfying certain performance criteria are eligible for the demand incentives under this scheme.
- Establishment of a network of charging stations – The scheme is supporting the establishment of adequate public charging infrastructure to instill confidence amongst EV users, through active participation and involvement of various stakeholders, including government agencies, industries, and public sector enterprises (PSEs). Up to 100% of the charging infrastructure cost, depending upon the project proposal, shall be available for promoting electric mobility.
- Administration of the scheme, including publicity, information, education, & communication (IEC) activities, and organisation of business meetings/seminars/conferences/symposia etc. to generate consumer awareness and promotion of the scheme on a needs basis.

The breakup of funding allocation year-wise and component-wise over the scheme's duration is presented in Table 4 (all amounts are in INR Crore).

Table 4: Fund allocation under FAME-II

Sr. No.	Component	2019-20	2020-21	2021-22	Total fund requirement in INR crores
1	Demand incentives	822	4587	3187	8596
2	Charging infrastructure	300	400	300	1000
3	Administrative expenditure, including publicity & IEC activities	12	13	13	38

Source - [15]

6 https://fame2.heavyindustry.gov.in/content/english/11_1_PolicyDocument.aspx

Table 5: Vehicle segment-wise incentives specific to registered electric two-wheelers -

Maximum number of vehicles to be supported	Approximate size of battery in kWh	Total approximate incentive @ INR 10,000/kWh for all vehicles	Maximum ex-factory price to avail incentive	Total fund support from MHI
1000000	2 kWh	INR 20000/-	INR 1.5 Lakhs	INR 2000 Cr

Source - [15]

The Ministry of Heavy Industries (MHI) notification on June 25, 2021 has extended the FAME-II scheme for two (2) years, i.e. up to 31 March 2024. To date, 51 electric two-wheelers models are available under FAME-II, and 1,54,939[7] electric two-wheelers have received the FAME-II subsidy. Further, MHI has sanctioned 2636 charging stations in 62 cities across 24 states/union territories (UTs) under FAME-II. Out of these 2636 charging stations, 1633 will be fast charging stations, and 1003 will be slow charging stations [16]. More recently, MHI also sanctioned 520 charging stations for INR 43 Crore (approx.) in cities such as Bangalore, Chandigarh, Jaipur, and Delhi National Capital Region (NCR) [17].

Production Linked Incentive (PLI) scheme for automobile and auto component industry

The PLI scheme for the automobile and auto component industry, notified by the Ministry of Heavy Industries (MHI) on September 23, 2021, aims to provide financial incentives to enhance domestic manufacturing capabilities of advanced automotive products in India. The main objectives of the scheme are overcoming cost disabilities, creating economies of scale, and developing a robust supply chain for advanced automotive technology products. The incentive under the scheme will be applicable starting from FY 2022-23 and will be disbursed in the following fiscal year, i.e. FY 2023-24, and so on for a total of 5 consecutive fiscal years. The scheme has a budgetary outlay of INR 25,938 crores, and the expected annual incentive outlay is summarised below in Table 6.

Table 6: Expected annual incentive outlay

Applicable incentive (Fiscal year)	Disbursement of incentive (Fiscal year)	Total incentive (INR crore)
2022-23	2023-24	604
2023-24	2024-25	3,150
2024-25	2025-26	5,925
2025-26	2026-27	7,199
2026-27	2027-28	9,060
	Total	25,938

Source - [18]

The scheme has two main components – Champion original equipment manufacturer (OEM) Incentive Scheme and Component Champion Incentive Scheme. The Champion OEM Incentive Scheme is a sales value-linked scheme that aims to address the cost disabilities related to advanced automotive technology vehicles faced by OEMs. The Component Champion Incentive Scheme is also a sales value-linked scheme and aims to identify and incentivise auto-component champions that can achieve a global scale of operations and become 'automotive champions'.

7 https://fame2.heavyindustry.gov.in/, Accessed on 20.12.2021

PLI scheme for National Programme on Advanced Chemistry Cell (ACC) Battery Storage

The PLI scheme for the National Programme on ACC Battery Storage, notified on June 9, 2021 by MHI, aims to set up a cumulative ACC manufacturing capacity of 50 gigawatt-hours (GWh) for ACCs and an additional cumulative capacity of 5 GWh for niche ACC technologies in India, with an emphasis on maximum value addition and quality output. Incentives will only be offered to firms that have been allocated ACC production capacity through a transparent Request for Proposals (RFP) mechanism. The beneficiary firm will have to commit to setting up a minimum 5 GWh ACC manufacturing facility.

The amount of subsidy to be disbursed is calculated as follows:

Applicable subsidy amount per kWh x Percentage of value addition achieved during the period x Actual ACC sales (in kWh), as specified in the RFP. The actual subsidy to be disbursed will be capped at 20% of the ACC sale price (net of goods & services tax (GST)). The year-wise breakup of fund allocation over the scheme's duration is summarised below in Table 7.

Table 7: Budgetary provision

FY	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	Total
Subsidy (INR Cr)	Establishment of manufacturing facilities		2700	3800	4500	4300	2800	18100

Source - [19]

The scheme document also specifies the monitoring mechanism for the disbursal of incentives to the beneficiary firms. The beneficiary has to achieve a domestic value addition of at least 25% and make the mandatory investment (INR 225 crore/GWh) within 2 years (at the mother unit level) and increase the domestic value addition to 60% within 5 years, either at the mother unit, in the case of an integrated unit, or at the project level, in the case of a "hub & spoke" structure.

MHI has stated that a total of 10 companies have submitted bids amounting to a capacity of approximately 130 Gwh under the PLI scheme for ACC battery storage [20]. The list of companies includes Reliance New Energy Solar Limited, Hyundai Global Motors Company Limited, Ola Electric Mobility Private Limited, Lucas-TVS Limited, Mahindra & Mahindra Limited, Amara Raja Batteries Limited, Exide Industries Limited, Rajesh Exports Limited, Larsen & Toubro Limited, and India Power Corporation Limited. The scheme is thus receiving an encouraging response from investors, as bids received are 2.6 times the manufacturing capacity to be awarded. A total of 4 companies are selected for incentive. This includes Reliance New Energy Solar Limited; Ola Electric Mobility Private Limited; Hyundai Global Motors Company Limited and Rajesh Exports Limited. These selected companies will receive incentives under India's ₹ 18,100 crore programme to boost local battery cell production[8].

Motor Vehicles (Registration and Functions of Vehicle Scrapping Facility) Rules, 2021

The Motor Vehicle Rules, notified by the Ministry of Road Transport and Highways (MoRTH) on September 23, 2021, apply to all categories of vehicles and their last registered owners, automobile collection centres, automotive dismantling, scrapping, and recycling facilities, and recyclers of all types of automotive waste products. The Rules shall also apply to the guidelines for Environmentally Sound Management of End-of-Life Vehicles and Automotive Industry Standard (AIS) 129. The rules specify the roles and responsibilities

8 https://pib.gov.in/PressReleasePage.aspx?PRID=1809037

of registered vehicle scrapping facilities. For example, a registered vehicle scrapping facility shall be authorised to make suitable entries in the VAHAN database of vehicle registration regarding vehicle scrapping and issuance of certificates of deposit and certificates of scrapping, either directly or through their collection centre.

The Motor Vehicle Rules, 2021 also outline the eligibility conditions and registration procedure for registered vehicle scrapping facilities. For instance, eligibility conditions state that the registered vehicle scrapping facility entity must meet the minimum technical requirements for collection and dismantling centres as per Central Pollution Control Board (CPCB) guidelines and have competent manpower and appropriate equipment to carry out the de-pollution and dismantling activities in a safe and environmentally responsible manner. Further, the rules specify the criteria for vehicle scrapping, inspection rights, scrapping procedures, and the issuance of vehicle scrapping certificates, along with requirements for scrapping yards and collection centres.

Battery Waste Management Rules, 2020

The Battery Waste Management Rules[9], notified on February 20, 2020 by the Ministry of Environment, Forest and Climate Change (MoEFCC), define Extended Producer Responsibility (EPR) as "responsibility of any producer of batteries for their products beyond manufacturing until environmentally sound management of their end-of-life products; for channelization of waste batteries to ensure environmentally sound management of such waste. Extended Producer Responsibility may comprise of implementing a take-back system or setting up of collection centres or both and having agreed arrangements with registered recycler either individually or collectively through a Producer Responsibility Organization recognized by producer or producers in their Extended Producer Responsibility – Authorization". Schedule III of the draft rules outlines the targets for EPR authorisation, as summarised in Table 8.

Table 8: Targets for EPR authorisation

No.	Year	Battery waste collection target (number/weight)
(i)	During the first two years of implementation of rules	30% of the quantity of waste generated indicated in the EPR Plan
(ii)	During the third and fourth years of implementation of rules	40% of the quantity of waste generated indicated in the EPR Plan
(iii)	During the fifth and sixth years of implementation of rules	50% of the quantity of waste generated indicated in the EPR Plan
(iv)	Seventh year onward of implementation of rules	70% of the quantity of waste generated indicated in the EPR Plan

Source - [21]

Chapter II of the draft rules covers the prohibition of heavy metal content (mercury, cadmium, etc.) in batteries and labelling requirements. Chapter III specifies the general responsibilities of manufacturers, importers, assemblers, and re-conditioners. Further, it outlines the specific responsibilities of various stakeholders such as manufacturers, producers, dealers, recyclers, consumers or bulk consumers, auctioneers, importers, state pollution control boards/pollution control committees, the CPCB, collection centres, dismantlers, and custom clearance agents. Chapter IV describes the procedure for seeking authorisation and registration for handling battery waste.

9 These are applicable for all types of batteries including batteries used in EVs.

4.2 State-level policies

This section analyses 19 state-level EV policies, including approved policies in Gujarat, Maharashtra, Karnataka, Delhi, Andhra Pradesh, West Bengal, Kerala, Odisha, Tamil Nadu, Madhya Pradesh, Telangana, and Uttar Pradesh and draft versions in Bihar, Goa, Haryana, Assam, Meghalaya, Punjab, and Chandigarh.

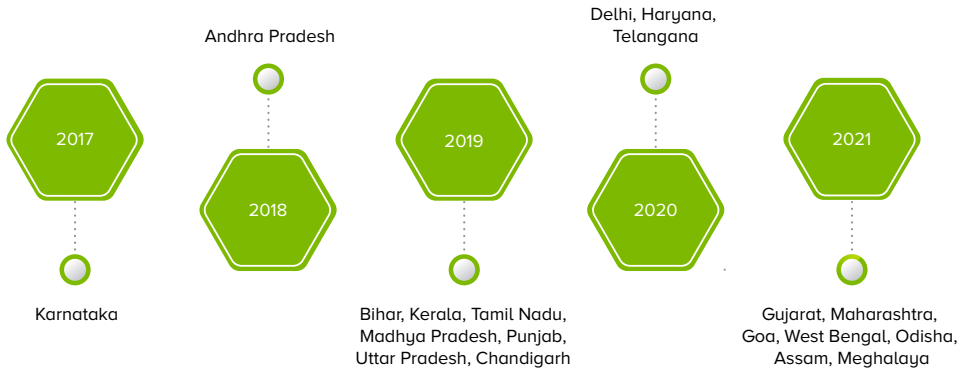


Figure 13: Timeline of state EV policies

The policies have been assessed based on the following criteria:

- EV adoption targets
- Consumer incentives for EV adoption such as capital subsidies, road and registration tax exemptions, scrappage, financing, priority registration, and free permits
- Operational incentives, including green zones, reserved parking slots, and toll fee waivers
- Charging infrastructure incentives such as capital subsidies for charging equipment, land subsidies, special EV tariffs, renewable energy use, amendment of existing regulations (e.g. building bylaws), charging facilities at government buildings, integration and management of EV charging infrastructure networks, and battery swapping incentives
- Manufacturing incentives, comprising capital subsidies, tax exemptions/reimbursements, interest subsidies, land purchase and registration incentives, retrofitting incentives, battery recycling and reuse incentives, and battery warranty and buyback agreements
- Skill development
- Research & development (R&D)

The states are scored from 0 to 1 on each of the above parameters, i.e. a score of 0 if the parameters are not addressed in the policy and a score of 1 if they are addressed. The scores for each state are then summed up, and the total score ranges from 0 to 25. The detailed table is provided in Annexure 1. Table 9 and Figure 14 depict the state ranking based on the overall scores of their EV policy documents.

Table 9: State-level EV policy scores

Sr. No.	State	Score
1	Haryana	20
2	Punjab	19
3	Madhya Pradesh	17
4	Maharashtra	16
5	Karnataka	15
6	Odisha	15
7	Goa	14

Sr. No.	State	Score
8	Uttar Pradesh	14
9	Delhi	13
10	Andhra Pradesh	13
11	Assam	13
12	Telangana	12
13	Chandigarh	12
14	West Bengal	11
15	Tamil Nadu	11
16	Meghalaya	11
17	Bihar	10
18	Kerala	10
19	Gujarat	7

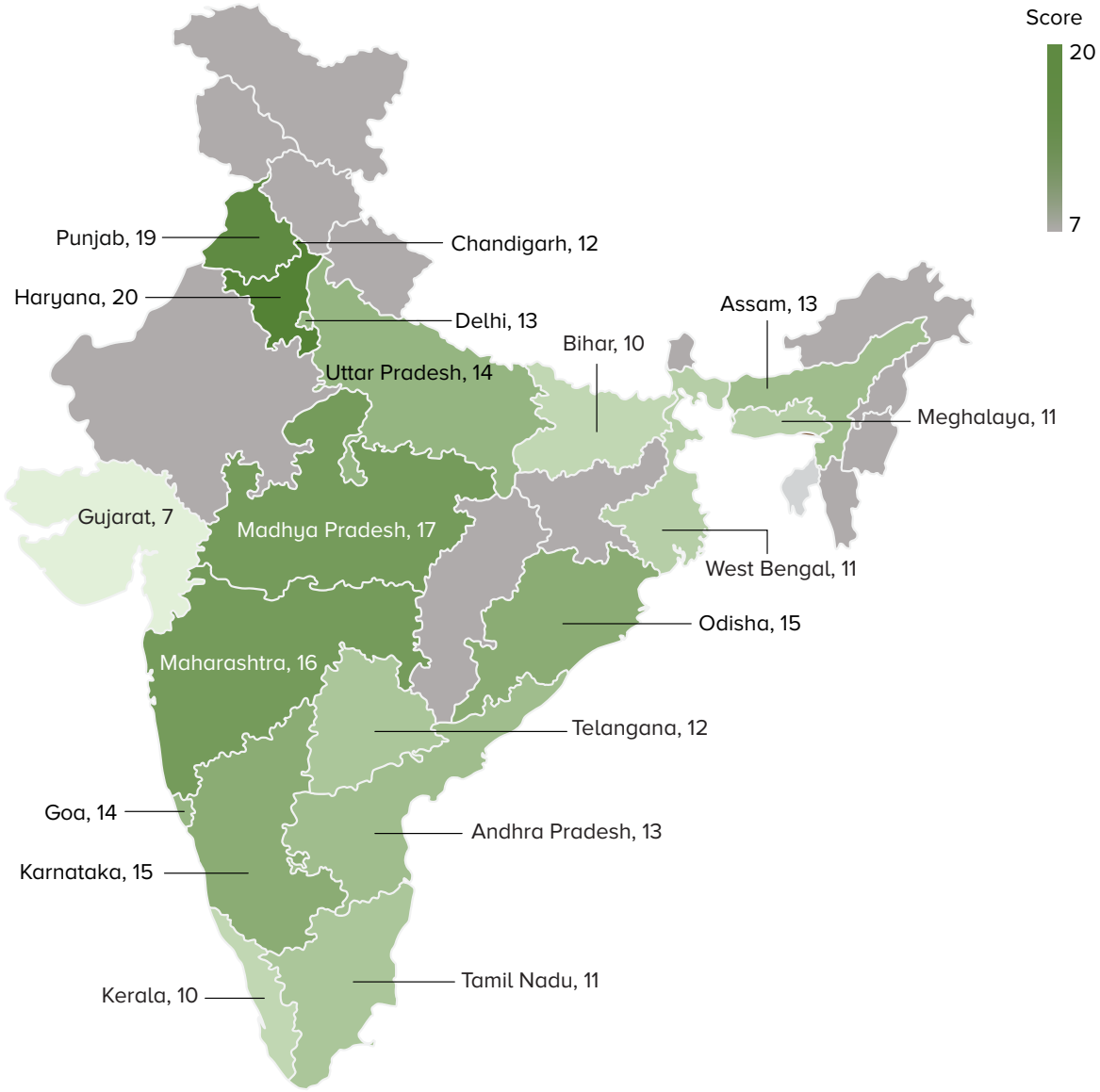


Figure 14: Map of state EV policy document scores

Figures 15-17 show the parameters addressed in the state EV policy documents.

State	EV Targets	Capital Subsidy (Consumer incentive for EV adoption)	Road & Registration Tax exemption	Scrappage policy	Access to financing/ Interest Subvention	Priority registration/ free permits	Green zones	Reserve parking Slots	Toll fee waiver
Andhra Pradesh	●	●	●	●	●	●	●	●	●
Assam	●	●	●	●	●	●	●	●	●
Bihar	●	●	●	●	●	●	●	●	●
Chandigarh	●	●	●	●	●	●	●	●	●
Delhi	●	●	●	●	●	●	●	●	●
Goa	●	●	●	●	●	●	●	●	●
Gujarat	●	●	●	●	●	●	●	●	●
Haryana	●	●	●	●	●	●	●	●	●
Karnataka	●	●	●	●	●	●	●	●	●
Kerala	●	●	●	●	●	●	●	●	●
Madhya Pradesh	●	●	●	●	●	●	●	●	●
Maharashtra	●	●	●	●	●	●	●	●	●
Meghalaya	●	●	●	●	●	●	●	●	●
Odisha	●	●	●	●	●	●	●	●	●
Punjab	●	●	●	●	●	●	●	●	●
Tamil Nadu	●	●	●	●	●	●	●	●	●
Telangana	●	●	●	●	●	●	●	●	●
Uttar Pradesh	●	●	●	●	●	●	●	●	●
West Bengal	●	●	●	●	●	●	●	●	●

Figure 15: State policy documents – EV targets, consumer incentives, & operational incentives

Note – Red indicates that parameter is not addressed in the state EV policy and green indicates that it is addressed in the policy.

State	Capital Subsidy on charging equipment	Land subsidies for charging infrastructure	Special EV tariffs for charging infrastructure	Use of RE in charging infrastructure	Ammending existing regulations for charging infrastructure	Charging stations at government buildings	Integration & management of EV charging infrastructure network	Battery recycling and reuse
Andhra Pradesh	●	●	●	●	●	●	●	●
Assam	●	●	●	●	●	●	●	●
Bihar	●	●	●	●	●	●	●	●
Chandigarh	●	●	●	●	●	●	●	●
Delhi	●	●	●	●	●	●	●	●
Goa	●	●	●	●	●	●	●	●
Gujarat	●	●	●	●	●	●	●	●
Haryana	●	●	●	●	●	●	●	●
Karnataka	●	●	●	●	●	●	●	●
Kerala	●	●	●	●	●	●	●	●
Madhya Pradesh	●	●	●	●	●	●	●	●
Maharashtra	●	●	●	●	●	●	●	●
Meghalaya	●	●	●	●	●	●	●	●
Odisha	●	●	●	●	●	●	●	●
Punjab	●	●	●	●	●	●	●	●
Tamil Nadu	●	●	●	●	●	●	●	●
Telangana	●	●	●	●	●	●	●	●
Uttar Pradesh	●	●	●	●	●	●	●	●
West Bengal	●	●	●	●	●	●	●	●

Figure 16: State policy documents – charging infrastructure incentives

Note – Red indicates that parameter is not addressed in the state EV policy and green indicates that it is addressed in the policy.

State	Capital subsidy for Manufacturing	Tax exemption/ reimbursement & interest subsidies for manufacturing	Land purchase & registration incentives for Manufacturing	Retrofitting	Battery recycling and reuse	Battery warranty and Buyback agreement	Skill development	R&D
Andhra Pradesh	●	●	●	●	●	●	●	●
Assam	●	●	●	●	●	●	●	●
Bihar	●	●	●	●	●	●	●	●
Chandigarh	●	●	●	●	●	●	●	●
Delhi	●	●	●	●	●	●	●	●
Goa	●	●	●	●	●	●	●	●
Gujarat	●	●	●	●	●	●	●	●
Haryana	●	●	●	●	●	●	●	●
Karnataka	●	●	●	●	●	●	●	●
Kerala	●	●	●	●	●	●	●	●
Madhya Pradesh	●	●	●	●	●	●	●	●
Maharashtra	●	●	●	●	●	●	●	●
Meghalaya	●	●	●	●	●	●	●	●
Odisha	●	●	●	●	●	●	●	●
Punjab	●	●	●	●	●	●	●	●
Tamil Nadu	●	●	●	●	●	●	●	●
Telangana	●	●	●	●	●	●	●	●
Uttar Pradesh	●	●	●	●	●	●	●	●
West Bengal	●	●	●	●	●	●	●	●

Figure 17: State policy documents – manufacturing incentives, skill development, and R&D

Note – Red indicates that parameter is not addressed in the state EV policy and green indicates that it is addressed in the policy.

- The EV policies of low-scoring states have inadequate provisions related to scrappage policies, priority registration/free permits, toll fee waivers, integration & management of EV charging infrastructure networks, retrofitting, and battery warranty and buyback agreements. Further, the policies also lack provisions for access to financing, green zones, land subsidies (charging infrastructure), and battery swapping incentives. Overall, the following critical policy gaps have been identified from the analysis of the state electric vehicle policies.
- Consumer incentives such as scrappage policies, access to financing, priority registration, & free permits
- Operational incentives including green zones, reserved parking, and toll fee waivers
- Charging infrastructure incentives such as charging stations at government buildings, integration and management of EV charging infrastructure networks, and battery swapping incentives
- Manufacturing incentives related to land purchase and registration incentives, retrofitting, & battery warranty and buyback agreements.

There is a need to address the abovementioned gaps in the state EV policies. For instance, an increased focus on scrappage policies at the state level is required. The state EV policies of Delhi and Maharashtra provide two-wheeler scrappage incentives of INR 5000 and INR 7000, respectively. The scrappage incentive is reimbursed provided there is evidence of matching contribution from the dealer or OEM and confirmation of scrappage of the ICE vehicle in the same vehicle category.

The gaps identified through the policy analysis were also discussed in the stakeholder consultation sessions.

4.3 Tenders and proposals

An invitation for Expression of Interest (EOI) for OEM Empanelment of Supply of Electric Two-Wheeler Vehicles (high-speed/low-speed) in Kerala was issued by Convergence Energy Services Limited (CESL) on June 17, 2021. The EOI aims to empanel OEMs to supply electric two-wheelers to end-consumers (applicable only to state government employees). CESL is responsible for making the largest number of vehicles available at the most competitive rates through procurement of high-quality products and offering electric two-wheeler financing and leasing at affordable rates. A critical element is an emphasis on OEMs providing sales delivery and servicing across the entire state of Kerala within six months of registering on the platform. In addition, provisions related to roadside assistance, hassle-free maintenance service, and turn-around time for repairs as defined in the service level agreement are included. Benefits (purchase preference) and exemptions (e.g. exemption from payment of tender document fees and bid security/ earnest money deposit) are provided to micro- and small enterprises (MSEs) and start-ups as long as they meet the terms and conditions stated in the tender document. The CESL website procurement data for July 2021 indicates that letters of empanelment have been provided to Ampere Vehicles, Ather Energy, Hero Electric, Kinetic Green Energy and Power, and Revolt Intellicorp. Kerala is the first state in the CESL portfolio to move forward in ordering electric two-wheelers. The launch of this scheme makes Kerala the first user of the digital marketplace MyEV. MyEV is a digital marketplace website currently active in Kerala and Goa, designed to provide a virtual experience akin to going to a showroom. It connects EV consumers directly with dealers and helps provide all pertinent information regarding electric two-wheeler design and specifications. CESL also issued EOIs for OEM Empanelment of Supply of Electric Two-Wheeler Vehicles (high-speed/low-speed) in Goa and Andhra Pradesh on July 20, 2021, and September 24, 2021, respectively.

In addition, CESL issued an EOI for the empanelment of financial institutions (FIs) (including banks and nonbank financial companies (NBFCs)) for EV financing across India on October 20, 2021. The FI should have experience in automobile financing, particularly EV financing. Provision of seamless financing solutions by eligible and qualified FIs will be facilitated by CESL in partnership with state governments.

An important feature of the EOI is the declaration of local content, which states that only Class-I and Class-II local suppliers are eligible to bid in this tender. The mandatory terms to be offered by the FIs for individual EV buyers are summarized in Table 10.

Table 10: Mandatory terms for individual EV buyers

Terms	Value
Min. loan to value ratio (LTV)	=<80%
Max. interest rate (fixed)	<20%
Loan tenor	24-60 months
Processing fee (as a % of loan value)	<4% or INR 4000/- (whichever is lower)

Source: [22]

CESL introduced the tender for the empanelment of charge point operators (CPOs) for supply, installation, testing, commissioning, operation, and maintenance of EV charging stations in India on Build, Own, and Operate (BOO) model in October 2021. CESL aims to engage CPOs for 8-10 years and is targeting the cities of Mumbai, Delhi, Bengaluru, Hyderabad, Ahmedabad, Chennai, Kolkata, Surat, Pune, Visakhapatnam, and Tirupati for the deployment of public EV charging and battery swapping stations for various EV segments, including two-wheelers.

Case study on demand aggregation (stakeholder consultation inputs)

CESL has ventured into the electric two-wheeler segment. The electric two-wheeler segment is uniquely positioned for large-scale adoption as it comprises a greater number of OEMs, models, and price points. CESL has developed the following two business models for FAME-approved electric two-wheeler models:

Business model 1: Private consumers can choose the OEM and model using the marketplace developed by CESL (portal and MyEV app). CESL has negotiated a below market value price with the government for electric two-wheelers. The app has information on different OEMs, models, service centres, and dealerships. In addition, the potential consumer can schedule test rides. The app is live in Kerala.

Business model 2: This model mandates government vehicles to become electric. CESL will provide electric two-wheelers to government employees on an easy loan and equated monthly instalment (EMI) basis. Therefore, it also addresses the financing barrier to electric two-wheeler adoption.

4.4 e-AMRIT portal

The e-AMRIT portal has been developed by NITI Aayog and the UK government and provides information on EV adoption in India to various stakeholders such as potential EV users, early EV adopters, government, academia, industry, etc. For instance, the e-AMRIT portal presents information such as the benefits of EVs, debunking common EV myths, EV incentives, and resources such as national and state-level policies. In addition, the portal presents financing and insurance options. The portal also provides various tools such as "Choose my Electric Vehicle", calculators for home charging, public charging, and journey costs, and a charging station locator. The "Choose my Electric Vehicle" tool also provides information about electric two-wheeler models (see Figure 18). Further, the portal includes information on business models, manufacturers, and service providers and new e-mobility businesses. It is set to play an important role in increasing consumer awareness of electric two-wheelers.

Make	Revolt Bike
Model	Revolt Bike
Ex Showroom Price	₹ 1,20,000
Battery Size (kWh)	3
Battery Type	Lithium ion
Charger Rating(kW)	3
Driving Range(km)	150
Charging time(hours)	3

Make	Bajaj Chetak
Model	Bajaj Chetak
Ex Showroom Price	₹ 1,00,000-12
Battery Size (kWh)	3
Battery Type	Lithium ion
Charger Rating(kW)	3
Driving Range(km)	90-10
Charging time(hours)	2-3

Make	Hero Photon
Model	Hero Photon
Ex Showroom Price	₹ 62,000
Battery Size (kWh)	2
Battery Type	Lithium ion
Charger Rating(kW)	2
Driving Range(km)	80
Charging time(hours)	2

Figure 18: Choose my Electric Vehicle tool

Source - [23]

The growth in electric two-wheeler adoption is being driven by the demand incentives under FAME-II, as well as state-level incentives over and above those under FAME-II. Further, several policies at the national and state level such as the PLI scheme for the automobile and auto component industry aim to catalyse domestic manufacturing of electric vehicle components. Similarly, the PLI scheme for the National Programme on ACC Battery Storage focuses on setting up battery manufacturing capacity. Moreover, regulations such as the Motor Vehicle Rules, 2021 and Battery Waste Management Rules, 2020 provide directions for the development of an ecosystem for the end-of-life management of vehicles and batteries. The demand aggregation activities by CESL and consumer awareness efforts by the e-AMRIT portal are also contributing to growing demand.

Overall, EV schemes and policies in India are concentrating on bridging the affordability gap between EVs and ICE vehicles, enabling charging infrastructure implementation, increasing consumer awareness and acceptance, and developing a manufacturing ecosystem. Increased EV adoption will depend on factors such as buyers' preferences (determined by vehicle affordability, performance, and durability) and user friendliness (ease of charging and maintenance) [24]. Although there are variations in the schemes and policies in terms of the type of incentive offered, scale, eligibility criteria, etc., there needs to be a mechanism for tracking and monitoring their implementation and progress. In addition, a common platform or portal is required to share best practices and lessons learnt among government, industry, and other relevant stakeholders.

5

Insights from Stakeholder Consultations

The research team conducted in-depth consultations with stakeholders to identify key measures to facilitate the wide-scale adoption of electric two-wheelers and address the key barriers in their value chains. As part of the analysis of the prerequisites for a market transformation of electric two-wheelers, stakeholder consultations were carried out to obtain an ecosystem-wide understanding of the various challenges and corresponding areas of intervention. As illustrated in Figure 19, the broad themes of indigenisation of manufacturing, end-of-life management, and consumer safety aspects were covered as part of the group consultation sessions. These sessions saw participation from 20 unique stakeholders spread across the value chain, ranging from OEMs, charging service providers, and government departments to civil society, end-users, funding agencies, and the end-of-life management industry. Additionally, one-on-one discussions were held with three stakeholders involved in R&D, EV aggregation, and fleet operations, to get their unique perspectives. The list of stakeholders is available in Annexure 1. The following section provides summaries of the various sessions. The key takeaways across the EV ecosystem have been collated to provide an overview of the perspectives obtained from the stakeholder consultations.

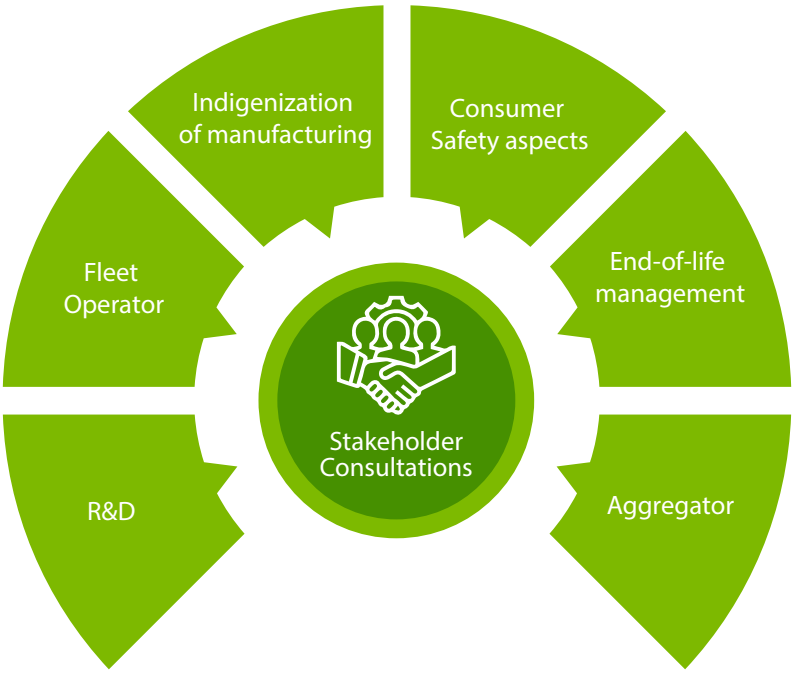


Figure 19: Overview of main stakeholder consultation sessions

Session summaries

Session 1: Indigenisation of EV manufacturing and supply chain

This session had the primary objective of deliberating on the key challenges surrounding the supply chain for battery and component manufacturing. A diverse group of experts spanning government, civil society, battery experts, and OEMs participated in the session. Various aspects related to battery chemistry, EV finance, government regulations, policies on domestic component and battery manufacturing, and R&D requirements were discussed. The key areas of intervention identified included battery end-of-life management, R&D for EV technologies, policies to scale manufacturing, and developing a strong EV after-market ecosystem.

- Urban mining[10] is a critical aspect for India, and there is potential for India to be a global leader in this domain. Battery re-use and recyclability need further deliberation.
- The PLI scheme should be transformed to be more holistic and incorporate both large and small manufacturers.
- The availability of spare parts and quality issues on EV components are aspects that require attention.
- India is emerging as a global hub of auto components. This opens up opportunities such as robust demand, competitive advantage and cost-effective manufacturing compared to Europe and Latin America, and export opportunities. We need to be cognisant of opportunities in the EV manufacturing space, along with the related challenges.

Session 2: End-of-life management of electric two-wheelers

The second consultation in the series focused on end-of-life management of electric two-wheelers. The objective was to deliberate on the key challenges surrounding the value chain of battery and auto component recycling. Various aspects related to regulatory, technology, and supply chain interventions were discussed. The key areas of intervention identified included battery recycling and reuse, streamlining coordination between stakeholders in the value chain, and policy and technology gaps associated with the battery ecosystem. The session had the following takeaways:

- A circular economy approach must be adopted to address the lack of accountability and unsafe handling of batteries. Such an approach should ensure that the spent batteries are traceable and can be dismantled (for second life use) and enable stakeholders to collect, process, and recover material from used batteries in an efficient, safe, and cost-effective manner.
- As lithium-ion battery recycling is a very nascent industry, the economic viability of battery reuse and recycling needs to be assessed for the Indian context.
- Defining the institutional mechanism to govern end-of-life management practices and policies such as EPR is important.
- The capacity for safe handling at end of life and battery traceability must be improved through supply chain interventions. Standardisation is also important.
- For vehicle end-of-life management, it is important to examine the overall energy balance of the two-wheelers and energy savings in material production through recycling.

Session 3: Consumer safety aspects

The third stakeholder consultation revolved around the thematic area of consumer safety aspects in the EV ecosystem. Discussion topics included on-road safety, vehicle safety performance, consumer information gaps, and charging safety aspects. The key areas of intervention identified were the following: improving consumers' EV operation awareness, developing guidelines on home charging, and standardising EV component quality. Developing an ecosystem-wide approach that includes the various EV use cases and corresponding support infrastructure should be the way forward. The session concluded with the following takeaways:

- EV use cases must be factored into all value chain stages, from the design and manufacturing stage to the after-sales ecosystem (communication and information sharing between ecosystem players). Varying operating conditions and geographical and weather patterns add to the complexity of producing robust and safe EVs.

10 Urban mining is defined as the recycling process of used batteries in which rare metals such as lithium, cobalt, nickel, manganese, etc. are recovered through chemical and mechanical treatments.

- End-user awareness on EVs must be improved. Handbooks with emergency response information should be provided through forums and websites, along with guidelines on EV operation and maintenance for end-users.
- The EV supply-side ecosystem must work on familiarising consumers with the different modes of EV operation.
- EV component quality must be ensured through standardisation. Quality assurance measures by component procurers are needed.
- Home charging infrastructure requires dedicated guidelines. Measures to check compliance are necessary to minimise the possibility of accidents.

One-on-one discussions

The stakeholder consultations were accompanied by one-on-one discussions with an expert from academia (with a focus on R&D), an electric two-wheeler aggregator, and an EV fleet operator. The discussions explored various important topics such as commercialisation of R&D, development of an EV marketplace, employment opportunities in last-mile delivery, and EV financing. The one-on-one discussions concluded with the following takeaways:

- Industrial and academic collaboration is required for the development of auto components such as motor controllers and batteries, as well as charging equipment.
- There is a need to establish a secondary market for the sale of second-hand or used EVs, and OEMs should provide a buyback option.
- Interventions such as OEM buy-back policies, consumer awareness campaigns on second-hand sales, and provision of lower EV financing rates by the government can facilitate greater EV adoption.

Session content

This section provides more detail on the specific topics discussed in the stakeholder consultations and one-on-one discussions.

Session 1: Manufacturing indigenisation & supply chain

Quality - product-life and safety

The availability of spare parts and quality issues related to electric two-wheeler components are two aspects that require attention. Cost is a major driver, and quality tends to take a backseat. While cost advantage is important, consumer safety cannot be overlooked due to a lack of ecosystem-wide thinking. Aggregators (government/private) can play a vital role in developing quality products. Bulk procurement through tenders can include penalty clauses and specific requirements related to quality and safety and launching models with a minimum 5-year running period. In this way, the government can implement and enforce stringent norms related to quality and safety.

Availability of high-quality components for pan-India use, import substitution, and indigenisation

India is emerging as a global hub of auto components. This opens up opportunities such as robust demand, competitive advantage and cost-effective manufacturing compared to Europe and Latin America, and export opportunities. We need to be cognisant of opportunities in the EV manufacturing space, along with the related challenges. Industrial and academic collaboration is required for the development of auto components such as motor controllers and batteries, as well as charging equipment. Several EV parts, including electric motors, batteries, and power electronics, are currently imported, which leads to an

increase in EV prices. Poor performance and lack of availability of parts negatively impact user confidence. There are also India-specific issues for auto components such as temperature and waterlogging. The conventional auto industry is supported by small-scale industrial clusters that are geographically dispersed. A domestic supply chain for EV components is missing, although there are allied industries that could refocus on auto components. It is critical to investigate ways to streamline existing industries to include EV auto components. Policies to ensure a strong ancillary ecosystem are necessary. In addition, electric two-wheeler OEMs need to declare the localisation percentage accurately, as indigenisation can play a key role in cost reduction.

Scaling manufacturing capacity to meet EV targets

Existing EV incentives cater to both the supply side and demand side. This includes measures such as upfront capital subsidies and operational subsidies such as concessions on taxes. The missing link in the chain is the scale or projected sales figures, which are not high enough to capture the attention of existing Tier 1 ICE vehicle suppliers. Unless regulation drives the e-mobility transition, it is difficult for the market to naturally transition to the expected level of scale for the two-wheeler sector, which is not subject to any significant fuel efficiency standards. This is critical for the sustainable indigenisation of the EV industry. For industry-wide transformation, a combination of supply- and demand-side policies, along with regulatory interventions, is required. There is also a need to issue or design standards to curb fossil fuel consumption. Policies aimed at the scaling of manufacturing capacity are critical to facilitating market expansion. Several Indian start-ups are working on indigenous electric two-wheeler models. The PLI scheme should be transformed to be more holistic and incorporate both large and small manufacturers.

Battery manufacturing

Regarding battery mineral availability, there is currently limited focus on increasing India's refinery capacity. Similar to the oil industry, to ensure material availability, collaborations and a long-term vision are necessary. By the time the PLI scheme becomes operational, India will have already imported a significant number of batteries. Battery chemistry is also an area of consideration. Apart from incentives associated with the PLI scheme for ACC Batteries, a new programme called 'Niche ACC Programme' is underway to explore alternate battery chemistry technologies. Another issue is that the transport of lithium-ion batteries from the manufacturing location to the assembly location increases the overall cost and also raises safety issues. Several EV manufacturers have attempted to co-locate lithium-ion battery manufacturing and vehicle assembly. From this perspective, India needs to develop local manufacturing of lithium-ion batteries.

Financially competitive

Another key challenge discussed in the first stakeholder consultation was the lack of adequate financing mechanisms for EVs. Financing is not easy in a nascent segment due to a lack of historical data and lack of confidence in the product. The absence of resale value in EV is of particular concern to financiers, and the available interest rates are consequently high. In order to address EV financing concerns, NITI Aayog has submitted a proposal to the Reserve Bank of India (RBI) to categorise loans to purchase electric vehicles under the priority sector lending (PSL) segment. If accepted, the proposal will lead to lower interest rates for electric vehicles. Manufacturers must also come up with a buy-back policy. Consumer awareness can be generated to encourage second-hand sales, which will improve confidence in the ecosystem. In general, consumer awareness and bargaining power need to improve, to address EV financing and resale concerns.

Need to make EVs commercially competitive with existing ICEs (addressing shortcomings in R&D)

Presently, EV R&D focuses on components such as motor controllers, batteries, chargers, and software. However, technology transfer to manufacturing units is missing. Commercialisation of R&D is not in alignment with market demand to scale the volume of manufacturing. Cost competitiveness with competing

component markets has not yet been achieved. Therefore, R&D must be aligned with market demand to succeed in commercialisation. There should be regulations developed to ensure technology transfer to manufacturing companies with plants in cities such as Lucknow, Gurgaon, Delhi, and Noida. Regarding battery technology, there is no immediate alternative, meaning R&D must focus on the following aspects:

- Battery pack manufacturing with adequate thermal management capability (up to 50 degrees Celsius (°C))
- Battery recycling
- Cell manufacturing

Servicing manual & protocols

There is a need for manufacturers to provide servicing manuals (similar to the ones for ICEs) that contain servicing protocols. At present, there is no information on such manuals being made available for electric two-wheelers.

Circular economy approach

Different EV use cases must be factored into all value chain stages, from the design and manufacturing stage to the after-sales ecosystem (communication and information sharing between ecosystem players).

Battery swapping incentives

Government incentives could be extended to battery swapping. Fast charging requires more expensive batteries and, consequently, there is a need to work on battery swapping, which will reduce upfront costs. EV battery standardisation is required for battery swapping. Mismatch in battery pack design among various manufacturers must be avoided to ease battery swapping [25]. Battery manufacturing must be scaled up to enable the provision of the higher number of batteries required in the swapping ecosystem. Digital infrastructure must be developed to improve battery traceability and eliminate battery misuse concerns. Some manufacturers are currently considering selling electric two-wheelers without batteries and asking the customer to use battery swapping services.

Session 2: End-of-life management

End-of-life management, which has largely meant scrappage in the context of ICE vehicles, has primarily been an informal sector activity thus far. With an incoming flow of electric two-wheelers and a range of potential second-life applications, recycling, restoring, and reuse become critical functions in the end-of-life management of EV components. There are key concerns regarding the preparedness of the regulatory ecosystem to ensure that end-of-life management in the informal sector complies with and is equipped to support the circular economy of the EV sector. The following are some of the key requirements:

Registration of scrappage and recycling vendors

As per regulations mentioned in the MoRTH draft guidelines for vehicle scrapping, entities that aim to establish a Registered Vehicle Scrappage Facility (RVSF) are required to possess specified clearances from the respective state/UT governments. Getting such clearances entails meeting the minimum technical requirements specified by the CPCB concerning collection and dismantling centres, obtaining a no objection certificate for operations from the State Pollution Control Board (SPCB), security certifications for the information technology (IT) systems for safe access to the VAHAN database, and abiding by the relevant labour laws, such as the Minimum Wages Act and Workmen Compensation Act.

Scrapping procedure

The draft MoRTH scrappage policy also outlines the procedure to be followed by the authorised entity for vehicle scrapping. The current policy, while requiring documentation of the vehicle registration and

owner, does not clearly state the terms of reuse of refurbished parts. In the context of EVs and second-life battery applications, regulations are necessary to outline the process of handling and refurbishing the reusable components.

Traceability of EV components for second-life applications

In the case of the RVSF not having adequate infrastructure to recycle hazardous components such as lithium-ion batteries, the rules specify that such materials are to be duly sold to authorised recycling agencies and mandates a record of the transaction including the commercial details of the recycler. A recent study on lithium-ion batteries identified retailers and dealers as points of leakage. Leakage at the collection stage needs to be eliminated, and there should be a proper accountability framework. The responsibilities of retailers, dealers, and service centres in the battery recycling ecosystem are not clearly defined. Most of the batteries are sold daily by retailers to kabadiwala through cash transactions. Therefore, lack of accountability and unsafe battery handling are major challenges. Additionally, overlay between battery recycling for EVs and other sectors such as lead-acid batteries and other electronic batteries has not been addressed.

Accountability needs to be defined. EPR can be applied in e-waste, but a practicable policy is needed. There are success stories in this regard in France, Eastern Europe, and Latin America. The informal sector can be strengthened by involving dealers and service providers in the early stages of the collection network. Further, MoEFCC is developing lithium-ion battery disposal guidelines. There is a gap in the regulations regarding the need for recyclers to test and track the second-life capabilities of batteries that are sold to them. A communication loop must be established for second-life batteries to be transferred through the extended supply chain to their second-life applications. These regulations are critical in the context of urban mining to reduce dependency on imports of rare-earth battery minerals.

Reporting on scrapping

The guidelines mandate that the RVSF be integrated with unique ID access into the VAHAN database. The RVSF must verify the identities of the people handing over vehicles for scrapping to ensure they are the vehicle owners, and they are expected to retain copies of such records for a period of six months. Using a password-protected user ID, the RVSF has to make suitable entries concerning the scrapped vehicles.

Financial transactions for scrapping

The draft rules include a provision for appeal in the case of violation to protect consumer interests.

All financial transactions must be recorded, and the RVSF must provide the following consumer incentive:

4-6% of the ex-showroom price to be provided to the owner for vehicle scrapping. Consumers can also get a 5% discount from automobile manufacturers on new vehicle purchases and a road-tax rebate of up to 25% for personal vehicles and up to 15% for commercial vehicles.

Economics of recycling and reuse

Policy ambiguity persists with respect to battery reuse and recyclability. There is a need to develop an end-of-life management ecosystem – similar to EPR in Germany or a separate entity that deals with batteries such as that in Japan. Moreover, coordination is absent among the stakeholders in the value chain. There is a need to study the profitability (i.e. economic viability), scale, and technological feasibility of recycling and second-life applications in India. Start-ups play a role in waste disposal in other sectors, and start-ups in the EV space are involved in refurbishing batteries. Expanding the role of start-ups in end-of-life management of EVs should therefore be further explored.

Material recycling

A heterogeneous mix of materials is obtained after dismantling, which is then underutilised or downcycled. Therefore, we need to ensure that all recyclable materials are utilised, along with 50-60% harmonisation of the materials used at the industry level. There is also a need to focus on dismantling in the high-volume electric two-wheeler segment. Metrics for individual materials must be developed, and homogenised mixes must be standardised. Material standardisation and harmonisation of the material mix are necessary.

Session 3: Consumer safety

Consumer awareness initiatives - for safe operations, maintenance, servicing and charging (including home charging)

End-user awareness of electric two-wheelers must be improved. Handbooks with emergency response information should be provided through forums and websites, along with guidelines on EV operation and maintenance for end-users. The EV supply-side ecosystem must work on familiarising consumers with the different modes of EV operation. Resources such as videos shared with consumers during EV sales can help address the information gap. Safety or hazard labels explaining the do's and don't's should also be adopted.

Guidelines for home and private charging

Home charging infrastructure requires dedicated guidelines. Measures to check compliance are necessary to minimise accidents. The Handbook of Electric Vehicle Charging Infrastructure Implementation specifies the need for electricity distribution companies (DISCOMs) to lay out clear guidelines for EV owners on private charging (e.g. in homes and offices), specifying the requirements and processes to apply for metered EV connections, to take advantage of any available benefits like EV-specific tariffs and customised EV charging programmes.

There is often a compromise made on safety protocols when setting up charging infrastructure, as well as a reluctance from Resident Welfare Associations (RWAs) and housing societies to set up or invest in proper charging infrastructure. Another issue is that domestic wiring is frequently not designed to handle the additional EV load on a recurring basis. Errors can also be sometimes made in the installation of electric equipment for EV charging. Compliance measures are necessary to minimise accidents, and this calls for better standards in charging equipment manufacturing. While EV charging infrastructure requirements have been included as amendments to existing regulations such as the Model Building Bye-Laws (MBBL), 2016 and the Urban and Regional Development Plans Formulation and Implementation Guidelines (URDPFI), 2014, the regulations explicitly state that minimum infrastructure requirements do not apply to private charging points set up for the personal use of EV owners [26]. Mandatory guidelines for home charging are therefore needed.

Safety and standardisation of key components

The quality of EV components must be ensured through standardisation. Quality assurance measures need to be taken by component suppliers. Standardisation on aspects such as size, capacity, and voltage profiles is necessary. The current voltage ranges of battery operation in EVs can pose safety issues. Instances of charging sockets burning are a quality issue that needs to be rectified at the manufacturing stage. The capital expenditure and skill set required to ensure safety in the ecosystem need to be assessed. With an increase in EV volume, improper handling of hazardous materials will also become a challenge.

The stakeholder consultation exercise revealed recurring concerns regarding EV component quality. Development and implementation of stringent norms related to auto component quality and safety are required. An important association for developing standards for vehicles and their components is the

Automotive Research Association of India (ARAI). The type approval is done vehicle model-wise with tests defined in the Central Motor Vehicle Rules (CMVR). The Type Approval Certificate is issued by the testing agency to the vehicle manufacturer, and, hence, the manufacturer holds the distribution rights. These documents are not available in the public domain through ARAI. The AIS 038 specifies the construction and functional safety requirements for the L, M, and N categories of electric power train vehicles, as defined in Rule 2 (u) of CMVR. The tests for two-wheelers (L1 and L2 categories) are specified in documents on vehicle level tests (2 Wheeler Battery Operated Vehicle (BOV) - CMVR Type Approval[11]) and component level tests (2 Wheeler (BOV) Component Level Tests[12]).

In addition, the AIS for EV testing and evaluation by ARAI are applicable. They provide testing and evaluation standards for EVs, hybrid electric vehicles, retrofit standards, and traction battery and charging standards. There are also other standards for EVs and EV charging, such as the Bureau of Indian Standards (BIS) standards TED 27 (electric and hybrid vehicles), ETD 11 (secondary cells and batteries), and ETD 51 (electrotechnology in mobility).

It is important to implement safety standards across the electric two-wheeler vehicle categories, including low-speed models, as there is greater adoption and commercial application in this segment.

Exemptions from existing standards & testing

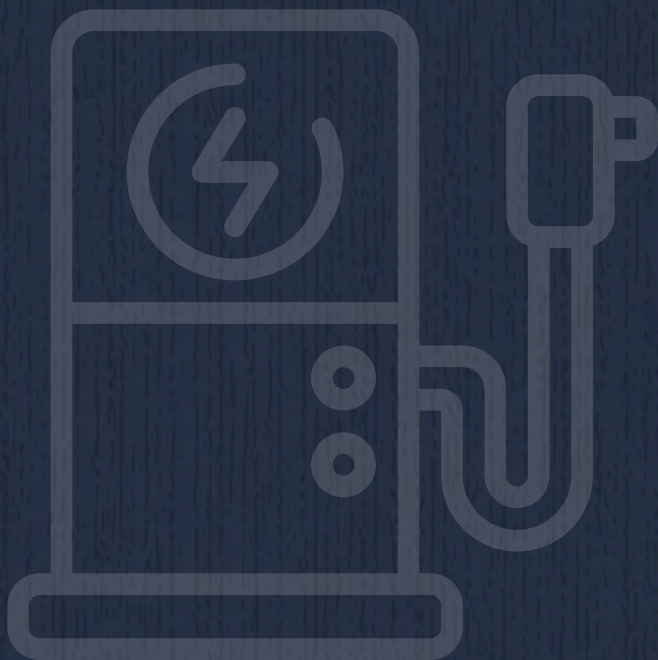
According to ARAI, electric vehicles having a maximum power of less than 250 W and speed less than 25 km/h are exempt from type approval requirements. If the vehicle is above these limits, it is treated as a motor vehicle and therefore needs to be type-approved.

11 Available - https://emobility.araiindia.com/wp-content/uploads/2018/06/Ready_Reckoner_2Wh_BOV_vehicle.pdf

12 Available - https://emobility.araiindia.com/wp-content/uploads/2018/06/2Wh_safety_component_list_BOV.pdf

6

Opportunities for Electric Two-Wheeler Market Transformation



6.1 Key recommendations

The following recommendations are derived from the various parts of the study, including the electric two-wheeler technology classification, consumer survey, review of national and state level policies and schemes, and stakeholder consultations. The recommendations aim to address the barriers to EV adoption in India, particularly in the electric two-wheeler segment.

Consumer perceptions

The results of the consumer survey show that a majority of ICE vehicle owners (nearly 89%) had a driving range below 30 km per day. In the case of EV owners, the respondents had varied daily usage requirements ranging from less than 10 km to over 30 km. However, a majority of them (56.7%) preferred a range of 100-200 km. The inadequate availability of charging stations and long charging time were the primary challenges associated with public charging, according to EV owners. Prospective EV owners listed features such as the fuel economy, range, better handling, smart control, and high acceleration as the most important features in an electric two-wheeler.

Improving consumer confidence - There is a need to develop a strong ancillary ecosystem for electric two-wheelers. The spare part requirements for electric two-wheelers are significantly different from those of their ICE counterparts. Although EVs have fewer moving parts, certain critical components such as the battery, motor, controllers, and microprocessors are essential to the vehicle's functioning, and adequate spare parts availability for these components is necessary to build a reliable EV ecosystem for consumers.

Consumer incentives at point of purchase - Over 90% of electric vehicles on Indian roads are low-speed electric scooters (speed less than 25 km/h) that do not require registration and licences [27]. Going forward, as the demand for high-speed EVs increases, favourable provisions in RTO procedures, such as priority registration, that incentivise consumers to choose EVs over ICE vehicles will act as positive catalysts in the EV market transformation. Moreover, as EV dealers are the direct touchpoint with consumers, consumer concerns such as range and charging anxiety and breakdown and repair-related support must be addressed at the point of sale through dedicated information and communication materials to improve user confidence and promote EV purchases.

Priority electric two-wheeler financing - A 2019 ASC Energy Letters study examined the reduction in cost required to achieve initial customer cost parity of electric two-wheelers with their ICE counterparts. The findings show that the initial customer cost for a typical 110 cubic centimetre engine ICE two-wheeler is around INR 70,000, while that of a comparable electric two-wheeler is over INR 1,00,000, even with fiscal incentives [13]. It is therefore important to address EV financing and resale concerns. There is a lack of information about the risks in EV financing, since it is still a nascent industry. NITI Aayog has submitted a proposal to the RBI to categorise loans to purchase electric vehicles under the PSL segment [28]. PSL status can help address EV financing issues such as high upfront costs. The recent NITI Aayog and RMI report states that priority sector recognition for retail EV lending can lead to an increase in investor confidence, ensure a swift and equitable transition, and accelerate EV adoption. The report considers socioeconomic potential, livelihood generation potential scalability, techno-economic viability, and stakeholder acceptability of various EV segments, and findings indicate the electric two-wheeler segment can be included in priority sector lending [29].

Setting up adequate charging infrastructure - The lack of charging stations is a challenge, particularly in the case of commercial electric two-wheelers. Further, an AEEE report on charging India's two- and three-wheeler transport states that the lack of standardisation in the design of chargers and batteries is a barrier to the rollout of charging facilities for the electric two-wheeler and three-wheeler segments. The report highlights the need to design and implement charging solutions that are "cost-effective, scaleable, and homegrown" [4]. There is a need to focus on home (residential) charging for electric two-wheelers. The

establishment of residential charging facilities would facilitate the widespread adoption of electric two-wheelers. For instance, mandating access to 5A sockets in parking locations linked to the homeowner's electricity meter will provide solutions to challenges related to access and trust.

The **critical issues related to charging infrastructure** faced by CESL as part of their work on electric two-wheeler charging station pilots in South Delhi (3) and Noida (6) are as follows:

1. e-rickshaws and electric two-wheelers are not using industrial connectors and therefore require converter cables.
2. The cost of public charging stations is higher than that of domestic charging. Hence, most users prefer residential charging (only 3 pin chargers are required). Unorganised subscription models for charging are prevalent. There is not much traction for public charging stations. This might change if battery swapping models are implemented; there is a need to examine user preferences for this.
3. Standardisation of batteries and electric two-wheeler chargers is required. OEMs have their own proprietary connectors and chargers, and charging infrastructure therefore caters to their own user bases. Standardisation of connectors is also required to make them compatible across the electric two-wheeler segment.

Source – External review meeting with Mr. N. Mohan, CESL

Product issues such as awareness, servicing, safety, and related issues

Low-speed electric two-wheelers - The viability of low-speed models is a challenge, as affordability is often prioritised over quality. Issues related to poor quality and performance can adversely affect consumer confidence. According to ARAI, EVs having a maximum power below 250 W and speed less than 25 km/h are exempt from type approval requirements. If the vehicle is above these limits, it is treated as a motor vehicle and would therefore need to be type-approved. Based on the discussion with ARAI, it was noted that quality is one of the main issues for low-speed electric two-wheelers and ARAI has stopped the certification of the L1 category (referred to as the "exempted category"). One of the key takeaways from the stakeholder consultations is that it is crucial to implement safety standards across the electric two-wheeler vehicle categories, including low-speed models, as there is increased adoption and commercial application in this segment. Although a reversal in this trend has been observed recently, with an increase in the sale of high-speed electric two-wheelers, it is still important to develop and implement safety standards across all electric two-wheeler vehicle categories, including low-speed models. The quality and safety issues related to the L1 category need to be addressed through testing and certification if they are to play a role in the EV transition. In addition to quality and safety standards, the low-speed models would require government incentives, as they are not eligible for subsidies under FAME-II.

EV component standardisation - As noted in chapter 5 (section on Safety and standardization of key components), safety and performance related standards for EVs are already formulated by ARAI; for instance, the AIS standards cover comprehensive safety of EVs (vehicle level and battery level including thermal management). It is important to note that the standards are aligned with global standards. There is a need for nuanced and comprehensive regulation to monitor the quality of individual EV components. The individual components, such as the battery, motor, microprocessors, and controllers, must also be standardised. This will bring benefits in terms of consumer safety, after-sales services, and traceability of critical components such as the battery. Further, specific standards for power quality requirements for charging are needed. ARAI is working towards standards for electric tractors, retrofit kits and chargers.

ARAI has also provided recommendations to the ministry to revise the categories and battery safety requirements.

In terms of battery safety, the battery management system (BMS) and cell quality are important. BMS can detect issues, and cell quality cannot be compromised on due to cost. The present gaps in the case of BMS is the non-availability of standard, the selection of BMS and its match to the Battery. ARAI has also indicated the importance of 24x7 monitoring of battery parameters through BMS. The Bureau of Energy Efficiency (BEE) is working on safety parameters and an EV labelling programme. Further, a basic checklist for potential EV users can be provided to ensure that they are buying from the right partners/ OEMs.

Guidelines on private charging for EV owners - In 2018, the Ministry of Power (MoP) issued guidelines and standards for EV charging infrastructure. After incorporating various stakeholders' feedback, MoP released the revised guidelines on October 1, 2019 [30]. The latest revised charging guidelines and standards were announced on January 14, 2022. A significant provision in the guidelines is that owners may charge their EVs at their residences or offices using existing electricity connections. However, the minimum infrastructure requirements applicable to public charging stations are not applicable to private charging points meant for self-use of individual EV owners operating on a non-commercial basis. This indicates a gap in regulations for residential charging and the need for home charging guidelines.

Battery swapping - Among the technologies and modes surrounding electric two-wheeler charging, battery swapping is emerging as an attractive solution and is seeing increasing investment from industry stakeholders. The sale and registration of EVs without batteries has been permitted by MoRTH, which is a boost for battery swapping solutions [25].

In anticipation of the major role of battery swapping in EV charging networks, it is imperative to develop & implement regulatory policies for this emerging EV market solution. Regulations must define the operational standards for battery swapping facilities. For instance, manual swapping stations are used for electric two-wheelers. Therefore, the battery pack design characteristics, such as weight, dimensions, and ergonomics, should enable ease of swapping [25]. The responsibilities of various stakeholders, ranging from battery manufacturers to authorised swapping facilities, must be defined. According to the e-AMRIT portal, there are separate projects for battery swapping standards for light electric vehicles (LEVs) and buses, and there will be two series of standards documents on the form factor of the battery pack, interoperable connection systems, communication between the BMS, EV, and charging station, and network management [31]. Battery packs conforming to these standards can be utilised. The section on Indian standards for battery swapping also states that the BIS is yet to develop Indian standards for EV roaming and grid-related management functions. Regulations on battery charging, standards for swapping infrastructure, and authorisation for the service facility must be addressed. Further, standardisation of batteries and development of guidelines on battery swapping facility safety and reliability are required. These steps are necessary as operations scale up in the swapping ecosystem.

In the Union Budget for 2022-23, Finance Minister Nirmala Sitharaman stated that a battery swapping policy will be launched, and interoperability standards will be formulated. The government also aims to address the space constraint in urban areas for setting up charging stations. Further, the private sector will be encouraged to develop sustainable and innovative business models for 'Battery or Energy as a Service', in order to improve the efficiency of the EV ecosystem.

NITI Aayog has prepared the draft Battery Swapping Policy. NITI Aayog held an inter-ministerial discussion to formulate a robust and comprehensive Battery Swapping policy framework in February 2022. NITI Aayog also held an extensive pre-draft stakeholder discussion with a wide spectrum of stakeholders representing Battery Swapping Operators, Battery Manufacturers, Vehicle OEMs, Financial Institutions, CSOs, Think Tanks and other experts.[13]

Recommendations for accelerating electric two-wheeler adoption

Local manufacturing and sourcing of raw materials, including the development of local lithium-ion battery manufacturing - It is expected that in EV manufacturing, there will be a major shift in the production of auto components, as the key mechanical components will be replaced by electronic components. The lack of a manufacturing and infrastructure ecosystem for key components and technologies can hinder EV adoption. Policy support should focus on enhancing infrastructure to facilitate the scale-up of manufacturing capacity. Electric two-wheeler manufacturers need to declare the localisation percentage accurately, as indigenisation can play a key role in cost reduction. Presently, FAME-II has a localisation requirement. According to FAME-II, hybrid/electric vehicles should be manufactured domestically and have a specific percentage of localisation, as may be notified from time to time to meet the qualifying criteria for demand incentives. EV manufacturers must ensure a minimum localisation content of 50% for electric two-wheelers to qualify for benefits under the scheme. There is a need to ensure transparency among manufacturers on the level of indigenisation, along with better reporting and tracking of the localisation level in the manufactured electric two-wheelers. In addition, material standardisation and harmonisation of the material mix are required.

Local manufacturing and sourcing of raw materials for batteries are important. The recently released report titled 'Lithium-Ion Battery (LiB) Manufacturing Landscape in India' builds the case for cell manufacturing in India, with cost opportunities in terms of labour and power and potential to lower dependency on raw material imports through long-term contracts or acquiring assets in mineral-rich nations [32]. The transport of lithium-ion batteries from the manufacturing location to the assembly location increases the overall cost and raises safety issues. Several EV manufacturers have attempted to collocate lithium-ion battery manufacturing and vehicle assembly units. From this perspective, it is important for India to develop local manufacturing of lithium-ion batteries. For instance, the PLI scheme for the National Programme on ACC Battery Storage focuses on developing battery manufacturing capacity. Additional measures taken by the Indian government include an increase in import duty on lithium-ion cells from 5% to 10%, as well as an increase in import duty on assembled battery packs from 5% to 15 percent. In addition to the development of local lithium-ion battery manufacturing, standardisation of EV batteries can play an important role. The Standards & Labelling Programme for High-Energy Lithium-Ion-Based Battery Packs & Systems introduced by the BEE in December 2021 specifies the energy-labelling requirement for high-energy lithium-ion-based battery packs and systems for EVs and prescribes minimum energy performance norms for battery packs and systems. It rates the high-energy performance of battery packs and systems based on specific energy, cycle life, and energy efficiency parameters. The programme is expected to provide a level playing field in terms of energy performance and quality of the batteries being commercially sold in India.

Address the gaps in state EV policies - There is a need to address the gaps identified in state-level EV policies—e.g. increased focus on scrappage policies at the state-level. A report by the Department-Related Parliamentary Standing Committee on Industry highlights the need for vehicle scrapping in a scientific manner using modern technology that can enhance value recovery from scrapped vehicles. The Committee recommends incentivising consumers who opt for EVs and scrap their old ICE vehicles at registered vehicle scrapping centres [33]. The state EV policies of Delhi and Maharashtra provide

13 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1818569#:~:text=Considering%20the%20constraint%20of%20space,efficiency%20in%20the%20EV%20Ecosystem.

two-wheeler scrappage incentives of INR 5000 and INR 7000, respectively. The scrappage incentive is reimbursed provided there is evidence of matching contribution from the dealer or OEM and confirmation of scrapping of the ICE vehicle in the same vehicle category. There is a need to implement similar scrappage policies in other states, as scrappage incentives play an important role in replacing ICE vehicles with EVs, without a net addition of vehicles on the road.

Another example is the implementation of a buy-back policy. The Maharashtra state EV policy has provisions on the buyback agreement. The policy states that OEMs that offer buyback schemes for vehicles that are up to 5 years old at a value reduced by not more than 7.5% per year of the vehicle age will be eligible for additional incentives, e.g. 6% of the total vehicle cost, capped at INR 10,000 for assured buyback and 4% of the total vehicle cost, capped at INR 6,000 for a battery warranty of at least 5 years. The assured buyback policies serve to ensure consumers of the resale value and address concerns such as difficulties in obtaining loans from financial institutions.

In the Union Budget, 2022-23, Finance Minister has also announced that special mobility zones with a zero fossil fuel policy will be introduced to promote a shift to the use of public transport in urban areas.

Battery R&D - At present, the battery types in electric two-wheeler models in India comprise lithium-ion, lead-acid, LFP, NMC, lithium nickel cobalt aluminium oxide, etc. Exploration of alternate battery chemistry technologies is key in India. According to a study by Indian Council for Research on International Economic Relations (ICRIER) and Shakti Sustainable Energy Foundation [34], the EV battery value chain, comprising material sourcing, component and cell manufacturing, packaging, vehicle integration, usage profile, second use, and end of life, needs support in terms of R&D, as the value chain is in a nascent stage in India. For instance, there needs to be a focus on battery pack and cell manufacturing, particularly components with adequate thermal management capability. Further, battery recycling with a focus on urban mining is critical.

Second life of batteries - Lithium-ion batteries degrade significantly over their service lifecycle and last for around 5 years in EVs. While the battery is no longer fit to serve an EV after 5 years, it contains sufficient capacity (~70% of initial capacity) and residual life and therefore still holds value in energy storage applications to support renewable power integration into the main power grid [35]. It can also be reused in stationary power storage applications like rooftop solar, home backup solutions, and power augmentation in public fast-charging stations. The following process is observed: used batteries are transported to processing plants where they are dismantled and tested by second-life battery manufacturers. They are then grouped according to their remaining capacity and performance, assembled, and delivered to customers for second-life use. The report suggests that battery chemistries such as LFP can be reused, as they do not contain high-value metals [36]. There is a need for a policy framework to facilitate second-life applications of EV batteries.

R&D for end-of-life management - There is a global shift taking place in the product lifecycle from a linear economy to a sustainable circular economy. An increasing shift in demand and subsequent resource scarcity has resulted in an increase in aggregate material requirement. Diverging from the traditional ‘produce-consume-dispose’ pathway, there is a need to take on a non-ending pathway consisting of collection, recycling, and recovery of raw materials. Therefore, R&D is critical to assessing the economic viability, scale, and technological feasibility of recycling and second-life applications in India.

Tracking progress and status of EV adoption in India - An annual report on the sector that covers industry-level, technological, and charging-related updates is needed. In addition, the report needs to track the progress of the sector in terms of regulations, specifically those related to the environment and efforts to strengthen the EV sector. This could also include the performance and utilisation of charging infrastructure and the performance of the businesses that install and operate these charging stations.

The need to track EV progress on all fronts has been endorsed by NITI Aayog. It is vital to track EV initiatives and policies, their impact on EV adoption, and projected future impact. One of the critical aspects is the tracking of the localisation norms followed by OEMs. Localisation information is not publicly available, but it is available with the government. OEMs submit this information on the part level, and it is not shared as it is proprietary information. However, they are open to considering sharing this information in a pan-India EV progress report, leaving out the specific OEM names.

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Annexure

Annexure 1

Sr. No.	State	EV targets	Consumer incentives - EV adoption					Operational incentives		
			Capital subsidy	Road & registration tax exemption	Scrappage policy	Access to financing/ interest subsidy	Priority registration/ free permits	Green zones	Reserved parking Slots	Toll fee waiver
1	Gujarat	1	1	0	0	0	0	0	0	0
2	Maharashtra	1	1	1	1	0	1	1	1	0
3	Karnataka	1	0	1	0	0	0	0	0	0
4	Delhi	1	1	1	1	0	0	0	0	0
5	Andhra Pradesh	1	0	1	0	0	0	1	0	0
6	Bihar	1	1	1	0	0	0	0	0	0
7	Goa	1	1	1	1	0	0	1	0	0
8	West Bengal	1	1	0	0	0	0	1	0	0
9	Kerala	1	0	1	0	0	0	1	0	0
10	Odisha	1	1	0	0	1	0	0	1	0
11	Tamil Nadu	1	0	1	0	0	0	0	0	0
12	Haryana	1	1	1	0	1	1	1	0	1
13	Assam	1	1	1	0	0	0	0	1	0
14	Madhya Pradesh	1	0	1	0	0	0	1	1	0
15	Meghalaya	1	1	1	0	0	1	0	1	0
16	Punjab	1	0	1	1	0	0	1	1	1
17	Telangana	1	1	1	0	0	0	0	1	0
18	Uttar Pradesh	1	0	1	0	0	0	1	0	0
19	Chandigarh	1	1	1	0	1	0	0	1	0

Sr. No.	State	Charging infrastructure incentives							
		Capital subsidy on charging equipment	Land subsidies	Special EV tariffs	Use of RE	Amending existing regulations	Charging stations at government buildings	Integration & management of EV charging infrastructure network	Battery swapping incentives
1	Gujarat	1	0	1	0	0	0	0	0
2	Maharashtra	1	1	1	1	0	0	0	1
3	Karnataka	1	1	1	1	1	1	0	1
4	Delhi	1	1	1	1	1	0	1	0
5	Andhra Pradesh	1	1	1	0	0	0	0	0
6	Bihar	1	0	1	0	1	1	0	0
7	Goa	1	0	1	1	0	0	1	0
8	West Bengal	0	1	1	1	0	1	1	1
9	Kerala	1	0	0	0	0	0	0	1
10	Odisha	1	1	1	1	1	0	0	1
11	Tamil Nadu	0	0	1	1	1	1	0	0
12	Haryana	1	1	1	1	1	1	0	1
13	Assam	1	0	1	0	0	0	1	0
14	Madhya Pradesh	1	1	1	1	1	1	1	1
15	Meghalaya	0	1	1	0	0	1	0	0
16	Punjab	1	1	1	1	1	0	0	1
17	Telangana	0	0	1	1	1	0	0	0
18	Uttar Pradesh	1	1	1	1	1	1	0	0
19	Chandigarh	1	1	1	0	1	0	0	0

Sr. No.	State	Manufacturing incentives						Skill development	R&D	Sum
		Capital subsidy	Tax exemption/ reimbursement & interest subsidies	Land purchase & registration incentives	Retrofitting	Battery recycling and reuse	Battery warranty and buyback agreement			
1	Gujarat	1	0	0	0	0	0	1	1	7
2	Maharashtra	1	0	0	0	0	1	1	1	16
3	Karnataka	1	1	1	0	1	0	1	1	15
4	Delhi	0	0	0	0	1	0	1	1	13
5	Andhra Pradesh	1	1	1	1	1	0	1	1	13
6	Bihar	1	0	0	0	0	0	1	1	10
7	Goa	1	1	0	0	1	0	1	1	14
8	West Bengal	0	0	0	0	0	0	1	1	11
9	Kerala	1	1	1	0	0	0	1	1	10
10	Odisha	1	1	0	0	1	0	1	1	15
11	Tamil Nadu	1	1	0	0	1	0	1	1	11
12	Haryana	1	1	1	1	0	0	1	1	20
13	Assam	1	1	0	1	1	1	0	1	13
14	Madhya Pradesh	0	0	1	0	1	1	1	1	17
15	Meghalaya	0	0	0	0	1	1	1	0	11
16	Punjab	1	1	1	0	1	1	1	1	19
17	Telangana	1	1	1	0	1	0	0	1	12
18	Uttar Pradesh	1	1	1	0	1	0	0	1	14
19	Chandigarh	0	0	0	0	1	0	1	1	12

Annexure 2

List of Participants

Sr. No.	Organisation	Name	Designation
1	Cygni Energy Private Limited	Venkat Rajaraman	CEO & Founder
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6	Earth Ride	Dhairya Gupta	Founder & CEO
7	EVQPoint Solutions Pvt. Ltd	Latif Ameer Babu S	CEO & Founder
8	Exponent Energy Private Limited	Akshat Modi	Lead - Strategic Partnerships
9	ICA	Mehul Garg	Consultant
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13	Karo Sambhav (EPR in E-waste, Plastics, & Batteries)	Pranshu Singhal	Founder
14	NITI Aayog	Randheer Singh	Director, Electric Mobility and Senior Team Member for Advanced Chemistry Cells Programme
15	Ola Mobility Institute	Yash Narain	Research Associate
16	Shakti Sustainable Energy Foundation	Ruchir Shukla	Director, Electric Mobility Programme
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