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Roadmap to Unlock the Value Chain of Two-wheeler Electric Vehicles in Indian Cities

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Forewords

Decarbonising transport systems is a key component of every city's push to reduce emissions to meet net-zero and climate action targets, as well as improve the quality of life and health and wellbeing of citizens. It plays a major part in building a green and just economic recovery from the Covid-19 pandemic and will help to create the growth, businesses and jobs of the future.

This is not a future that can be built by national and local governments in isolation, however. It is also about more than just cities in the same country sharing best practice; it requires outreach to international partners to acquire knowledge and help identify the new mobility models and ecosystems that will underpin this new economy.

The net-zero agenda is inextricably linked with innovation and socio-economic development and growth. Rather than a challenge, this must be seen as a great opportunity. Entirely new sectors, services and even industries need to be built. The action of governments at this juncture is crucial to provide focus and clarity to help guide policy and business decisions, especially when it comes to transportation.

India knows it must confront the challenge of simultaneously fostering economic growth, building an equitable society, and moving towards a green and clean future. In transportation, this raises many questions that must be tackled today. How do we reduce emissions? How do we change the current energy matrix? How do we make mobility more sustainable? And how do we ensure our cities are resilient?

Electric vehicles are a powerful tool to bring about positive and lasting change in cities. As well as contributing to the net-zero and clean air agenda, they provide India with the opportunity to move from a net importer of fossil fuels and electric mobility supply chain parts and solutions to a leading hub of development and deployment and, in turn, a regional and global powerhouse of exports.

To make this a reality requires national and local governments, industry, the private sector, and academia to work together and forge relationships with international partners such as the UK. With its wealth of experience, Connected Places Catapult is committed to encouraging India to convert its actions into real-world deployments that will truly make a difference. We look forward to embracing the opportunities the electric vehicle space provides for partnership working.

This roadmap aims to help policymakers navigate a path towards building a greener future for India and, crucially, one that is hardwired with resilience. For if we have learned one thing from the past two years, plans and strategies must also protect us from further threats going forward, whatever they may be.



Nicola Yates OBE
Chief Executive Officer,
Connected Places Catapult

I am delighted to launch this Roadmap to Unlock the Value Chain of Two-wheeler Electric Vehicles in Indian Cities. This work by the UK's Connected Places Catapult, with the support of UK Research and Innovation (UKRI) India, is a testament to the commitment of the Indian and UK governments and our research and innovation partners to work together to keep our communities moving while reducing air pollution.

Global interest in developing clean and environmentally friendly energy technology for vehicles is intensifying. Both the UK and India have made serious commitments to develop, deploy and share technologies, and to adopt policies, to transition towards Net Zero. India's commitment to work intensely towards accelerated proliferation and adoption of zero emission vehicles, is demonstrated with signing the Clean Transport Breakthrough at the World Leaders' Summit in November 2021 and the non-binding ZEV Declaration at COP26.

Aligning with the 2030 Roadmap for India-UK future relations, this roadmap highlights the effectiveness of UK-India partnership and paves the way for further collaboration to drive sustainable growth for both countries. It evaluates the status quo and encourages bilateral partnership and cooperation between our countries. It points to the importance of cooperation on urbanisation and smart and sustainable cities; promotes related trade and investment opportunities; and encourages the deeper understanding of social and spatial inequality needed to lead to the engineering of healthier urban environments. The roadmap provides a robust policy and market assessment of electric two-wheeler penetration in Indian cities and aims to provide an effective model for enhancing integrated electric scooter rental and charging infrastructure.

Since 2008 UKRI and India have jointly invested over £330 million, funding over 250 projects, generating £450 million in further funding from public, non-profit and industry partners, and bringing together more than 220 lead institutions from the UK and India to make a difference for society and the economy in both of our countries. UKRI India plays a key role in enhancing the UK-India research and innovation relationship by facilitating a diverse portfolio of research and innovation collaboration covering climate, energy, environment, health, societies and culture, and technology-driven innovation.

I look forward to future partnerships between UKRI and our partners in India that will develop climate change solutions for smarter, cleaner, and more inclusive mobility options.



Rebecca Fairbairn
Director of UKRI India

List of most commonly used abbreviations

For a full list please see Annex II

E-2W	Electric Two-Wheeler
EV	Electric Vehicle
ICE	Internal Combustion Engine
MSME	Micro, Small and Medium Enterprises
PPP	Public Private Partnership
R&D	Research and Development
V2G	Vehicle to Grid

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Executive Summary

This Connected Places Catapult roadmap, funded and commissioned by UKRI India, sets out to support senior decision-makers in India's city and state governments as to how to design and build the appropriate enabling environment for the private sector to facilitate shared electric two-wheeler (and micro-mobility) business models.

The roadmap can act as a practical springboard for building and strengthening stakeholder relationships in industry and local government between the UK and India in this key sector of the economy. It also focuses on creating an evidence-based framework to enable on-the-ground pilots and scaling up of shared electric mobility models in Indian cities. The final recommendations look at how to support relationship-building between UK and Indian partners, leading to collaborative programmes with a focus on scaling the pilot.

To drive electric vehicle (EV) penetration in Indian cities, aligned policies and regulatory environment at national and local level are required, reflected by deployments of EVs that make commercial sense, either individually or in sharing economy models. However, a fragmented policy landscape resulting in states adopting a myriad of uncoordinated policy incentives and tools to encourage EV (and electric two-wheeler (E-2W) more specifically) penetration has to date resulted in different EV deployment models with varied levels of success across Indian states, which need better harmonisation with policy inroads. Given the size and scale of Indian cities, getting this mix is essential and the impact and benefits can be significant and crucial, not least for addressing critical air pollution issues and helping to achieve National Climate Action Plan and innovation goals.

The findings of the report suggest a set of recommendations to drive the current modus operandi of the majority of shared mobility models in India, which are private sector led business-to-consumer (B2C) with limited role of city governments, to an internationally successfully proven business model of urban government-led pilots of shared electric mobility in partnership with the private sector.

The report covers the following areas:

Policy and regulatory overview: an exploration of India's EV ecosystem and state- and national- policies and regulatory frameworks, highlighting some of the inherent problems that are impeding the progress of electric mobility (e-mobility) market penetration with specific reference to electric two-wheelers (E-2Ws).

Existing supply chain review: demand- and supply-side incentives and the role they play in the E-2W value chain; an overview of the current state of India's charging infrastructure and the battery recycling and battery swapping markets.

Micromobility¹ (specifically e-scooter and e-bicycle) hire scheme review: India's shared mobility landscape and its evolution; how growth in demand is being fueled by several factors such as e-commerce and ride-hailing services.

Existing EV market and operating challenges: an overview of the raft challenges that threaten the growth of e-mobility in areas such as battery manufacture, skills, investment, standardisation and restrictive business models.

The role of cities and potential engagement models and potential opportunities to mitigate the challenges: overview of e-micromobility providers and how they work with cities; case studies from cities like London, Paris and New York, which have rolled out successful pilots and programmes and a recommended way forward to approach government-led shared mobility in-city pilots for E-2Ws.

¹ Micromobility is generally defined as encompassing small, lightweight vehicles operating at speeds typically below 25 km/h (15 mph) and driven by users personally.

1 Introduction

Recent years have seen a huge growth of shared e-mobility models in cities around the world, with micromobility now seen as an integral and essential part of their citywide transportation. This is also strongly linked to a wider uptake of EV based forms of mobility in cities. As well as being used for short commutes and first-mile/last-mile connectivity improvements, they have an increasing role to play in the logistics and delivery sectors. Implementing such schemes brings a set of distinct challenges for each city although there is much that can be learned from sharing experience and best practice. The drivers and motivation often have a synergy, with all cities aiming to reduce their reliance on cars and, in turn, tackle critical challenges such as congestion and poor air quality.

India is home to some of the most congested and polluted cities in the world. Therefore, its transition to electric mobility is high on the agenda of local, state and national governments. Although shared mobility does not necessarily need to be electric, nor do electric vehicles need to operate using a sharing model, findings from this roadmap report show that the largest benefits to be reaped are precisely in the growing E-2W shared mobility market. A scalable and cost-effective shared mobility pilot in an Indian city has capability to deploy large volumes of E-2Ws on the road and play an important part in the transition to decarbonisation of the transport sector. Successfully implementing such programmes would lower the price point, increase uptake and access for lower socio-economic classes, enable alignment with the Indian government's sustainable mobility vision and create new industries, job and investment opportunities.

Despite progress, a list of main challenges in EV adoption in India remains, such as cost of ownership, range anxiety, storage, user acceptance and rolling out adequate charging infrastructure. Through this report, we build the evidence base and undertake an assessment of new approaches to electric, shared mobility models that look to build and strengthen stakeholder relationships in industry and local government between the UK and India. We also highlight the opportunities for trialling some of these successful business models in the near future.

Based on our findings, the cities can, and should play a more prominent role in the deployment, and uptake of EVs in the city. By supporting circular economy based last-mile solutions the city can maximise public transport use, remove the challenge of individual cost of ownership, storage and security,

and allow for the slow roll out of city wide charging stations. By focusing on battery charging and bike storage stations, strategically places at transport hubs and popular final destinations, the city can help support greater public and shared transport usage. It can support where and when people move, and help to decongest and depollute its streets as convenience and cost drivers push users to public and shared mobility. As a result, a shared business model of EV uptake in Indian cities will increase, which is linked to direct contribution to cleaner air for the Indian urban population. It will also lead to strengthening ties between the private sector and Indian local and regional governments in the urban areas where piloted business models could take place. The expected outcome is for EVs to further increase market share through these additional channels covering food/document/package delivery, as well as the large passenger travel market through a sharing mobility system model.²

We begin by providing an overview of India's EV ecosystem and explore the state- and national-level policies and regulatory frameworks that can be put in place to promote E-2W adoption. We also examine existing supply chains and the current state of charging infrastructure, as well as the battery recycling and battery swapping markets, which are critical to progress. The roadmap also reviews India's shared mobility landscape, providing an overview of current challenges that threaten the growth of e-mobility and feature case studies of pilot programmes from around the world. We conclude with a set of recommendations on how governments can mainstream and deploy shared E-2W mobility programmes.

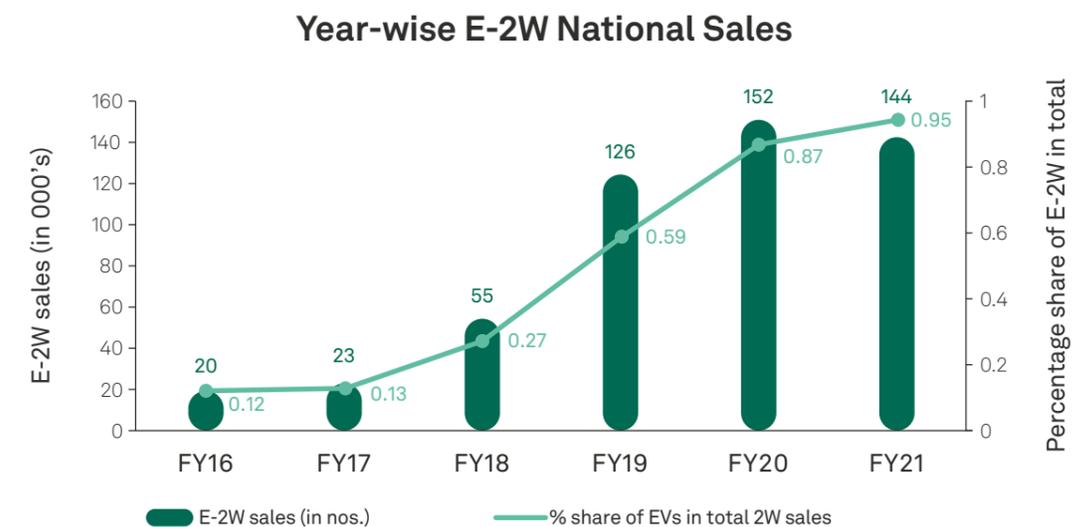
2 India's EV Ecosystem

Conducive policy and regulatory landscapes play a pivotal role in driving EV penetration in Indian cities to address critical air pollution issues and help achieve National Action Plan on Climate Change³ goals. India is one of 25 member countries of the Global EV30@30⁴ initiative coordinated by the International Energy Agency (IEA) to achieve 30% of all new vehicle sales as EV by 2030. Green and electric mobility is a key transport sector action point of the National Clean Air Programme 2019.

2.1 Size of the E-2W Market in India

Recent policies have helped to create an emerging EV ecosystem and as a result India is seeing considerable growth in the overall electric mobility sector. E-2W penetration in particular has been increasing steadily over the past few years but still accounted for less than 1% of vehicles by the end of 2021. Cumulatively, around 520,000 E-2Ws were sold between 2016-21, representing 48% growth across the past five years (Figure 1).

Figure 1: Annual E-2W national sales



Source: WRI India

Currently, the E-2W market is dominated by Indian registered companies (see Annex VI at the end of the document for a breakdown of market share by main actors in the India EV ecosystem). While internal combustion engine (ICE) two-wheeler manufacturers with established distribution networks (e.g. Hero Motors and TVS) have diversified into EV manufacturing, the market has also seen many new entrants with no or limited automotive heritage (e.g. Ather and Okinawa), which indicates a low barrier to entry into the market. High-speed vehicles accounted for 28% of sales in 2021 (47% year-on-year growth). Most companies offer with-battery and without-battery models to lower upfront purchase costs while integrating this with a parallel battery-swapping business model. Nevertheless, while the initial uptake of E-2Ws has been hampered by concerns around high upfront cost, range anxiety and technology risk perceptions, growth forecasts for this market are optimistic. Indeed, multiple national assessments from different sources consistently indicate high-growth potential and steady long-term growth for E-2Ws across India.

³ India's National Action Plan on Climate Change – [Link](#)

⁴ More on this available [here](#)

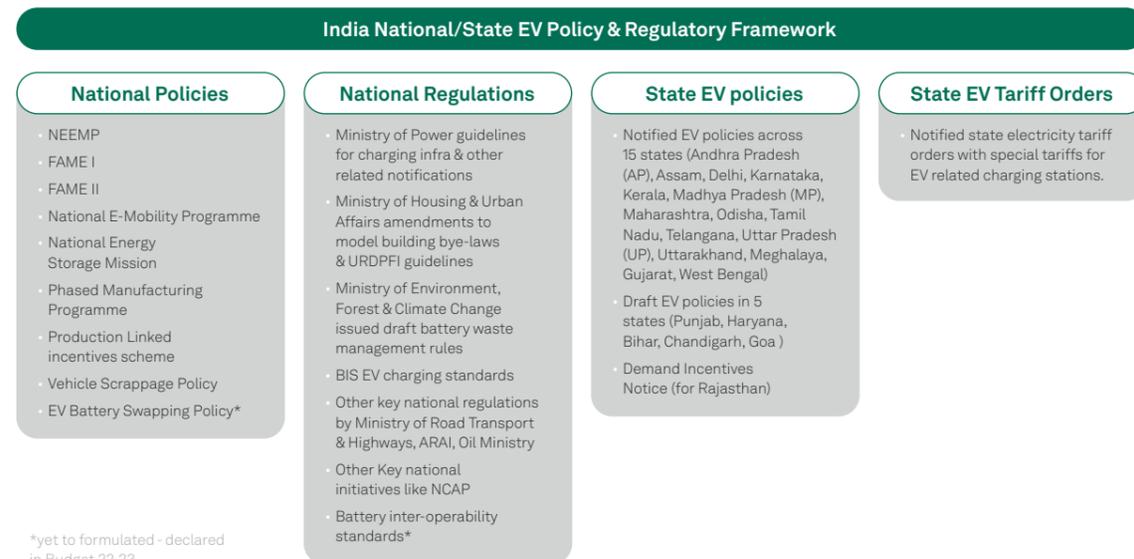
According to the Global EV Outlook 2020, India could achieve 30% EV sales penetration by 2030. Around 80 million EVs (cumulatively) are expected to be sold up to 2030, 70% of which will be E-2Ws and E-3Ws with the remainder cars and buses, according to analysis by NITI Aayog and RMI in 2019. The E-2W market is projected to grow to 56.6 million by 2030 (cumulative annual growth rate of 91%). In terms of EV sales penetration (sales against total vehicles in the same category), E-2Ws and E-3Ws are projected to have 80% penetrations by 2030, compared to commercial cars (70%), buses (40%) and private cars (30%) respectively.

Global factors such as technology developments and maturity, fall in battery prices and improvements in battery quality and successful implementation of national and state level policies, as well as value chain localisation and research and development, are among key growth factors according to World Resources Institute (WRI) India. Other drivers cited for this level of projected growth include local factors such as availability of charging infrastructure (and battery swapping infrastructure), shared mobility models that optimise vehicle penetration, and consumer-related factors such as behaviour shifts to shared mobility/leasing models rather than increased EV off-take and ownership models.

2.2 National EV Policy Landscape

Wide-ranging national- and state-level policies and regulations have been enacted over recent years promoting demand for EVs (Figures 2 and 3), creation of public charging infrastructure and stimulating domestic EV and battery manufacturing in India. Based on analysis of existing national level policies (NEEMP, FAME I/II, Phased Manufacturing Programme, Production Linked incentives scheme, Vehicle Scrappage Policies, etc.) alongside new or amended regulations by several Ministries (MOP, MORTH, MoHUA, MoEFCC), we uncover the many stakeholders at national, state, and city level who play unique roles across policy formulation and implementation.

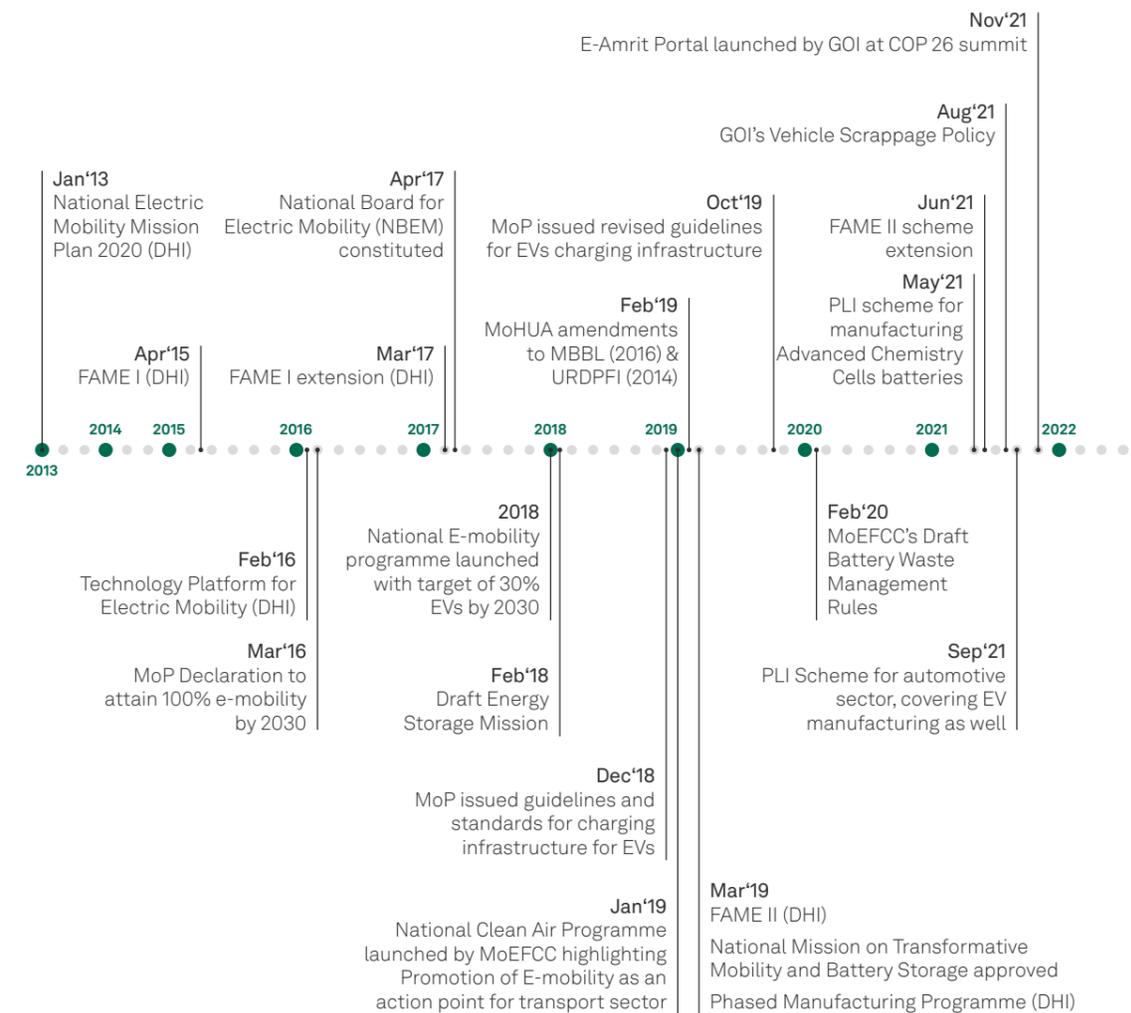
Figure 2: Figure 2 National and state EV policy and regulatory landscape



*yet to formulated - declared in Budget 22-23

Indeed, the growth in EV penetration and electric shared mobility schemes relies on a complex ecosystem of partners with policymakers from different ministries and frameworks playing a pivotal role, especially for charging infrastructure (see Annex III for a breakdown of the national actors and their roles).

Figure 3: Evolution of national policies and regulations



Despite rapid progress in recent years, certain gaps and policy issues are yet to be addressed for sustainable EV penetration in India. The biggest challenges in the current policy landscape for EV penetration along with key recommendations are summarised in Table 1.

Table 1: Key takeaways on national EV policies and regulations

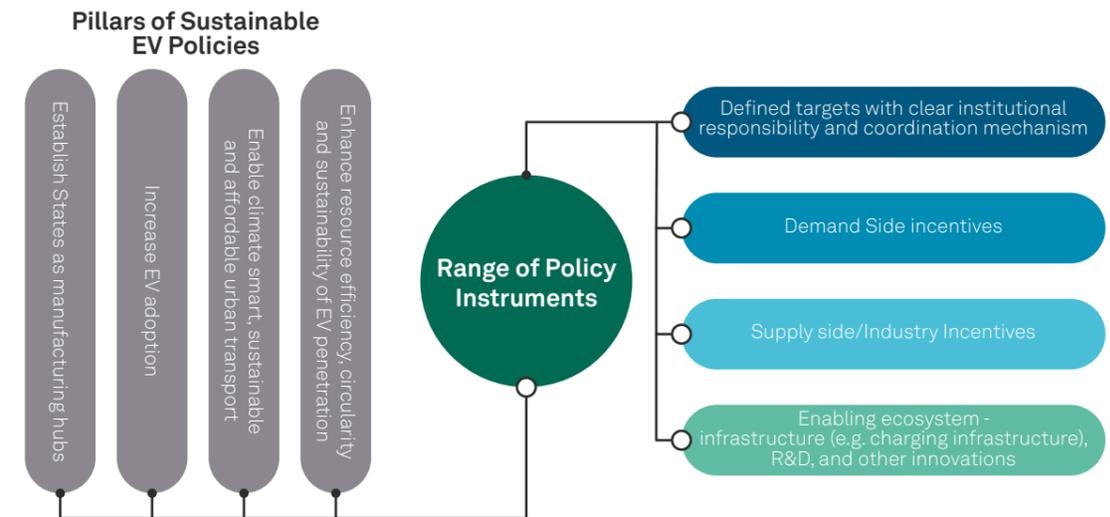
Issue	Significance	Suggested solution
While the Government of India has formulated progressive policies for EV penetration, there is no mandate for EV adoption in the country.	Mandated targets are critical to provide long term assurance to investors and private operators and encourage investments in clean fuel (such as transition of ICE vehicles to BS-VI standards - based on Euro 6 emission standards) in an integrated manner.	While efforts to incentivise behaviour change with incentives and policies are crucial, setting targets allow for these mandated numbers to give the market certainty and encourage investment and engagement from the private sector.
The current national policy landscape lacks incentives or penalties to promote transition of existing ICE vehicles to EVs.	Government of India's vehicle scrappage policy lacks integration with EV transition. The scrappage policy removes inefficient and polluting vehicles but does not push EV adoption without it being coordinated with a national mandate for EV adoption.	Retrofit allowances or other incentives (e.g. scrappage incentives) for converting an ICE vehicle to EV would need to be introduced along with the concepts of fee-bating (i.e. levying a penalty or surcharge) on ICE vehicle users.
Lopsided flows of subsidy support for charging infrastructure exist, with the majority flowing towards Public Sector Undertakings (PSUs) and government agencies.	As a result, flows to private sector companies are limited and are directed through municipalities, which have limited capacity to design, structure and implement such evolving public-private partnerships (PPPs).	For potential trials and scaling of EV sharing mobility models, this translates into a critical need to augment the role and capacities of cities in selecting locations and for setting up charging infrastructure in line with cities' specific needs, while leveraging national incentives to promote PPPs.
The current national regulatory framework does not mandate integration of green energy sources for charging infrastructure, nor for overall EV value chain. Similarly, there is currently no policy push for enabling the demand for second-life applications for the EV batteries.	Shared mobility models integrated with battery swapping are critical for enabling a long-term sustainable transition of EVs.	Therefore, a key priority would be the long-term and sustainable financing of EV transitions and battery recycling initiatives, with enabling potential for second-life applications of batteries.

While city governments will play a key role in implementing and optimising shared mobility EV models taking place in urban areas, national and state governments need to provide the necessary reform push to align incentives and investments. They also need to capacitate cities and augment their role as key implementing and monitoring public agencies in India's EV transition.

2.3 State EV Policy Landscape

Each level of government in India has its own jurisdiction in matters of legislation, taxation and administration. While there are policies and regulations set out on national level, each state also implements additional mandates and incentives to complement these. Figure 4 gives a broad framework of the four pillars underpinning analysis of Indian state EV policy and the range of policy levers used to achieve them.

Figure 4: Framework for state EV policy analysis

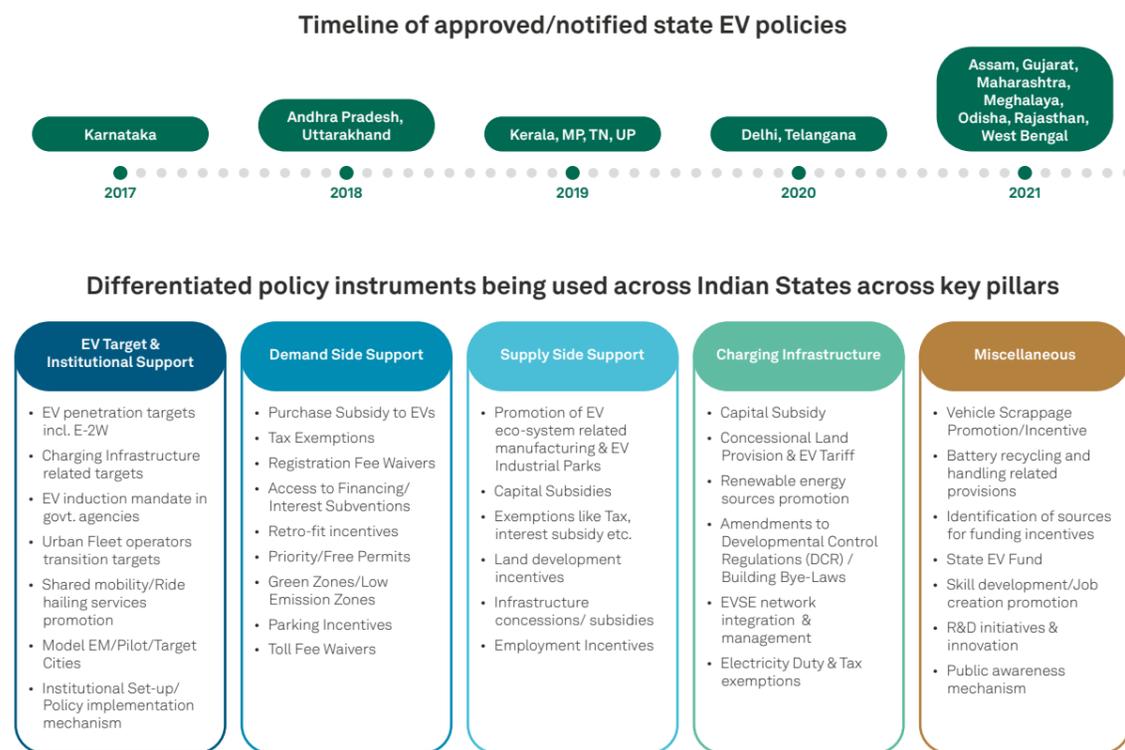


State-level EV policies feature diverse institutional models and policy implementation mechanisms. Most states employ nodal departments for implementation or steering committees for inter-departmental coordination. Some states have designated the department of commerce and industries as a common nodal agency. For further information, refer to Annex III.

State EV policies vary widely in scope and scale, with most policies enacted in the last two-three years and having a validity period of five years from the date of notification. States are split amongst those that have approved or notified EV policy, as seen in Annex IV. Others have notification by state transport departments on EV benefits and existing draft policies. The policies differ in terms of targets, supply side incentives (e.g. EV manufacturing), demand side incentives (consumer and charging infrastructure investments) and others (as summarised in Figure 5). EV penetration targets range from 10 to 25% by 2025-2026, with half of states having aggressive EV fleet targets of 50%-100% for food and e-commerce delivery operators for example.

In addition, Annex IV lists the five states with specific targets for setting up charging infrastructure. Eight states have taken a lead in promoting shared mobility/ride-hailing as part of their EV policies. Several states have policies clearly allowing ride-hailing service providers to operate E-2W taxis and promote the adoption of such taxis for short distances. Such policies are model-agnostic, meaning operators have the freedom to choose among shared mobility/ride-hailing models such as dockless or docked systems, and do not provide details on the potential models that cities could enable in a sustainable manner.

Figure 5: Evolution of state level EV policies



2.3.1 State-level demand-side incentives

As seen in Figure 4, there is a range of policies, incentives and subsidies widely used amongst Indian states. Most commonly used as key enablers for EV markets that are at nascent stages are demand-side incentives. Across states, the execution and enforcement of demand incentives primarily fall within the mandate of transport, urban development authorities and particularly, urban local bodies (ULBs). Financial incentives, such as purchase subsidies, help in reducing the higher upfront costs of EVs while operational incentives help in encouraging on-road EV usage.

Non-financial incentives comprise free/priority permits for EVs and complementary bans on permit renewals for ICE vehicles, alongside other key policy tools to enable EV transition, such as higher road taxes for internal combustion engine (ICE) vehicles. Demand incentives need a balanced approach on incentive, fiscal burdens and cost allocations, and defined budgetary allocations to enable a transition to electric mobility that is both time-bound and orientated around environmental sustainability outcomes.

In terms of the spectrum of demand-side incentives, state policies cover a wide mix (highlighted in Annex V) comprising of purchase subsidies, tax exemption, registration fee waivers, interest subventions for enhancing access to finance, retrofit incentives, priority/free permits, green/low-emission zoning, parking incentives, and toll fee waivers.

2.3.2 State-level supply-side incentives

For encouraging the production of EVs and related components of the EV value chain, supply-side incentives are provisioned in the state EV policies aimed at vehicle manufacturers, battery producers (and associated chemical industry), and auto-ancillary manufacturers. For example, policy can influence the quality of the batteries being produced: if cheap batteries with short lives meet the criteria for subsidies then they will be produced and will be discarded regularly and replaced by new batteries frequently. If there are standards and policies in place to maintain a life expectancy then the ill-effects of the 'disposable' battery will be mitigated appropriately.

Supply-side incentives generally come not only in the form of capital subsidies, grants, tax exemptions and employment incentives, but also as infrastructural support such as land allocation, subsidised utilities (water and power), and industrial parks. Further, employment incentives, including skills development and job creation, are fundamental to such supply-side incentives to achieve inclusive industrial growth and employment generation. While some Indian states (see Annex V) have applied existing industrial policy incentives for the EV sector on par with other industries, others have provisioned more favourable incentives in their state EV policy by highlighting it as a priority sector.

2.3.3 State-level charging infrastructure incentives

With the objective of alleviating EV consumer's range anxiety, state policies are pillared on creating a robust network of EV charging infrastructure. The charging infrastructure incentives are provided in form of capital subsidies, concessional land, tax exemptions, and preferential tariffs.

These infrastructure mandates at the state level generally come under the purview of energy department agencies including state electricity regulatory commissions, electricity transmission and distribution companies, and renewable energy development agencies. For capital-intensive public charging stations with multiple EV points and high-powered DC chargers, state EV policies lay down fiscal and non-fiscal incentives (such as capital subsidies and concessional land allocations). Concessional land provisions play a key role in reducing the high cost of land acquisition for EV charging through instruments such as concessional rental charges and long-term leases, with ULBs and UDAs to play a key role in provision of land and integrating public charging infrastructures into overall urban development. State policies have also promoted the integration of digital infrastructure, such as smart data portals and performance monitoring systems and services, such as digital payments and cloud services, to enable a robust EV supply equipment (EVSE) network integration and management. States have also promoted the use of renewable energy sources for charging infrastructure.

2.3.4 State-level battery recycling incentives

Most state policies have highlighted some form of battery recycling and handling related provisions, with objectives varying from encouraging reuse of batteries to setting up recycling infrastructure and promoting urban mining for rare earth metals in collaboration with battery and EV manufacturers.

The political and regulatory landscape divergence across states could impact regional agglomeration economies and penetration rates of EVs. Hence it is necessary that such state level policies are integrated regionally to leverage economies of scale for critical value chain elements such as recycling and battery circularity.

Other state-level innovative incentives

Further innovative measures and incentives highlighted in state EV policies include:

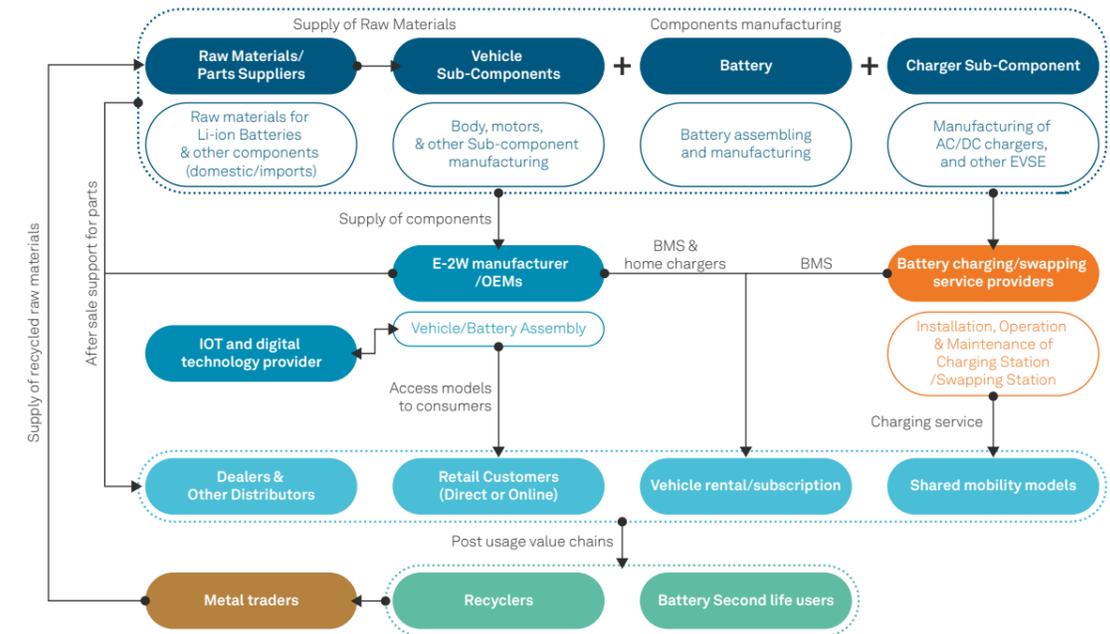
- Issuing e-mobility bonds by ULBs for financing EV infrastructure and transition.
- Innovative 'Zero Emission Vehicle (ZEV) Credit Program' to enable a credit mechanism (similar to the carbon credits given to hard-to-abate industries) to promote EV production targets across manufacturers.
- Delhi has planned to introduce mechanisms (such as additional road tax, pollution cess, congestion fee) to implement levying a surcharge on inefficient polluting vehicles with efficient ones receiving a rebate, the revenues from which will form part of an EV fund.
- R&D programmes, incubation centres, start-up funds, EV venture capital funds for piloting, financing and supporting high-value industrial growth. For example, establishment of a centre of excellence/automotive research/advance mobility in the state to provide a platform for government and academic partnerships for technology development, international and national academic and think-tank collaborations.
- Public outreach and consumer sensitisation programmes to tap on the role citizens can play in sustainable EV transition in the states, especially when it comes to behavioural changes. Such policy interventions include: testbeds, test rides in collaboration with various vehicle manufacturers, green days in cities, EV expos and more.
- Karnataka announced in summer of 2021 the roll-out of the Electric Bike Taxi Scheme, which allows private players and individuals to offer e-bike services up to 10km, thereby enabling pooling of private EV bikes for improving last-mile connectivity as well as boosting self-employment.



3 E-2W Value Chain Review

The E-2W value chain is complex, relying on a range of components and component parts with manufacturing and supply challenges (Figure 6). Digital technologies (e.g. Internet of Things (IoT)) and post-usage value chains – particularly providing batteries with a second life – play a key role for environmental gains. For instance, many E-2Ws may end up in landfills - and not all parts will be recyclable - if the correct measures are not in place.

Figure 6: The E-2W value chain



3.1 E-2W Manufacturing

To date, India boasts nearly 20 OEMs registered specifically for E-2W production under several subsidies. However, the actual number of E-2W OEMs is estimated to be higher as some have not registered for any government subsidies yet. While many new OEMs, including legacy automobile players, are entering the E-2W manufacturing market, lack of an EV mandate (as mentioned in policy takeaways) and the parallel requirements of transition of BS VI norms (i.e. standards that need to be complied by ICE manufactured similar to Euro VI standards) will impact the investments and scale that the legacy automobile players can commit for EV transition.⁵

⁵ Based on research, BS VI norms compliance by automobile OEMs would require heavy investments (to the tune of £6.2–7.2bn) in the manufacturing processes and technologies that could impede investments and manufacturing scales in EVs.

E-2W manufacturing challenges and recommendations

Currently, Indian manufacturers are pushed towards two tracks (without clear linkage or integrated strategy): one towards shift to clean ICE vehicle standards (BS VI norms) and another towards EVs. With a high economic and livelihood dependence on ICE automobiles, **a push by the national government for calibrated transition that focuses on skill development and training is critical for ensuring sufficient resource foundation (technical capacities and human capital).**

Because many existing private operators in E-2W manufacturing are start-ups, they lack financial capacities to meet the steep eligibility criteria for Government of India's ₹25,938-crore (£2.59bn) production-linked incentive (PLI) scheme to promote the manufacturing of battery and hydrogen fuel cell vehicles.⁶ The eligibility criteria of investment in fixed assets of a substantially large sum are compounded by additional investments, which are also required over the next five years to avail incentives. **Hence, it is critical to implement at national and state level a graded and start-ups/SMEs-inclusive eligibility criteria that would enable them to benefit from government schemes.**

High upfront costs, low resale value, high financing costs, and lack of financing options for consumers will continue to impede the E-2W uptake. A two-wheeler loan from banks comes with interest rates ranging between 16%-21% per annum and **innovative financing solutions being tested in the market (for instance by Ather, Revolt) need to be expanded at scale.**

E-bicycles and other types of low-speed micromobility E-2Ws play a key role in optimising EV penetration, hence these **should form a part of wider state and national government strategies and policies to promote EV manufacturing hubs in India.**

6 Financial Express: Cabinet clears Rs 25,938 crore PLI scheme: Boost to EVs, hydrogen fuel cell vehicle manufacturing – [Link](#)

3.2 E-2W Charging Infrastructure Ecosystem

The charging infrastructure market is fragmented and unstructured due to segregation of public vs. private players and public vs. commercial charging. The market comprises: i) major charge point operators' (CPO) established charge points; and ii) public charging stations established under different national policy schemes. According to a 2021 report by the World Bank, by the end of 2019 there were 1,827 publicly accessible EV chargers in India, of which only 5% (91) were fast chargers while slow chargers were around 95% (1,736).

Table 2 and Figure 7 summarise existing key determinants and industry initiatives for charging infrastructures. Power companies work with traditional fuel outlets, and charging infrastructure OEMs collaborate with real estate companies on residential projects. Meanwhile, E-2W manufacturers are exploring decentralised charging systems by working with shop owners to locate chargers on their sites.

Table 2: Key determinants for EV charging infrastructure

Location	Key Components	Charging Types
<p>Specific guidelines have been issued by MoHUA on setting up charging infrastructure in cities, buildings, offices etc.</p> <p>Based on location type where most charging infrastructure has been rolled out in cities (offices, malls, residential complexes, public spaces, PCS), and on major high-ways between cities (less relevant for E-2W). There are plans to expand the network esp on major express-ways & highways as highlighted by plans of DHI and MoRTH.</p>	<p>Hardware – Charge points, connectors, and chargers & associated equipment.</p> <p>Software & Services – Platform or Software as a service, charging units installation and maintenance, and towing service & battery delivery service</p> <p>Maintenance Services – Maintenance of charging stations and other hardware/software</p>	<p>Indian EV charging market comprises:</p> <p>Direct Charging, using AC/slow chargers (E-2W & E-3W) and DC/fast chargers (primarily E-4Ws target market).</p> <p>Battery swapping, using charged batteries to replace a discharged battery. Battery swapping is evolving as a key solution for E-2W shared mobility as well as for direct consumers (more details in later sections).</p>
Charging Types End Use	Key Cost Determinants	Revenue/Pricing Mechanism
<p>Home charging – Generally using a 230V/15A single-phase plug delivering an output power of upto 2.5 kW (for E-2Ws).</p> <p>Public charging – Refers to outside-home charging in commercial places, government office complexes, petrol pumps, parking lots etc.</p> <p>Commercial/Captive charging – Generally for a company's own fleet of vehicles or an aggregator's own fleet. This model is predominantly relevant for last mile connectivity/delivery/logistic players.</p>	<p>Capital Expenditure – Land cost (if owned), supply and installation of EVSE, charger management systems, meter, LED screens, CCTV camera, etc</p> <p>Operational Expenditure – Power Cost (energy charges, demand charges, electricity duties etc.); Leasing cost; Rebalancing activity for swapping models; Maintenance cost and other services cost such as payment gateway charges, parking charges, employee costs etc.</p>	<p>Time based fees – Users are charged based on the duration the vehicle is connected for charging.</p> <p>Energy-based fees – Users are charged based on the energy consumed during charging.</p> <p>Fixed fees – Users are charged a fixed/flat fee irrespective of charging duration or energy consumed.</p> <p>Membership/subscription fees – Users are charged on a monthly or annual basis.</p> <p>Non-energy revenue through advertisements</p>

Figure 7: Key strategies and industry initiatives for EV charging infrastructure



In terms of charging infrastructure growth drivers and forecasts, of a total of around one million public charging stations projected for India by 2030, around 0.30 million public charging stations (PCS) will be needed for E-2Ws and E-3Ws. The overall charging infrastructure requirement provides a significant investment opportunity for public and private enterprises. Specifically for E-2Ws, the current charging infrastructure business models may evolve significantly as the penetration of E-2Ws augments, leading to an increased: i) swapping infrastructure network; ii) charging at workspaces and residential places and iii) requirement of the city to formalise the development and implementation models of charging infrastructure via public-private partnership (PPP) models.

Charging infrastructure challenges and recommendations

Lack of adequate scale and investments in charging infrastructure critically impacts consumer confidence and EV penetration. The current scale planned by the national government is limited to 62 cities with around 40 chargers per city, resulting in insufficient scales while considering the population density of cities. **Urban development authorities (UDAs) would need to ensure that the pace of charging infrastructure establishment is in line with the long-term needs of the city where the infrastructure will be laid out.**

There are further challenges associated with land acquisition for setting up charging infrastructure in convenient locations as well as high lease costs and uncertain lease periods for rental land. **UDAs need to leverage public lands and develop strategic and investment roadmaps for developing charging infrastructure across cities.** They need to play a key role in mainstreaming collaborations between upstream, such as utilities, and downstream stakeholders (for unlocking land availability).

The market suffers from low charging infrastructure utilisation rates and lack of financial viability for early market players in the charging infrastructure business. In fact, the lopsided subsidies for public and private operators are impeding the charging infrastructure market. Subsidies are provided in a piecemeal manner (only for charging infrastructure and not for capital costs of trunk infrastructure). **There is a critical need for the Government of India to augment the role and capacities of UDAs in selecting locations and setting up charging infrastructure, while building on national incentives to promote PPPs.**

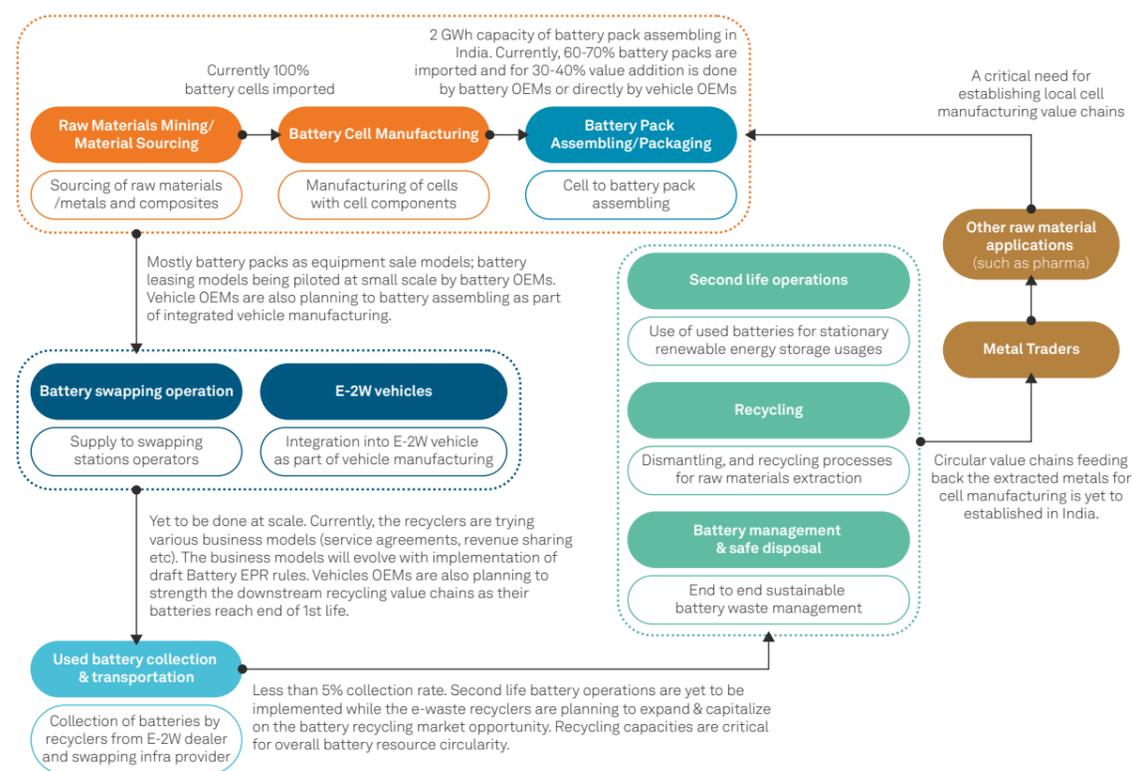
Absence of city-level data platforms for aggregating locations of charging stations impedes consumer access. Because charging infrastructure is critical for addressing consumers' charge and time anxiety, as well as for enabling sustainable mobility across cities, urban systems (planning systems, infrastructure investments) need to expand to include the charging infrastructure related service delivery aspects. **Existing national service level benchmarking, subsequent fiscal transfers and public investments need to expand to include key determinants, such as charging infrastructure, of EV penetrations. Upgraded city level data platforms undertaken by UDAs will buttress such a transition.**

3.3 Battery Manufacturing and Recycling EV Value Chain

The Indian battery manufacturing and recycling EV value chain has several dependencies, as seen in Figure 8 below. The market is developing rapidly, and significant players are emerging. India is heavily reliant on importing batteries as a result of its limited reserves of key minerals required for manufacture. Thus, the ability to recycle and reuse batteries is extremely important. Currently, most businesses operating in the recycling sector are based in Europe and China with only 5% located in India, according to the World Bank. According to JMK Research, the battery recycling market will build momentum from 2022 onwards as lithium-ion (li-ion) batteries reach the end of their first life.⁷

Because India is not a manufacturer of li-ion batteries, OEMs rely heavily on the import of key metals and battery cells. Investing in recycling infrastructure is critical to reduce imports and make battery manufacturing resource-efficient and to drive circularity of key metals involved in the process.

Figure 8: The EV battery manufacturing and recycling EV value chain in India



The energy-intensive production of li-ion batteries carries a significant environmental burden, while the batteries form a hazardous waste product after use. Annex VI explains some of the environmental issues associated with battery production and use, such as the danger of lithium being absorbed by edible plants and entering the food chain and why recycling needs proper handling. On the upside, following their first life powering vehicles, such batteries can still retain between 50-90% of their power, making them eminently suitable for reuse and a second life.

In 2020 the Ministry of Environment and Forests and Climate Change issued the Battery Waste Management Rules that mandate the extended producer responsibility (EPR) for waste collection centres, targets for take-back schemes and guidelines for recyclers.⁸ The socioeconomic rationale for battery recycling stems from the increasing EV penetration, which correlates directly with an increase in the consumption of li-ion batteries and

the rise in the number of used batteries, requiring a critical focus on sustainable battery management to avoid health and environmental hazards. Reuse and recycling are economically and environmentally more advantageous than manufacturing new li-ion battery packs but, for a sustainable business model, there is a need for large quantities of end-of life batteries which is determined by and dependent on the size of the EV market.

Developing the battery recycling and reuse sector is key to any nation's electric transition from an environmental perspective. Reducing the environmental impact of battery production means that the gains from e-mobility, especially in the E-2W market, will increase. For India, it also brings considerable business and economic opportunities to create an almost entirely new sector that in turn will attract investment and create jobs. The willingness of large and well-known companies to be involved at such a nascent stage is indicative of its potential. Nevertheless, it is a sector that needs to be governed by policy and regulation and therefore requires local and state governments to work with private sector companies.

Battery manufacturing and recycling challenges and recommendations

Most current batteries are imported into India, creating high import dependence, quality concerns and cost competitiveness concerns for Indian players. Currently, the batteries imported are not suitable for hot and humid climatic conditions in India without adaptation. In addition, inadequate battery localisation (for Indian conditions) and testing infrastructure further compound the risks of low-quality battery penetration in India. The current scale of the Indian market is sub-optimal for leveraging price bargaining propositions with global battery manufacturers. Due to lack of stringent quality norms in India and strong price competitiveness, low-grade batteries form a significant part of the Indian market. The vehicle subsidies are currently based on battery size – not quality – for calculation, so there is no impetus for OEMs to use higher quality batteries. **National and state polices need to push for longer warranties as a prerequisite to shift to quality.**

High battery replacement cost is another factor behind the subdued interest of a buyer towards E-2Ws. Consultations with private operators highlighted that battery second life usage is currently not feasible in the Indian context. Therefore, **prolonging the first life of the battery is key to the shift to sustainable EV penetration and national and state authorities would need to work with the private sector to ensure maximising the battery's life and performance.**

Recycling value chains are still at a nascent stage in India, with the majority of batteries in the market still in operation in their first life. As a result, there are limited collection systems, and limited recycling done at scale. Vehicle OEMs are focusing primarily on market penetration as of now and plan to establish recycling value chains once their batteries start reaching end of first life. **National and state government incentives (fiscal and non-fiscal) are needed for setting up battery recycling facilities.**

Low efficiencies and high collection and transportation costs negatively impact on the current recycling industry's economic viability. Sustainable value chains, in line with the regional EV penetrations and financial viabilities of recycling business, is yet to be seen in India. In addition, the market faces key safety risks associated with collection, transportation and storage of lithium batteries (hazardous materials) with risks of short-circuiting leading to fire hazards. **All of these need national regulation and policies in place to minimise costs, contain risk and ensure safety standards are maintained.**

⁷ The Economic Times – Lithium-Ion battery recycling presents a \$1,000 million opportunity in India – Link
⁸ It should be noted that although li-ion batteries remain the dominant ones, there are several other types of emerging technologies such as sodium ion which may form part of the mix in the future.

The secondary market for recycled and repurposed batteries is lacking. Even for second life applications of batteries, there is no established market, leading to key demand risks for recyclers. **National and state policies, including economic instruments, for enabling such an ecosystem for market forces (product quality, costs and more) to function need to be established.** The business models for collection and recycling are yet to evolve as the draft battery management rules and EPR are established. For example, there is currently no way of tracking the end-of-life fates of used EV batteries. Such data are critical to plan and implement EPR in coming years.

3.4 E-2W Battery-Swapping Ecosystem and Business Model

Battery-swapping stations act as aggregators, charging batteries by using electricity connections from either Power DISCOMS or via open access. The swapping operator either purchases charged batteries from a battery manufacturer or manufactures its own. The operator also sets up bulk facilities for charging discharged batteries received post-swapping. The time for swapping the batteries is comparable to the time it takes to refill an ICE vehicle at a fuel station. EV users generally sign-up with a specific operator for swapping batteries and visit that operator each time. Turnaround time for battery-swapping is a key parameter across the market to showcase operational efficiency and services.

The rationale for battery swapping and its suitability for the Indian EV market is outlined in Figure 9. Swapping is an intensive business. Typically, the swapping operator needs to purchase 1.5-2 times the batteries as the number of EVs to provide smooth functioning. A typical swapping station requires an investment of about £7-8,000 for a 20-vehicle station, excluding battery costs. O&M costs include: i) cost of electricity for charging; ii) fixed and operational costs of swapping outlets; iii) battery transportation/logistics including rebalancing; and iv) cost of provision of data platforms for battery monitoring.

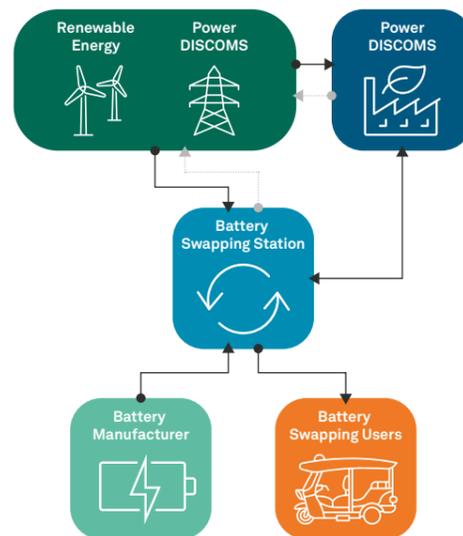


Figure 9: Rationale for potential suitability of battery swapping in India

Need for Battery Swapping

Battery cost typically represents 30% to 50% of total cost which is one of the key barriers to EV adoption. Battery swapping provides a method wherein the battery can be decoupled from an EV and provided through a service, thereby lowering the upfront cost of an EV and offering a better value proposition. Recognition of need for battery swapping stations in reducing commercial EV's downtime, as EV's usage in commercial applications help in reducing operational costs compared to ICE vehicles. The reduced charging time through battery swapping will aid in the uptake of EV's in commercial segment.

High Upfront EV Cost: TCO for an E-2W is getting on par with an ICE 2W counterpart, but upfront costs of EVs is still ~30-50% higher thereby impacting large scale adoption

High vehicle utilization help in increasing the economic viability of EVs (E-2Ws & E-3Ws) in commercial applications like last-mile connectivity and delivery and integration with shared mobility

High E-2W Battery Replacement Cost: In an average E-2W, a battery pack is replaced every 3 to 5 years post first life usage. The replacement of battery pack costs ~ INR 45k (GBP 450), which is costly proposition for a price conscious user.

Range Anxiety: Indian EV market majorly consists of E-2Ws & E-3Ws used in B2B applications. The E-2Ws on an average provide a range of 70 to 80 km on a single charge while the average delivery person travels ~200 km daily, thereby needing multiple charging downtimes daily.

Longer battery charging time: Longer battery charging time compared to an ICE vehicle counterpart acts as a barrier to EV adoption. Also, fast plug-in battery charging reduces battery life due to battery degradation.

Discharged batteries are charged in a controlled environment during battery-swapping, helping in extending battery life and minimizing safety concerns.

Battery swapping models' challenges and opportunities

There are four significant factors contributing to a challenging roll-out of a battery-swapping model in EVs currently:

- Goods and service tax (GST) on swappable batteries is 18% as opposed to 5% on factory-fitted EVs and their charging equipment (EVSE). Similarly, high GST is applicable for battery-swapping services as well as charging services.
- Lack of subsidy support for battery swapping model (especially applicable to E-2Ws).
- A high number of excess batteries are required to fulfil service and meet demands. As batteries are often the most carbon intensive aspect of a vehicle's manufacture, this can have significant impact on total embedded emissions of the system. Having clear use cases for second life batteries can help to mitigate this and ensure that there are enforced end of life recycling centres. Anything that can be done to prolong the life of the battery and E-2W vehicle (either by time or by mileage) is incredibly important.
- Lack of standardisation, which is impeding potential interoperability between battery packs and scaling up of the battery swapping operations.

While city governments will play a key role in implementing and optimising such models, national and state governments need to provide the necessary push to reform and realign incentives and investments. Misalignment between subsidies for vehicles and charging infrastructure would require **increased focus and investments – potentially with role of cities and PPPs – for enabling a sustainable ecosystem.**

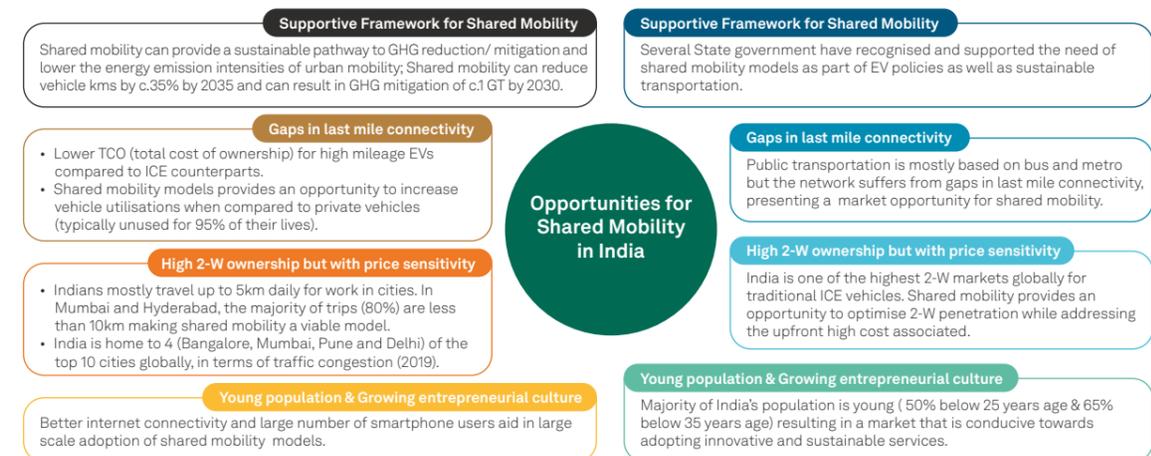
Current national regulatory framework for collection and recycling of EV li-ion batteries remains absent. Furthermore, there is no policy push for enabling the demand for second-life applications for the EV batteries. **There is a need for the currently absent mandate in the national regulatory framework on the integration of renewable energy sources for charging infrastructure and for overall EV value chain.**

In addition, the success of applicable requirement of indigenous components is yet to be established. OEMs are required to use a certain percentage of indigenous components to be eligible for availing subsidy. India's auto ancillary industry for EVs is at a nascent stage with only a limited number of indigenous manufacturers of EV components and high dependence on imports of such components. This business-as-usual approach could lead to increased prices and a drop in EV adoption for the initial years. **This represents a substantial opportunity for UK-Indian joint ventures on components where there is British expertise and quality which could be scaled.**

4 Electric Shared Mobility Landscape

The demand for E-2W shared mobility is estimated to increase over the next decade based on last-mile delivery, e-commerce, self-drive rentals and ride-hailing services. Shared services (considering all categories of vehicles) can reduce the number of vehicles on the road by around 60 million by 2030, alleviating traffic congestion from cities, according to Niti Ayog (see Figure 10). Daily urban trips are projected to reach 500 million by 2030, ensuring that shared mobility represents a key investment opportunity saving around £249 billion by 2030 on avoided oil imports through shared electric mobility systems.

Figure 10: Shared mobility ecosystem opportunities in India



Nevertheless, shared mobility will lead to significantly higher demands on individual vehicle usage, with consequent demands on maintenance and reduced lifetime, which must also be acknowledged. Specific to the E-2W market, according to McKinsey analysis (2020), E-2W shared mobility options will result in 8-9 million shared mobility E-2W units by 2030.

Self-drive rentals and ride-hailing are expected to have a compound annual growth rate (CAGR) of around 40-50% and 100% respectively by 2025. For each of the category, the market is projected to grow to:

- **E-commerce:** fleet size - 80k to 120k; travel distance per day - 90 to 100km; growth rate (2025) - 14 to 16% CAGR
- **Food and grocery delivery:** fleet size - 375k to 425k; travel distance per day - 120 to 130 km (F); 70 to 80km(G); growth rate (2025) - 15 to 20% CAGR (for food delivery), 25 to 30% (for grocery delivery)
- **Self-drive rentals:** fleet Size - 80k to 120k; travel distance per day - 90 to 100 km; growth rate (2025) - 100% CAGR
- **Ride-hailing:** fleet Size - 80k to 120k; travel distance per day - 90 to 100 km; growth rate (2025) - 40 to 50% CAGR

4.1 Evolution of Shared Mobility Models and Services in India

Shared mobility solutions from bikes, e-bikes to e-scooters (as vehicle of choice) are abundant in India for short distance travel at economical rates. There has been a significant change in how the public perceive the shared economy in terms of goods, mobility properties and more, with the medium- to long-term impact of the COVID-19 pandemic remaining to be seen. As a result, business models providing alternatives to expensive vehicle ownership are gaining increasing traction amongst customers.

Evidence points to EV-based shared mobility services gaining momentum and importantly, creating both new value streams and employment opportunities. Several developments in the sector will continue to bolster its growth and E-2Ws will play a key role. For example, an increasing number of business models based on E-2Ws' adoption for last-mile connectivity and delivery services are already emerging in India. The major drivers for growth of these trends include:

- Price parity with ICE vehicles due to lower total cost of ownership
- Less dependence on charging infrastructure due to lower power requirements and ability for battery-swapping
- Incentives from India's central and state governments encouraging EV adoption
- Entrepreneurial start-ups addressing a key gap in urban services
- Decreasing battery pack costs; growing consumer awareness and interest.

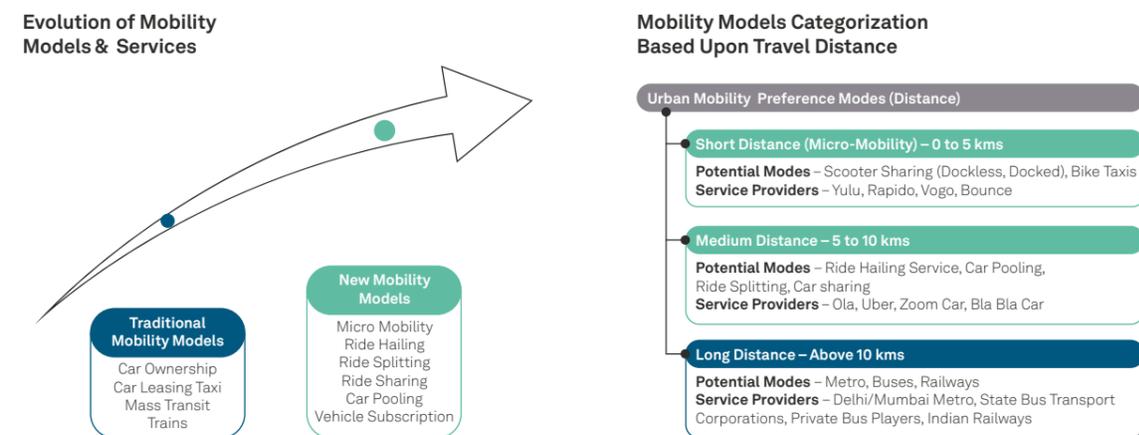
Various private sector driven B2C models are being implemented in India in collaboration with cities and metro authorities. Investments and risks are borne by the shared mobility private operator across all schemes. Key EV ecosystem players, mapped to market based operating models and key ingredients underpinning the business models (i.e. private sector with light touch city collaboration) include:

- **Yulu** – MoU with state regional authority (ensuring the operator functions without competitive procurement) dockless model in a defined area with geo-fencing for parking space, battery swapping and charging network. The operator could receive free land use rights or pay a very nominal fee for the use of land for parking.
- Leveraging city bike-sharing policies issued by governments for operators on a first come first served basis.
- **Bounce** – Bangalore and Hyderabad dockless model with pickup and drop off services at any location.
- Permit systems for shared mobility providers in the city. There is no exclusivity, hence multiple private operators operate bringing in price competition.
- **Rapido** – based on a ride hailing and aggregator model, similar to bike taxi models in Southeast Asia, through a driver operated two-wheeler service.
- **Zomato, Swiggy E-delivery** – 'vehicle as a service' B2B model collaboration for delivery services.
- Several Pay-as-you-use payment modes (apps) or weekly/monthly subscriptions and leasing/rental for daily or short rides or Leasing/rental models where the vehicle is leased for longer period.
- Partnerships with E-2W manufacturers and battery OEMs with a network of swapping and/or charging networks.

The evolution and growth of E-2W shared mobility (Figure 11) will depend significantly on:

- Shift of the city government planning systems to include shared mobility as a key service delivery. This will result in the transition of such shared mobility models as key city service for last mile connectivity.
- Maturity of the engagement models with cities, financial viability of the sector, and PPP models to enable equalised risk-return sharing.
- Consumer uptake with increased safety and reliability for consumers.
- Enabling city infrastructure (such as dedicated lanes, zones) and robust charging network availability.
- Shift of existing city data systems to interoperable transit data that enables end-to-end first- and last-mile connectivity and mobility-as-a-service (MaaS) provisions for citizens.

Figure 11: Shared mobility: evolution of mobility models



Most of the current shared mobility models are supported with smart solutions such as keyless options, provision of helmets, app-based platforms, artificial intelligence/data enabled operational planning, and battery performance monitoring systems. Current models differ in scale and size ranging from 20-500 shared mobility vehicles in a target area. Projects with larger scales are operationally challenging, as well as capital-intensive, hence reliability and consumer continuity at demand points is a key objective.

4.2 E-2W Shared Mobility Challenges and Opportunities

The E-2W shared mobility market in Indian cities is still at a nascent stage when compared to scale in the global cities and of the international operators. Primarily, the shared mobility models adopted in Indian cities differ significantly from those in global cities, falling short in terms of:

- Scale of shared mobility schemes
- Role of cities in driving shared mobility as an integral part of multi-modal city transportation.
- Long-term approach for integration of shared mobility as a key city service and its role for overall EV transition in cities
- Provisioning of supporting infrastructure such as lanes, zones etc and enabling ecosystem for sustainability of such models
- Procurement/engagement modalities
- Safety aspects
- Service delivery accountability and reliability
- Environmental sustainability
- Operational innovations and sustainability

The shared mobility market in Indian cities is primarily driven with a market-based approach of new private operators/start-ups venturing into the market in a limited scale. Some of the Indian shared mobility models are as small as 20 vehicles. Based on the market consultations, the current business models suffer from key gap of being financially sustainable with high CapEx and OpEx intensive businesses.

The market suffers from key challenges in terms of low accessibility and high financing cost. Lending institutions perceive shared dockless models as high-risk for any loan lending to shared mobility operators. Further, there are policy and regulatory impediments for deployment of shared mobility solutions with long processes that vary city by city.

To counter the challenges mentioned above, various promotional factors and incentives have been deployed, which have encouraged faster adoption of EVs in shared mobility. State EV policies have included initiatives for EV adoption as summarised in Table 3.

Table 3: Tools for shared e-mobility promotion

Factors for Shared Electric Mobility Promotion	
Parking and pick-up benefits	Parking benefits include free/discounted and designated parking spots at key locations. Pick-up benefits could include preferred pick-up locations for EV fleet thereby pushing users for choosing EV fleet and service providers to transition their fleet to EVs for accessing those users.
Road Tax & Toll Fees discount/exemption	Road tax and toll fees exemption/discount for shared electric vehicle fleet can incentive service providers to transition their fleet to EVs.
Licensing & registration fee benefits	Preference to shared and commercial EVs during registration and licensing process through low or no fees and short waiting time along with provision of registering batches of EV fleet together.
Congestion pricing	Congestion pricing includes levying varying fees and penalties on operating polluting vehicles in key demand urban areas based upon amount of emissions or total occupants for incentivising operations and utilisation of shared and clean technology-based vehicles.
Creation of Low-emission zones	Creation of Low-emission zones in high demand and congested urban pockets where the access and permit can be restricted to clean-technology based shared vehicles while levying higher charges/penalties on polluting vehicles for entering the zones.



5 Engagement Models for Government-Led Electric Scooter Rental Trials

Case studies presented in this section provide an overview of how cities are collaborating with private players to mainstream E-2W based shared mobility as part of their sustainable transportation strategy. In each of the cities – London, New York and Paris – three operators were contracted for a period of 1-2 years after a competitive procurement process for an urban e-scooter trial, with extension clause after a detailed set of requirements and criteria are met.



Transport for London (TfL) E-Scooter Trial

Lime, Dott and TIER were chosen as operators for a Transport for London (TfL) trial of e-scooters in the city. The trial began in June 2021 in 10 London boroughs after a detailed set of requirements were met. Ongoing performance of operators is monitored according to a set of indicators, including: utilisation and trip data; user feedback; fines; safety and incident reporting; environmental and sustainability metrics; tracking education; and marketing activities. TfL specified further safety standards than those at the national level.⁹

As part of the pilot, the selected operators are charged an upfront fee to be involved in the trial as well as periodic charges and per-vehicle charges that are shared between TfL and the different boroughs. All the investments are completely undertaken by the private operator. All the three selected operators share the same parking bays which have a set capacity, while they are each responsible for redistributing/ balancing scooters to ensure consistent public availability. Most of the operators currently swap batteries during redistribution by van or cargo bike. Specialised battery performance platforms are set by each of the operators, the data of which is shared with the city as well.

The e-scooter trials in London highlight the importance of getting the right density of bikes and parking to provide a service that is reliable and accessible as the public wants a mode of transport as and when they need it. Without this, there would not be sufficient ridership and hence income to cover operating costs.

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In more detail, the TfL e-scooter trials' requirements included:

- Indemnity and liability insurance to cover the loss and damage of scooter.
- Parking specifications and strategies to mitigate high risk behaviours
- Regular data-reporting to TfL through a data platform with two-way data exchange
- Outreach and education for users and non-users, community and stakeholder organisations
- Training and safety, with information on where users can ride, how to ride and operate device safely, where and how to park, and government safety standards
- Equitable access plans to support use by key workers and low-income groups

Additional eco-circularity provisions included:

- Extending vehicle lifespan, zero emission operations, circular economy principles (reducing waste and energy consumption, using recycled materials, reusing parts, localising the supply chain).



New York E-scooter Pilot Programme

In April 2021, New York City selected Bird, Lime and Veo, for its first pilot of a shared e-scooter programme, allowing each of the three companies to deploy 1,000 scooters in the Bronx over two years. The New York City Department of Transportation followed a competitive procurement process for selection of the operators.

The programme involved a phased approach with focus on areas with poor connectivity in the second stage. Namely, 4,000-6,000 scooters to extend the geographic boundaries to reach transit deserts that are unserved by existing bike-share programmes. E-scooter models and pricing plans are left to the private operator although the city government plays a role in fixing and approving caps.



PARIS Paris E-Scooter Operation Tender

The City of Paris followed a competitive procurement process for selection of three scooter operators. Dott, Lime and TIER were selected as part of the procurement process, and signed a public space occupancy agreement, which authorises them each to deploy a maximum of 5,000 machines in the city for a fee for a period of two years. The city has created 2500 dedicated parking places for such shared mobility operators. The operators were selected according to three criteria: i) environmental responsibility (40% weightage) ii) user safety (30% weightage) iii) scooter maintenance and charging management (30% weightage). Environmental standards requirements enabled swappable batteries for all new scooter models, multimodal integration, various programmes such as commitment to reusing or recycling and participation in carbon neutral protocols. Safety standards, embedded insurance, data privacy, and vehicle safety as part of the pilot. Similarly, operational standards laid down standards for operations, management, maintenance, and charging of their fleets, with a key focus on ensuring equitable geographical distribution of e-scooters throughout Paris.

These e-micromobility business and operational models have characteristics in common:

- Pilots and schemes initiated through an open tendering or management contracts.
- SMEs and start-ups encouraged to bid (due to provisions for self-certification, framework agreements, value bands and lower thresholds).
- Shift from conventional bid evaluation to more flexible and succinct process.
- Shared revenues from upfront fees and periodic (per vehicle) charges shared between public agency and operators.
- Capital investments exclusively by the private operators.
- Performance monitoring and recalibration through service level indicators, including: E-2W utilisation rates, trip data, user feedback, fines, safety and incident reporting, environmental metrics, education and marketing.
- Sustainability to get right density of bikes and parking to ensure seamless and just in time access for riders.
- Eco circularity provisions extending vehicle lifespan, zero emission operations, circular economy principles (reducing waste and energy consumption, using recycled materials, reusing parts, localising the supply chain).

6 Summary

Thus far, we have highlighted how recent national and some state-specific policies have nurtured an emerging EV ecosystem in India, and areas where the policy tools can be enhanced and standardised. For instance, how state EV policies are accelerating the national policy direction, but diversity across the states means leaders and laggards. We have also reviewed the range of challenges and opportunities within the E-2W manufacturing, charging and battery swapping technologies value chains. In each section we have provided suggestions on key areas that have been identified as paramount for national and state government levels to prioritise.

Cities around the world are adopting shared e-mobility models as an integral and essential part of their city-wide transportation and transition to EVs. India is no exception and E-2W shared mobility models are gaining momentum in its cities, primarily evolving from bikes, e-bikes and e-scooters (as vehicle of choice) for short distance travel at economical rates. However, so far these have concentrated around market-based models where the private sector leads, with light touch city collaboration leveraging earlier bikeshare schemes.

Taking this into consideration, as well as the case studies drawn upon from around the world on how cities are realising their E-2W shared mobility strategies, we are in the position to suggest a practical model for Indian cities that can support accelerating their move towards greener micromobility solutions. This model outlined below firstly as a pilot with potential to scale, strongly suggests that city authorities need to take proactive role in mainstreaming shared e-mobility.

How to run an E-2W shared mobility pilot in India

A scalable and cost-effective shared mobility pilot in an Indian city has capability to deploy large volumes of E-2Ws to lower the price point, increase uptake and access for lower socio-economic classes, enable alignment with government's sustainable mobility vision and create new industries, job, and investment opportunities. The following recommendations are aimed at helping decision-makers implement, pilot and scale-up E-2W shared mobility programmes as a key strand of their strategies.

The pilot should result in a project structure that is responsive to the city's needs and addresses the prioritised first- and last-mile connectivity issues. It is paramount to engage with various city- and state-level stakeholders as well as key players in the market such as OEMs and shared mobility service providers. Working closely with the private operator and city government will enable the selection of key locations and development of an installation plan for docking stations and specifications for the data platform. The insights from these engagements should inform the development of the pilot concept which will define the scope, financing structure, implementation modality, operational model, revenue, risk-sharing and potential scale-up plan. This will be part of an iterative process which will also support the city to procure a suitable private operator.

Once a private operator is appointed, the project team will provide post-implementation technical and monitoring support to ensure successful operations on the ground. During the pilot operations phase, data collection will take place over a defined period to carry out a comprehensive impact assessment of the pilot and establish key frameworks for future adaptation/scaling by and across the city.

Lastly, all learnings and key recommendations would be compiled and widely disseminated for potential replication or improvement in other areas of the city as well as other cities.

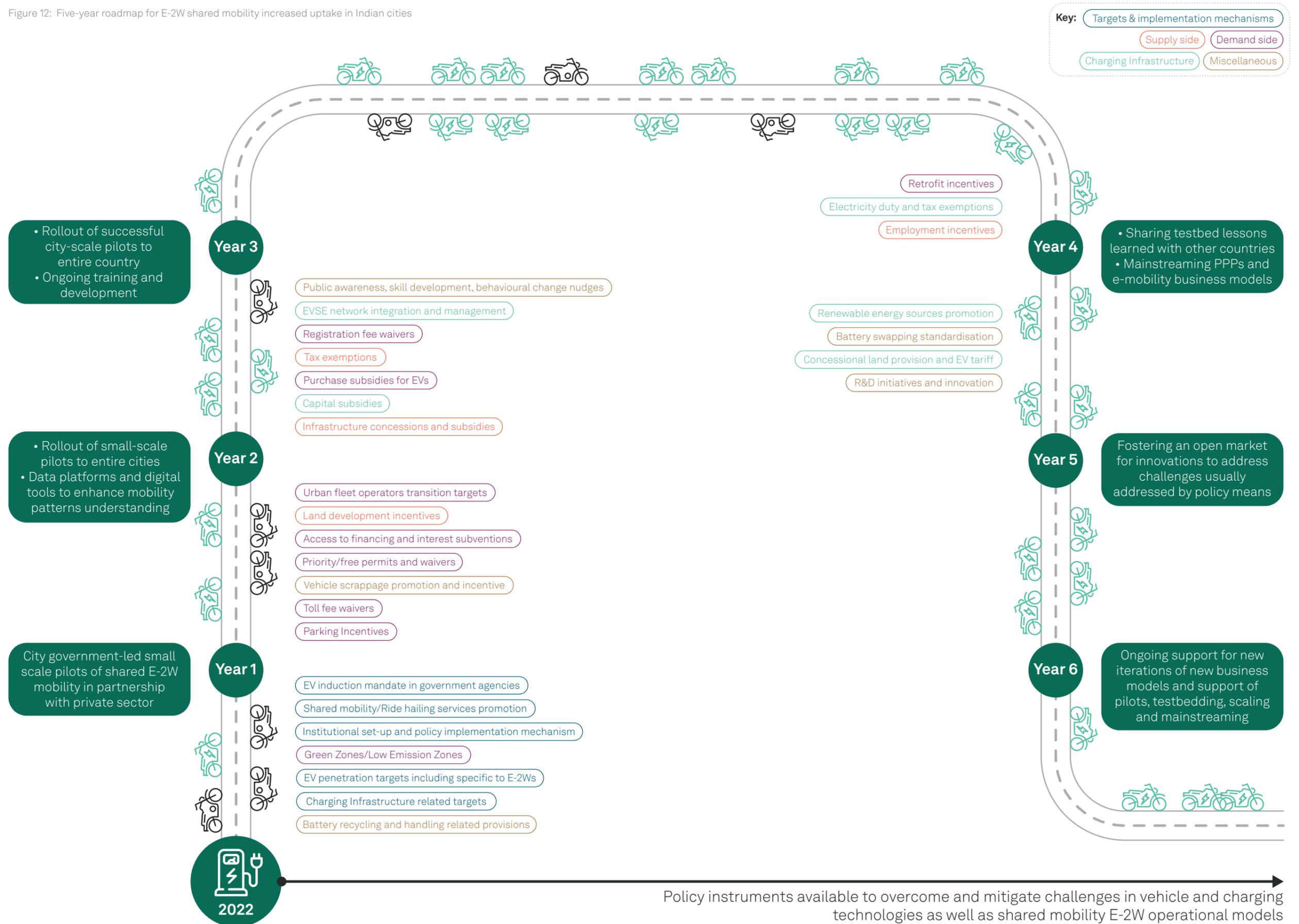
7 Five-year Roadmap for E-2W Shared Mobility Increased Uptake in Indian Cities

Based on the international examples and benefits outlined in previous sections, we recommend that cities in India take a proactive role in mainstreaming shared mobility for E-2Ws. The Five-year Roadmap for E-2W Shared Mobility Increased Uptake in Indian Cities (Figure 12) is developed to help shape future urban and state policies in this direction, act as a tool to prioritise future decision making, commitments, and investments and identify required actions that support these investments at city level.

By reviewing the dependencies between policy and regulatory implementations by city and state governments and the respective vehicle and charging technologies and operational models for shared E-2W mobility, the roadmap asserts that policy and regulation play a pivotal role in driving E-2W penetration. The next few years would be key for state policies that currently vary widely in scope and scale to match more progressive policies put in place by the national government with the key addition of a mandate for EV adoption in India.



Figure 12: Five-year roadmap for E-2W shared mobility increased uptake in Indian cities



Demand- and supply-side incentives, which come in different forms, also play an important part in the development of EV markets, especially at a nascent stage. Further, to enable the implementation and scaling of EV sharing business models, cities must be able to in select locations for programmes and of charging infrastructure to meet their specific needs. In turn, the current charging infrastructure market which is fragmented and unstructured due to segregation of the public versus private players and public versus commercial charging, represents a significant investment opportunity for public and private organisations.

As pilot schemes around the world have shown, in larger cities in particular, regional transport authorities must play a key governance role in collaborating with individual local authorities. This role includes procuring the operator through simplified and innovative processes as well as putting in place the necessary policy and legal environment for the sustainable adoption of e-shared mobility models. City governments should work closely with the selected operators to define the area of coverage, identify parking zones, 'no-go' and 'go-slow' zones, set safety norms, ridership requirements and local regulatory compliance and define other key characteristics of the programme. They should also access operational data from the private operators which is then used for planning multi-modal transportation in the city as well as for optimising the pilot in collaboration with shared mobility operators.

City-level data platforms for aggregating locations of charging stations must be put in place for enhancing access to programmes for consumers. Accessing operational data will help to inform multi-modal transport planning as well optimising schemes. In turn it should help to address issues such as range anxiety as well as promote and encourage the use of sustainable mobility across cities.

The evolution and growth of the E-2W shared mobility market relies on a number of factors, including PPP models to enable equitable risk-sharing, enabling city infrastructure such as dedicated lanes and zones, as well as robust charging networks. The E-2W market is expected be fuelled by first- and last-mile connectivity and delivery and logistics services, which will require coordination on the multiple layers of Indian policy and regulatory framework and at the same to allow for an open testbed to pilot/adopt E-2W schemes at varied scales where some companies will fail but, in the process, it will foster an open market for innovation.

Last but not least, research and development as a key focus area to promote the respective states as centres of innovations and excellence should also be prioritised. This would include facilitating the running of technology incubators and ensuring start-up and venture funds are in place to assist pilots and support high-value industrial growth.



Annex 1: Key Sources of Information

Reports

- NITI Aayog & RMI reports
- Moving Forward Together - Enabling Shared Mobility In India (2018 Report)
- India's Electric Mobility Transformation (2019 Report)
- NITI Aayog Report 2021 - Status quo analysis of various segments of electric mobility and low carbon passenger road transport in India
- NITI Aayog - Handbook of electric vehicle charging infrastructure implementation Version 1 (2021)
- World Bank 2021 Report - Electric Mobility In India
- JMK Research
- Recycling of Lithium-ion batteries in India (2019 Report)
- E-2W India Market Outlook (2020 Report)
- E-2W India Market Outlook (2021 Report)
- Evolving EV charging infrastructure in India (2021 Report)
- Mckinsey Report (2020) - The unexpected trip: The future of mobility in India beyond COVID-19
- CEEW-CEF Report 2021 - Charging up the EV supply chain

Websites

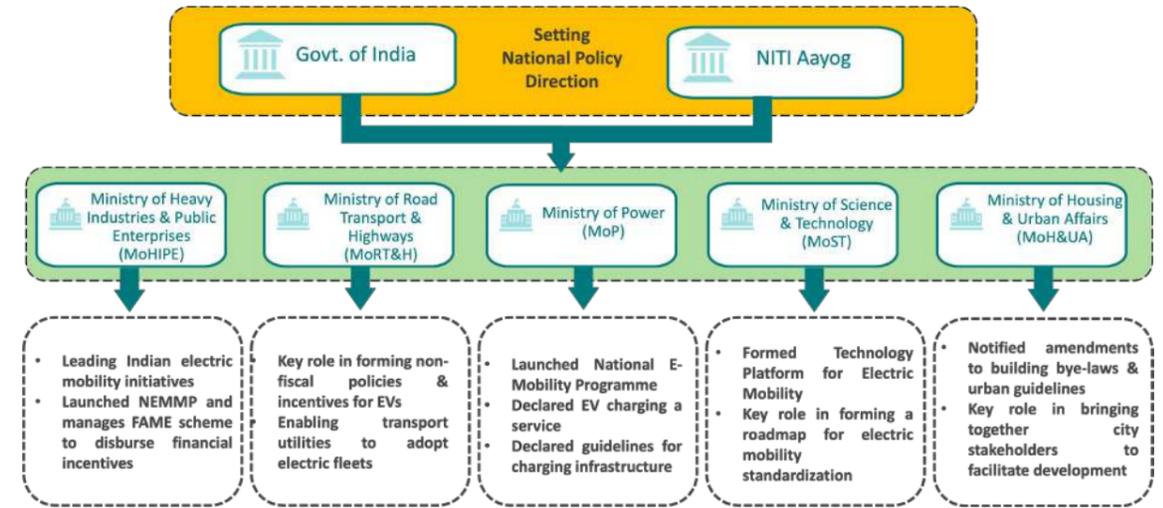
- JMK Research website - <https://jmkresearch.com>
- EVreporter website - <https://evreporter.com>
- Vahan Dashboard - <https://vahan.parivahan.gov.in/vahan4dashboard/>
- FAME II website - <https://fame2.heavyindustries.gov.in>
- CEEW-CEF website - <https://cef.ceew.in/solutions-factory/tool/electric-mobility>
- Bloomberg New Energy Finance Website
- Company Websites of Key Players in ecosystem
-

Annex 2: Full list of Abbreviations

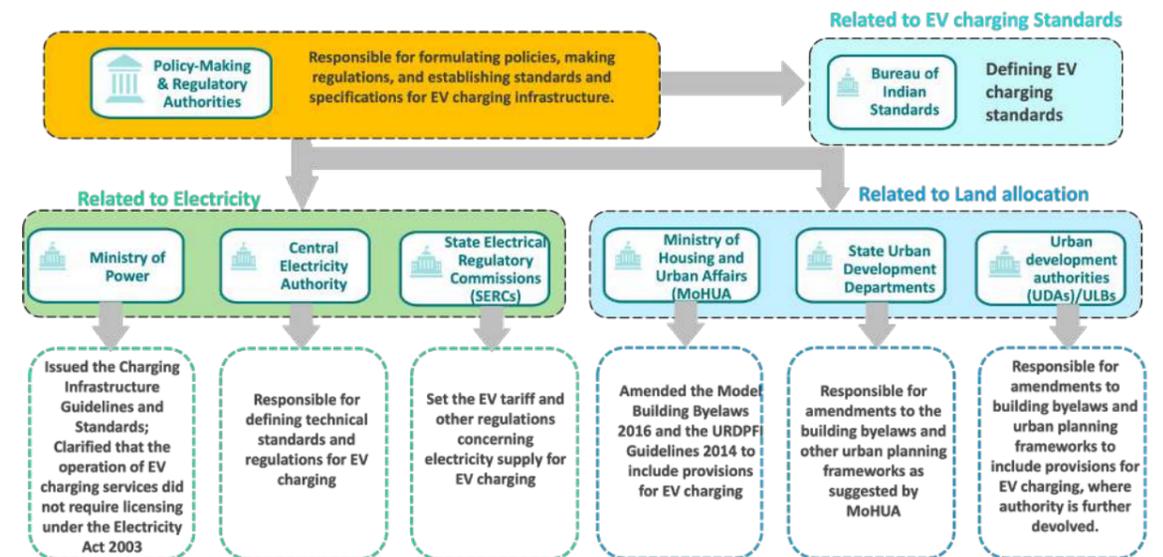
2W	2 Wheeler	E-3W	Electric Three-Wheeler
3W	3 Wheeler	E-4W	Electric Four-Wheeler
4W	4 Wheeler	E-Auto	Electric Auto
AC	Alternating Current	E-MSP/NSP	Electric Mobility Service Provider/Network Service Provider
ACC	Advanced Chemistry Cell	E-rickshaw	Electric Rickshaw
ARAI	Automotive Research Association of India	E-Waste	Electronic Waste
B2B	Business to Business	EESL	Energy Efficiency Services Limited
B2C	Business to Consumer	EO	Energy Operator
BAU	Business As Usual	EPR	Extended Producer Responsibility
BBMP	Bruhat Bengaluru Mahanagara Palike	EV	Electric Vehicle
BCS	Battery Charging Station	EVSE	Electric Vehicle Supply Equipment
BEE	Bureau of Energy Efficiency	FAME	Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
BESCOM	Bengaluru Electricity Supply Company Limited	FCI	Fixed Capital Investments
BHEL	Bharat Heavy Electricals Limited	GHG	Green House Gas
BIS	Bureau of Indian Standards	GST	Goods and Service Tax
BMS/TMS	Battery Management System/Thermal Management System	GT	Giga ton
BMTC	Bengaluru Metropolitan Transport Corporation	GW	Giga Watt
Bn	Billion	GWh	Giga Watt Hour
BPCL	Bharat Petroleum Corporation Ltd	HPCL	Hindustan Petroleum Corporation Limited
BSO	Battery Swapping Operator	HS	High Speed
BSS	Battery Swapping Station	HT	High Tension
CEA	Central Electricity Authority	ICE	Internal Combustion Engine
CEEW-CEF	Council on Energy, Environment & Water - Centre for Energy Finance	IEA	International Energy Agency
CI	Charging Infrastructure	IEC	Information, Education and Communication
CPO	Charge Point Operator	IGL	Indraprastha Gas Limited
DC	Direct Current	IOCL	Indian Oil Corporation Limited
DCR	Development Control Regulations	IOT	Internet of Things
DHI	Department of Heavy Industries	IS	Indian Standards
DISCOM	Distribution Company	JV	Joint Venture
DULT	Directorate of Urban Land Transport	KIADB	Karnataka Industrial Areas Development Board
E-2W	Electric Two-Wheeler	KREDL	Karnataka Renewable Energy Development Limited

KW	Kilo Watt	R&D	Research and Development
kWh	Kilo Watt Hour	REIL	Rajasthan Electronics & Instruments Ltd.
LFP	Lithium Iron Phosphate	RTO	Regional Transport Office
Li-ion	Lithium Ion	SERC	State Electrical Regulatory Commission
LMO	Lithium Manganese Oxide	SGST	State Goods & Services Tax
LMV	Light Motor Vehicle	SNA	State Nodal Agency
LS	Low Speed	SPV	Special Purpose Vehicle
LT	Low Tension	TCO	Total Cost of Ownership
MBBL	Model Building Bye-Laws	UA	Urban Agglomeration
MoEFCC	Ministry of Environment, Forest & Climate Change	UDA	Urban Development Authority
MoHIPE	Ministry of Heavy Industries & Public Enterprises	ULB	Urban Local Body
MoHUA	Ministry of Housing and Urban Affairs	UMTA	Unified Metropolitan Transport Authority
MoP	Ministry of Power	URDPFI	Urban and Regional Development Plans Formulation and Implementation
MoRTH	Ministry of Road Transport and Highways	V2G	Vehicle to Grid
MoST	Ministry of Science & Technology	V2X	Vehicle to Everything
MoU	Memorandum of Understanding	WRI	World Resources Institute
MSME	Micro, Small and Medium Enterprises		
MT	Metric ton		
NCA	Lithium Nickel Aluminium Cobalt Oxide		
NCAP	National Clean Air Programme		
NEEMP	National Electric Mobility Mission Plan		
NESM	National Energy Storage Mission		
NMC	Nickel Cobalt Manganese		
NSP	Network Service Provider		
NTPC	National Thermal Power Corporation		
O&M	Operation & Maintenance		
OEM	Original Equipment Manufacturer		
PCI	Public Charging Infrastructure		
PCS	Public Charging Station		
PLI	Production Linked incentives		
PMP	Phased Manufacturing Programme		
PPP	Public Private Partnership		
PSU	Public Sector Undertaking		
PWD	Public Works Department		

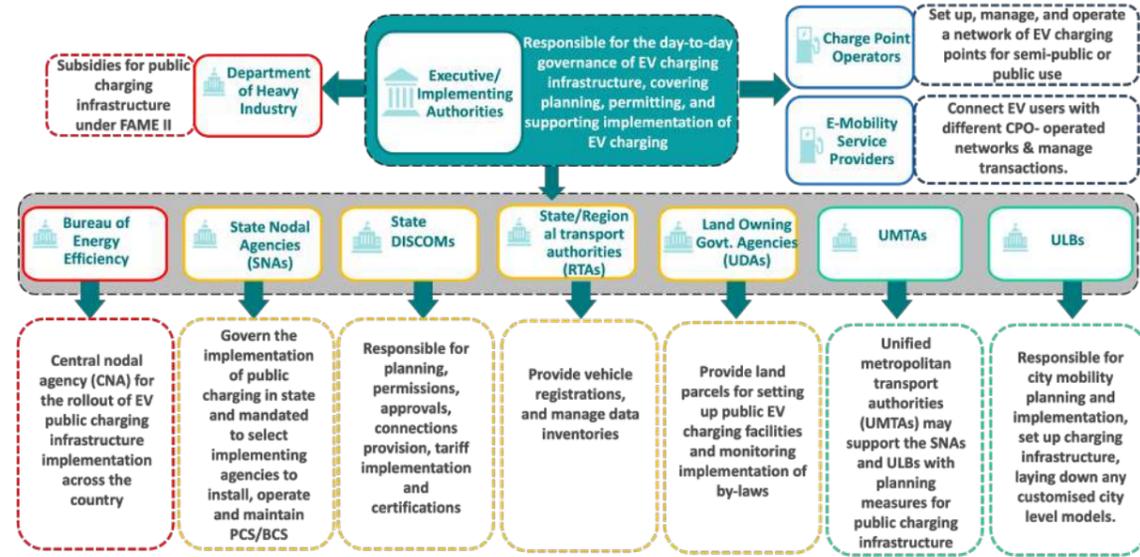
Annex 3: National and State level Policy Landscape



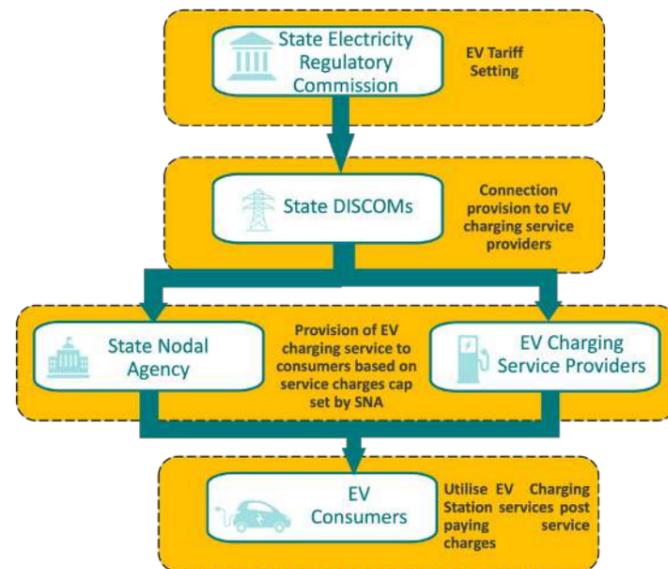
Annex 3b: Charging Infrastructure Policy



Annex 3c: Charging Infrastructure Implementation



Annex 3d: Institutional Structure for Tariff Setting



Annex 4: State by state comparison on EV policies, targets and implementation

In terms of diversity across Indian states:

- Most state policies having a validity period of five years from the date of notification. Tamil Nadu and Telangana have 10-year policies; Delhi's EV policy is valid for three years while Rajasthan's incentive notice is valid for only one year. Gujarat has a policy valid for four years while Maharashtra's targets correspond to a four-year validity.
- Major diversity on EV targets across states where targets defined as a % of total vehicle registration or as a cumulative number by end of policy period. Penetration across states ranges from 10% to 25%, with majority aiming for 25% by mid-decade (by 2025-2026), with 10% for Maharashtra by 2025 and 25% for Delhi by 2024 & MP by 2026. Only Goa (still in draft) has aimed to achieve 30% penetration by 2025. Telangana, and Rajasthan have no defined targets.
- Only four states have defined targets for E-2Ws with EV policies differing in terms of additional coverage of hybrid and new-fuel based vehicles. Maharashtra has set 10% E-2W penetration by 2025; Gujarat and Assam have set 0.11 m and 0.1 m E-2W targets by 2025/2026. Seven state EV policies restrict the coverage to battery/grid-based EV vehicles, while other states (such as TN and UP) have allowed the hybrid vehicles as part of the policy coverage. Further, few states (such as AP, MP, UP) include new fuel (hydrogen/fuel cells) based vehicles.
- Five states (Maharashtra, AP, UP, Kerala and WB) have included specific targets for setting up charging infrastructure with Maharashtra defining differentiated city specific targets (such as 1500 for Greater Mumbai) to be achieved by end of policy period.

Annex 5b: Demand side incentives

State	Purchase Subsidy (EV)	Purchase Subsidy (E-2W)	Tax Exemptions	Registration Fee Waivers	Access to Financing/Interest Subvention	Retrofit Incentives/promotion	Priority or Free Permits	Green Zones/Low Emission Zones	Parking Incentives	Toll Fee Waivers
Maharashtra (Final)	●	●	●	●	●	●	●	●	●	●
Delhi (Final)	●	●	●	●	●	●	●	●	●	●
Karnataka (Final)	●	●	●	●	●	●	●	●	●	●
Gujarat (Final)	●	●	●	●	●	●	●	●	●	●
Andhra Pradesh (Final)	●	●	●	●	●	●	●	●	●	●
Assam (Final)	●	●	●	●	●	●	●	●	●	●
Odisha (Final)	●	●	●	●	●	●	●	●	●	●
Madhya Pradesh (Final)	●	●	●	●	●	●	●	●	●	●
Tamil Nadu (Final)	●	●	●	●	●	●	●	●	●	●
Kerala (Final)	●	●	●	●	●	●	●	●	●	●
West Bengal (Final)	●	●	●	●	●	●	●	●	●	●
Uttar Pradesh (Final)	●	●	●	●	●	●	●	●	●	●
Telangana (Final)	●	●	●	●	●	●	●	●	●	●
Meghalaya (Final)	●	●	●	●	●	●	●	●	●	●
Rajasthan* (Notice)	●	●	●	●	●	●	●	●	●	●
Goa* (Draft)	●	●	●	●	●	●	●	●	●	●

Annex 5c: Supply side incentives

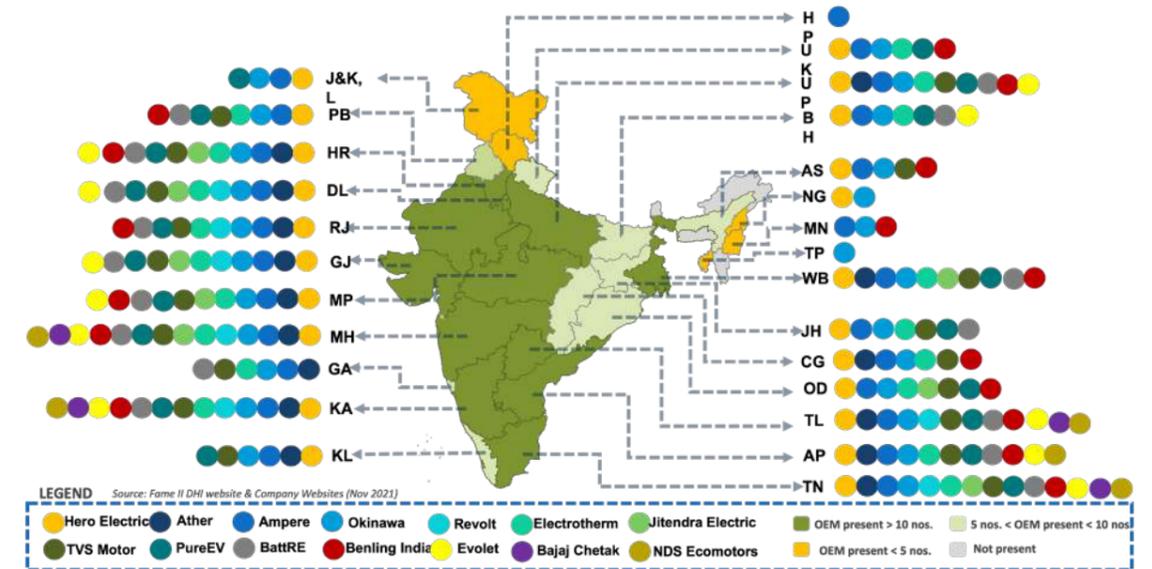
State	Promotion of EV manuf.	Promotion of EV component manuf.	EV Industrial Parks and EV Clusters	Promotion of Battery manuf.	Capital Subsidies	Exemption (Tax & Int. subsidy)	Land development incentives	Infrastructure concessions & subsidies	Employment Incentives & Skill develpt.
Maharashtra (Final)	●	●	●	●	● All the benefits under 'D+' category of mega projects/other categories	●	●	●	●
Delhi (Final)	●	●	●	●	●	●	●	●	●
Karnataka (Final)	●	●	●	●	●	●	●	●	●
Gujarat (Final)	●	●	●	●	● As per provisions of the Gujarat Industrial Policy-2020 for parties intending to set up or upgrade their facilities for manufacturing in the EV sector	●	●	●	●
Andhra Pradesh (Final)	●	●	●	●	●	●	●	●	●
Assam (Final)	●	●	●	●	●	● Incentives - Assam's IIP (2019) & NEIS (2017)	●	●	●
Odisha (Final)	●	●	●	●	●	● Incentives - IPR (2015) & MSME Policy (2016)	●	●	●
Madhya Pradesh (Final)	●	●	●	●	● Incentives under MP's IIP (2010) incl. increased incentives for land& FAR	●	●	●	●
Tamil Nadu (Final)	●	●	●	●	●	●	●	●	●
Kerala (Final)	●	●	●	●	● Cap. subsidy, concession in electricity, tax breaks as per IT & ESDM Policy	●	●	●	●
West Bengal (Final)	●	●	●	●	●	●	●	●	●
Uttar Pradesh (Final)	●	●	●	●	● Land Subsidy and incentives to be provided as per UP IIEPP 2017 policy	●	●	●	●
Telangana (Final)	●	●	●	●	●	●	●	●	●
Meghalaya (Final)	●	●	●	●	●	●	●	●	●
Rajasthan* (Incentives Notice)	●	●	●	●	●	●	●	●	●
Goa* (Draft)	●	●	●	●	●	●	●	●	●

Annex 5d: Charging infra enablers

State	Capital Subsidies (EVSE) for CI	Concessional Land Provision	Concessional EV Tariffs/ Separate EV Tariff Order	Use of Renewable Energy Sources	Provisions in DCR/Building Bye-Laws	EVSE network integration & management	Electricity Duty Exemption	Tax Exemptions/ Reimbursement for SGSTs
Maharashtra (Final)	●	●	●	●	●	●	●	●
Delhi (Final)	●	●	●	●	●	●	●	●
Karnataka (Final)	●	●	●	●	●	●	●	●
Gujarat (Final)	●	●	●	●	●	●	●	●
Andhra Pradesh (Final)	●	●	●	●	●	●	●	●
Assam (Final)	●	●	●	●	●	●	●	●
Odisha (Final)	●	●	●	●	●	●	●	●
Madhya Pradesh (Final)	●	●	●	●	●	●	●	●
Tamil Nadu (Final)	●	●	●	●	●	●	●	●
Kerala (Final)	●	●	●	●	●	●	●	●
West Bengal (Final)	●	●	●	●	●	●	●	●
Uttar Pradesh (Final)	●	●	●	●	●	●	●	●
Telangana (Final)	●	●	●	●	●	●	●	●
Meghalaya (Final)	●	●	●	●	●	●	●	●
Rajasthan (Incentive Notice)	●	●	●	●	●	●	●	●
Goa (Draft)	●	●	●	●	●	●	●	●

Annex 6: Charging infrastructure implementation models and battery swapping initiatives

Annex 6a: Existing market penetration reveals a multiplicity of E-2W players across States



Annex 6b: Charging Infrastructure: Implementation Models

Captive development by fleet operators and OEMs

- Ola**
 - OLA is developing its own hyper network for E-2Ws. Ola also partnered with M&M for an "electric mass transport project" in Nagpur aiming to develop charging infrastructure for 200 EVs (cars and autos) on to its app.
- Ather Energy**
 - Ather has developed its own charging station network, called Ather Grid, across cities like Delhi, Bangalore, Chennai etc. for promoting EV adoption
 - Ather also provides its users with home charger, Ather Dot, that can be installed in bungalows, apartments, parking spaces.
- Yulu**
 - Established a partnership with Adani group (Elec Co) for its charging station network with space provided by the Adani group while Yulu will carry out installation and operation. The concessional tariff will be lower than the current commercial tariffs for its PCS. The company is looking to open the charging station to all users in future. For Yulu users, currently the charging service is free of cost.

Charging Infrastructure by collaboration or JV

- Tata Power**
 - MoUs signed with HPCL, IOCL, IGL etc. for setting up commercial EV charging stations at their retail fuel outlets
 - MoU signed with MG Motors for setting up fast-charging stations at MG Motors' select dealerships.
 - Partnership with Tata Motors for developing charging stations in Maharashtra
- MoU signed b/w Exicom and BHEL** for helping BHEL in setting up an EV charger manufacturing facility
- NTPC** has tied up with entities like IOCL, HPCL, DMRC, Ola, Lithium, Bounce, Zoom Car etc. for public charging infrastructure development and utilization.
- EESL** has already tied-up with public/private entities like BHEL, HPCL, BSNL, Chennai Metro, Maharashtra Rail Corporation Ltd etc, for setting up public charging infrastructure.

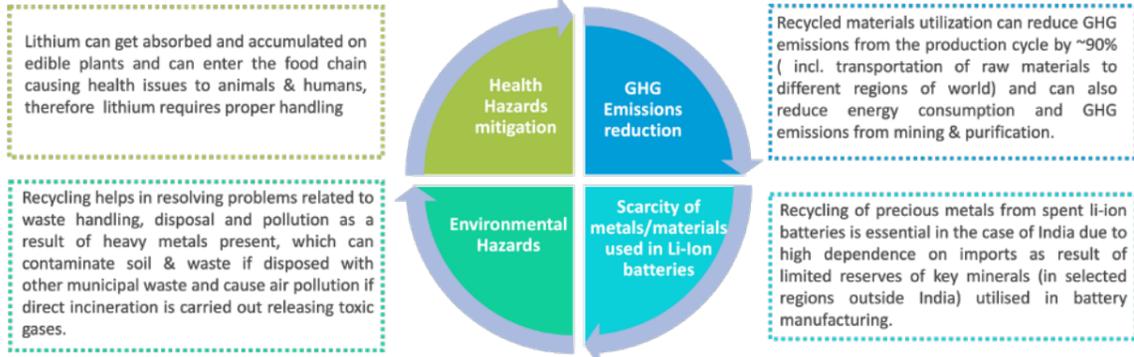
Home and workplace charging

Tie-ups between Charging Infrastructure OEMs and real estate developers for making residential properties EV ready (ie partnerships between Magenta Charge Grid & Lodha Group, and PlugNgo & DLF)

- Magenta Power**
 - Magenta Power's 'ChargeGrid' provides charging solutions for home and commercial spaces; Tie-ups done with Lodha Group for installing electric mobility charging solution in their realty projects at Dombivli and Thane
- PlugNgo**
 - PlugNgo has collaborated with DLF for making DLF's cyber city complexes & commercial spaces EV ready.

Annex 6c: Strong case for battery recycling and circularity given high battery import dependence and huge potential EV market in India

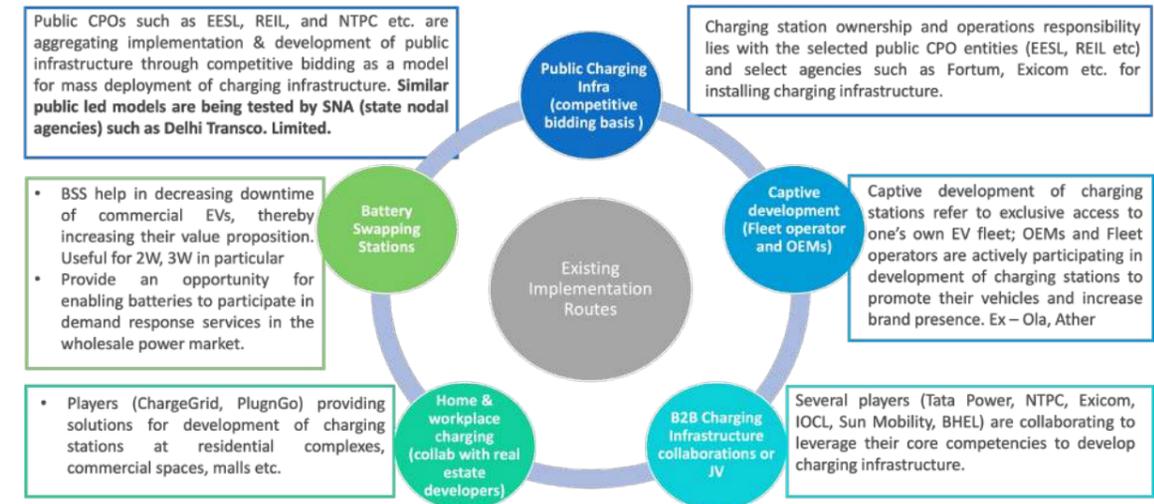
- The increasing EV penetration correlates directly with increase in the consumption of lithium-ion batteries and the rise in the number of used batteries, requiring a critical focus on sustainable battery management to avoid health & environmental hazards
- Reuse and recycling are economically and environmentally more advantageous than manufacturing new Li-ion battery packs, but for a sustainable business model there is a need for large quantities of end-of life batteries which is determined by the size of the EV market.
- Lastly, India is not a manufacturer of Li-ion batteries and OEMs rely heavily on the import of key metals/battery cells. Investing in recycling infrastructure is critical to reduce imports and make battery manufacturing resource efficient & circularity driven through utilization of key metals extracted for manufacturing more batteries



Annex 6d: Innovative market penetration models with product differentiations being adopted

Player	B2C model	No of dealers/centres	Market entry business models	Key Investments	LS Models	HS Models	Price range (GBP)@100 INR/GBP	Manufacturing Facilities (existing and planned)
Hero Electric	Dealership	600+	Sale and lease/subscription models.	Own funds with external fundraising of GBP 16.6 mn in Dec'18 and GBP 22.66 mn in July 2021	6	4	466 – 839	Manufacturing facility near Ludhiana, Punjab with 1 lakh units per year and plans to increase capacity to 5 lakhs per year by march, 2022.
Okinawa	Online + Dealership	550	Sale With detachable battery for home charging	Self-funded.	5	4	620- 1060	Manufacturing facility in Bhiwadi, Rajasthan with production capacity of more than 1.8 lakh units per year. Plans for new 5-lakh unit per annum plant at Alwar in Rajasthan
Ampere	Dealership	300	Sale and lease/subscription models; With battery & without battery with subscription.	Wholly-owned subsidiary of Greaves Cotton.	8	3	345 to 690	Two manufacturing facilities Coimbatore with production capacity of 60,000 vehicles; Plans for a new plant with 10 lakhs units in Tamil Nadu.
Ather	Online + experience centres	15	Sale and lease/subscription models Parallel Ather grid network	Raised capital of about GBP 107.24 mn with Hero MotoCorp and Sunny Bansal as major investors.	0	2	1060-1470	Manufacturing facility in Hosur, Tamil Nadu with annual capacity of 1.1 lakhs vehicles. Plans to expand the existing capacity to 4 lakhs per annual with new manufacturing plant in Hosur, Tamil Nadu .
Revolt	Online + revolt hubs	11	Sale and lease/subscription models with detachable battery for home charging	50% stake acquired by RattanIndia in April 2021	0	2	1110- 1290	Plant in Manesar, Haryana spread over 1 lakh sq.km with 1.2 lakhs capacity.
Ola	Online	NA	Sale Parallel Ola's hypercharge network	GBP 447.23 from investors	0	2	1000 - 1300	New manufacturing plant located in Tamil Nadu under construction with 10 million per unit capacity.

Annex 6e: Variety of implementation modes for charging infrastructure



Annex 6f: Indian companies are implementing battery swapping models for E-2Ws & E-3Ws

Sun Mobility	Caters to Buses, 2W and 3W with IOT enabled swapping model. Partnership with Uber and Piaggio Vehicles for fleet swapping solution; assisted IOCL in setting-up of BSS for E-3W (Chandigarh)
Lithion	Provides an Intelligent Energy platform for battery swapping infrastructure with primary focus on swapping solutions for E-2Ws and E-3Ws in Delhi NCR region
Charge Up	Caters to E-rickshaws through provision of IoT enabled solutions for battery swapping. Providing battery swapping facility for Li-ion batteries manufactured by Greenfuel Energy Solutions
Gogoro	Gogoro, globally established swapping operator, has tied up with Hero Electric for providing swapping solutions for its E-2Ws in India
Ola	Operational BSS in Delhi NCR for E-2W and E-rickshaw; Plans to bring 1 million EVs on Indian roads by 2022 and set up an ecosystem involving battery swapping stations for E-2Ws and E-3Ws
Amara Raja	BSS for E-2Ws and E-3Ws. Established battery swapping stations for E-auto fleet in Tirupati city and partnered with BPCL for battery swapping project in Kochi and Lucknow.
Zypp	Rental vehicle provider with swappable option: A rider can rent an e-scooter for INR 109 (GBP 1.09) per day to INR 3.6K (GBP 36) per month, with a single swap costing INR 10 (GBP 0.1)
Okaya Power	Commissioned IoT based battery swap station in Delhi and planned to install another 300 swapping stations across India in 2020

Recent GOI policy push as part of budget 2022/23 on developing **'battery swapping policy and battery interoperability standards'** will provide further impetus to the battery swapping business models across India.



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UKRI India plays a key role in enhancing the research and innovation collaboration between the UK and India. Since 2008, the UK and Indian governments, and third parties, have together invested over £330 million in co-funded research and innovation programmes. This investment has brought about more than 258 individual projects. The projects were funded by over 15 funding agencies, bringing together more than 220 lead institutions from the UK and India. These research projects have generated more than £450 million in further funding, mainly from public bodies but also from non-profit organisations and commercial entities, attesting the relevance of these projects.

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Connected Places Catapult is the UK's innovation accelerator for cities, transport, and places. We provide impartial 'innovation as a service' for public bodies, businesses, and infrastructure providers to catalyse step-change improvements in the way people live, works and travel. We connect businesses and public sector leaders to cutting-edge research to spark innovation and grow new markets. We run technology demonstrators and SME accelerators to scale new solutions that drive growth, spread prosperity, and eliminate carbon.

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For over 20 years, Triple Line has worked with governments, financial institutions, the private sector, foundations and civil society to deliver an expanding portfolio of development assistance in countries across Africa, Asia, and the rest of the world.

Climate change, loss of biodiversity, growing poverty, entrenched inequality, unemployment, access to decent work, shifting demographics – these are just some of the complex problems standing in the way of the global sustainable development goals. We are helping to address many of them at both a policy level and on the ground. By combining innovative thinking with practical solutions, we aim to help meet today's challenges and prepare for tomorrow's opportunities.

Our ultimate goal is to create opportunities for people, protect the environment, and generate prosperity in responsible ways that create lasting value, unleash innovation and build inclusion and equity.

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