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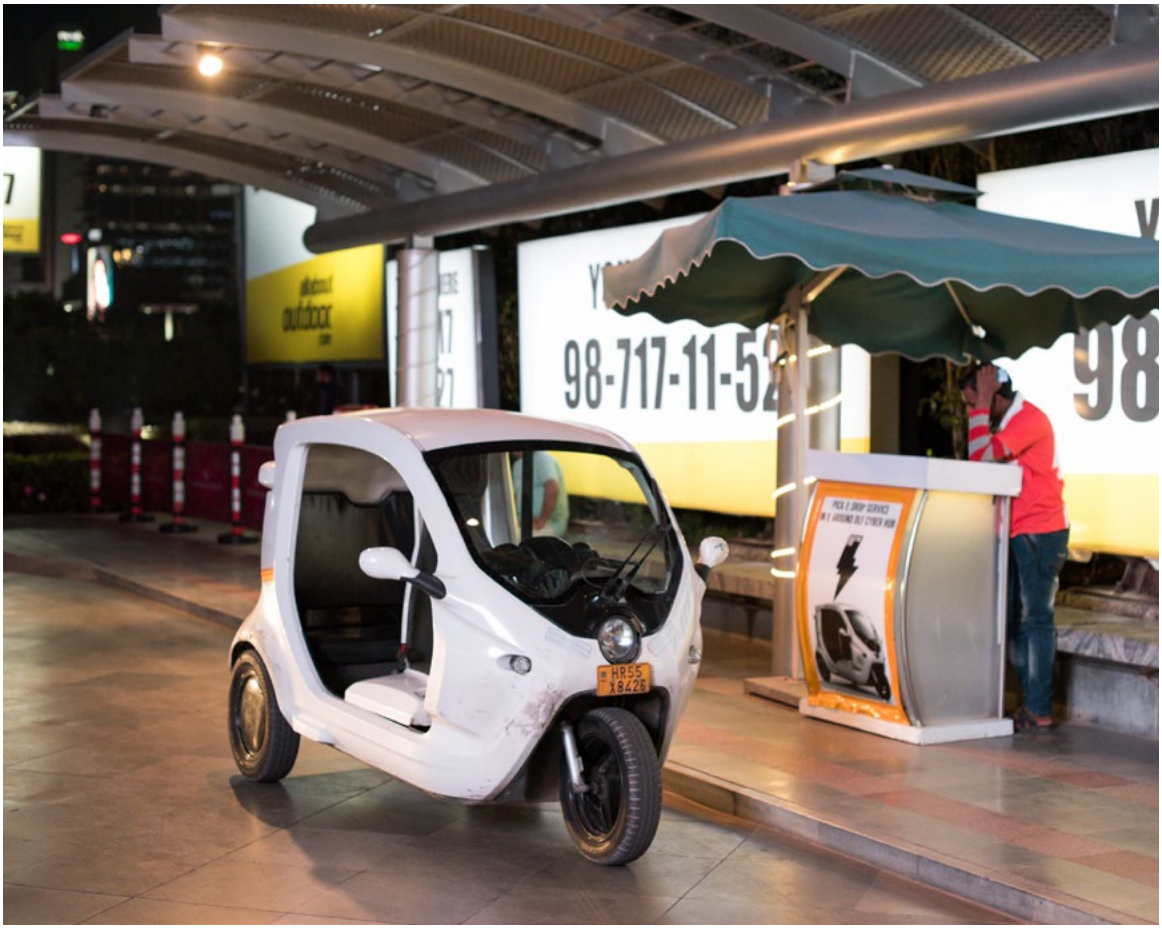
# Electric Mobility Market Assessment, Business Model and Action Plan in India

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## Acronyms

| Abbreviation | Full form |
|---|---|
| **ARAI** | Automotive Research Association of India |
| **BEST** | The Brihanmumbai Electricity Supply and Transport |
| **BHEL** | Bharat Heavy Electricals Limited |
| **CAPEX** | Capital Expenditure |
| **CaaS** | Charging as a Service |
| **DISCOM** | Distribution Company |
| **DoM** | Directorate of Mobility (Kerala) |
| **DoT** | Department of Transport |
| **DT** | Distribution Transformers |
| **e-2W** | Electric two wheelers |
| **e-3W** | Electric three wheelers |
| **e-4W** | Cars |
| **e-bus** | Electric buses |
| **EESL** | Energy Efficiency Services Limited |
| **e-LCV** | Electric Light Commercial Vehicle |
| **EMI** | Equated Monthly Instalment |
| **e-mobility** | Electric mobility |
| **e-rickshaw** | Electric rickshaws |
| **EV** | Electric Vehicles |
| **EVSE** | Electric Vehicle Supply Equipment |
| **FAME** | Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles |
| **FY** | Fiscal Year |
| **GCC** | Gross Cost Contract |
| **GST** | Goods and Services Tax |
| **ICE** | Internal Combustion Engine |
| **IFC** | International Finance Corporation |
| **IRR** | Internal Rate of Return |
| **JnNURM** | Jawaharlal Nehru National Urban Renewal Mission |
| **KUIDFC** | Karnataka Urban Infrastructure Development and Finance Corporation |
| **kWh** | Kilowatt hour |

| Abbreviation | Full form |
|---|---|
| **LCV** | Light Commercial Vehicle |
| **MCA** | Model Concession Agreement |
| **MPSRTC** | Madhya Pradesh State Road Transport Corporation |
| **MSRTC** | Maharashtra State Road Transport Corporation |
| **MTC** | Metropolitan Transport Corporation (Chennai) |
| **NEMMP** | National Electric Mobility Mission Plan |
| **NTPC** | National Thermal Power Corporation Limited |
| **OEM** | Original Equipment Manufacturer |
| **OPEX** | Operating costs |
| **PHEV** | Plug-in Hybrid Electric Vehicle |
| **PMPML** | Pune Mahanagar Parivahan Mahamandal Limited |
| **PPP** | Public Private Partnership |
| **PSU** | Public Sector Undertaking |
| **PT** | Public Transport |
| **PTA** | Public Transport Authority |
| **REIL** | Rajasthan Electronics and Instruments Limited |
| **RTO** | Regional transport office |
| **SECI** | Solar Energy Corporation of India |
| **SPV** | Special Purpose Vehicle |
| **STU** | State Transport Undertaking |
| **TANGEDCO** | The Tamil Nadu Generation and Distribution Corporation Limited |
| **TCO** | Total Cost of Ownership |
| **TNUDF** | Tamil Nadu Urban Development Fund |
| **TNSRTC** | Tamil Nadu State Road Transport Corporation |
| **ToD** | Time of Day |
| **TOU** | Time of Use |
| **VGF** | Viability Gap Funding |

# Executive Summary

**The deep economic transformation of India will be accompanied by rapid growth in passenger and freight demand and require a transition to more sustainable transport solutions.** Transport demand is expected to increase by 2.7 times over 30 years[1]. While transport has been instrumental to India's past growth, it has been accompanied by severe air pollution challenges, with half of the 50 most polluted global cities being in India, heavy dependence on oil imports (82%), and rapidly growing carbon emissions. Sustainable development, as pursued by the Government of India, calls for a transport transition that decouples the need for motorized transport from economic growth, shifts transport to more efficient modes, and accelerates the uptake of zero-emission vehicles.

**In this context, electric mobility (e-mobility) is anticipated to play a major role in India's transport transition during this decade.** The Government of India has been steadily moving towards a "shared, connected and electric" mobility ecosystem to achieve its stated goals on emissions reductions, energy security and industrial development. It is doing so through wide-ranging policy and regulatory measures to encourage EV adoption, creation of public charging infrastructure and incentivizing domestic EV and battery manufacturing facilities[2]. This transport transition is accompanied by a complementary energy transition. During the recent 26th Conference of Parties (COP26) held in November 2021, India committed to a net-zero carbon target by 2070 and reaffirmed climate mitigation measures to be achieved by 2030, pledging to increase non-fossil energy generation to 500 GW by 2030 while meeting 50% of its energy demand from renewables.[3][4]

**To drive EV adoption, the government has introduced several policy initiatives targeting the entire value chain at the national and state levels.** At the national level, NITI Aayog is leading the mission on **Transformative Mobility and Battery Storage** to promote clean, connected, shared, sustainable and holistic mobility initiatives. The Faster Adoption and Manufacturing of Electric (FAME) subsidy scheme[5] targets 7000 e-Buses, 500,000 e-3 Wheelers, 55000 e-4 Wheeler Passenger Cars (including Strong Hybrid) and 1 million e-2 Wheelers. The Production Linked Incentive (PCI) for National Programme on Advanced Cell (ACC) Battery Storage (NPACC) intends to boost indigenous battery manufacturing capacity.[6] Most state governments have implemented complementary initiatives to drive EV adoption with 18 states having finalized their EV policy while another 6 are drafting their own.

**Nonetheless, from a market penetration perspective, as of 2021, India remains in its early phase of adoption, compared to its ambitious targets.** The Government of India has set out its vision of achieving 30% of all vehicle sales to be electric by 2030, but current sales for cars and electric two-wheelers (e2W) represented only only 0.2 percent and 1.3 percent of sales in 2021 respectively (Table ES.1). Given the current level of penetration, achieving the adoption targets will require concerted action that moves India rapidly from a phase of initial adoption to one of accelerated transition.

1 India's Transport Transition, Deloitte for World Bank (2022).
2 Electric Mobility in India: Accelerating Implementation, World Bank 2021.
3 https://ukcop26.org/cop26-goals/ accessed on 30 December 2021
4 https://www.ceew.in/news/cop-26-ceew-unpacks-indias-2070-net-zero-target-and-other-climate-mitigation-measures accessed on 30 December 2021
5 https://fame2.heavyindustries.gov.in/
6 https://pib.gov.in/PressReleasePage.aspx?PRID=1717938 accessed on 20th August 2021

**Table ES.1:** EV penetration by market segments as a percentage of total vehicle sales from FY 19-FY 21
Source: SIAM Database, FADA[7]

| Mode | FY 19 | Penetration % | FY 20 | Penetration % | FY 21[8] | Penetration % |
|---|---|---|---|---|---|---|
| e-2W | 126,000 | 0.9% | 152,000 | 0.9% | 149,000 | 1.3% |
| e-3W | 100,000 | 14.3% | 90,000 | 14.1% | 88,000 | 34% |
| e-4W | 3,600 | 0.11% | 3,400 | 0.12% | 5,900 | 0.2% |
| e-bus | 400 | 0.04% | 600 | 0.08% | 1,850 | 11.7% |

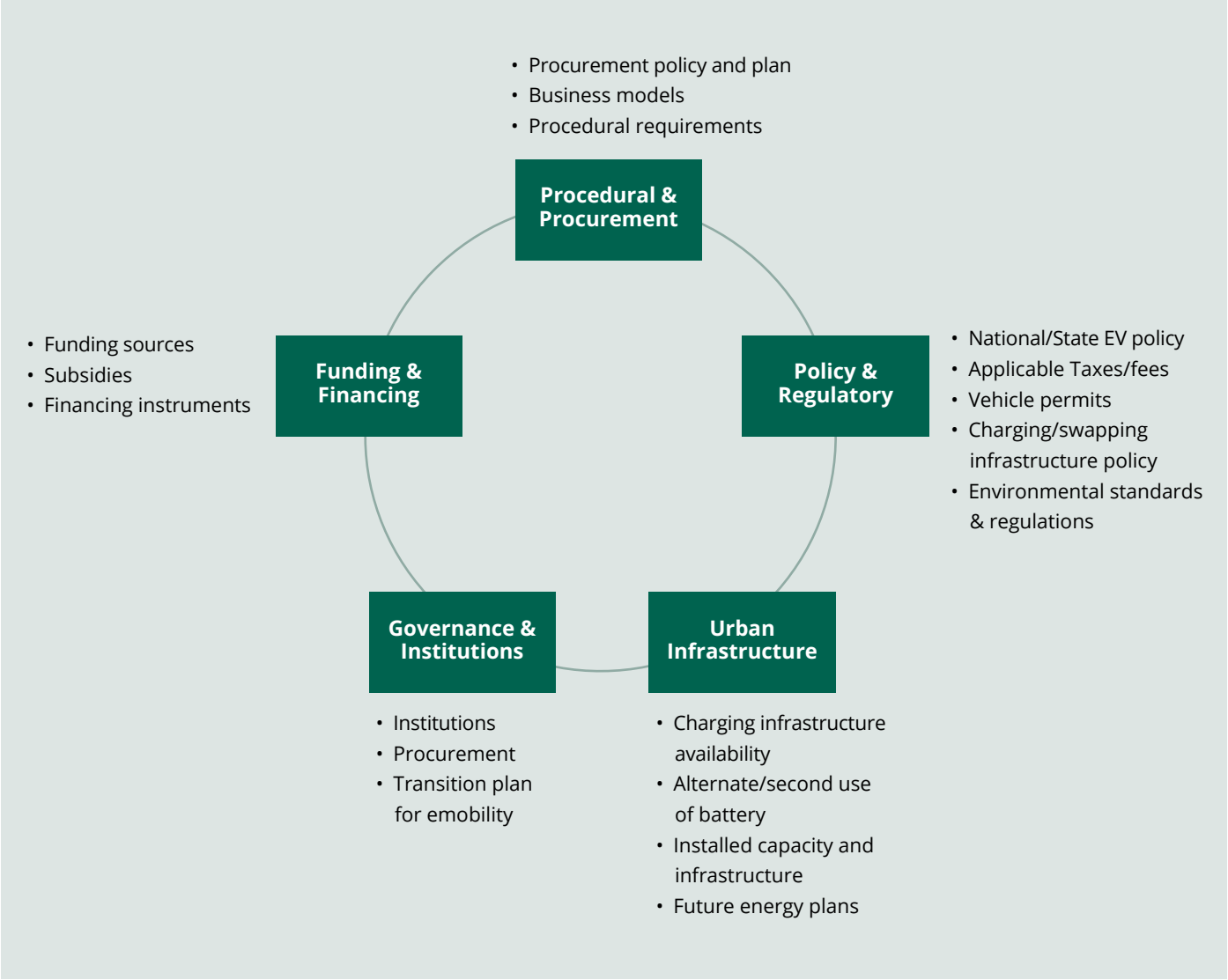
Note: 3W numbers do not include e-rickshaws. Historical data is available at an aggregated market segment of 2W, 4W and 3W, and is disaggregated for the forecast period; EV Penetration % estimated with total sales reported by FADA

**Accelerating adoption at scale requires a detailed look at three main factors of adoption: competitiveness compared to internal combustion engine (ICE) vehicles, access to charging infrastructure and access to financing.** Competitiveness is determined by the operational range, dependability, and the cost of EVs, all of which are evolving rapidly. The cost efficiency of EVs relative to ICEs, as measured by the total cost of ownership (TCO) over the vehicle lifetime[9], varies significantly across vehicle and market segments, driven by characteristics such as typical operating range,[10] particulars of each city,[11] or the attractiveness of ICE alternatives[12]. Access to dependable charging infrastructure requires major new investments, which are slowed by complex coordination and challenging economics given current low EV penetration. Access to finance is essential to spread the higher upfront cost of EVs over time and align the cash flow associated with EVs ownership with that of ICE options, but remains very limited in scale at this point.

**Actions across five dimensions can enhance those factors but require a coordinated effort at many levels.** As a new technology cutting across sectors, EVs require systemic adjustments to governance and institutions, policies and regulations, procedures and procurement, energy infrastructure, and funding and financing approaches (Figure ES.1). EV implementation requires a high level of coordination, both vertical (national, states and urban local bodies) and horizontal (industry, transport, energy, urban, environment). Designating nodal agencies at the central and state levels to drive the policies and plans promoting EV adoption is a critical measure to achieve such coordination, as exemplified by Delhi. This recommendation applies across all EV segments discussed in this report.

7 FADA Releases FY20-21 & April'21 Vehicle Registration Data, Federation of Automobile Dealers Associations, 10 May 2021
8 https://www.autopunditz.com/post/ev-sales-decline-over-19-percent-in-fy2021-to-2-36-802-units accessed on 1st March 2022
9 Includes upfront purchase costs, registration costs, operating costs including charging/fuelling costs, loan repayment costs and road tax.
10 With heavier usage, EVs become more attractive than ICEs due to lower operation and maintenance costs. E.g., fleet operators have higher average daily trip lengths as compared to personal users.
11 For instance, Nagpur has shorter average trip lengths than Pune which could result in lower vehicle use. Chennai has much higher per capita 2W ownership than Mumbai which could create economies of scale and render associated services such as charging facilities more viable.
12 For instance, the large increase in fuel price over the past year made ICE alternatives less attractive.

**Figure ES.1:** Key Levers




Expanding on the World Bank publication on Accelerating Implementation of Electric Mobility in India (April 2021), this report **evaluates each vehicle and market segment considering their unique characteristics.** Analytical models based on key cost drivers for each segment were used to project market penetration in a range of scenarios (from business-as-usual or "BAU" to comprehensive implementation of recommendations). A deep dive analysis was undertaken for three states (Maharashtra, Tamil Nadu, and Madhya Pradesh) across ten of their largest cities, then aggregated at the state and national levels for a comprehensive picture.

The following two scenarios were assessed as a part of this study to estimate the impact of the key action plan recommendations, with associated Action Plan recommendations described at the end of the Executive Summary:

- **A Business-as-Usual (BAU)** scenario representing a continuation of central and state government policies as of January 2022 without any additional concerted effort to drive EV penetration. It incorporates the impact of declining battery prices and FAME subsidy and State EV policies implemented till January 2022. In this scenario, the business models continue to operate under the constraints elaborated in Chapter 2.
- **An Alternate scenario** assuming implementation of key action plan recommendations with coordinated approach across policy initiatives at central and state level, institutional re-alignment and unlocking of affordable financing for e-mobility by adopting innovative solutions to bring access to financing at par with ICE financing, including risk sharing facilities, buyback guarantee, help to buy approach, interest subvention schemes for disbursing subsidized credit to e-3W and e-2W players.

## 2W, 3W and car market assessment

India's e-mobility adoption is following a different trajectory from that observed in many other parts of the world, with two and three wheelers emerging as the first growth segments. The introduction of battery-powered low speed rickshaws (e-rickshaw) in several states of India (with an estimated 2 million operational vehicles across the country in FY21) has already electrified part of last mile connectivity. The rest of the three-wheeler (3W) vehicle segment is now set to be at the forefront of the e-mobility story of India. Likewise, two-wheelers (2W), which account for 70-80% of total vehicle market and experience rapid growth (over 10% per annum in the past decade), are expected to be a key driver in India's e-mobility transformation.

**TCO is already favourable for e-2W and e-3W markets.** e-2W fleet and e-3W (fleet and goods) market segments have either matched or beaten the TCO of ICE counterparts due to longer average trip lengths, offering high potential to drive EV adoption. In comparison, the e-2W personal segment currently offers moderate potential with a TCO that is now similar to that of ICE counterparts, while e-4Ws (fleet and personal) remain significantly more expensive than ICE counterparts, thereby offering lower immediate potential to drive adoption.

**Even so, pursuing BAU would mean falling short of targets for all but e-3Ws.** Despite declining costs of batteries, and existing central and state government subsidies, EV sales penetration rates are not expected to meet targets in a BAU scenario. Financing, policy, and regulatory hurdles are partly to blame. Limited financing availability, high financing costs and high down payments for 2Ws and 3Ws deter EV purchase compared to ICEs. The current structure of vehicle permits hinders the development of fleet-based business models. For instance, 2Ws are not classified as transport vehicles, and the number of permits issued to passenger 3Ws is capped, restricting fleet sizes. Exclusion of certain vehicle segments from subsidies, e.g., EVs sold without batteries, and higher taxes imposed on separate battery sales, hinder the development of battery swapping models which could boost user convenience and reduce range anxiety.

**Fleet-based ride hailing, and last mile delivery models offer the maximum potential for scalability and relative TCO advantage in the 2W, 3W and car vehicle segment and can be complemented by battery-as-a-service (BaaS) solutions.** To achieve TCO competitiveness, higher km coverage is required to offset the significant upfront cost, which can be achieved in fleet-based models. The decoupling of the battery cost from the vehicle can accelerate the upfront cost parity for the end user. BaaS includes battery swapping, leasing, or subscription models. It can improve operational efficiency for fleets and improve user convenience across all segments.

**Figure ES.2:** Selected business models
Source: Steer representation


**A three-pronged approach with fine-tuning of policies and regulations can accelerate EV adoption:**

- **Foster uptake by fleet-based businesses.** Policy and regulatory changes can remove constraints on fleet-based business models. Quick wins include allowing e-2Ws to be classified as transport vehicles (allowing them to be used in commercial fleet operations), allowing e-3W permits to be granted to both drivers and corporate fleet operators and aggregators and removing the cap on permits for e-3Ws up to desired penetration levels. Such uptake will create a critical mass of demand for heavily used vehicles and lead to enhanced quality, technological options, dependability, and reduce the cost of available models, thereby accelerating penetration for personal usage.
- **Facilitate access to competitive financing.** Targeted funding and comprehensive measures to unlock access to commercial financing are required to that end. Targeted government funding can lower the upfront cost or financial cost of EVs, and address remaining TCO gaps with ICE vehicles, enhancing commercial bankability. Scrapping programs or EV funds established and funded through levies on ICE vehicles and fuels can provide such incentives sustainably in support of the EV transition. Unlocking commercial financing requires including EV financing as priority sector lending, creating effective solutions to reduce the perceived default risks associated with this emerging technology, fostering financial mechanisms like asset leasing companies that provide financing at scale, and building awareness and capability in the commercial financing ecosystem to finance EVs.

- **Create a level-playing field for BaaS.** A level-playing field across EV charging options is required to facilitate the emergence of an innovative EV ecosystem. For BaaS, and in particular swapping, this would involve aligning GST on battery sales, extending subsidies to EVs sold without batteries in both national and state programs, and fostering the emergence of BaaS ecosystems of sufficient scale to allow for efficient deployment and availability.


*Photo credits: Bounce*

**Careful implementation of action plan recommendations is expected to boost EV penetration significantly relative to BAU,** as shown in the table below and would translate in a major difference in the EV stock reaching 69 million in the alternate scenario (accumulated capital expenditure of US$158 billion) compared with 27 million in BAU, based on the modelling carried out as part of this study.

**Figure ES.3:** Comparison of EV penetration rates in FY30 across the BAU and Alternate scenarios
Source: Steer estimates

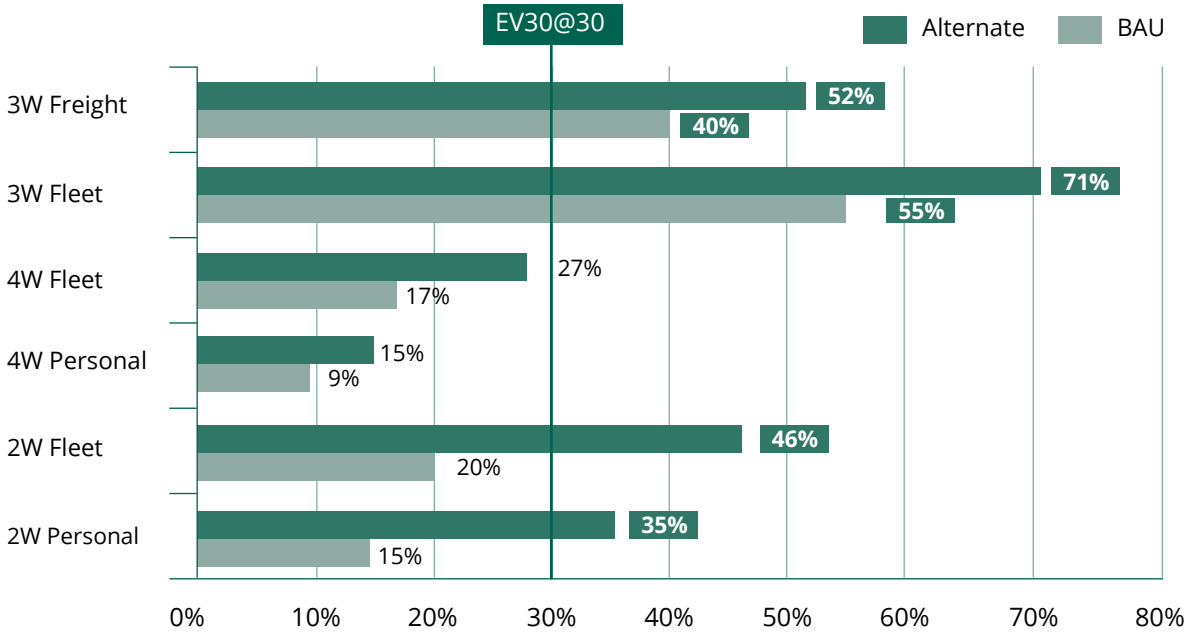



**Table ES.2:** Comparison of EV stock numbers in FY30 across the BAU and optimized scenarios
Source: Steer estimates

| Market Segment | EV Stock | | Total Investment Value (INR Million) | |
|---|---|---|---|---|
| | BAU | Alternative | BAU | Alternative |
| 2W personal | 16,616,000 | 39,781,000 | 1,998,000 | 4,686,000 |
| 2W Fleet | 5,566,000 | 15,568,000 | 413,000 | 1,156,000 |
| 4W Personal | 2,050,000 | 3,484,000 | 2,824,000 | 4,351,000 |
| 4W Fleet | 346,000 | 597,000 | 465,000 | 745,000 |
| 3W Fleet | 1,790,000 | 2,282,000 | 506,000 | 637,000 |
| 3W Freight | 661,000 | 850,000 | 249,000 | 320,000 |
| **Total** | **27,029,000** | **62,562,000** | **6,455,000** | **11,895,000** |

## Bus Market Assessment

**Bus markets can be classified into three broad categories based on the differences in the typical daily utilisation which strongly influences the TCO:** (i) **Intracity buses** operate within city limits in urban areas; (ii) **Mofussil buses** (an extension of intracity bus services) operate services to far-flung suburbs and neighbouring districts; and (iii) **Intercity buses** that operate between urban areas.

**Bus services are managed and/or operated by the public and private sectors.** State Road Transport Undertakings (STUs) manage public sector buses in cities and in some states, inter-city transport as well. Some STUs operate their own buses, while others outsource operations to private players. Most STUs in India are unprofitable and focus on sustaining current operations rather than replacing or augmenting fleets. As a result, the STU's share of buses has been declining. Private sector buses make up more than 90% fleet countrywide, plying as contract carriage, school buses and employee buses. Electrification of private sector bus fleets through an enabling investment environment is therefore key to accelerate the pace of e-bus adoption in the country.

**Bus fleet electrification across public and private segments is impeded by its current economics, existing subsidies, lack of charging infrastructure, limited domestic production and technological challenges.** Without subsidies, e-buses have an estimated 14% to 18% higher TCO than ICE vehicle as of 2022, and a much higher upfront cost. Combined with weakened financials of bus operators due to the COVID-19 pandemic, this precludes access to financing at scale, short of securing government support to fill the gap. The exclusion of private buses from the FAME-II subsidy scheme limits the current market mostly to a few STUs. Lack of readiness of depot, charging and grid infrastructure to support e-bus operations is another obstacle, since bus operators are not yet versed in the development of such infrastructure. The low level of e-bus penetration to date (about 1850 e-buses sold in fiscal year 21) has led to limited increases in domestic production capacity. Further, while lessons are starting to emerge from the early adoption of e-buses under FAME-I, STUs and operators are still in the process of understanding how to plan and operate e-buses as part of their overall fleet and select the right technologies.

**TCO parity for e-buses relative to ICEs is expected to be achieved in the next 2-4 years with continuing subsidies, gains from economies of scale and technological improvements.** Parity is likely to be achieved first for routes with higher annual distance operated such as intracity and mofussil services, followed by shorter range intercity services. Long range intercity services which are dominated by private operators are constrained by battery range and lack of charging facilities on route. Economies of scale through aggregating fleet procurement, and contractual improvements (for public sector buses) can reduce costs and help achieve parity. Further reductions in battery prices owing to technological improvements could accelerate the achievement of TCO parity.


*Photo credits: UITP*

**Early adoption of e-buses in India has been dominated by STU service contracting and highlighted several contracting challenges.** India's e-bus market is currently dominated by public sector procurement due to the availability of FAME II subsidies only for public operators. FAME-II can provide subsidies for up to 7,000 buses, under a gross cost contract (GCC) model. Its initial implementation till June 2021 underlined several challenges: (i) insufficient readiness and preparation of the contracting authorities; (ii) insufficient bid timelines; (iii) distortive capital subsidies and guarantee requirements; (iv) limited depot readiness; (v) imbalanced risk-sharing (utilization, electricity costs); (vi) limited payment security; and (vii) imbalanced approach to dispute resolution. Those resulted in higher costs than anticipated, challenges in achieving financial closure and multiple retenders. Market feedback also highlighted a lack of scale economies in e-bus procurement, maintenance, and financing and mismatch between the roles and specializations of various stakeholders in the e-bus ecosystem. FAME-II is valid up to 2024 and was recently revamped to enhance contracting and achieve scale economies, through combined tendering for larger metropolitan areas.

A four-pronged approach can accelerate e-bus adoption focused on closing the cost gap with ICE buses, fostering a market attractive to manufacturers, building capacity, and facilitating access to finance:

- **Improve the existing e-bus procurement regime for public transport services through a revised GCC Model or alternative business models, or both.** The report recommends several contracting and tendering improvements[13] to the current GCC regime estimated to reduce TCO revealed through tender by 10 to 15 percent compared to values achieved in early 2021. It also outlines alternate business models centered around fleet aggregation, supplemented by unbundled energy provision and optional leasing options. Projections suggest that business models centered on fleet aggregation, as implemented in countries like Chile, could yield significant cost savings in the order of 15-25 percent. The contract recently tendered by CESL can be seen as a combination using improved contracting and demand aggregation.
- **Unbundle fleet procurement and operations to encourage scale economies.** The current GCC framework bundles fleet procurement and operations. Contracts are typically limited in size, as they are confined to a particular geographical area (e.g., a city), thereby limiting economies of scale. The report reviews fleet aggregator models, under which the aggregator (which can be a national, state, or creditworthy private entity) undertakes fleet procurement, financing and (optionally) maintenance. A single fleet procurement can service multiple, separate operations contracts. For instance, a state government, with an established EV policy, could aggregate demand for e-buses across different cities. Once procured, the fleet could be distributed across several operations contracts to be signed between STUs and private operators, across the different cities. This also allows the transfer of financial, capital cost and technology risks from the operator to the aggregator. In such case, the aggregator can achieve economies of scale and access pools of financing targeting lease type operations. Such unbundling requires an already well-established STU institutional capacity to manage interfacing risks and continuous capacity building of all stakeholders. A centralized contract management and procurement cell can be established to facilitate such an approach.
- **Facilitate access to competitive financing.** Targeted funding and comprehensive measures to unlock access to commercial financing are required to accelerate a transition to e-buses, both public and private. Shared mobility, leveraging on bus transport, will play a major role in India's transport transition. While improvements in STU procurement can bring e-buses close to parity with ICE buses with subsidies, support to private e-buses would be equally warranted from a policy point of view, to close the TCO gap with ICE buses. This can be achieved through lowering GST and other taxes across the e-bus supply chain, extension of subsidies under FAME to private sector

13 The recommendations cover bid timelines, subsidy design, bank guarantee requirements, eligibility criteria for operators, payment security, performance penalties, and responsibility for the provision of supporting infrastructure.

buses, establishing and leveraging EV funds based on fees collected on ICE 2/3W and cars, and fostering commercial exploitation of depot land through public-private partnerships. On the financing side, government can enhance the bankability of contracts by STUs, offer de-risking instruments to banks and private investors in the context of STU contracts or facilitate access to commercial financing by private operators until a target level of e-bus stock penetration is achieved.

- **Foster the rollout of e-bus charging infrastructure.** Availability of charging infrastructure at state level ensures that operators can readily switch to e-buses. This is critical to support intercity e-buses which require both origin-destination and on route charging infrastructure. Alternate business model combinations and the action plan in Chapter 3 recommend unbundling of charging infrastructure through policy mandates and involvement of the private sector. The development of network of charging-as-a-service (CaaS) providers can improve charging infrastructure provisions, tapping on companies with the requisite specialist capabilities and investment potential. Such networks are anticipated to require some public sector support in its initial years, until demand materializes.

**Government intervention is essential initially to drive the transition to e-buses considering the existing TCO gap.** Initially, public funds are best spent on cities with the highest potential impact on air quality, GHG emissions and congestion, and on putting in place elements that can accelerate the transition of the private sector to e-buses (charging and financing access). The report proposes a framework for selecting the most suitable business model(s) for a state or a city based on a systemic review of institutional readiness, financial capacity, and potential for aggregation in procurement. Government's investment in e-bus service procurement for public operations could act as pump-priming the e-bus sector with increased competition and improved manufacturing capacity which should help bring down the upfront costs and attract private sector operators to switch to e-buses

**Implementation of the prioritized action plan recommendations is expected to tackle the three key problems** mentioned above – improved competitive position of EVs relative of ICE, better access to charging infra and better access to financing, which would translate in a major difference in the E-bus stock reaching 98,000 buses in the alternate scenario (accumulated capital expenditure of US$17 billion) and a sales penetration of 50% in 2030 compared with 52,000, and 22% in BAU, based on the modelling carried out as part of this report.

**Table ES.3:** Comparison of E bus stock across the BAU and Alternate scenarios
Source: Steer estimates

| Market Segment | FY23 | FY24 | FY25 | FY30 | Total Investment Value (INR Mn) |
|---|---|---|---|---|---|
| BAU | 11,000 | 16,000 | 22,000 | 52,000 | 700,000 |
| Alternate Scenario | 15,000 | 23,000 | 31,000 | 98,000 | 1,303,000 |

## Charging infrastructure markets

**Provision of adequate charging infrastructure is a key enabler for EV adoption across modes and market segments.** Charging infrastructure is the backbone of any electric mobility implementation. Provision of adequate, affordable, accessible, and reliable charging networks is a pre-requisite for mass EV adoption and could help promote awareness and reduce range anxiety among potential EV users. All business models and market segments of charging and swapping infrastructure such as residential, office, captive, public and swapping stations are expected to play a key role in mass uptake of EVs. For the general public, the priority is to facilitate charging at locations where people naturally park already for many hours, supplemented by a network of public fast charging facility allaying concerns over range.

**The scarcity of public charging infrastructure is a major constraint to EV adoption in India.** There are only 1640 operational public charging stations in India, with the nine mega cities (population of over 4 million) accounting for almost 60% of the installed chargers. This is far below the estimated 4.2 million chargers (excluding 15 Amp chargers) needed by 2030 across various locations in a BAU scenario. There are numerous initiatives being taken by both public and private players in deployment of charging infrastructure across the country. The recent announcement by the Department of Heavy Industries (DHI) to deploy nearly 2,700 charging stations across 62 cities under public procurement model is expected to catalyze the expansion of the public charging network. The Ministry of Power has also announced plans for chargers across 69,000 petrol stations, of which 22,000 are expected to be installed in the next 5 years.

*Photo credits: UITP*

Challenges differ across market segments. Uncertainty in initial demand for charging infrastructure and difficulty and cost of securing land in urban areas currently discourage private investment in public charging stations or charging depots for e-buses. Administrative complexity slows down the rollout of charging in residential areas. Limited financial capacity of DISCOMS slow down adjustments that may be required to the local distribution network. Swapping solutions face a non-level playing field both in access to subsidies and taxes. Lack of consistent tariffs across locations increases risks and reduces the commercial viability of business models.

A four-pronged approach can accelerate charging infrastructure rollout:

- **Extend government support to enhance the viability of business models for public charging infrastructure and e-bus charging.** Lowering fixed costs in the initial rollout of charging facilities enhances the business case for charging. This can be achieved through the provision of land at concessional prices, capital subsidies and viability gap funding for public charging infrastructure. As discussed in the previous section, it is recommended that the government invests in intercity charging infrastructure to drive the adoption of intercity e-buses.
- **Support alternative business models to accelerate EV adoption in fleet-based models.** Captive charging and battery swapping solutions are expected to serve the charging needs of commercial fleet operators. This is where commercial business opportunities already exist, although financial returns are tied to the level of utilization of these charging facilities. Commercial viability will improve as EV penetration rates across various vehicle markets increase, but in the coming 3 to 5 years, access to commercial financing at scale is expected to require some initial government support until the market matures.
- **Facilitate grid connection.** The public is expected to mostly charge at residential and office locations, and where it already parks regularly. This demand can be addressed by amending development control regulations at such locations, integration of charging in city parking policies, and creation of a single-window facility to coordinate and facilitate the rollout of charging options with separate metering for EVs.

- **Create a level-playing field for BaaS and charging options.** A level-playing field across EV charging options is required to facilitate the emergence of an innovative EV ecosystem. For BaaS, and in particular swapping, this would involve aligning GST on battery sales, extending subsidies to EVs sold without batteries in both national and state programs, and fostering the emergence of BaaS ecosystems of sufficient scale to allow for an efficient deployment and availability. For fleet charging, it means aligning tariff policies to allow the best solutions to emerge from the market.
- **Foster co-ordination with Energy Departments.** Mass deployment of charging infrastructure at different locations requires coordinated action involving different government departments at the city or state level as setting up of charging stations requires availability of affordable land at strategic locations, provision of supporting energy infrastructure such a power line and predictable electricity tariff, availability of concessional finance for longer tenure to provide commercial support to the business models.

Careful implementation of action plan recommendations combined with the volume of EVs expected under the Alternate Scenario would lead to a need for an estimated 8.6 million chargers (excluding 15 Amp chargers), or 36 million chargers (including 15 Amp chargers) for a total investment of US$2.9 billion (urban only).

**Table ES.4:** 2030 charging infrastructure forecast- Alternate scenario (in thousand charger points)
Source: Steer estimates

| Type of Charger | Resi-dential | Office | Cap-tive | Public | Battery Swapping | Total Chargers | Total Investment required (INR Mn) |
|---|---|---|---|---|---|---|---|
| 15 Amp | 27,100 | 120 | 420 | | | 27,640 | 55,000 |
| AC001 | 3,960 | 80 | 620 | 440 | 1,940 | 7,040 | 27,000 |
| Type2AC | 1,220 | 30 | 40 | 40 | | 1,330 | 69,000 |
| Bharat DC 001 | - | - | 8 | 2 | 220 | 230 | 59,000 |
| CCS2 | - | - | - | | | 4 | 4,000 |
| **Total** | **32,280** | **230** | **1,088** | **486** | **2,160** | **36,244** | **214,000** |

## Financing solutions

**Increasing the flow of affordable financing into the EV market is crucial to increase penetration.** As is typical with an emerging technology, the current market for EV financing is still in its infancy and is characterized by various funding and financing barriers across EV market segments. These barriers must be overcome to allow much needed investment to flow into the sector which in turn can increase the supply of affordable financing to business and individual borrowers.

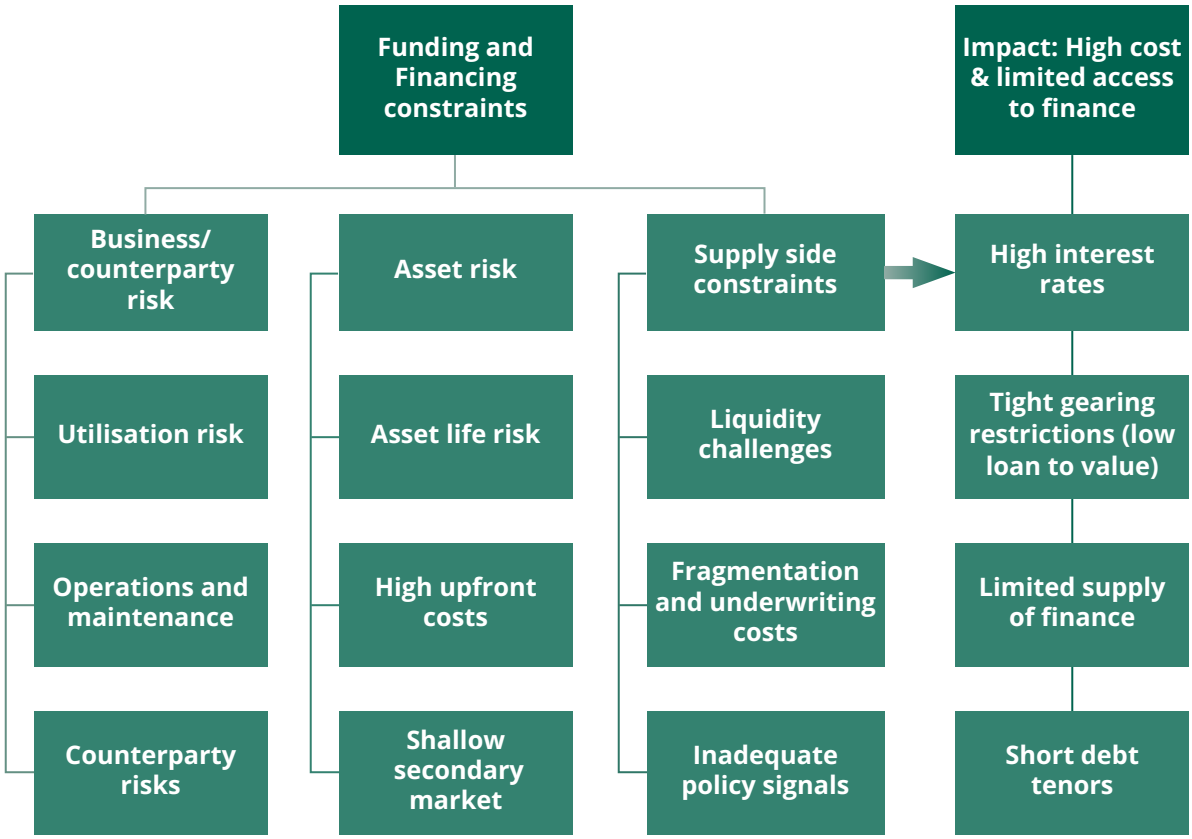
The funding and financing barriers identified in the figure below are not entirely unique to EV financing and can also be seen in the conventional ICE vehicle financing market in India. However, EVs add an extra layer of complexity in terms of credit risk.

This is particularly the case given the interdependency with public charging infrastructure which, if underprovided for, can undermine the operations of high utilization business models where EVs have a TCO advantage (e.g. fleet businesses). As such, lenders have to carefully appraise whether the charging interface is effectively managed before making a firm commitment, to avoid a business risk that is challenging to manage and could increase credit risk.

Additionally, the asset life of what is a nascent technology is still to be fully discovered and understood by financiers, with unknowns in terms of battery life, uncertain maintenance requirements and a low base of mechanical capacity and expertise to provide effective lifecycle and after-sale maintenance. This can result in uncertainty around residual value which in any vehicle financing is often the key element of lender security. This is exacerbated by an immature and shallow second-hand market for EVs, meaning lenders cannot rely yet on market valuations like those in the large second-hand market for ICE vehicles.
The higher upfront purchase cost of EVs also present potential challenges to financiers. All other things being equal, higher purchase prices results in larger loan sizes for borrowers. This can be a particular challenge in the light vehicle segments (e-2W/e-3W) where the TCO advantage of EVs is higher but the creditworthiness of potential borrowers is often low. As a result, borrowers may not be able to access the higher capital required and/or be able to afford the commensurate increase in vehicle deposits and interest rates associated with larger loan amounts.
This situation also presents a challenge for financiers in terms of the additional liquidity required to meet the higher financing requirement. Much lending in the vehicle finance sector is undertaken through thinly capitalized NBFCs already facing liquidity challenges due to non-performing loans and high underwriting costs. This can result in challenges in NBFCs accessing affordable wholesale funding.

**Indian policymakers could adopt a range of potential financial options to unlock the flow of affordable finance into the EV sector.** If unaddressed, these funding and financing barriers (and the impact they have in tightening credit conditions for EV financing) will have a detrimental impact on delivering India's EV penetration targets. A laissez-faire approach of allowing the market to gradually adjust to the new technology and the associated financial

**Figure ES.4:** EV Funding and Financing Barriers
Source: Steer review




risks will result in an extended period of adjustment that is unlikely to support the step-change in penetration required by government targets. Policymakers in many countries are faced with the same reality and are having to formulate a catalytic policy response to overcome these barriers and stimulate market growth. Risks can be better discovered, understood, and effectively managed by lenders, with some support and risk protection. For this purpose, a range of potential financial solutions have been proposed in this report aimed at unlocking the EV financing market:

- **Debt mobilization through de-risking is the most efficient way to deploy public funds.** Government can guarantee lenders against default by businesses or individual borrowers. This would reduce financing costs and lower the TCO. Such guarantees can also cover more vehicles than direct subsidies as only potential losses on loans are covered, bringing down the cost per vehicle compared to subsidy schemes. First loss facilities have been shown to be efficient for all vehicle types. As an illustration, allocating the same amount of public funding in a wholesale market first loss facility would increase the number of EVs by an estimated 19% over providing a simple vehicle discount is provided, thereby increasing overall budget efficiency. Each INR 75m ($1m) of government funding invested in such first loss facilities would generate between 12,000 and 17,000 additional vehicle sales over the period 2022 and 2030 compared to the base line.

- **Government funding is critical for public charging infrastructure, given the uncertainty in demand in the medium term.** Government investment in charging infrastructure can drive EV sales, and unlock cheaper financing for businesses by lowering business risks. Investment in charging infrastructure will also boost investor confidence and signal the government's intent to promote EV adoption. An estimated 22,000 to 33,000 additional EV sales are expected for each INR 75 m (US$1 million) of government funding for charging.
- **Government can leverage development financial institution (DFI) funding strategically to complement debt mobilization and direct subsidies.** While the systemic impact of DFI funding could be low, equity investments could facilitate market entry for innovative firms, and have a demonstrative effect for domestic lenders and investors.

## Impact of action plan recommendations

*56 million tonnes of cumulative well-to-wheel carbon savings in India across FY2022-30*

India's transport sector amounts to about 13% of total CO2 emissions (IEA, 2021[14]). The land transport sector accounts for 87% of these emissions.[15]

The analysis estimates well-to-wheel[16] carbon savings of 16 million tonnes in FY2030 which factors in the carbon contribution of ICEs and battery operated EVs. Tank-to-wheel carbon savings were also reviewed for comparison with other studies, as shown in the table below:

**Table ES.5:** Benchmarking Steer estimates of decarbonization (tank-to-wheel) under alternate scenario with other studies for FY 2030
Source: Change in CO2 emissions-New Policy scenario (2030); CSTEP, CEEW, IRADe, PNNL, and TERI (2019). Comparison of Decarbonisation Strategies for India's Land Transport Sector: An Inter Model Assessment. New Delhi: TERI; *Average emissions across the alternate sources

| Carbon savings | Steer | CSTEP | PNNL | CEEW | IRADe | TERI |
|---|---|---|---|---|---|---|
| Reference emissions 2030 (million tonnes) | 566* | 630 | 376 | 378 | 833 | 615 |
| Electrification of Transport fleet (sales penetration) by 2030 | • e-2W: 38%<br>• e-4W:17%<br>• e-3W: 65%<br>• e-bus: 50% | • e-2W: 30%<br>• e-4W: 3%<br>• e-3W: 50%<br>• e-bus: 10% | | | | |
| Reduction from electrification of transport (%) | 6% | 2.5% | 26% | 1.2% | 6.6% | 8.1% |
| Carbon savings from electrification (million tonnes) | 32 | 16 | 98 | 5 | 55 | 50 |

**Electrification of the sector to predicted levels could result in 6% reduction tank-to-wheel carbon emissions from the sector (assuming the average of 566 million tonnes in 2030).** The Steer estimate is on the conservative side as it only seeks to estimate direct benefits from EV adoption. EV uptake combined with other decarbonization strategies such as modal shift from private to public or shared transport modes, travel demand management strategies, and use of other alternative fuels such as blending bio-ethanol in petrol or diesel would reduce transport emissions even further.

**The impact of decarbonization is directly linked to vehicle ownership and growth trends in each state and at the national level.** If action plan recommendations are implemented with the financing solution of a wholesale market first loss facility, it would lead to a cumulative well-to-wheel carbon savings of 56 million tonnes across FY2022-30, saving a treatment cost of INR 28 billion, with the highest impact coming from 2W, 3W and e-buses.

14 308 MT out of 2310 MT in CO2 emissions. IEA website accessed November 4, 2021.
15 Comparison of Decarbonisation Strategies for India's Land Transport Sector: An Intermodal Assessment NITI Aayog, USAID, Shakti Foundation, 2019
16 Well-to-wheel emissions include all emissions related to fuel production, processing, distribution, and use. In the case of gasoline, emissions are produced while extracting petroleum from the earth, refining it, distributing the fuel to stations, and burning it in vehicles. In contract, Tank-to-Wheel (TTW) refers to a subrange in the energy chain of a vehicle that extends from the point at which energy is absorbed (charging point; fuel pump) to discharge (being on the move).

**EV adoption is also expected to result in significant reduction in fuel usage**. Mass deployment of EVs across sectors could potentially result in cumulative fuel savings of 59 billion liters during FY 2022-30. Fuel savings primarily result from transition to e-2W, e-3W and e-4W. Switching petrol-based 2Ws to EVs contributes to about 50% of total fuel savings, followed by diesel-based 3Ws contributing about 30%. EV penetration in e-4W and e-bus segments each result in about 10% of total fuel savings.

**Figure ES.5:** Report overall approach: Prioritization of action plan recommendations
Source: Steer representation

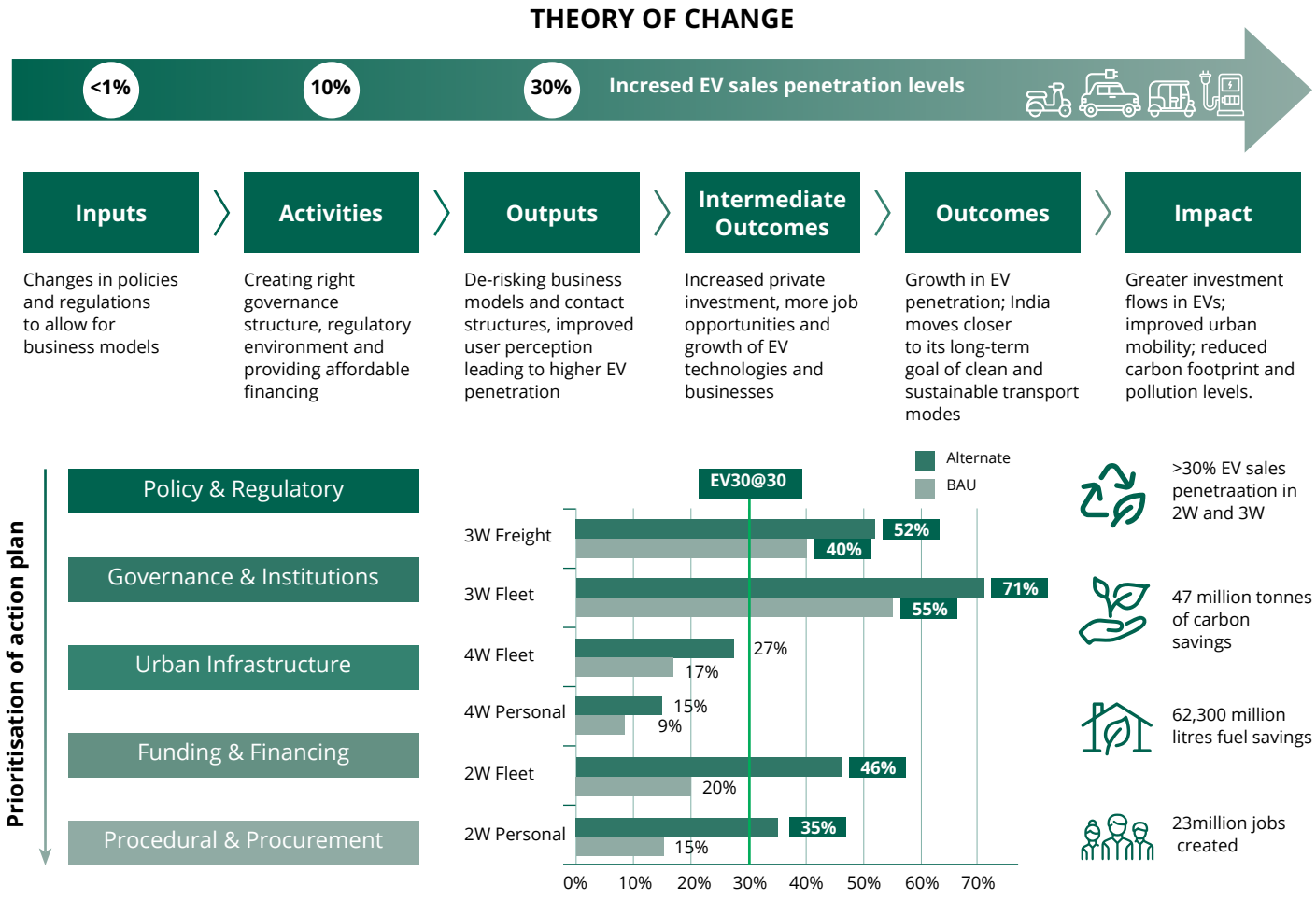


**Figure ES.6:** Prioritized action plan recommendations for e-2W, e-3W and e-4W
Source: Steer representation

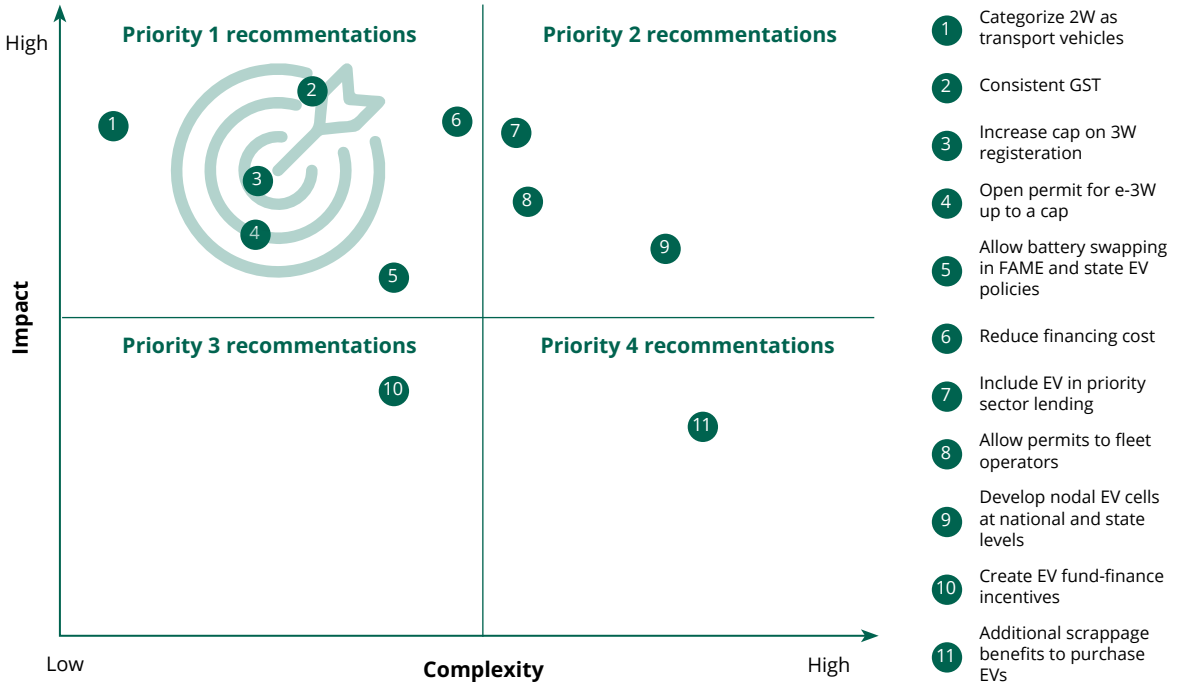



**Figure ES.7:** Prioritized action plan recommendations for e-bus adoption
Source: Steer representation

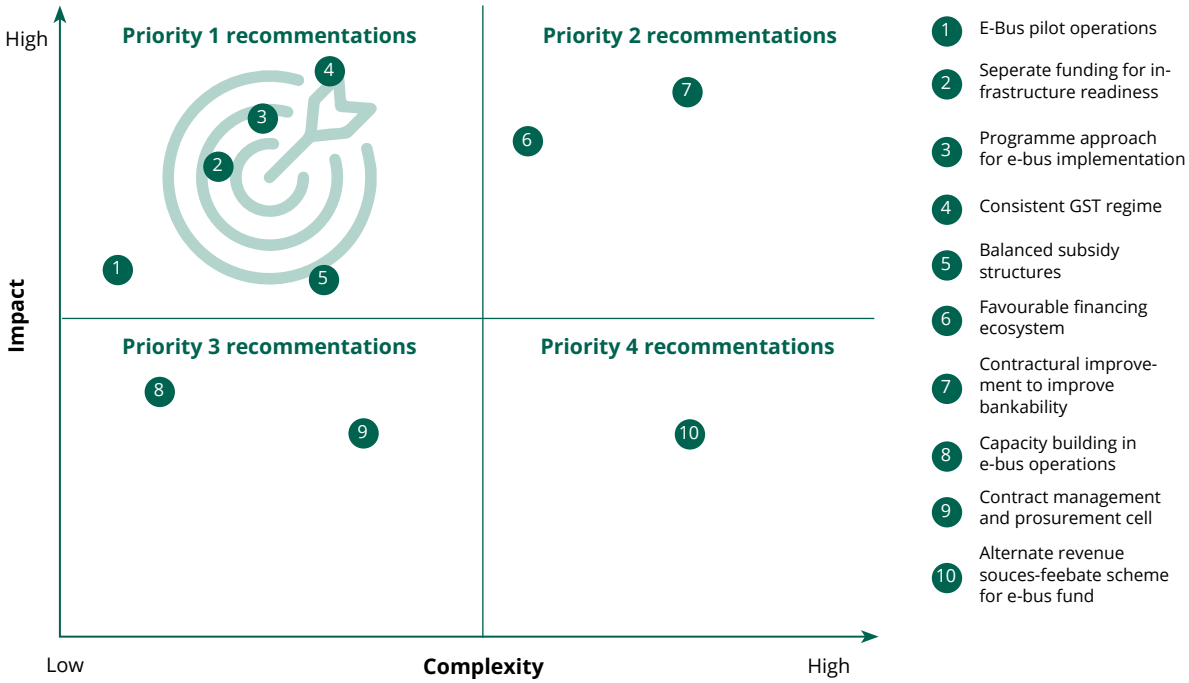
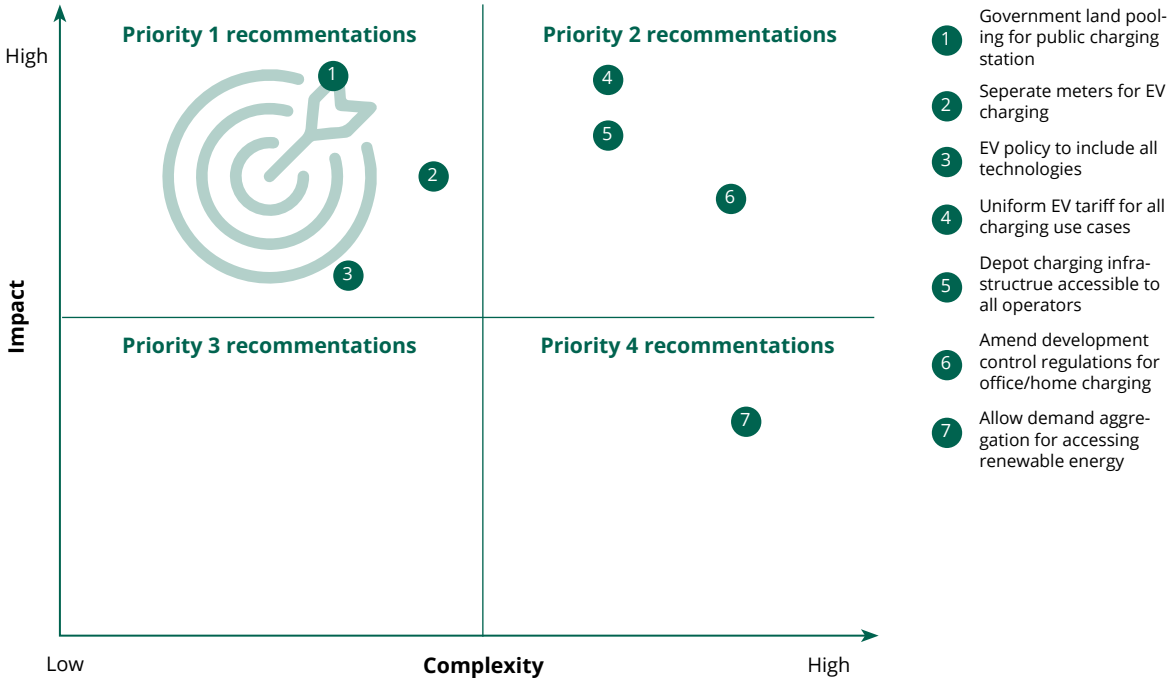


**Figure ES.8:** Prioritized action plan recommendations for charging infrastructure
Source: Steer representation



# 1.

# Electric Mobility Market Overview

*Photo credits: Ather Energy*

## Overview

The purpose of the study is to assess current electric mobility market conditions and outline a viable market roadmap for increasing uptake of electric vehicles (EVs) in India. The background section in this chapter presents a brief on India's position with respect to adoption of electric mobility to meet its climate change targets. This chapter also provides a summary of the approach followed in this report with respect to the following:

- Market assessment for forecasting penetration of new vehicle sales by 2030
- Key action plan interventions required at national and state level to accelerate transition to EVs
- Impact of implementing key action plan recommendations on EV penetration, decarbonization, fuel savings and job creation

## Background

The Government of India is committed to sustainable growth in the power and transport sector particularly by embedding renewable energy in electric mobility provision to meet its decarbonization goals. India has participated in the United Nations Framework Convention on Climate Change and the Paris Agreement. During the recent 26th Conference of Parties (COP26) held in November 2021, India has committed towards becoming net-zero carbon target by 2070 and other climate mitigation measures to be achieved by 2030. COP 26 is a commitment for countries to come forward with emission reduction targets by 2030 and becoming net zero by 2050 through a combination of measures such as phasing out coal, curtailing deforestation, switching to electric vehicles and encouraging investment in renewables. India has pledged to phase down coal-based power and increase non-fossil energy generation to 500 GW by 2030 while meeting 50% of energy demand from renewables.[1] [2]

*Photo credits: Ather Energy*

1 https://ukcop26.org/cop26-goals/ accessed on 30 December 2021
2 https://www.ceew.in/news/cop-26-ceew-unpacks-indias-2070-net-zero-target-and-other-climate-mitigation-measures accessed on 30 December 2021

Road transport is a leading contributor to global carbon emissions. Many governments globally are looking to reach 'net-zero' emissions from the sector by 2050 with a focus on avoiding unnecessary motorized travel, shifting demand to more efficient modes like public transport, and accelerating the transition towards cleaner fuels such as electricity or hydrogen.

India's National Electric Mobility Mission Plan (NEMMP) in 2013 has been developed to provide the roadmap and framework for adopting a full range of electric mobility solutions for India which would also enhance the nation's crude oil security.[3] India is among the few countries that support the global EV30@30 campaign, which targets at least 30% new vehicle sales to be electric by 2030. The government is creating an enabling environment through various policy initiatives such as Production Linked Incentive (PLI) Scheme and Faster Adoption and Manufacturing of Electric (FAME) and subsidy programs. Also, state governments are developing complementary policy initiatives to provide further support to e-vehicle manufacturing and utilization. A key factor for the success of e-mobility is provision of reliable, accessible, and affordable charging solutions for each market segment.

To enable the growth of the e-mobility market and develop sustainable business models for electric mobility in India, NITI Aayog is leading the national mission on **Transformative Mobility and Battery Storage** to promote clean, connected, shared, sustainable and holistic mobility initiatives. This Mission includes preparation of a roadmap to leverage the size and scale of the ecosystem of electric mobility and mobilize private capital and commercial financing for battery storage and e-mobility markets for transition to clean mobility in India. NITI Aayog in partnership with UK government has launched e-AMRIT (Accelerated e-Mobility Revolution for India's Transportation) to be a one-stop destination for raising awareness about electric mobility and informing the consumers about the benefits of switching to electric vehicles.[4] There are several policy initiatives being taken by the Government of India to create an ecosystem fostering mass scale adoption of electric vehicles.

- The Government of India has approved an outlay of INR 18,100 crore for five years for implementation of Production Linked Incentive (PLI)[5] scheme under the National Programme on Advanced Cell (ACC) Battery Storage (NPACC), which is intended to establish an indigenous manufacturing capacity of 50-gigawatt hour (GWh) of ACC. Each selected ACC manufacturer will have to set-up a facility of at least 5 GWh with a cap of total subsidy at 20 GWh. The beneficiary would ensure a domestic value addition of 25% within two years and raise it to 60% domestic value addition within 5 years either at mother unit or integrated unit or at a project level in case of hub and spoke structure.[6]
- The Government of India issued a PLI scheme for Automobile and Auto Component Industry on 23 September 2021 with a budgetary outlay of INR 25,938 crore for Advance Automotive Technology (AAT) products manufactured in India from 1st April 2022 for a period of five years. This scheme is being offered to existing automotive players as well

3 National Electricity Mobility Mission Plan (NEMMP), 2020, Department of Heavy Industry, Ministry of Heavy Industries & Public Enterprises

4 https://e-amrit.niti.gov.in/about-the-portal accessed on 21 February 2022

5 https://pib.gov.in/PressReleasePage.aspx?PRID=1717943 accessed on 21 February 2022

6 https://pib.gov.in/PressReleasePage.aspx?PRID=1717938 accessed on 20th August 2021

as new investors looking to enter the sector. It has two components- the 'Champion Original Equipment Manufacturer (OEM) Incentive Scheme' which is also a sales value-linked incentive applicable on advanced automotive technology components of vehicles, Completely Knocked Down / Semi Knocked Down kits and vehicle aggregators. As on January 2022 a total of 115 companies filed application under the scheme and 20 applicants have been approved under the Champion OEM initiative.[7]

- Ministry of Road Transport and Highways (MoRTH) has issued a draft -'Motor Vehicles (Registration and Functions of Vehicle Scrapping Facility) Rules' in March 2021 which is focused on laying down procedure for establishing registered vehicle scrapping facilities for all types of automotive waste products.[8] The policy is expected to boost new vehicle sales by phasing out older polluting vehicles. The higher fuel price coupled with incentives offered under Central and State government policies would promote shift towards cleaner fuels including electric vehicles.
- Ministry of Power has issued the revised consolidated guidelines and standards for developing Charging Infrastructure for Electric Vehicles. The guidelines include provisions for setting up private and public charging stations. It also provides guidance on land use and access, electricity tariffs, role of state and central government and timelines for installation of public charging stations.[9]

So, what does it take to convert the vision and such policies into a rapid uptake of EV? First, a good understanding of what is driving and will drive market penetration of EVs by vehicle type and market segment, considering the competitive position of EV versus their internal combustion engine (ICE) counterparts in terms of Total Cost of Ownership (TCO). Achieving cost parity will drive adoption and access to financing. Second, ensuring that the existing institutional, legal and regulatory framework are fine-tuned to allow those markets to rapidly blossom. Third, easy access to charging options adapted to each market segment. Fourth, access to financing at scale and on terms that are at least matching that of ICE vehicles.

The World Bank Group (WBG) is supporting NITI Aayog in undertaking a series of actions to build the market and enabling the ecosystem to encourage growth in the electric mobility market over the short, medium and long term.[10] The aim of this study is to recommend measures that would promote early market development for unlocking the market to meet the targeted sales penetration of electric vehicles. Through this initiative, the NITI Aayog and WBG seek to identify and catalyze early investments and promote private capital by deploying available financing instruments to kickstart some of the selected business models and accelerate delivery of real change on the ground in the EV market space.

This study focuses on assessing market potential and key upstream barriers to uptake of the e-mobility market across 2/3W and cars, e-buses and charging

7 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1797610#:~:text=This%20scheme%20will%20facilitate%20the,this%20category%20of%20the%20scheme. accessed on 21 February 2022

8 Draft of Motor Vehicles Registration and Functions of Vehicle Scrapping Facility) Rules 2021, Ministry of Road Transport and Highways, Notification dated 15 March 2021, New Delhi

9 Charging infrastructure for electric vehicles (EV)- the revised consolidated guidelines and standards, Ministry of Power, Government of India, 14 January 2022

10 Program for Transformative Mobility and Battery Storage (P172223), Program Information Document (PID), the World Bank, May 08, 2020

infrastructure. A range of business models were prioritized for each market segment and an action plan roadmap has been developed to create the right enabling environment for the downstream investments to be unlocked and for these business models to achieve success. It focuses on developing an accelerated path to achieve the targeted EV penetration sought in EV30@30 campaign[11] by recommending the most impactful policy changes and by unlocking affordable financing into the sector.

India's e-mobility revolution is following a different trajectory from that observed in many other parts of the world, with electric two and three wheelers emerging as the first growth segment. The introduction of battery-powered slow speed rickshaws (e-rickshaw) in several states of India (estimated to be 2 million operational across the country in FY21) has already electrified part of last mile connectivity. The rest of the three-wheeler (3W) vehicle segment is now set to be at the forefront of the e-mobility story of India. Likewise, two-wheelers (2W), which account for 70-80% of total vehicle market, are expected to be front-runners in adoption of EVs. The EV transition will require innovative financial solutions. NITI Aayog has recently published a toolkit of solutions to mitigate risks and market barriers for mobilizing EV financing. In this direction, a first-loss risk sharing facility is under development as requested by NITI Aayog to the World Bank to offer risk cover to Non-Banking Financial Companies (NBFCs) and Banks to improve their confidence in lending to EV priority sectors. This instrument would act as a guarantee in event of delay in payments or defaults on EV loans and is expected to bring financing costs down.[12]

**Mobilising finance for EVs in India**

EV financing is faced by range of financing challenges such as high financing costs, low loan-to-value ratios, short loan tenures and limited financing options. Financial institutions are not lending to the sector due to associated asset and business model risks such as limited technological understanding, uncertainty of resale value, policy risk and perceived product quality resulting low confidence in financing the EV markets.

NITI Aayog is working towards introducing measures that could facilitate EV financing such as setting up a USD 300 million first loss risk sharing instrument with the World Bank which would act as hedging and guaranteeing mechanism for banks and NBFCs to manage delays or defaults on EV loans. This is expected to bring the financing costs down by 10-12%.

To promote other enabling measures such as incentivizing financial institutions to support the risk sharing instrument, NITI Aayog has proposed Reserve Bank of India (RBI) to include of EVs as a priority sector for lending by scheduled commercial banks. This would mandate the banks to allocate a certain proportion of the level of credit towards EVs. Inclusion of EVs as a priority sector is expected to increase investor confidence by aligning market signals with central and state government's policy vision, improve access to finance for NBFC by providing opportunity for co-origination and co-lending between banks and NBFCs, guide financial institutions to increase credit penetration and accelerate EV adoption by providing access to finance.

11 https://www.cleanenergyministerial.org/campaign-clean-energy-ministerial/ev3030-campaign accessed on 18 September,2021

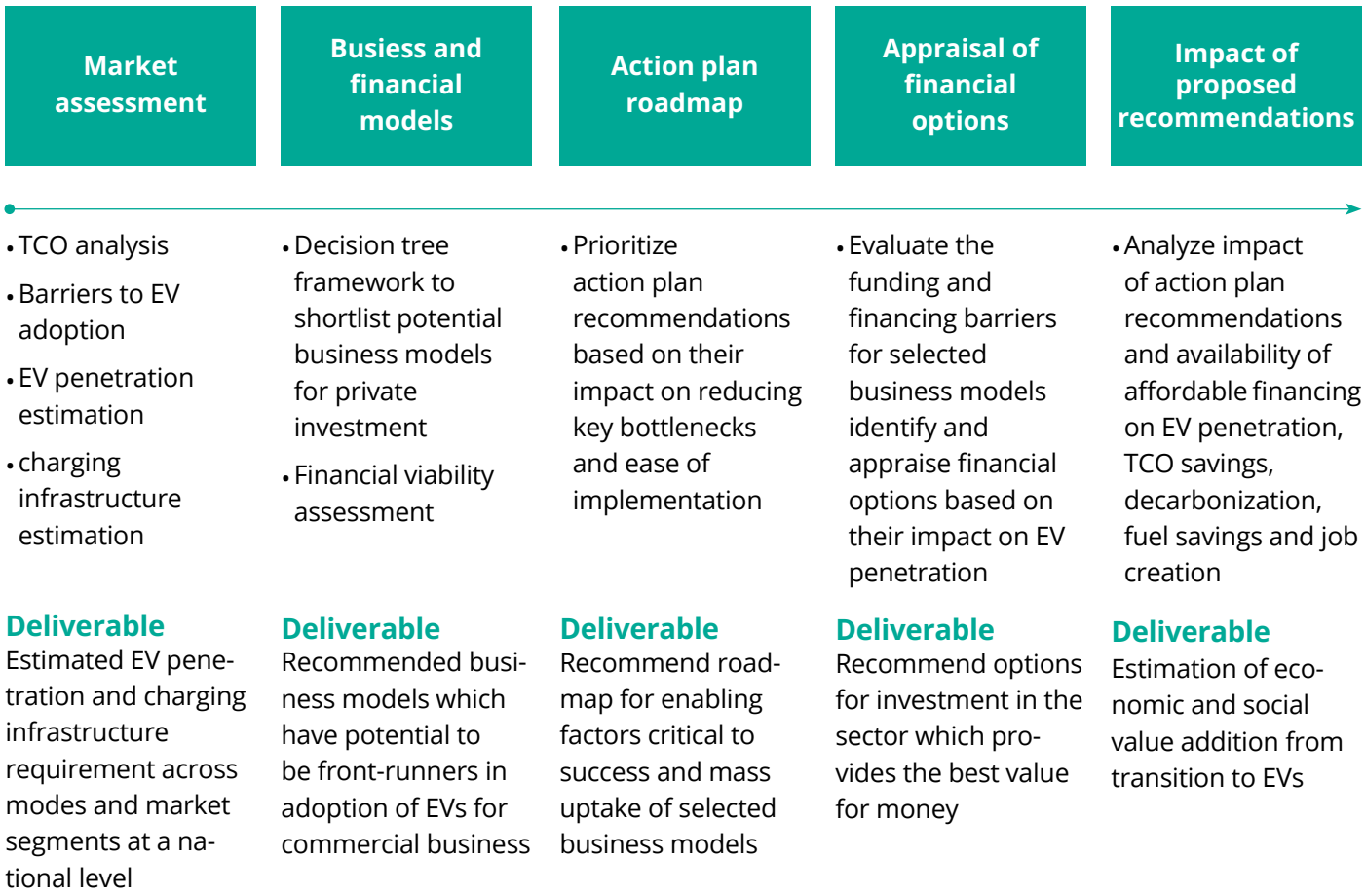
12 Banking on Electric Vehicles in India: A blueprint for Inclusion of EVs in Priority Sector Lending Guidelines, NITI Aayog, RMI India, January 2022

## Approach adopted for the study

The Government of India has set out its EV30@30 vision of achieving a target of 30% EV penetration in all vehicle sales by 2030.[13] It has been developing key policy initiatives focused on achieving this goal, however, without a concerted effort towards removing bottlenecks in high potential market segments India may fall short to the 30% sales penetration target.

This study focuses on identifying the necessary actions and specific business models which represent the most promising opportunities in terms of investment returns and scalability in the short, medium and long term to kickstart the multiplier growth in EV sales penetration from the current levels of under 1%. The challenges in the EV industry are quite steep, therefore the solutions developed in this study are equally radical to bear results in the short term while opening up business opportunities in medium to long term. The following schematic summarizes the approach taken for this study.

**Figure 1.1:** Summary of approach adopted for the study
Source: Steer representation




13 Higher targets are considered for market segments like 2 and 3 wheeler markets when planning sector interventions.

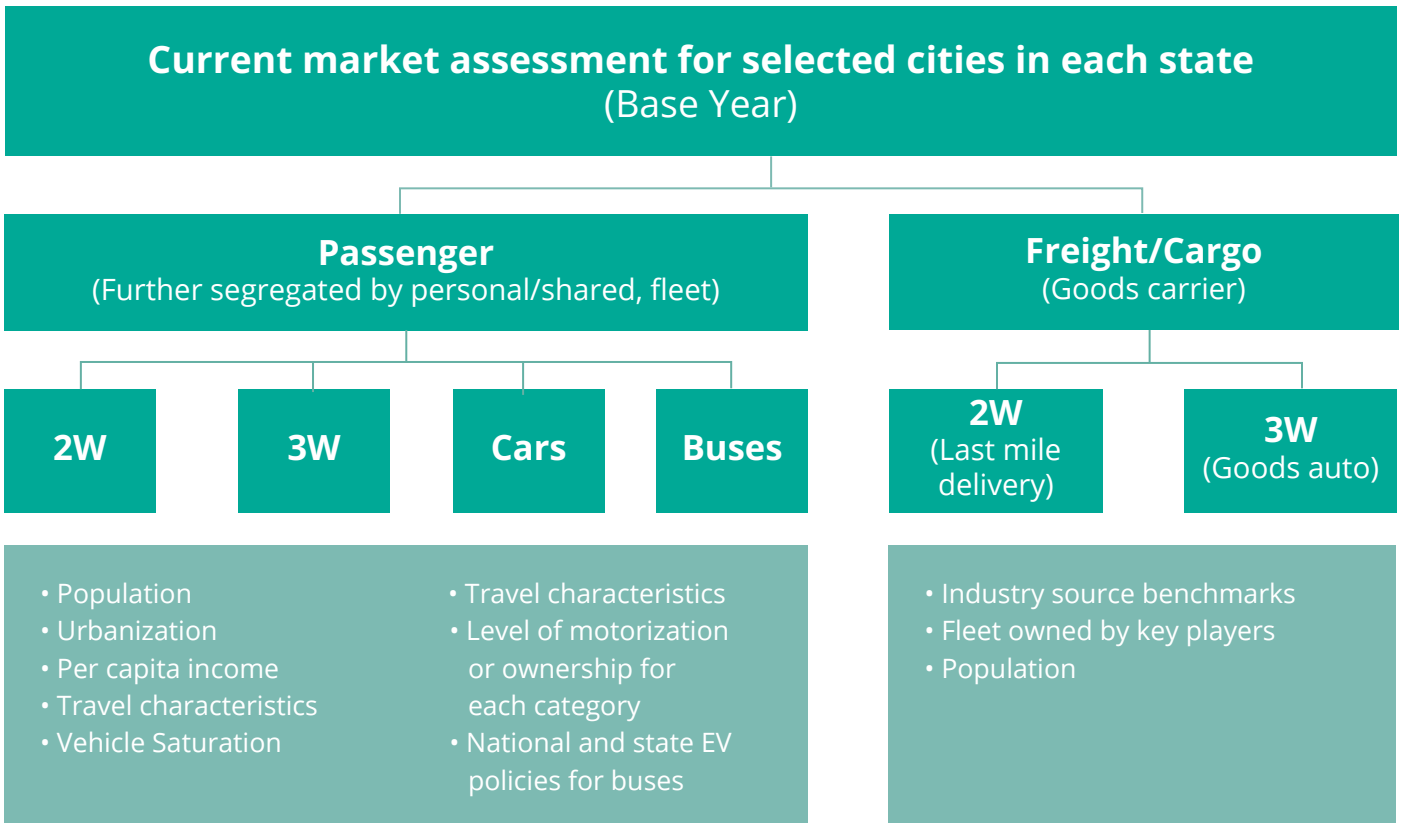
### Approach for market assessment

The study built a bottom-up picture of the overall vehicle market and its anticipated evolution over the forecast horizon years (FY25, FY30). In this assessment, a deep dive analysis was done for the four states selected for this study- Maharashtra, Tamil Nadu, Madhya Pradesh and Kerala (e-buses) to forecast the level of EV penetration across their largest cities. EV penetration was assessed at an individual city level for each vehicle (2W, 3W and 4W) and market segment ('personal' or 'fleet') in selected cities within those states. The results were then scaled up across the selected states and to national level to develop an overall picture of the e-mobility market.

Overall, 2W and 3W markets are expected to grow the fastest by FY25 in terms of EV sales. This is primarily driven by progress towards TCO parity or advantage which EVs have either already achieved or are likely to achieve relative ICE vehicles within this period. Each vehicle and market segment has been evaluated taking into consideration their individual distinct characteristics

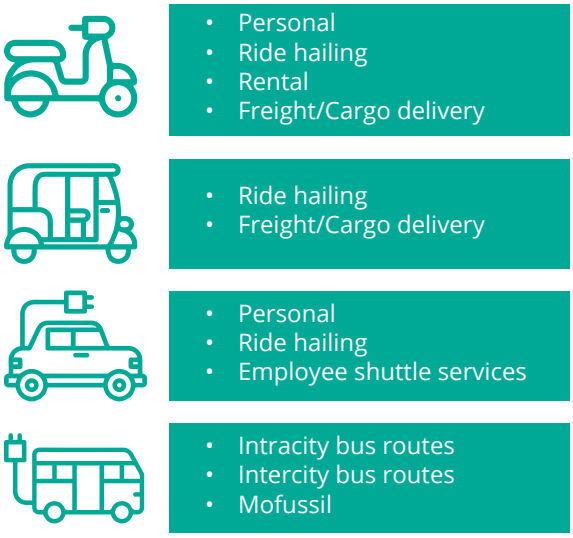
To arrive at market assessment results, a multi-dimensional EV forecast model has been developed incorporating socio economic and demographic factors along with incentives offered under current policies at central and state level, impact of declining battery prices and constraints under which each market segment operates which is further described in Chapter-2.

**Figure 1.2:** EV market assessment model components
Source: Steer representation



The key market segments evaluated in the EV market space has been presented in the figure below. All the market segments evaluated need to be complemented with provision of adequate charging facilities, therefore, business models for charging infrastructure are also covered as a part of the study.

**Figure 1.3:** Electric mobility market segments in India
Source: Steer representation




**Two-wheelers:** This is primarily divided between personal and fleet market segments. The fleet segments involve the following:

- **Ride hailing:** As a part of shared mobility, this caters to passenger mobility in form of bike taxis for providing last mile connectivity. Aggregator platforms such as Ola and Uber are already operating such ride hailing services in many metropolitans across the country.
- **Rental:** 2W rentals are primarily used for providing last mile connectivity. More recently with increase in COVID 19 cases leading to decline in shared mobility demand, many rental platforms have offered their 2Ws for providing last mile delivery services.
- **Freight/ cargo delivery:** With increase in e-commerce businesses and hyperlocal deliveries, the demand for last mile delivery services has increased across markets such as food delivery, parcel/ courier market and grocery delivery. As a result, the majority of commercially plying 2Ws are catering to the delivery market segment.

**Three-wheelers:** This is a commercial vehicle used either in ride hailing segment and cargo delivery.

- **Ride hailing:** 3Ws historically have been an important intermediate public transport mode in cities, catering to first and last mile connectivity needs as well as to short to medium distance trips in the absence of adequate public transport provision. Currently, slow speed electric rickshaws (e-rickshaws) are more prevalent for providing last mile connectivity, however they have not been incorporated in this market assessment as they are not formally registered in several states and often do not comply with the safety parameters for an L5 3Ws.
- **Freight/ cargo delivery:** With an increase in demand for urban freight services, 3Ws have become an important mode for deliveries. They are a more suitable cargo vehicle for e-commerce deliveries of non-perishables. There has been significant investment in this mode by larger players such as Amazon, Flipkart and Reliance, who use them in their delivery fleet.

**Four-wheelers:** They are primarily used for meeting personal commute requirements of individuals or for providing ride hailing

as taxis. Commercial fleet market segments evaluated in this market assessment include:

- **Ride hailing:** These are taxis or cabs, commercially used as a transport mode via a ride hailing aggregator platform. Ola and Blu Smart are examples of organizations which have deployed cars (e-4W) in their taxi fleets.
- **Employee shuttle services:** These are provided to meet employee transportation needs and have recently gained momentum in electric mobility market, with Lithium operating a fleet of about 1500 cars providing such services to large corporates including Google.

**Bus:** This market segment is evaluated based on the distance and region covered by the bus. The three segments evaluated under the study include:

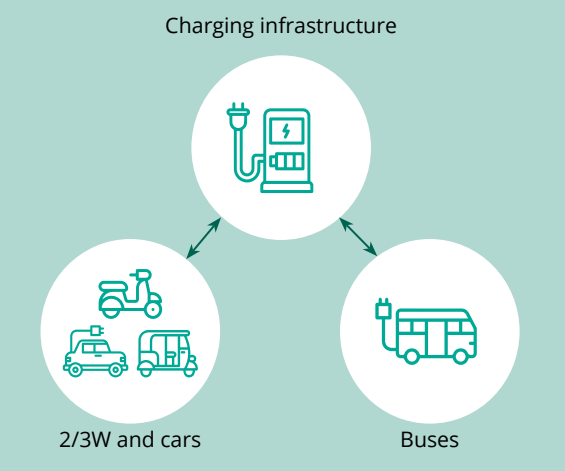
- **Intracity buses** which operate within city limits
- **Mofussil buses** (an extension of intracity bus services) that operate services to far-flung suburbs and neighboring districts
- **Intercity buses** that operate between different cities

### Selected EV market segments

Given the above markets, the following key market segments are evaluated in this report:

- **2/3W and cars:** This includes e-2W, e-3W and e-4W market segments such as personal, passenger fleet and last mile delivery fleet.
- **E-buses:** Intercity and intracity bus markets are operated across both public (State Transport Undertakings) and private sector players
- **Charging infrastructure:** Development of adequate charging and swapping network is a pre-requisite for mass uptake of EVs. This includes all charging solutions such as residential, office, public, captive charging models as well as battery swapping solutions focused on e-3W passenger fleet segment.

**Figure 1.4:** EV universe- primary markets
Source: Steer representation




### Vehicle ownership forecast

As part of this study, Steer has developed a bespoke approach to forecast vehicle ownership for each city. The growth in vehicle ownership (rate per 1,000 people) is closely linked to the growth in population in the area of influence and of economic activity as represented by city/district GDP. However, as vehicle growth cannot continue indefinitely, a saturation level of ownership is defined. The main inputs used are:

- Population growth;
- City level per capita economic growth;

Initial and saturation level for each mode's ownership.

The model formulation to predict vehicle ownership was:

$$VO = \frac{Sw}{1 + e^{a} * e^{(b*growth\ driver)}}$$

Where:

- VO = Estimated vehicle ownership (vehicles/inhabitant);
- Sw = Saturation Level (as per assumptions);
- Growth driver = Per capita (GSDP/ Population) in case of 2-wheelers and 4-wheelers, population in case of 3-wheeler passenger auto and 4-wheeler passenger fleet/ taxi and GSDP for 3 wheeler cargo fleet;
- Pop = Population (million inhabitants)
- a= intercept; b=slope

The parameters of the model, intercept and slope were derived using historical ownership and growth driver data for the period FY16 to FY20. Current market size was estimated on the basis FY20 data and growth trend for each market segment was estimated based on trends observed over the last 3 to 5 years (subject to the availability of data[14] ). The vehicle ownership numbers are then used to arrive at total vehicle population in each city. The year-on-year difference in the vehicle population is assumed to be the vehicle sales/registration.

## EV penetration

The output from the vehicle ownership model, i.e. the number of new vehicles registered/sold was then split between ICEs and EVs based on a logit choice model. The key input for estimating EV penetration is the total cost of ownership (TCO) of a vehicle. Total cost of ownership of a vehicle reflects the sum of all costs involved in the purchase, operation and maintenance of a given vehicle during its lifetime. Since India is known to be a very price sensitive market, the TCO is a key factor influencing consumer choice.

The projection for EV penetration rates were conducted exclusively for each shortlisted city by individual market segments in the selected four states-Maharashtra, Tamil Nadu, Madhya Pradesh and Kerala. The EV penetration calculated were multiplied by the total fleet size to give the EV market forecast for each city. Since the market assessment model is developed in detail with city level assessments, they were extrapolated to arrive at state level and India level EV penetration.

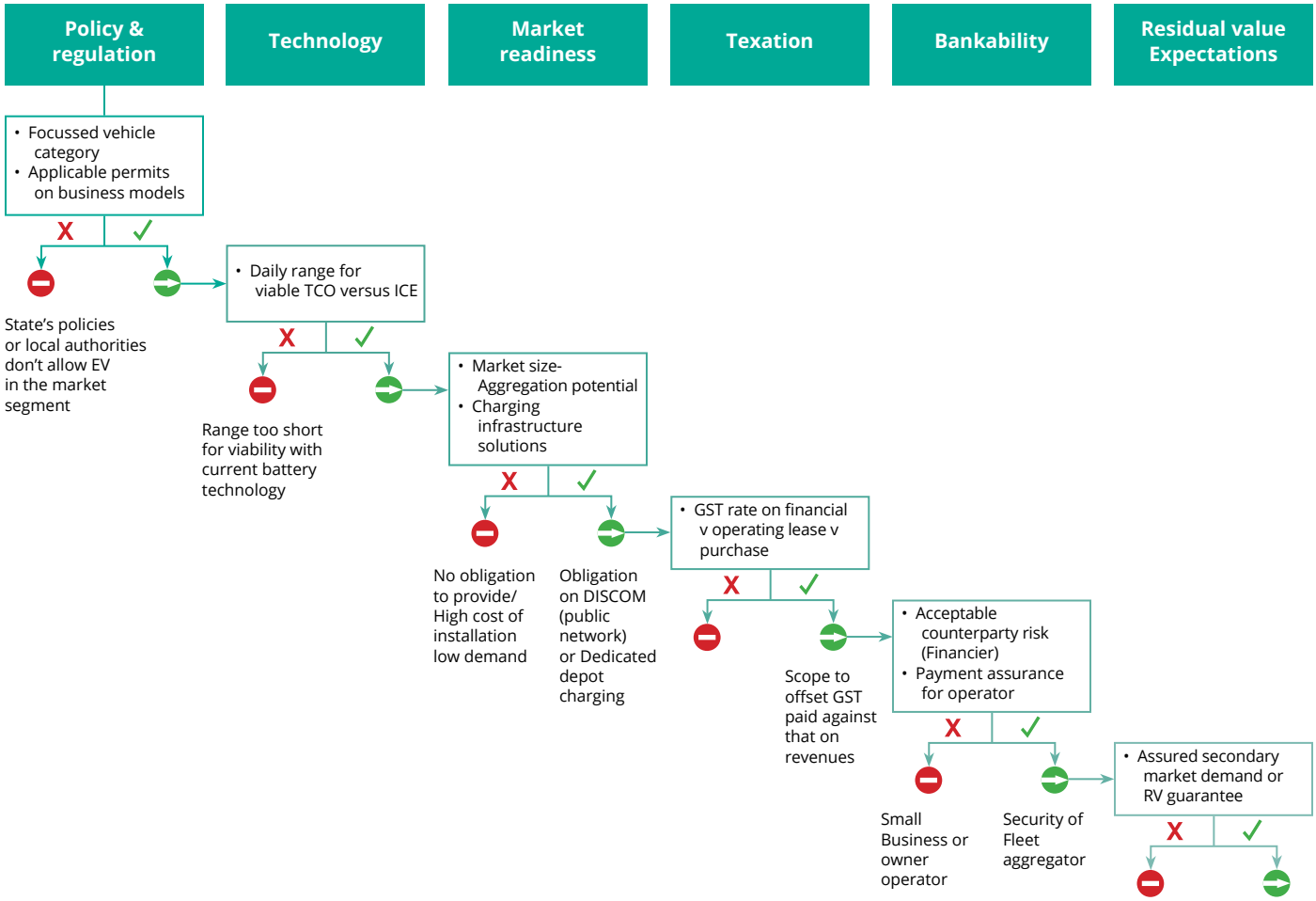
14 Note: In certain cities, especially in Madhya Pradesh, the latest vehicle registration data available is for FY18. We have requested the respective state departments to supply the missing data but for the purposes of this exercise, the FY20 number has been estimated assuming a continuation of past trends.

## Approach for selection of business models

Priority markets for EV adoption have been selected on the basis of a decision tree framework with a succession of potential gateways or enabling actions which could, respectively, either obstruct or enhance the viability of each business model. The framework illustrated below is adapted for each market segment, depending upon the parameters that have most impact on its viability to select high growth potential models.

Over 50 business models across market segments and modes were assessed and mapped with qualitative inputs from extensive stakeholder discussions and quantitative parameters, such as TCO and market penetration potential to shortlist viable business models. For each shortlisted business model, detailed financial model analysis with alternate project structuring was undertaken to select the business models with most viable commercial proposition. The alternate business models and results of financial viability assessment for high potential 2W, 3W and fleet models is presented in Chapter-3.

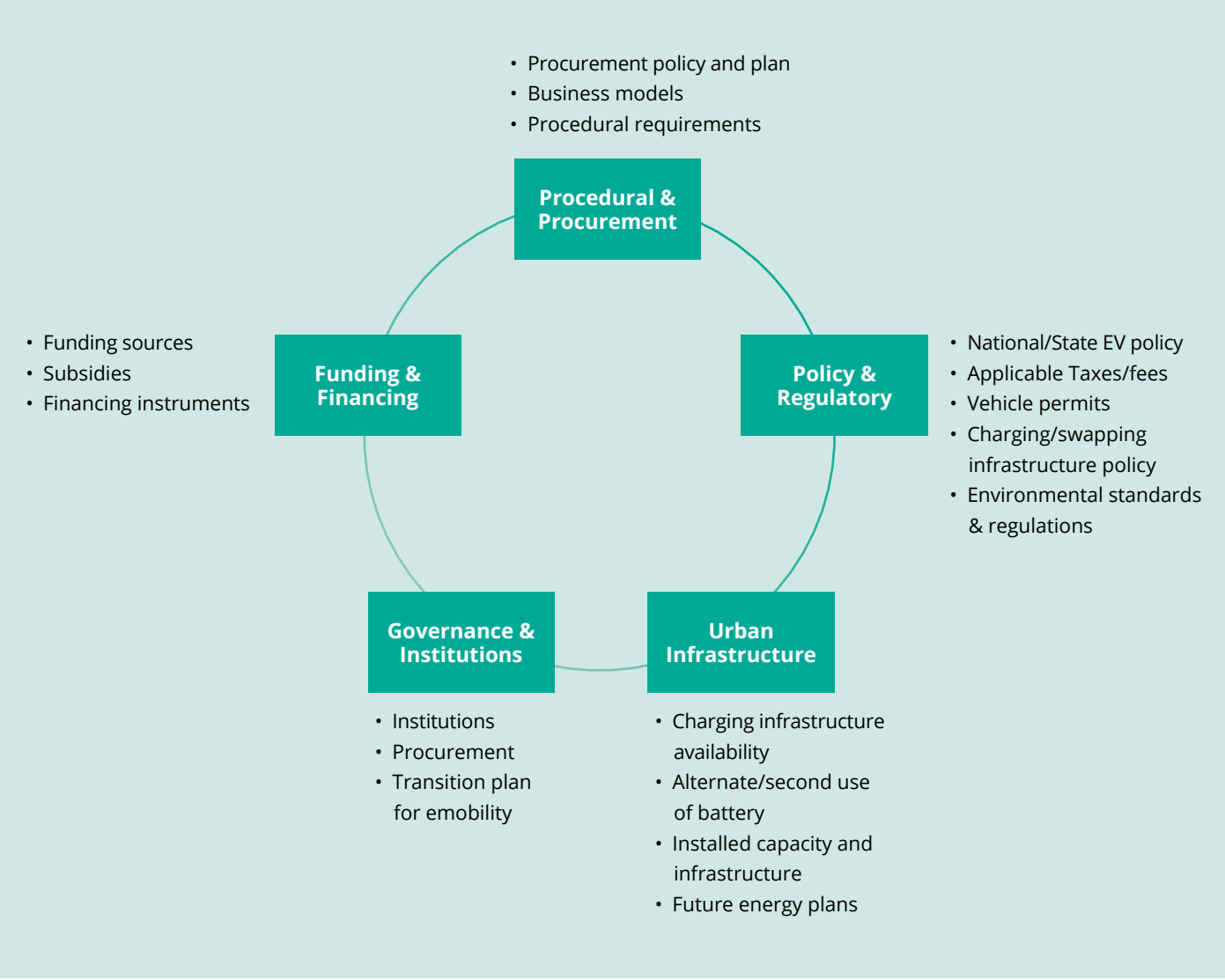
**Figure 1.5:** Business model decision tree
Source: Steer representation



## Approach for developing action plan roadmap

Action plan steps presented in this report are based on assessment of enabling environment factors which are considered critical to the success of business models. The desired features of the EV ecosystem are grouped under five broad headings, presented in the figure below.

**Figure 1.6:** Overall EV ecosystem
Source: Steer representation



The absence of critical features may restrict or delay market development. Several of these aspects cut across all market segments, although some features are relatively more important within specific market segments which are presented in detail in Chapter-2 for key market segments based on feedback from stakeholder consultations.

The action plan roadmap has been conceived following the 'Theory of Change' which stipulates how an intervention can deliver the desired results of a program or policy by creating an enabling environment for meeting its long-term objectives.[15]

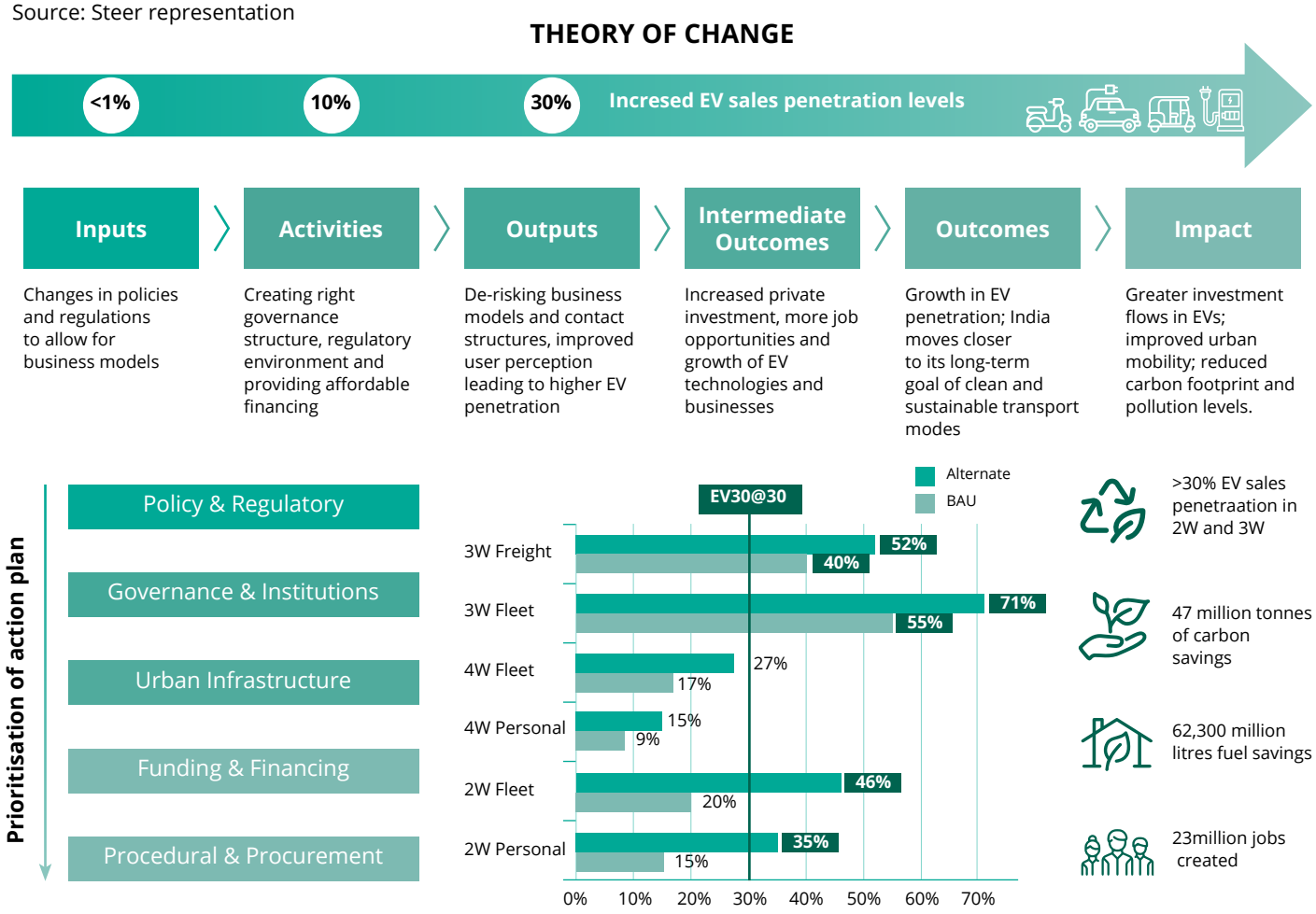
The scenarios presented below were assessed as a part of this study to estimate the impact of the key action plan recommendations:

- **Business-as-Usual (BAU):** This scenario represents a continuation of central and state government policies as on January 2022 without any concerted effort to move the needle towards high EV penetration. It incorporates the impact of declining battery prices and FAME subsidy and State EV policies implemented till January 2022. In this scenario, the business models continue to operate under the constraints elaborated in Chapter 2.
- **Alternate scenario:** This scenario assumes implementation of key action plan recommendations with coordinated approach across policy initiatives at central and state level, institutional re-alignment and unlocking of affordable financing for e-mobility by adopting innovative approach including risk sharing facilities, buyback guarantee, help to buy approach, interest subvention schemes for disbursing subsidized credit to e-3W and e-2W players. Such an approach can be made more effective by a focus on specific business models and market segments that are likely to drive EV adoption, including 2W, 3W and fleets.

The schematic below showcases how policy, governance, financing and procurement related interventions as a part of the proposed action plan roadmap can deliver the outcomes such as increased EV penetration, shift to sustainable transport modes, higher investment, creation of jobs and reduced adverse impact of transport sector on environment. The inputs are the direct changes and actions that are executed today to deliver the objectives of the overall program or policy.

15 Review of the use of 'Theory of Change' in international development, Review report, Isabel Vogel, April 2012

**Figure 1.7:** Prioritization of action plan recommendations
Source: Steer representation




The framework for prioritizing action plan recommendations is not unidirectional; it indicates the critical levers required for developing a roadmap where government has substantive role to play till a benchmark penetration is reached from where market forces would be taking over for mass scale adoption. The recommendations are inter-dependent between different actors in public and private sectors. The rationale behind the suggested prioritization framework is presented below:

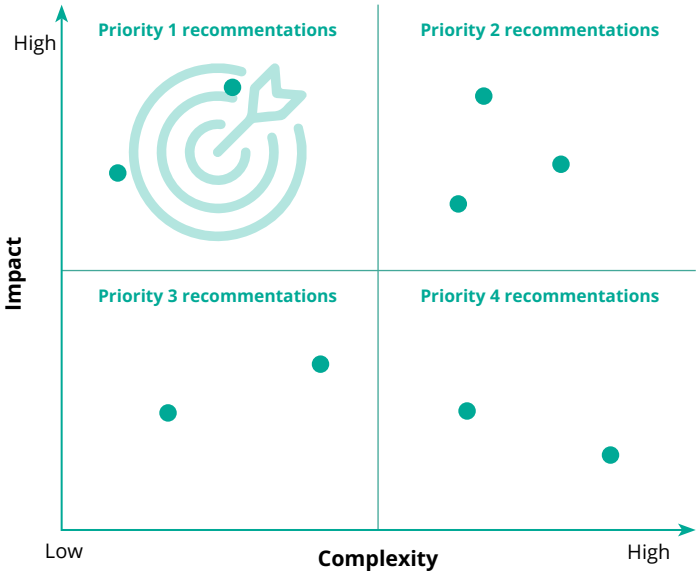
- Policy and regulatory barriers are the first gateway in the decision tree framework for selecting prioritized market segments as it focuses on removing critical bottlenecks which hinder the existence or scale up of potential business models.
- Strong governance mechanisms and institutions are a vital block for effective implementation of such policy or regulatory changes; hence they have to be aligned as soon as the necessary regulation is implemented by the government agency.
- Urban infrastructure in form of availability of adequate charging and ancillary infrastructure is the backbone of EV industry. Once business models are allowed under the national or state EV policies, the next focus should be on

deployment of charging infrastructure at strategic locations to increase EV penetration across high potential business models.

- Existence of different business models is contingent on effective policy implementation and provision of adequate charging infrastructure, however due to high financing costs and lack of availability of credit, the scale and viability of business models is adversely impacted. Therefore, after aligning policies and infrastructure, support to EV businesses has to be provided in form of affordable and accessible financing options which is seen as a critical factor for success of any business model. The approach used for identifying and appraising financial options to unlock flow of affordable financing in the EV sector is discussed in detail in Chapter-6.
- Improved procedures and efficient procurement processes are important for optimizing business operations. Therefore, after implementation of above recommendations, procedural and procurement related action plan steps may lead to improved viability and scalability of alternate business models.

The multiplier impact in terms of increase in EV penetration may differ across market segments and geographies due to differences in effectiveness of policy implementation, governance frameworks, urban infrastructure development and available funding options. To develop an effective roadmap for implementation of action plan recommendations, a framework has been developed to prioritize recommendations within each category of critical ecosystem factors based on their expected impact versus the complexity of implementation.

**Figure 1.8:** Impact vs complexity framework of recommendations
Source: Steer representation




'Impact' refers to the benefit the recommendation has on the scaling the potential business models. 'Complexity' refers to the time, effort, and cost to implement a recommendation. A combination of complexity and potential impact has been assessed to prioritize the action plan recommendations.

Deep-dive analysis for each barrier impacting operations and viability of business model was done with stakeholder consultations across different agents in the EV value chain. This was further validated with extensive policy and regulatory investigation to assess the reason and impact of such barriers. A series of consultations were held on the draft action plan recommendations with the state and national government agencies as well as private sectors players to get feedback on the applicability, impact, and ease of implementation of the proposed recommendations.

The prioritization framework was developed based on the ecosystem factors (policy, governance, urban infrastructure, financing and procurement) described above, impact of the recommendation in improving the perception factor which influences consumer's and business choice to adopt EVs and the stakeholder feedback in terms of the complexity of implementing the recommended measures.

The key action plan recommendations are the essential levers that could help in achieving the EV30@30 target by taking the average EV penetration levels from 17% in BAU to 35% in the alternate scenario. Higher EV penetration would also result in positive socio-economic, and environment impacts in terms of fuel savings, job creation and decarbonisation. The impacts highlighted in the above schematic are discussed in detail in Chapter 6- Impacts of proposed intervention.

## Report structure

This report is divided into seven sections:

1. **Overview** provides a brief on India's targets of electric mobility adoption to meet its climate change targets and the approach used in this study for assessing the market potential, identifying potentially scalable business models and prioritizing action plan recommendations to meet the EV30@30 targets.
2. **Market assessment** provides an introduction to the India's transport sector and an overview of current state of EV penetration and barriers faced in each of the market segments.
3. **2/3W and Cars** presents an estimated EV penetration in 2W, 3W and Cars market segments. Within each market segment, it identified potential business models and recommends an action plan roadmap for increasing adoption of selected business models.
4. **E-buses** provides an overview of adoption of e-buses under the current procurement framework. It also provides alternate business model options and key action plan recommendations to support economies of scale in e-bus procurement, operations and financing.
5. **Charging infrastructure** presents the state of charging infrastructure at global and national level and the forecasted charging swapping infrastructure requirement to support EV penetration across different market segments. The action plan recommendations provided in this chapter are aimed to improve commercial viability and scale up of charging and swapping business models.
6. **Financing solutions** focuses on understanding the challenges and barriers to funding and financing in detail to identify a set of financial options that could be deployed by Indian policymakers to unblock the flow of affordable finance into the EV sector and increase EV penetration for the shortlisted business models beyond baseline/do-minimum levels.
7. **Impact of action plan recommendations** summarizes the impact of taking a coordinated approach and highlights the value of implementing the combination of recommended measures and effective financing both on carbon emissions and for job creation in India.

# 2.

# Market Assessment

## Introduction

This chapter presents the current status of India's transport sector and the relative positioning of EV in the sector. Within the electric mobility sub-sector, various market segments have been studied to identify potential opportunities and barriers in large scale adoption of EVs. The chapter is structured as followed:

- **India's transport sector** presents a literary introduction to the sector, its economic drivers and historical growth trajectory.
- **Market segments** introduces the different potential markets available for each vehicle mode. It also presents an overview of current state of EV penetration for each of these market segments
- **Market opportunities and barriers** presents an overview of factors promoting as well as posing a threat to the development of EV market in India. These factors are categorized among the ecosystem factors regulatory, policy, governance, urban infrastructure, financial, and procurement as described in Chapter-1.

## India's Transport sector

Transport is among the fastest growing sectors in India. Energy demand associated with transport is expected to increase significantly, especially with expansion plans for transport infrastructure in roads, railways, metro, ports and airports. India has the second largest road network globally with about 5.89 million kms[16]. As per India Energy Outlook 2021 by International Energy Agency, the growth in India's transport sector is likely to increase the oil demand to almost 8.7 million barrels per day by 2040 assuming a balanced assessment of the current policies and constraints of India's energy systems.[17] According to International Energy Agency, the road sector in India also accounts for over 90% of total carbon emissions by the transport sector.[18] There is a strong push towards sustainable development with electrification of transport and deployment of energy efficient measures to potentially bring down this oil demand to 1 million barrels per day by 2040.[19]

With economic growth and development, average level of travel in India has increased to 5,000 kms each year, which is a threefold increase compared to 2000. In the last two decades, vehicle ownership has increased five-fold led by two-wheelers and three-wheelers. Growth in freight activity has resulted in quadrupling of truck ownership between 2000 and 2019.[20]

Witnessing the world's highest growth rate of urbanization, India's urban population grew by 91 million between 2001 and 2011. As per the census 2011, 31% of India's population resided in cities,[21] which is expected to grow to 40% in 2030 and 50% in 2050,[22] thus creating pressure on the mobility needs of the country—which will result in growing vehicle ownership and demand for public transport.

16 Basic road statistics in India, Ministry of Road Transport and Highways, 2016-17

17 India Energy Outlook 2021, Special Report, International Energy Agency
18 India 2020, Energy Policy Review, International Energy Agency
19 India Energy Outlook 2021, Special Report, International Energy Agency
20 India Energy Outlook 2021, Special Report, International Energy Agency
21 Provisional population totals, Paper 2, Volume 1, Rural-Urban Distribution, Census of India, 2011
22 Faster adoption of Electric Vehicles in India: Perspective of consumers and industry, The Energy and Resources Institute, 2019

Indian cities with over 1 million population account for 30% of total registered vehicles. With lack of adequate public transport, growing cities experience a high share of transport demand led by two-wheelers (2W) and three-wheelers (3W). Average 2W ownership is at 45%-50% of households in tier II and tier III cities and close to 30% in tier I cities[23]. 'Tier I' includes cities with population of 8 million or above; 'Tier II' cities population ranges from 4-8 million; Tier III includes cities with population of 1-4 million and; 'Tier IV' is classified as cities with population between 0.5-1 million[24]. Therefore, a significant opportunity exists in terms of electrifying two and three-wheelers to lower energy demand and reduce carbon emissions.

Overall, total vehicle registration has grown from 18 million in FY16 to 21 million in FY20.[25] Vehicle registrations witnessed a sharp decline during FY21 to 15 million due to COVID 19 impacting global automobile demand. 2W registrations have consistently accounted for 75%-80% of these registrations. Currently a majority of 2W demand is being met by petrol variants which are a significant contributor to greenhouse gas emissions and PM2.5 particulate matter. Further, the lack of adequate public transport systems in cities has led to high dependence on 2/3W and cars.

Economic growth coupled with urbanization, rising incomes and aspirations promoting higher vehicle ownership and usage in Indian cities, has paved way for promoting electric mobility market in India. Unlike other developed regions such as Europe and the US which have an average car ownership of 79% and 88%[26], average car ownership per 1000 people is at 35 in cities with over 1 million population. Therefore, the path of e-mobility that India takes may not be led by cars (4W) like in other developed economies.

Two-wheelers (2W) account for majority of personal vehicle sales in India and three-wheelers (3W) act as a key (intermediate) public transport mode and are extensively used for last mile freight deliveries. Successful business models within the Indian e-mobility sector are also likely to be driven by such light vehicle modes.

At a global level significant technological advancement is anticipated, with evolving battery chemistry and progressively greater efficiencies and longer range being achieved by battery packs. However, these trends may take time to impact the Indian market directly as a vast majority of the EVs in India are expected to be light vehicles which are powered by the batteries below 10kWh. The additional complexity caused by the ongoing COVID pandemic and its impact on global supply chains is causing many industry players to rethink their strategies around procurement and their sourcing of EV battery, vehicle components and supporting charging infrastructure.

23 Faster adoption of Electric Vehicles in India: Perspective of consumers and industry, The Energy and resources Institute, 2019
24 https://www.india-briefing.com/news/india-tier-2-tier-3-cities-right-business-15932.html/ accessed on 27 October 2021
25 FADA Releases FY20-21 & April'21 Vehicle Registration Data, Federation of Automobile Dealers Associations, 10 May 2021
26 https://www.bloomberg.com/news/articles/2015-04-17/a-pew-survey-charts-global-car-motorcycle-and-bike-ownership accessed on 20 August 2021

## Market segments

### Current state of electric mobility

The success of EV in the overall vehicle mix has been limited except for e-3W, due to higher upfront costs and technology apprehension around batteries and their range. The current level of e-mobility penetration is very low for e-2W, e-4W and e-bus as seen in the table below.[27]

**Table 2.1:** EV penetration by market segments as a percentage of total vehicle sales from FY 19-FY 21
Source: SIAM Database, FADA[28]

| Mode | FY 19 | Penetration % | FY 20 | Penetration % | FY21[44] | Penetration % |
|---|---|---|---|---|---|---|
| e-2W | 126,000 | 0.9% | 152,000 | 0.9% | 149,000 | 1.3% |
| e-3W | 100,000 | 14.3% | 90,000 | 14.1% | 88,000 | 34% |
| e-4W | 3,600 | 0.11% | 3,400 | 0.12% | 5,900 | 0.2% |
| e-bus | 400 | 0.04% | 600 | 0.08% | 1,850 | 11.7% |

Note: 3W numbers do not include e-rickshaws. Historical data is available at an aggregated market segment of 2W, 4W and 3W, and is disaggregated for the forecast period; EV Penetration % estimated with total sales reported by FADA

Even though the vehicle sales number have declined for e-2W and e-3W, the penetration levels have improved due to decrease in the overall vehicles sales in FY 21. EV penetration has witnessed significant increase in e-bus and e-4W categories. The use of light vehicles such as two and three-wheelers for short distance trips and last mile delivery are leading the EV growth story. These are also the vehicle segments which are witnessing EVs having an advantage over ICE vehicles in terms of Total Cost of Ownership (TCO) which combines both upfront and operating costs. The TCO results for each market segment are discussed in Chapter 3 for 2/3W and cars and in Chapter 4 for e-buses.

Two-wheelers in general dominate the overall vehicle sales and the same trend is being replicated in EVs. It is also the segment where several Original Equipment Manufacturers (OEMs) have stepped in and are currently producing various slow (<25km/hr), mid (25-40 km/hr) and high (>40 km/hr) speed variants. This has also led to the upfront price point of an e-2W being within acceptable range of an ICE 2W which is supporting faster adoption. Policy initiatives being implemented by central and state government across India are seen to be supporting adoption of e-2W across various states of India.

e-3Ws have seen a steady uptake initially due to the introduction of the slow speed variants, commonly known as e-rickshaws, in various parts of India. It is estimated that there are nearly 2 million such e-rickshaws

27 https://cp.catapult.org.uk/wp-content/uploads/2021/03/210318_1020_CPC_India_Report.pdf
43 FADA Releases FY20-21 & April'21 Vehicle Registration Data, Federation of Automobile Dealers Associations, 10 May 2021
44 https://www.autopunditz.com/post/ev-sales-decline-over-19-percent-in-fy2021-to-2-36-802-units accessed on 1st March 2022

current plying on Indian roads. This rapid increase in e-rickshaws is due to low barriers of entry for both manufacturers and operators, limited regulations around their design and operation and lower cost relative to ICE 3Ws. These are considered to be a replacement of the traditional cycle rickshaws and serve an important purpose within the last mile connectivity by serving short distance trips.

E-rickshaws are key to urban mobility for last and first mile connectivity and due to welfare reasons city/state authorities have taken a light touch approach to their regulation as they provide employment to low skilled groups and can be considered as a steppingstone for L5 e-3W[30] as the price point is lower. The slow speed e-rickshaws are currently powered by lead acid batteries and are not compliant to automotive standards as they are not classified as 'transport vehicle' under the Motor Vehicle Rules. Most of them are unregistered making financing at scale challenging, and they are accordingly not covered in this study. Better regulation in terms of quality, licensing, battery disposal should be encouraged in case of e-rickshaws as these vehicles form a significant means of urban mobility.

The more traditional mid to high speed 3W, categorized as L5 within vehicle specification norms, are currently dominated by ICE vehicles driven by CNG and petrol engines. However, this vehicle segment of L5 3W is seeing rapid uptake of EV with multiple OEMs launching new products combined with policy initiatives taken by central and state governments supporting this uptake of e-3W. This study focuses on the mid to high-speed segment (L5) of e-3W.

The low levels of EV penetration in cars (4W) and bus market is due to the high upfront prices, relatively low performance and dependency on the development of charging infrastructure coupled with limited number of products. Given these challenges, adoption of four wheelers and electric buses has been low and is expected to grow in tandem with the development of charging ecosystem and more products catering to specific market segments being developed.

## Market opportunities and barriers

In countries where EV adoption has accelerated, it is reaching a level where it is comparable to their ICE counterparts in terms of performance, including speed, pick-up, and range. Additionally, EVs are growing to present users benefits in the form of operational cost savings due to better efficiency, lower maintenance requirement, and lower energy and emissions. Key drivers influencing transition towards electric mobility include:

- **Climate change targets:** According to a recent World Air Quality Report by IQAir[31], India dominates the PM 2.5 emissions globally and is home to 22 of the top 30 most polluted cities in the world. Transportation is a leading source for all pollutants and PM 2.5 emissions. India has committed to reducing its GHG emissions by 33% to 35% percent below 2005 levels by 2030. To lower the contribution of transport sector to overall carbon emissions, the government is focusing on including EVs in their policies to promote transition to clean mobility.[32]

30 According to International Centre for Automotive Technology- L5 auto-rickshaw is a motor vehicle with maximum speed exceeding 25 kmph and engine capacity exceeding 25 cc if fitted with a thermic engine, or motor power exceeding 0.25 kW if fitted with electric motor.

31 World Air Quality Report, Region and City 2.5 Ranking, 2020, IQAir

32 Zero Emission Vehicles (ZEVs): Towards a policy framework, NITI Aayog, World Energy Council,

- **Fuel costs:** India imports 85% of its oil requirement and its cost stood at USD 55 billion in FY 2020-21.[33] 95%[34] of transport fuel requirement is met by oil imports and this ratio is expected to increase with growth in mobility demand. India is also a cost-conscious market, with increase in prices of fuel and electric vehicle's total cost of ownership (TCO) being competitive or cheaper than ICE counterparts, there is significant potential for uptake of EVs in India especially in light vehicle categories like e-2W and e-3W.
- Growth of e-commerce: Rapid growth in e-commerce businesses has increased demand for last mile delivery services. With COVID-19 pandemic resulting in the increase in online shopping in urban areas, there is increased demand for affordable last mile connectivity influencing transition to light electric vehicles such as e-2W and e-3W. Shift to e-delivery fleets is being witnessed by hyperlocal delivery start-ups such as BigBasket, Blinkit, Swiggy and Zomato as well as major e-commerce players such as Amazon and Flipkart.

### Barriers to uptake

The barriers to uptake of EV market segments are identified and mapped for each ecosystem enabling factor. These barriers have been identified based on over 100 stakeholder interviews conducted across the EV supply chain including government institutions, vehicle manufacturers (OEMs), fleet operators, bus concessionaires, charging infrastructure operators, battery manufacturers and financial institutions. The consultations took place in 2020 and early 2021. Some of those barriers have been or are in the process of being addressed for example through adjustments made for the FAME II program.

### 2/3W and Cars

**Table 2.2:** Challenges faced by private vehicle market segments

| Challenges | Personal | Ride-hailing | Last mile delivery |
|---|---|---|---|
| Regulations in many states under the Motor Vehicle Act categorize 2W as non-transport vehicles which cannot be used for commercial operations such as a taxi, or for rental purposes, or for deliveries (requires yellow registration number plates).<br><br>**Category:** Policy and Regulatory<br>**Impacted mode:** **e-2W** | X | ✓ | ✓ |

33 Roadmap for Ethanol Blending in India 2020-25, Report of the Expert Committee, NITI Aayog, Ministry of Petroleum and Natural Gas, June 2021
34 India Energy Outlook 2021, Special Report, International Energy Agency

| Challenges | Personal | Ride-hailing | Last mile delivery |
|---|---|---|---|
| Even though EV policy states no registration fee on these vehicles, new registrations of L5 category e-3W at RTOs is obstructed in multiple states due to bureaucratic hurdles. Owning to pollution from diesel 3Ws in the past, governments in many large metropolitans had imposed restriction on registering new 3Ws. This had not been amended even after introduction of CNG and improvement of emission norms in many cities, leading to very few new 3W registrations[35]. This is the primary reason for marginal yearly growth in this vehicle segment. Moreover, to meet the growing urban mobility needs, there has been significant adoption of e-rickshaws in many cities which do not require permits and lack safety regulations.<br><br>**Category:** Policy and Regulatory<br>**Impacted mode:** **e-3W** | – | ✓ | X |
| Ministry of Road Transport and Highways MoRTH, Government of India has recommended exemption from permit requirements for e-3Ws[36] but the measure not yet implemented in many states. Permits for e-3W are currently issued to individual 3W drivers and not to corporate fleet owners. Results in black market for permits, with drivers selling them to fleet owners or other drivers at a significant premium. In many cities district level RTOs issue route-wise permits which significantly limits the aggregation potential for a fleet operator and slowing the development of a network.<br><br>**Category:** Policy and Regulatory<br>**Impacted mode:** **e-3W** | – | ✓ | X |
| Selling battery separately from vehicle attracts Goods and Services Tax (GST) of 18% instead of 5% for the fixed battery in the vehicle, leading to inverted tax structure. Given that the life of the vehicle is longer than the battery and its cost comprises about 40% of the total vehicle cost, the higher GST rate on battery is a significant deterrent for end-user who is making a choice between EV and ICE variants. Also, for alternate business models such as battery swapping or battery leasing / subscription models, the higher GST rate on battery coupled with electricity duty results in double taxation and is a significant cost impacting the commercial viability of the business model.[37]<br><br>**Category:** Policy and Regulatory<br>**Impacted mode:** **e-2W and e-3W** | ✓ | ✓ | ✓ |

35 https://epca.org.in/EPCA-Reports1999-1917/report-no-95-removal-of-three-wheeler-cap.pdf accessed on January 2021. Validated from stakeholder consultations with 3W OEM for local RTOs at Bhopal, Mumbai and Chennai
36 https://morth.gov.in/sites/default/files/circulars_document/Incentivisation_of_Electric.pdf
37 Accelerate corporate adoption of EVs in India, Policy and regulatory recommendations for Government of India, WBSCD, October 2020

| Challenges | Personal | Ride-hailing | Last mile delivery |
|---|---|---|---|
| As per Central Motor Vehicle Rules (CMVR), OEMs with motor ratings below 250W and a speed limit of 25 kmph are liable for homologation cost of INR 500,000 and those above these limits are subject to a licensing cost of INR 5,000,000<br>Many of these slow speed vehicles are fitted with cheaper imported parts leading to low price point for these vehicles.<br>With such products not being subjected to stringent checks their penetration remains higher than the safer versions recognised under the FAME II policy.<br>According to the research done by WBSCD, about 70-80% of e-2Ws bypass Automotive Research Association of India (ARAI- CMVR) regulations by getting vehicles approved as non-number plate vehicles. Also, indications that many e-2W fleet operators later increase the motor wattage and speed depending on operations (last mile delivery/ ride hailing) posing a serious safety hazard on the driver of these vehicles.<br><br>**Category:** Policy and Regulatory<br>**Impacted mode:** **e-2W** | X | ✓ | ✓ |
| Residual or secondary market sale of electric scooters is negligible due to lack of understanding of battery technology for e-2Ws.<br>Lack of technical bodies/ agencies estimating battery life and performance is also a key barrier in estimating residual value of e-2Ws.[38]<br><br>**Category:** Policy and Regulatory<br>**Impacted mode:** **e-2W, e-3W and e-4W** | ✓ | ✓ | ✓ |
| High financing costs of e-2Ws between 15%-24% and for e-3W between 24%-30% on reducing balance with significant down-payment requirements. Financial institutions extending loans to this category are mostly NBFCs or Fintech companies such as RevFin, OTO Capital, Zest Money etc. whereas many commercial banks either don't extend loan facility to EVs or treat them as 'white goods' instead of automobile loans leading to a much higher rate of interest. The low residual value expectation due to lack of technological understanding and lower battery life is another key challenge resulting in higher cost of financing this vehicle segment.<br><br>**Category:** Financial and funding<br>**Impacted mode:** **e-2W and e-3W** | ✓ | ✓ | ✓ |

38 Regulatory mechanisms for electric three wheelers, Parul Thakur and Sugandha Pal, TERI, December 2019

### e-buses

In case of e-buses, there is a significant gap in TCO between diesel and e-buses in the majority of intracity operations. Consequently, the pace of electrification of bus fleet in intracity markets in the short to medium term will be largely policy driven. Unprofitable public bus operations, high capital costs of e-buses and the additional fiscal constraints on both public and private operators due to the COVID crisis have slowed down the transition to e-buses in the near-term. For the intercity bus markets, the lack of public charging infrastructure, range concerns (technology) and lack of subsidies for the private sector market along with the impact of COVID have slowed the uptake. The key barriers in the existing FAME subsidy provision and execution of GCC contracts for all market segments - intra-city, inter-city and mofussil – as applicable in 2020 and early 2021, are presented below:

**Table 2.3:** Challenges faced by e-bus market segments: Intra-city, inter-city and mofussil
Source: Steer Review

| Challenges |
|---|
| **Exclusion of private operators from FAME II subsidy:** Under the operational guidelines of FAME II subsidy, only public bus operators or STUs are eligible to receive the demand incentives offered. Given the higher upfront cost of buses and associated cost of developing charging infrastructure, TCO parity doesn't exist for e-buses over shorter distances whereas for longer routes the battery size is large and price of the bus may be much higher than a competing ICE vehicle, therefore private bus operators have not invested in shifting to electric fleet<br><br>**Category:** Financial and funding |
| **Lack of depot and grid readiness:** Under the model concession agreement (MCA) issued by NITI Aayog, the responsibility for making the depot infrastructure ready for installation and use of charging infrastructure lies with the contracting authority. However, during stakeholder consultations it was found that even provision of basic power infrastructure (11kV line) was not done by the authority. In several cases, the tender does not even specify the location of depots, which increases the risk premium perceived for these contracts and results in high GCC bids. Likewise, the lack of charging infrastructure in open access for intercity bus transport limits the uptake.<br><br>**Category:** Urban Infrastructure |
| **Lack of scale economies:** in 2020, three authorities i.e. BEST in Mumbai (300 buses) Janmarg in Ahmedabad (300 buses) and Uttar Pradesh (combined procurement of 600 buses for deployment across 11 cities) constituted about 50% of the total buses sanctioned under the FAME subsidy scheme. The FAME-II scheme is proposed to support only 7,000 buses and, without operating subsidies, these buses are commercially unviable for both intra-and inter-city routes. Therefore, there is limited incentive for OEMs to invest in R&D to improve the bus technology and performance or in capacity development for mass production of these buses, which has resulted in an uncompetitive product priced significantly higher than its ICE counterpart.<br><br>**Category:** Urban Infrastructure |

| Challenges |
|---|
| **High cost of capital:** In the bundled GCC approach under FAME II, the responsibility of procurement, operation and development of associated charging infrastructure lies with the operators, which results in large upfront capex requirement to be fulfilled by the operator consortium consisting of OEMs as lead partners. Therefore, most of these OEM-operators require large upfront financing as well as working capital loans to finance their e-bus operations. Operational risk coupled with technology risk associated with e-buses results in higher cost of capital when attempting to raise business finance.<br><br>**Category:** Financial and funding |
| **Uncertainty of payment by government operators:** Poor financial health of State bus agencies, coupled with higher costs of operations of e-buses, has contributed to delay/ default of payments to operators. While the terms of payment in the case of service provider default were retained in local tenders, many cities changed the default clauses associated with delay in payments (as well as contract termination clauses) to relax obligations of the authority. The requirement of minimum amount to be maintained in the escrow account under the contract has also been changed by several cities. All these measures have adversely impacted the bankability risk of the project for service providers and their financing entities, deterring some potential bidders from applying.<br><br>**Category:** Financial and funding |
| **Unbalanced risk sharing in contractual framework:** In the GCC regime under FAME II, the risk allocation is skewed heavily towards the operator as all functions such as fleet provision, maintenance, operation and charging infrastructure provision are bundled. The performance and subsidy bank guarantees are additional contractual obligations of the operator. The risk premia to counter the risks of bundled operations based on a new technology, along with unbalanced application of penalties which can be imposed on the operator, result in higher quoted GCC rates<br><br>**Category:** Procedural and Procurement |

## Charging infrastructure

The type of business model in charging space is determined by its location and the market segment it caters to, the following figure gives an overall understanding of the charging infrastructure market.

**Figure 2.1:** Charging infrastructure market segments

**Personal**

- **Residential:** Assumed to be the primary location of charging for personal users led by e-2W
- **Office:** Will facilitate opportunity charging for personal users

**Commercial**

- **Captive:** Fleet operators of e-2W, e-3W and e-4W
- **Public:** Key enabler for all market segments to grow
- **Battery Swapping:** Specific market segments led by fleet operator of e-3W
- **Depot charging:** Specific for e-bus operations

The barriers identified in uptake of charging infrastructure market segments are based on stakeholder discussions across the charging infrastructure supply chain

**Table 2.4:** Challenges faced in charging and swapping business models
Source: Steer Review

| Challenges | Battery Swapping | Captive Charging | Public Charging |
|---|---|---|---|
| Availability of land at subsidized prices is a key challenge in setting up charging stations. Stations require significant capex/ expense which at the current level of utilization of public and captive charging stations significantly hampers the commercial viability of the business. As per the findings from the pilot done by Ola Electric in Nagpur, land lease rental alone was at INR 23-28 per sq.ft. accounting for about 31% of the opex, which strongly discourages private players to scale up their operations.<br><br>**Category:** Policy and Regulatory | | ✓ | ✓ |
| Selling battery separately from vehicle attracts GST of 18% instead of 5% for the fixed battery in the vehicle. The higher GST rate on battery is a significant cost impacting the commercial viability of the business model.[39]<br><br>**Category:** Policy and Regulatory | ✓ | | |
| Weak regulatory frameworks don't assign responsibility of recycling or reuse to consumer or OEM. 75% is the value of cells in the battery, of which 40% extraction is possible. After processing, only 10% can be extracted in the form of primary metals-lithium, cobalt, nickel. This process is very time-consuming and expensive. The residual value is typically realized in 3 years and is not an attractive business proposition for any large player. As EVs adoption in India is still at a nascent stage, planning for other alternate stationary use of batteries or safe disposal and recycling plants is necessary so that it doesn't result in a large environmental cost in the short to medium term.<br><br>**Category:** Policy and Regulatory | ✓ | | |

39 Accelerate corporate adoption of EVs in India, Policy and regulatory recommendations for Government of India, WBSCD, October 2020

| Challenges | Battery Swapping | Captive Charging | Public Charging |
|---|---|---|---|
| Subsidized electricity tariff is not made available in certain cases such as for captive charging stations or for setting up stations in parking lots and commercial buildings (such as malls/ office complexes) and for individual battery swapping stations. Also, to avail subsidized electricity tariff the electricity connection and metering needs to be separate from other electricity uses. The Supply Code and Tariff Regulations vary from state to state and implementation costs for setting up connection and metering further increases cost of stabling a charging and swapping station.[40]<br><br>**Category:** Policy and Regulatory | ✓ | ✓ | |
| Battery swapping is an attractive proposition for e-3W and e-2W for ride hailing fleet as it significantly reduces downtime of the vehicle. However, the biggest challenge in this model is the variable battery standards used by OEMs in light vehicle categories especially for e-2W. If battery swapping must be accepted at a large-scale, multiple OEMs would need to accept a common set of norms for sizes of battery pack which may limit battery performance in the short-term.<br><br>**Category:** Urban Infrastructure | ✓ | | |
| For installation of DC chargers to provide opportunity charging, the constraint of availability of high-voltage power across the city is deterrent in setting up fast/ rapid chargers.<br><br>**Category:** Governance and Institutions | | ✓ | ✓ |

40 Charging India's two- and three-wheeler transport, A guide for planning charging infrastructure for two- and three-wheeler fleets in Indian Cities, Shyamasis Das, Chandana Sasidharan, Anirudh Ray, September 2020

# 3.

# 2/3W and Cars

*Photo credits: Ather Energy*

## Introduction

This chapter discusses the market potential in terms of EV sales penetration of 2/3W and car segments in BAU scenario keeping in view balanced assessment of current policies and constraints in each market segment. The major sections of this chapter include the following:

- **Estimated market penetration** in each market segment based on TCO and other macro-economic growth factors
- **Shortlist key business models** is based on the TCO assessment and projected EV penetration in BAU scenario. These are further assessed quantitatively on a financial viability tool to select high potential business model which can lead to widespread adoption of EVs across market segments
- **Action plan recommendations** based on stakeholder feedback and their likelihood to increase adoption of high potential business models

## Market overview and priority segments

### Current market penetration

EV sales contributed to about 1.6%[41] of total vehicle sales in India in 2021[42]. Given the low current levels of penetration, the 2030 target appears to be ambitious given that India stands at the nascent stage of EV adoption. A significant proportion of EVs currently are e-rickshaws and e-2W, with a majority of these powered by lead acid batteries. EV sales have been highest in 2Ws at 149,000 vehicles, equaling approximately 61% of total EV sales in 2021. Market penetration was negligible in cars and heavy commercial vehicles in 2021. One of the key determinants of users' preference for an EV over its ICE counterpart is the total cost of ownership (TCO) over the typical life of a vehicle, which includes upfront purchase costs, registration costs, operating costs including charging/fueling costs, loan repayment costs and road tax. These costs exhibit large variations across vehicle and market segments, driven by their inherent characteristics:

- Typical operating range e.g. fleet operators have higher daily average trip lengths as compared to personal users;
- Geographical area e.g. Nagpur has shorter average trip lengths than Pune and Chennai has much higher per capita 2W ownership than Mumbai; and
- Counterpart ICE vehicle e.g. 3W market has CNG operated vehicles as an ICE option.

From our analysis of TCO, discussed later in this chapter, TCO for 2W and 3W fleet market segments have already reached TCO parity or have TCO savings when compared to their ICE counterparts, making these EV market segments particularly attractive target markets for transition to EVs.

### SWOT analysis of key market segments and business models

Business models across the market segments were studied in detail based on secondary research, financial viability analysis, and feedback from key market players.

41 EV sales: https://www.autopunditz.com/post/ev-sales-decline-over-19-per-cent-in-fy2021-to-2-36-802-units
42 FADA Releases FY20-21 & April'21 Vehicle Registration Data

**Table 3.1:** SWOT analysis of selected business models and potential players
Source: Steer Review

| Market Segment | Business model | SWOT Analysis | Potential players Stakeholder feedback |
|---|---|---|---|
| **e-2W Personal (Financing)** | De-risked lending by commercial bank or NBFCs/ Fintech companies | **Strength** – Provides more affordable EV option for individual purchasers by lowering cost of finance for EVs closer to that of ICEs<br>**Weakness** – Large scale market but potential for EV market penetration/growth is lower than fleet and cargo sector<br>**Opportunity** – Stimulate/ accelerate market growth<br>**Threat** – May encourage purchase of lower specification imported units rather than encourage higher end indigenous production | • Revolt for specialized financing arm for e-3W<br>• Zest money<br>• OTO Capital (TATA Capital financier) |
| **e-2W fleet (Freight)** | Aggregator model to provide services to e-commerce players for last mile delivery | **Strength** – Good potential for market growth in growing e-commerce sector<br>**Weakness** – 2W cargo not authorised in all states<br>**Opportunity** – Wider authorisation of e-3W for deliveries<br>**Threat** – n/a | • Delivery<br>• Big Basket |
| **e-2W fleet (Ride hailing)** | Derisked lending by commercial bank or NBFCs/ Fintech companies | **Strength** – Fast growing market sector. EV economics more favorable than personal 2W market<br>**Weakness** – Limited understanding of technology advantages among owner/drivers working as contractors.<br>**Opportunity** – Regulation to require use of EVs in this market sector (within defined urban areas)<br>**Threat** – Lack of charging infrastructure in key locations may constrain potential for growth | • E-bikego<br>• EESL (fleet provider) [43] |

43 https://www.bloombergquint.com/business/india-offering-evs-to-taxi-firms-as-government-fleet-swap-drags accessed on 11 November 2020

| Market Segment | Business model | SWOT Analysis | Potential players Stakeholder feedback |
|---|---|---|---|
| **e-3W fleet (Freight)** | Aggregator model to provide services to e-commerce players for last mile delivery | **Strength** – Good potential for market growth in growing e-commerce sector<br>**Weakness** – Constrained by RCO bureaucracy delaying / increasing cost of deployment<br>**Opportunity** – Favorable TCO relative to ICEs<br>**Threat** – Battery range/ performance issues limiting application in some businesses | • Clean Motion<br>• Sheru |
| **e-4W fleet (Employee shuttle service)** | Fleet aggregator model where operator provides employee shuttle services to companies against an operating contract defining revenue per km. | **Strength** – Fast growing market sector, with some employers requiring use of EVs. Economics more favorable than personal 4W market<br>**Weakness** – EVs not economic for all shuttle operations but could be improved by widening vehicle usage (B2C off-peak)<br>**Opportunity** – Charging hubs with potential for high utilization at employment sites/business parks<br>**Threat** – n/a | • Meru<br>• Lithium |
| **e-4W fleet (Ride hailing)** | Fleet aggregator model for providing taxi services to consumers | **Strength** – Fast growing market sector. EV economics more favorable than personal 4W market<br>**Weakness** – Limited understanding of technology advantages among owner/drivers working as contractors.<br>**Opportunity** – Regulation to require use of EVs in this market sector (within defined urban areas)<br>**Threat** – Lack of charging infrastructure in key locations may constrain potential for growth | • Blu Smart (Asset light model)<br>• EESL (fleet provider) [44] |

44 https://www.bloombergquint.com/business/india-offering-evs-to-taxi-firms-as-government-fleet-swap-drags accessed on 11 November 2020

### TCO analysis

Total cost of ownership of a vehicle reflects the sum of all costs involved in the purchase, operation and maintenance of a given vehicle during its lifetime. Since India is known to be a very price sensitive market, the TCO is a key factor influencing consumer choice.

TCO has been estimated for different fuel categories in each market segment in major cities of Madhya Pradesh, Maharashtra and Tamil Nadu. The ICE fuel categories considered for comparison are petrol, diesel and CNG vehicles, as applicable in each market segment. The TCO analysis for EVs is performed in real terms for five years starting 2020 and 2025, which allows for the assessment of improvement in battery technology and expectations of lower battery costs going forward, partly offset by gradual reduction in government subsidies on the overall TCO of each market segment category.

The components for estimation of TCO are presented in the following figure:

**Figure 3.1:** TCO analysis cost components

| Capital Cost | Financial Cost* | Operations & Maintenance Cost |
|---|---|---|
| • Ex showroom price<br>• Taxes<br>• Subsidies/ incentives | • Equated Monthly Installment (EMI)<br>• Downpayment<br>*if financed instead of price | • Fuel Cost<br>• Maintenance cost<br>• Battery replacement cost (applicable only for EVs) |

Key assumptions for undertaking TCO analysis are:

- TCO of EVs across market segments is inclusive of incentives given under FAME-II. It is considered that government incentives, such as given under FAME-II scheme, would begin to taper by 2025 with higher penetration across market segments. Accordingly, these incentives are assumed at 95% and 75% of 2020 value in 2025 and 2030 respectively for applicable market, on account of which TCO may slightly increase from 2025 to 2030. This assumption of subsidies does not extend to 4W personal segment as there are no FAME-II incentives offered today for this segment.
- As per a NITI Aayog's India Energy Storage Mission, an increase in domestic manufacturing and learning curve about battery technology would bring down battery price around $100-110 per kWh (INR 7,500-INR 8,250) by 2025 and to about $70-75 per kWh by 2030 . The decline in battery prices has been included in the TCO estimation for the forecast years.
- ICE is a mature market, thus its TCO is stable across the years. Any substantial change in TCO of ICE vehicles would be primarily driven by change in fuel prices.

TCO analysis for selected EV market segments at a city level are presented in the figure below. The detailed assumptions for TCO estimation is presented in Annexure A

**Table 3.2:** TCO in INR per km across market segments (for Mumbai)
Source: Steer estimates

| Market segment | ICE (2022) | EV (2022) | EV (2027) | EV (2032) |
|---|---|---|---|---|
| **2W personal** | 4.64 | 4.53 | 4.54 | 4.74 |
| **2W fleet** | 2.65 | 1.71 | 1.59 | 1.60 |
| **4W Personal** | 25.91 | 32.99 | 31.14 | 30.58 |
| **4W Fleet** | 12.74 | 14.36 | 13.49 | 13.80 |
| **3W Fleet** | 6.07 | 4.95 | 4.87 | 4.65 |
| **3W Goods** | 9.56 | 7.11 | 6.76 | 6.90 |

An overview of TCO analysis presented above shows,

- Different cities show different TCO in the same market segment due to variation in trip lengths, the city of Mumbai has been shown as an example. Typically, smaller cities with shorter trip lengths and lesser distance covered in a day show higher TCO. Therefore, in smaller cities, fleet market segments having larger number of trips per day would be the preferred market segments for adoption and shift to EVs.
- TCO of e-2W and e-3W market segments have already reached parity or shown advantage over their ICE counterparts due to longer trip lengths; making these market segments more attractive options for transition to EVs. In case of e-4W, both personal and fleet segments, ICE vehicles are expected to remain more attractive in terms of life-cycle costs compared to the EV segment. This is primarily due to the travel distances staying below the TCO breakeven thresholds across personal and fleet segments.
- TCO variation between 2022, 2027 and 2032 is not significant as some impact of reduced battery prices is balanced by assumed reduction in subsidy from the current levels to 95% by 2027 and subsequently to 75% by 2032.

In case of e-3W passenger fleet segments, charging and swapping would co-exist in the short to medium term until their battery is improved to support their daily distance needs on a single charge. Swapping is primarily a solution for passenger fleets to reduce their charging downtime during revenue earning hours of the day with a swapping solution. This solution also reduces the upfront capital requirement for purchasing an e-3W. However, there is an increased cost of swapping the battery due to the cost of multiple batteries per vehicle to be procured by the swapping service provider. Below table shows a comparison of per km TCO between fixed and swappable solutions for e-3W passenger fleet in selected cities.

**Table 3.3:** City-wise comparison of TCO in INR per km of battery swapping and charging models for e-3W passenger fleet in 2022
Source: Steer estimates

| City | Swapping | Charging |
|---|---|---|
| Mumbai | 5.68 | 4.91 |
| Nagpur | 4.64 | 3.74 |
| Chennai | 4.56 | 3.69 |
| Coimbatore | 5.62 | 4.89 |
| Bhopal | 4.73 | 3.98 |
| Indore | 7.33 | 6.96 |

The provision of charging stations is growing, however there is an expectation that with larger number of battery players entering the market over time, the share of swapping as a service would grow substantially in the coming decade. These market shares assumed for estimating charging infrastructure demand are presented in the table below:

**Table 3.4:** Year-wise market share of battery swapping and battery charging for e-3W passenger fleet

| Year | Swapping | Charging |
|---|---|---|
| 2022 | 5% | 95% |
| 2027 | 25% | 75% |
| 2032 | 25% | 75% |

To estimate the potential EV penetration, a bespoke choice model was built to estimate the EV vs ICE share for each individual market segment for selected cities and then scaled up at a national level. The key inputs in the choice model are the estimated TCOs and a perception factor influenced by multiple factors including policies, availability of public charging stations, vehicle choice range, resale value, EV awareness and driving range per charge which capture the overall EV landscape. Based on the market assessment model and TCO analysis, the following table summarizes the projected EV penetration in priority market segments.

**Table 3.5:** EV annual sale projection in terms of number of vehicles and as a % of total vehicle sales of 2/3W and cars for India in business-as-usual (BAU) scenario
Source: Steer estimates

| Market segment | FY21 | FY25 | FY30 | EV share (FY25) | EV share (FY30) |
|---|---|---|---|---|---|
| 2W personal | 149,000 | 1,573,000 | 3,423,000 | 8% | 15% |
| 2W Fleet | | 557,000 | 1,106,000 | 12% | 20% |
| 4W Personal | 5,900 | 140,000 | 568,000 | 4% | 9% |
| 4W Fleet | | 25,000 | 89,000 | 8% | 17% |
| 3W Fleet | 88,000 | 159,000 | 254,000 | 46% | 55% |
| 3W Freight | | 51,000 | 118,000 | 33% | 40% |
| **Total** | **243,000** | **2,505,000** | **5,558,000** | **12%*** | **18%*** |

High potential Moderate potential Low potential

*Weighted average across market segments.

**Table 3.6:** EV stock numbers and total investment value of e-2W, e-3W and e-4W for India in business-as-usual (BAU) scenario
Source: Steer estimates

| Market segment | EV Stock | | Total Investment Value (INR Million) | |
|---|---|---|---|---|
| | FY25 | FY30 | FY25 | FY30 |
| 2W personal | 3,549,000 | 16,616,000 | 418,000 | 1,998,000 |
| 2W Fleet | 1,128,000 | 5,566,000 | 84,000 | 413,000 |
| 4W Personal | 276,000 | 2,050,000 | 345,000 | 2,824,000 |
| 4W Fleet | 55,000 | 346,000 | 68,000 | 465,000 |
| 3W Fleet | 734,000 | 1,790,000 | 205,000 | 506,000 |
| 3W Freight | 205,000 | 661,000 | 77,000 | 249,000 |
| **Total** | **5,947,000** | **27,029,000** | **1,197,000** | **6,455,000** |

## Priority markets

The business model structures evaluated for financial viability analysis across market segments are described below:

### BM1: Fleet operator-asset heavy

In this case, the fleet operator is responsible for procurement, operation and maintenance of the fleet throughout the business tenure. The key roles played by other counterparties are outlined below

- **Financing Institution:** A commercial bank extends loan to the fleet operator for procuring vehicles.
- **Manufacturer:** An Original Equipment Manufacturer (OEM) is responsible for fleet provision and long-term contract for fleet maintenance.
- **Energy provider:** The fleet operator chooses between setting up its own charging stations or having leasing arrangements with 3rd party service providers.

Examples of the business model: Ola, Lithium and Energy Efficiency Services Ltd. (EESL) are procuring vehicles from OEMs for their fleet operations.

### BM2: Third party fleet aggregator

This model is an asset light version of the above business model, where the fleet operator is separate from fleet provider.

- **Fleet Provider:** This is a third-party service provider who is providing the vehicles on lease to the fleet operator. The fleet provider is mostly the financing arm of the OEM (e.g. Mahindra Finance) who provides the vehicles on lease.[45]

Examples of the business model: Blu Smart has its deployed 100% of its fleet on leasing model. The charging infrastructure is also deployed by third party providers.[46] An international example of taxi provision by third party has been studied in case of Shenzhen Pengcheng Electric Taxi Co. presented below.

*Photo credits: Clean Motion*

45 https://www.financialexpress.com/auto/car-news/mahindra-e-verito-and-e2o-to-be-part-of-ubers-fleet-in-two-major-cities/945850/ accessed on 11 November 2020

46 https://www.pluginindia.com/blogs/qna-blu-smart-electric-ride-hailing-2020-updates accessed on 11 November 2020

58 Analysis of "Shenzhen Model" for New Energy Vehicle Promotion in Public Transportation, Qihang Zhang 2019, IOP Conference Series: Earth and Environmental Science

Source: https://www.smartcitiesdive.com/news/electric-taxi-fleet-shenzhen-china/545347/


**Electric taxi in Shenzhen**

For provision of electric taxis in the city of Shenzhen, the Shenzhen Bus Group together with BYD Company Limited jointly established Shenzhen Pengcheng Electric Taxi Co. The company purchases the taxis at an instalment payment option with zero down payment. The China Development Bank provides financial support amount to 10 billion yuan for the program. BYD provides 4 years or 100,000 kilometres warranty for electric taxis, power battery pack, motor and drive motor controller which eases the concerns about the service life of electric taxis among the taxi companies and drivers.[47]The financial support offered by a development bank and technology risk borne by OEM allowed for drivers and smaller taxi operating companies to transition to e-buses. Such an initiative can be deployed in India with a government agency such as EESL acting as a fleet provider of e-3Ws or e-4Ws which are further leased to individual drivers for promoting uptake of EVs accompanied by provision of funding by a development bank.

### BM3: Driver partners leasing the vehicles

This is a variant of the asset light fleet operator model. In this case, the fleet operator doesn't own the vehicles but facilitates the provision of financing to their driver partners. The key roles played by other counterparties are outlined below

- **Fleet operator:** The fleet operator enters into partnerships with fintech companies or commercial financing institutions to enable the drivers to access financing for purchasing the vehicle. The Equated Monthly Instalments (EMI) of the vehicle are deducted by the fleet operator in an escrow account arrangement before transferring the net earnings to the drivers.

47 Analysis of "Shenzhen Model" for New Energy Vehicle Promotion in Public Transportation, Qihang Zhang 2019, IOP Conference Series: Earth and Environmental Science

- **Financing Institution:** This model is more popular with NBFCs and fintech companies which have lesser requirement of paperwork to avail loans. The financing interest rate on these is typically vehicles higher than commercial interest rate to account for counterparty risk of default.

Examples of the business model: Ola and Uber have widely deployed their fleet on this model for their ICE vehicles.

### Assessment of Business Models

Each business was assessed in terms of its ability to become commercially viable, a prerequisite for scalability. The business-as-usual financial model solves the revenue yield (revenue per km) required to achieve a target investment return (a 'hurdle rate'). A hurdle rate is a commonly used investment concept that represents the minimum rate of return on an investment that is used to determine whether the investment is a viable commercial proposition. The following hurdle rates have been assumed based on our stakeholder consultation exercise:

– Hurdle rate (IRR) for fleet operator models: 15%
– Hurdle rate (IRR) for aggregator models: 10%

**Table 3.7:** Summary of financial viability assessment of business models

| Business model | Policy/ Regulatory bottlenecks | Key financial results | Opportunity to improve commercial viability | Risk assessment |
|---|---|---|---|---|
| **e-2W cargo fleet operator** | State Motor vehicles rules to be amended | **EV:** Revenue per km: INR 12.9<br>Equity IRR: 15%<br>Gross margin: 9.5%<br>**ICE:** Revenue per km: INR 9 (asset-light); INR 13.7 (asset-heavy) | • Vehicles owned by fleet operator<br>• Reduced financing cost<br>• Drivers purchase vehicles | Not viable without regulatory change. EV costs lowered, making a more commercially attractive proposition. |
| **e-2W aggregator** | NA | Revenue per vehicle per month: INR 1,811<br>Equity IRR: 10%<br>Gross margin: 67% | • Reduced financing cost | Aggregator has ability to market attractive proposition. At scale take-up reduces exposure to individual customer default. |
| **e-3W cargo/ freight fleet operator** | FAME to allow subsidy to be available to fleet operator | **EV:** Revenue per km: INR 16.3<br>Equity IRR: 15%<br>Gross margin: 25%<br>**ICE:** Revenue per km: INR 20.9 | • Vehicles owned by fleet operator<br>• Reduced financing cost | EV costs lowered, making a more commercially attractive, lower risk proposition. |

| Business model | Policy/ Regulatory bottlenecks | Key financial results | Opportunity to improve commercial viability | Risk assessment |
|---|---|---|---|---|
| **e-3W aggregator** | FAME to allow subsidy to be availed by fleet aggregator | Revenue per vehicle per month: INR 7,405<br>Equity IRR: 10%<br>Gross margin:66% | • Reduced financing cost | Aggregator has ability to market attractive proposition. At scale take-up reduces exposure to individual customer default. |
| **e-3W passenger fleet operator** | Permit and registration to be allowed at local city RTOs | **EV:** Revenue per km: INR 16.1<br>Equity IRR: 15%<br>Gross margin: 21%<br>**ICE:** Revenue per km: INR 19.7 (asset-heavy); INR 12 (asset-light) | • Vehicles owned by fleet operator<br>• Reduced financing cost | Needs change in permit polity to implement. Lower EV costs make commercially viable. |
| **e-4W passenger fleet operator** | NA | **EV:** Revenue per km: INR 18<br>Equity IRR: 15%<br>Gross margin: 44%<br>**ICE:** Revenue per km: INR 19.3 | • Drivers purchase vehicles<br>• Vehicles provided by 3rd party fleet provider<br>• Reduced financing cost | Lower EV costs make commercially viable. Ability to improve payment security by deducting driver finance payments from gross income. |
| **e-4W employee shuttle operator** | NA | Revenue per km: INR 14<br>Equity IRR: 15%<br>Gross margin: 40% | • Vehicles owned by fleet operator<br>• Vehicles provided by 3rd party fleet provider<br>• Reduced financing cost | Fleet operators have an advantage of opportunity charging at client locations. Commercial model can be enhanced by serving taxi market off-peak. |
| **e-4W passenger fleet operator** | NA | Revenue per vehicle per month: INR 22,930<br>Equity IRR: 10%<br>Gross margin: 83% | • Reduced financing cost | Low risk extension of established and proven vehicle financing model to EV market. |

Business models which offer the maximum potential for scalability and relative TCO advantage include fleet-based ride hailing and last mile delivery models in e-2W and e-3W markets. To achieve TCO competitiveness, higher km coverage is required due to significant upfront cost which can be achieved in fleet-based models.

**Figure 3.2:** Selected business models

- e-2W ride hailing fleet
- e-2W freight fleet

- e-3W ride hailing fleet
- e-3W freight fleet

- e-4W ride hailing fleet
- e-4W employee shuttle

## Market barriers and proposed intervention

### Action plan recommendations

An overarching recommendation for effective implementation of the proposed action plan is creation of a nodal agency at central and state level to ensure effective governance, implementation, and monitoring of EV policies and to drive the policies and plans promoting greater adoption of EVs. Since implementation of EV policies requires coordination between multiple public and private stakeholders in the value chain, it is important to create an institutional mechanism to allow them to interact, collaborate and undertake coordinated decision making.

At central government level, an empowered committee and cell may be created under a body which can oversee holistic formulation and implementation of EV related policies. The executive committee under this cell may be responsible for overall policy formulation and implementation, developing plans and rules, and monitoring of EV related programs of the government. This committee may have representation of different ministries and departments.

The Transport and Climate initiative is one such example where city councils are working with district authorities for coordinated action towards adoption of clean energy.

**The Transport and Climate Initiative (TCI)**

**Internationally in countries where EV penetration is high like the US, it is seen that coordinated government action for effective policy implementation has been key to wider adoption of clean energy vehicles. The Transport and Climate Initiative (TCI) is one such example where 13 Northeast and Mid-Atlantic states and the District of Columbia are coordinating for developing clean energy economy and reducing carbon emissions.**[48] TCI is a group of top environment, energy and transportation officials working on targeted reduction of greenhouse gas emissions to prevent climate impacts. They have launched the Northeast Electric Vehicle Network to coordinate state action towards development of regional EV charging network in line with the overall clean energy transition goals.[49]

48 https://www.transportationandclimate.org/content/about-us accessed on 7th May 2021
49 https://www.transportationandclimate.org/node/30 accessed on 7th May 2021

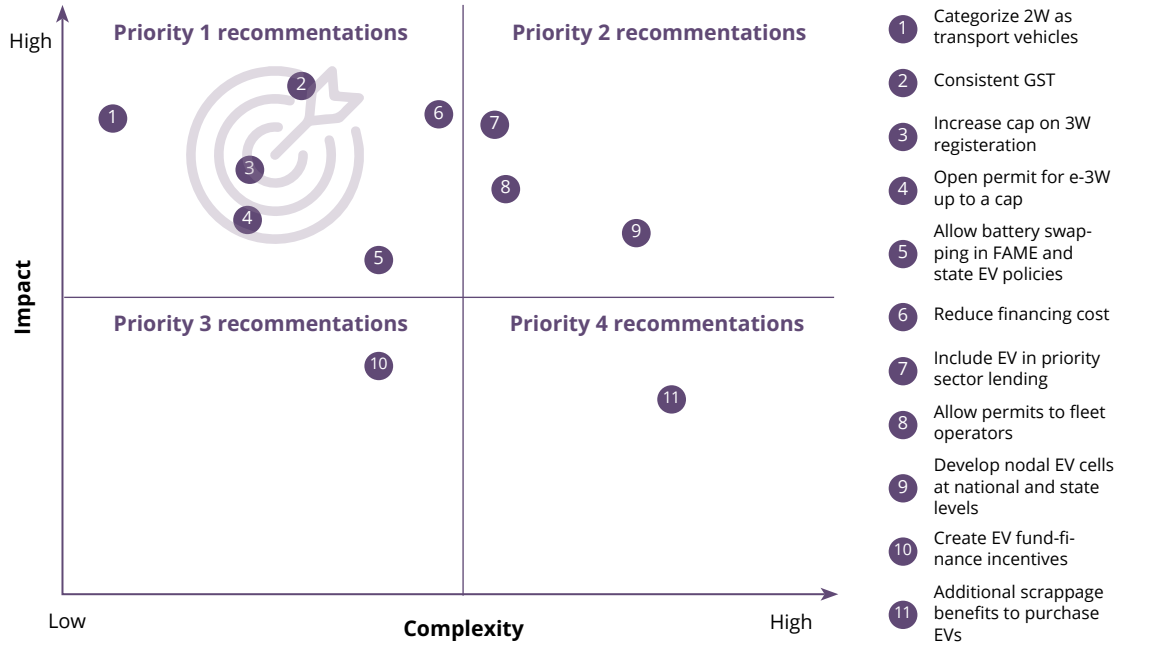
FAME policy is being implemented by the Department of Heavy Industries (DHI) under Ministry of Heavy Industries and Public Enterprises and a Centre of Excellence has also been set up at DHI to focus on supporting development in EV and associated manufacturing ecosystem in line with the central government's National Electric Mobility Mission Plan.

To function in coordination with the states and ensure effective delivery of action plan recommendations, it is recommended to set up an EV cell within a leading department, such as the state's Transport Department. This cell may be responsible for inter-agency coordination between different state government departments such as transport, urban development, energy, industries as well as with the empoweredcell set-up under the central government, to deliver EV policy targets in line with national plans.

Delhi government has initiated setting up of an EV cell within the Delhi Transport Infrastructure Development Corporation(DTIDC) to accelerate implementation of the state's EV policy. DTIDC is under the administrative control of Ministry of Transport, Government of National Capital Territory (NCT) of Delhi to manage all three Inter-State Bus Terminus (ISBT) in Delhi.[50] Post the launch of the new EV policy in 2021, state government of Maharashtra has also started setting up of EV cells in Mumbai[51] and Pune in association with Brihanmumbai Municipal Corporation and Pune Municipal Corporation to fast-track adoption of EV in the cities.[52]

The following figure summarizes the priority of implementation for key recommendations using the approach described in Chapter-1

**Figure 3.3:** Prioritization framework for e-2W, e-3W and e-4W action plan recommendations
*Financial solutions to reduce financing cost for EVs has been presented in Chapter 5; Steer representation




50 https://theprint.in/india/delhi-govt-starts-process-to-set-up-dedicated-cell-for-facilitating-adoption-of-e-vehicles/864458/ accessed on 11 March 2022
51 https://auto.hindustantimes.com/auto/electric-vehicles/maharash-tra-govt-launches-mumbai-ev-cell-for-faster-electric-mobility-transi-tion-41645626003023.html accessed on 11 March 2022
52 https://www.financialexpress.com/auto/electric-vehicles/punes-ev-cell-puts-in-place-plan-to-drive-adoption/2382046/ accessed on 11 March 2022

Detailed action plan recommendations are presented in the annexure-C. Key action plan recommendations required for unlocking high potential business models and creating an enabling environment for mass-uptake of EVs are described below:

**Table 3.8:** Action plan roadmap and barriers addressed for 2/3W and cars
Source: Steer recommendations

| Recommendation | Description | Barriers addressed |
|---|---|---|
| National level recommendations | | |
| **Make GST rates consistent across the EV value chain**<br><br>**Category - Policy and Regulatory** | Goods and Services Tax (GST) Council to amend the GST Law and issue relevant circular/ notification to implement uniform tax rates | Higher GST rate of 18% applicable on selling batteries separately impacts the commercial viability of battery swapping /leasing / subscription models. Also, battery replacement costs are almost 50% of capex and higher GST on batteries increases TCO of an EV |
| **Allow battery swapping / subscription in FAME**<br><br>**Category - Policy and Regulatory** | Department of Heavy Industries (DHI) to amend FAME II policy guidelines to allow battery swapping or subscription business models by splitting incentives between battery provider and purchaser of EV | Benefits offered under FAME subsidy is not offered to vehicles sold without batteries hindering growth of fleet and battery as a service business models |
| **Incentivizing transition to EVs through scrapping program**<br><br>**Category - Policy and Regulatory** | Ministry of Road Transport and Highways (MoRTH) may include additional incentives for purchasing EV in the Scrappage policy | Residual or secondary market sale of EVs is negligible due to lack of understanding on battery technology |
| **Reduce financing cost for EV**<br><br>**Category - Financial and Funding** | The Central EV cell to set up a dedicated EV financing vehicle and reduce financing cost by adopting an innovative approach including risk sharing facilities, buyback guarantee, help to buy approach, interest subvention in collaboration with commercial banks for disbursing subsidized credit to e-3W and e-2W players | High financing costs (e-2Ws: 16%-24% and e-3W :20%-35%) with significant down payment requirement leads to higher upfront capex for purchasing an EV |

| Recommendation | Description | Barriers addressed |
|---|---|---|
| National level recommendations | | |
| **Include EV in priority sector lending (PSL) by banks**<br><br>**Category - Policy and Regulatory**<br>**Category - Financial and Funding** | Reserve Bank of India (RBI) to classify EV sector as a 'priority sector' and to mandate all scheduled commercial and cooperative banks to extend a specified portion of net bank credit (total lending) to EV sector. NITI Aayog has suggested design considerations and guidelines for including EVs as a priority sector. It has proposed alternate portfolios of EV segments to be included for PSL[53] | |
| **Recommendation** | **Description** | **Barriers addressed** |
| State level recommendations | | |
| **Allow battery swapping / subscription in State EV policy**<br><br>**Category - Policy and Regulatory** | Any incentives provided by state EV policies to allow battery swapping or subscription business models by splitting incentives between battery provider and purchaser of EV.<br>Maharashtra and Delhi EV policies allow splitting purchase incentives between vehicle OEM and battery swapping player. | Benefits offered under State EV policy are not offered to vehicles sold without batteries hindering growth of fleet and battery as a service business models |
| **Categorize 2Ws as transport vehicles**<br><br>**Category - Policy and Regulatory** | Department of Transport (DoT) in states to recognize 2Ws as transport vehicles and amend Motor Vehicle (MV) Act section 66 to grant 'contract carriage' permits to e-2Ws | As 2Ws are not categorized as transport vehicles, they cannot be used for commercial fleet operations (ride hailing, rental or last mile delivery) |
| **Registration and permits of e-3Ws at RTO**<br><br>**Category - Policy and Regulatory** | DoT in states to adopt MoRTH guideline on registering an e-3W without permit requirement till a target proportion of existing on-road fleet is comprised of EVs | In almost all States, there is a cap on registration and permits issued for passenger 3Ws restricting large scale deployment of these vehicles |

53 Banking on electric vehicles in India, A Blueprint for inclusion of EVs in priority sector lending guidelines, Report, NITI Aayog, RMI, RMI India, January 2022

| Recommendation | Description | Barriers addressed |
|---|---|---|
| State level recommendations | | |
| **ZEV mandate for large scale fleet operators**[54]<br><br>**Category - Policy and Regulatory** | DoT in states to mandate fleet conversion to EVs for large scale ride hailing operators<br>Department of Industries in states to amend the EV policy to allow 3W permits to be granted to both individual drivers and corporate fleet operators/ aggregators | Non-issuance of permits to fleet operators or aggregators significantly limits the potential for large adoption of fleet businesses |
| **Create an 'EV Fund' for incentives offered under EV policy using feebate concept of charging polluting vehicles and sale of fuel**<br><br>**Category - Policy and Regulatory** | State Finance Department to allow levy of an environment tax on sale of fuel (diesel or petrol) and/ or a congestion fee to be used for providing financial incentives under the EV policy | State's exchequer is burdened with existing responsibilities across sectors, therefore has limited resources for providing incentives under EV policy. |

54 Regulatory pathways for zero-emission vehicle mandates, ICCT, July 2019

# 4.

# E-buses


*Photo credits: JBM*

## Introduction

This chapter presents a study of the current adoption of e-buses in India, barriers in fleet electrification including the gross-cost contract (GCC) framework currently used for public sector e-bus procurement and options available to overcome these barriers in the form of policy changes, action plans and business models. The major sections of this chapter include the following:

- **Market overview and barriers** in each market segment based on route characteristics, TCO comparison analysis for market segments and existing business models
- **Identification of improvements and options for alternate business models** based on a targeted review of relevant international and India experience. (These options were assessed quantitatively on a financial viability tool to select high-potential business models which can support economies of scale in e-bus procurement, operations and financing)
- **Prioritized action plan recommendations** based on stakeholder feedback from various state agencies, bus operator associations and OEMs.

## Market overview and priority segments

### Current market penetration

Apart from suburban rail (and metro rail more recently) in some large metropolitan cities, buses have traditionally been the lifeline of mobility and provided accessibility to jobs, education, health, shopping and leisure-purpose travel for a large proportion of the urban population in India. Bus markets can be classified into three broad categories based on the differences in the typical daily utilization, as average annual utilization per bus strongly influences the total cost of ownership (TCO).

- **Intracity buses** that operate within city limits in urban areas
- **Mofussil buses** (an extension of intracity bus services) that operate services to far-flung suburbs and neighboring districts
- **Intercity buses** that operate between urban areas

Bus services are managed and/or operated by the public or private sector depending on the history of institutional evolution and reforms in each state. State Road Transport Undertakings (STUs) are public transport undertakings that manage public sector buses in cities and in some states, inter-city transport as well. While some STUs operate their buses in-house (MTC Chennai), others outsource their operations to private players (AICTSL Indore). Most STUs in India are supported through public subsidies, with their primary focus being on sustaining current operations. As a result, the share of buses managed by STUs has been declining relative to the total number of registered buses. For example, in Maharashtra's inter-city market segment, 82% is privately operated whereas 18% is public. According to the registration data for the city of Pune, the number of buses operated by the public operator, Pune Mahanagar Parivahan Mahamandal Limited (PMPML), has decreased over the last five years while the fleet size of private buses has grown at a CAGR of over 20%.

The FAME II policy was revised in June 2021 to promote penetration of e-buses by lowering upfront costs. It has been extended till March 2024 and the maximum cap of subsidy has increased to 40% of the cost of the bus. Presently, DHI has sanctioned subsidy for 5,595 e-buses. Of these buses, 5,095 are for intra-city operations, 400 for inter-city operations and 100 for providing last mile connectivity[55]. About 900 e-buses are operational as of February 2021.[56]

More recently, under FAME II policy, Energy Efficiency Services Limited (EESL) has been nominated to aggregate demand for e-buses across 9 cities with population over 4 million (Mumbai, Delhi, Bangalore, Hyderabad, Ahmedabad, Chennai, Kolkata, Surat, and Pune) on OPEX basis.[57] Convergence Energy Services Limited (CESL) part of EESL, has floated a tender to deploy e-buses under a 'Grand Challenge' mode in January 2022.

Image Source: https://english.cdn.zeenews.com/sites/default/files/2022/03/07/1020539-1001963-dtc-electric-bus.jpg

### Procurement of e-buses on 'Grand Challenge'

Under the 'Grand Challenge', STUs/ PT Authorities were requested to subscribe for e-buses with FAME II incentive being offered on OPEX basis. The primary objective of this procurement mode was to homogenize and aggregate demand through standardization resulting in lower upfront costs of the e-bus. [58] EESL through its wholly owned subsidiary-CESL as project manager has launched a tender in January 2022 for procurement of 5,450 single decker and 130 double decker e-buses under 'Grand Challenge' mode for Bangalore, Delhi, Hyderabad, Surat and Kolkata. Under the conditions of procurement, the bidder has to manufacture, supply, operate and maintain buses as per the required specifications for a contract period of 12 years after scheduled operation date. Additionally, the bidder would also develop, operate, maintain the depots and be responsible for procurement and installation of charging infrastructure for charging the e-buses. The tender is expected to lower upfront capex costs by standardizing bidding conditions across these five cities.[59]

55 https://dhi.nic.in/writereaddata/fame/famepressrelease/1-E__didm_WriteReadData_userfiles_Press%20Release%20for%20Buses.pdf
56 Analysis of registered e-buses from Vahan Dashboard (as on February 2021) by Spoctech Solution
57 The Gazette of India: Extraordinary, Part II Sec 3(ii), Ministry of Heavy and Public Enterprises, Department of Heavy Industry, Notification, New Delhi, 11th June 2021
58 Draft Grand Challenge for E-Bus Deployment Under FAME-II, CESL
59 Request for proposal for selection of bus operator for procurement, operation and maintenance of 5,450 electric buses and 135 double decker electric buses and allied electric and civil infrastructure on

India's e-bus market is currently dominated by public sector procurement due to availability of FAME subsidy only under a gross cost contract (GCC) model. Buses managed and operated by the private sector, that make up for more than 80-90% fleet across the country, ply as contract carriage, school buses and employee buses. While this share may vary from state to state, electrification of private sector bus fleet through an enabling investment environment is key to accelerate the pace of e-bus adoption in the country and achieve the desired local pollution control targets and national climate goals.

## TCO analysis

TCO analysis for buses was carried out comparing diesel and e-buses for the following typical air-conditioned (AC) bus operations:

- 9-metre intracity AC bus
- 12-metre intracity AC bus
- 12-metre intercity AC bus

Gross Cost Contract, Open tender, CESL, dated 20 January 2022

The TCO was estimated across a ten-year period, aggregating total expenses per year. The analysis also takes into consideration subsidy provided under FAME II incentives. The figures below illustrate TCO across the bus segments in 2022. They suggest that TCO parity in e-buses is achievable in the near future, leveraging the positive gains from economies of scale and technology development in this sector, with continued subsidies.

It must be noted, from the range of bids received for FAME-II projects, there is a significant variance in the estimation of TCO value. This variance is on account of limited and differing availability of data on capex prices of e-buses, battery prices, annual reduction in cost of battery and metrics on battery degradation. For the purposes of the TCO analysis presented above certain assumptions have been taken on these input values based on conversations with multiple industry stakeholders and publicly available sources which have been further detailed in Annexure-A.

**Figure 4.1:** TCO Analysis of EV with subsidies (9-m intracity, 12-m intracity and 12-m intercity) and Diesel buses (INR per km)
*10-year TCO has been calculated for e-buses; Source: Steer estimates

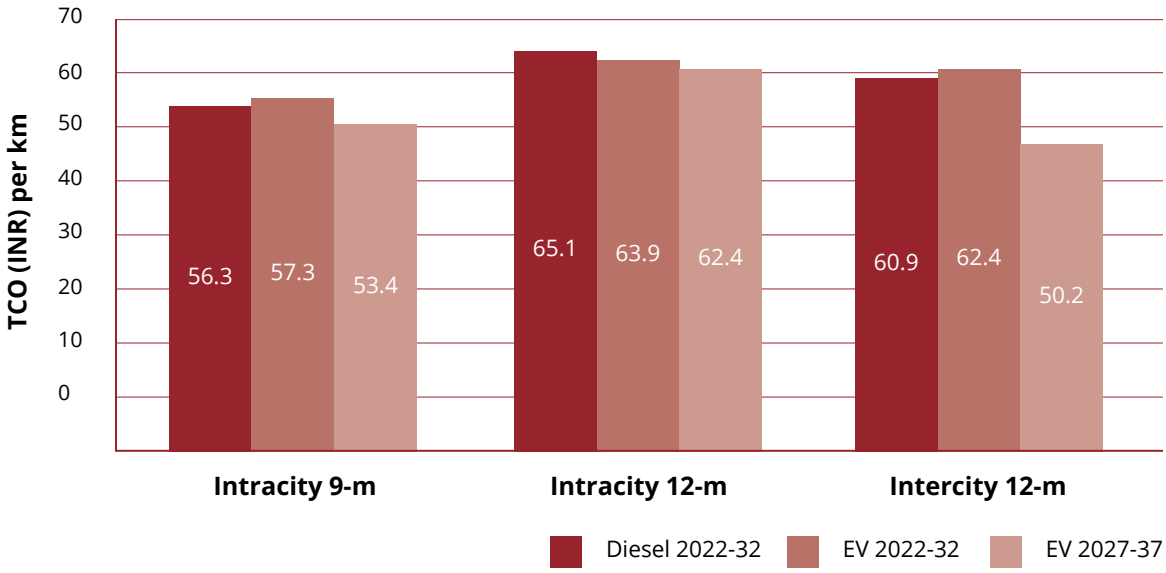
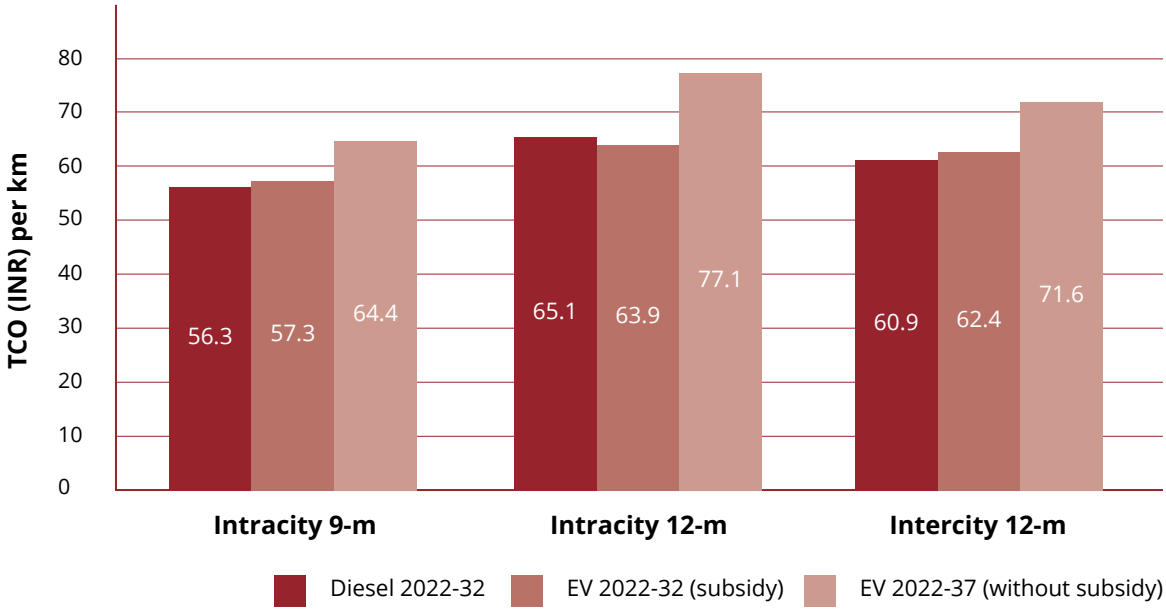


**Figure 4.2:** TCO Analysis of EV with and without subsidies (9-m intracity, 12-m intracity and 12-m intercity) and Diesel buses in 2022 (INR per km)
*10-year TCO has been calculated for e-buses; Source: Steer estimates




The figure above shows that for traditional ICE (diesel) buses vs. e-buses, there is parity in TCO terms which has achieved with subsidies in case of some market segments such as intracity 12-m due to the rise in ICE fuel prices, high annual distance operated, and current battery capacity suited for the average daily distance covered by such buses. Parity of e-buses with ICE on TCO basis is likely to be achieved first on routes with higher kms such as mofussil (extension of intracity buses to suburban areas and neighboring districts) and intercity services.

With further improvements in technology and battery chemistry this parity between ICE and e-buses is expected to be achieved for other market segments as well in the coming few years. TCO parity of e-buses with ICE on TCO basis is expected to be a key trigger for rapid adoption by public agencies who can avail the subsidies and are able to demonstrate the ability to effectively manage the e-bus operations. The CESL tender for aggregation and procurement of e-buses for deploying in metropolitan cities with 4 million plus population is an example of expansion of e-bus network for public bus operations in urban environment.

For the intracity employee shuttle market, which represents a significant and more importantly a growing share of the total intracity bus market, the typical AC 12-m diesel bus costs in the range of INR 3-5 million whereas the equivalent e-bus costs range around INR 13-17 million before subsidies. The average use of an intracity bus is no more that 200km/day and a typical one-way yield is in the range of INR 20-30 per passenger. Accordingly, private operators may start seeing competitive TCOs for e-buses only once the prices are substantially reduced or adjustments are made to yield reflecting better service quality or battery size to match the different usage pattern.

The intercity bus market is dominated by private operators, e.g. 82% private vs.18% public share in Maharashtra intercity market as this market offers higher yields compared to intracity context. Adoption of e-buses by private operators has been limited due to change in travel behavior and a sharp decline in tourism industry as well as commuter movements amid the COVID 19 pandemic in the last two years. However, with sustained high level of ICE fuel prices and potential reduction in e-bus capex from improved manufacturing capacities and battery technology, private operators are expected to start transitioning towards electrification of their fleet in medium to long term as they witness the TCO savings being offered by e-buses in the coming years.

*Photo credits: UITP*

### Key barriers to e-bus penetration

Extensive stakeholder consultations undertaken with OEMs, STUs, private operators and state transport departments in 2020 and early 2021 underlined a number of key barriers to e-bus penetration in the business-as-usual scenario as presented below, as also earlier explained in Chapter 1:

- High cost of capital for e-bus purchase
- Aftermath of COVID-19, which greatly weakened the finances of bus operators
- Exclusion of private sector market from the FAME II subsidy
- For bus service delivery under government agencies or companies:
  - Unbalanced risk-sharing in the existing GCC contractual framework
  - Lack of scale economies in e-bus procurement, maintenance and financing
  - Mismatch between role and specialization of various stakeholders in e-bus deployment including challenges around operations by an OEM-led consortium and installation of charging infrastructure being the responsibility of the operator
  - Low creditworthiness of many public transport authority for operator payments
- Lack of readiness of depot, charging and grid infrastructure to support e-bus operations

Greater penetration is expected when barriers in contractual, tendering and commercial aspects of procurement are addressed, along with a favorable tax, subsidy and policy regime. The extension of FAME II subsidy till FY2024 and the recent CESL tender which is aggregating e-bus demand across multiple state governments is a step in the right direction. Such aggregation initiatives would have a long-term impact in building capacity of manufacturers to expand their production line and gain from economies of scale, resulting in lower upfront cost of e-buses.

## Market assessment results

The market assessment model used in estimating total market size for e-2W, e-3W and e-4W was used in estimating the total bus market. Thereafter the e-bus penetration of the total market was estimated based on the policy initiatives currently underway that are focused on intracity public bus context followed by market segments which offer favourable cost economics with the right technology mix. Table 4.1 below shows the results of this assessment.

**Table 4.1:** e-bus projection in terms of number of vehicles and as a % of total vehicle annual sales for India in business-as-usual (BAU) scenario
Source: Secondary research (FY19-21) and Steer estimates(FY25, FY30)

| Market segment | FY19[60] | FY20 | FY21 | FY25 | FY30 |
|---|---|---|---|---|---|
| e-bus sales | 400 | 600 | 1,850 | 5,600 | 6,000 |
| EV penetration | 1.0% | 1.5% | 11.7% | 13% | 22% |

**Table 4.2:** EV stock numbers and total investment value of e-buses for India in business-as-usual (BAU) scenario from FY23-30
Source: Steer estimates

| Market Segment | FY23 | FY24 | FY25 | FY30 | Total Investment Value (INR Mn) |
|---|---|---|---|---|---|
| e-bus stock | 11,000 | 16,000 | 22,000 | 52,000 | 700,000 |

60 https://jmkresearch.com/electric-vehicles-published-reports/electric-buses-india-market-analysis/ accessed on 1st March 2022

In the last two years, personal travel choice patterns have shifted preference towards private vehicle use due to COVID 19 and as a consequence bus market has suffered significantly both in terms of intracity and intercity bus operations suffering significant shortfall in passenger revenues. However, with high coverage of its vaccination and opening up of economy, a revival in the bus market is expected in short to medium term. Annual bus sales are expected to increase to about 40,000 to 50,000 following revival of bus demand till FY2025, post which it is expected to taper down to the long-term bus sales trend of 30,000 per annum.

Also, the current status of technology and product availability within e-buses limits the maximum range on a full charge at around 300 km. This is expected to improve with technological advancement of the e-bus vehicles. In the last ten years, battery prices have significantly reduced owing to improvements in technology and greater demand. The battery prices are expected to decline over time to make e-buses increasingly competitive with equivalent ICE variants. This coupled with the government boost from subsidies to develop supporting infrastructure- such as charging stations is expected to further improve the e-bus TCO in comparison with ICE variants boosting uptake in the market.

In the BAU scenario, the e-bus penetration is expected to grow from the current level of 12% to 22% of annual bus sales by FY2030 driven by policy push to adopt e-buses in urban intracity transport context and focus on achieving carbon neutrality may also foster e-bus penetration in intercity markets where technology is favorable to serve the selected routes.

## Learnings from previous experience

Based on a targeted review of the experience of cities, markets and players that provided both relevance and evidence for potential success in either similar socioeconomic contexts or having similar implementation barriers to India, key lessons from Santiago (Chile), Bogota (Colombia), London (UK), Zenobe (UK) and Proterra (US), Delhi (India) and Shenzhen (China) are listed below:

- Separation of the role of fleet provision including procurement, availability, and maintenance allows potential for aggregation to appropriately distribute risks and responsibilities.
- Battery swapping has restricted application in case of e-buses
- E-bus programs should focus on homogenization
- Capital-rich and technologically specialized players can aggregate fleet provision to address capital cost and financing risks.
- Long-term maintenance by OEMs is needed to address technology risks and questions on residual value.
- Capital cost and battery replacement risk can be mitigated by leasing, once adjustments are made so that it does not attract higher GST rates.
- Capital and operational subsidies should continue until commercial viability is achieved.
- Ring-fenced trust funds are needed to improve payment securities.
- Apart from the above, direct payments from a creditworthy authority to lender subaccounts and state payment guarantees also improve bankability.

Latin American cities show how unbundling and long-term maintenance contracts with OEMs is important in addressing challenges faced by small-time operators related to technological risks and high capital cost of e-bus. On the other hand, London's e-bus experience suggests that e-bus markets once matured may return to bundled models when technological readiness has been demonstrated and bankability has been improved through competitive bus prices, available secondary markets and better PT authority capabilities.

Experience from Latin America is relevant to the Indian context in that it demonstrates how some of the concerns around bankable e-bus procurement and deployment at scale can be addressed. Different models can be considered depending on the level of institutional maturity and market development, such as separation of the role of fleet provider, who will procure and ensure fleet availability, from that of the operator. Being able to procure and aggregate on a large scale provides financial, technological or commercial advantages, and fleet providers may also potentially take responsibility for fleet maintenance as well. These enabling levers can bring step-change improvements in TCO, resulting in improved commercial viability, scalability and bankability. Therefore, apart from suitable contractual relationships, aggregation by suitable financially strong fleet providers can play an important role in acceleration of e-bus adoption and successful deployment.

## Alternate business model options for e-bus procurement

The existing e-bus procurement regime for public transport services in India could be improved through either or both of:

- A Revised GCC model with a targeted set of changes to contractual and tendering aspects
- Alternate business models centered around fleet aggregation, supplemented by unbundled energy provision and optional leasing options

### Revised GCC model: With improved contractual terms

Based on a review of the first phase of FAME II tenders in 2020 and early 2021, several potential improvements were identified in the e-bus procurement under FAME II. Eligibility to FAME II subsidies requires the use of gross-cost contract (GCC) model and an associated model concession agreement (MCA). The review indicated that the tenders of various cities deviated from the model concession agreement on contractual terms including fee revision and provision of depots ready for installation of charging infrastructure.

The table below lists the major gaps to be addressed in the existing GCC regime under FAME II along with key proposed modifications, as identified in a parallel study to that presented in this report.[61] Improvements made to the GCC model as applied in the early implementation of FAME II could help achieve estimated TCO cost savings of 10-15%.[62]

**Table 4.3:** Key proposed recommendations related to contracting and tendering in the existing GCC model
Source: Spoctech Solutions and Steer for the World Bank Group

| Gap | Proposed solution in the Revised GCC model |
|---|---|
| Lack of readiness and preparation of the contracting authority | • Adequate timelines to authority and bidders<br>• Authority to prepare feasibility report and detailed project report (DPR)<br>• Depots with status of charging infrastructure readiness to be provided in the tender |
| Insufficient bid timelines to allow due diligence by bidders | • Minimum 45 days to be provided as bid notice |
| Capital subsidies potentially distorting bus prices | • Capex subsidy could be changed to hybrid subsidy |
| Large subsidy bank guarantee required from operators | • The need for the subsidy bank guarantee may be reconsidered or adjusted |
| Lack of depot infrastructure readiness | • Responsibility for depot infrastructure including civil and trunk infrastructure to lie with authority, or alternatively site availability with permits and suitable power connection to be provided by authority. |
| Eligibility criteria for operators not matching specialization | • OEM not to be mandatorily part of the operator consortium |
| Lack of payment security | • MCA + additional securities<br>• Financially strong or creditworthy intermediary to act as guarantor |

61 Please refer to Spoctech Solutions and Steer's report on Improving the Bankability of E-bus Procurement in India for greater detail on contractual modifications that we recommend improving the existing GCC model under FAME II
62 These estimates are based on analysis carried out Spoctech Solutions and Steer in a parallel study to this report.

| Gap | Proposed solution in the Revised GCC model |
|---|---|
| MCA-recommended fee revision not followed | • Fee revision clauses to be simplified and included as in the MCA and reflective of cost evolution. |
| Unbalanced penalties related to performance | • Capping of penalties |
| Uncertainties around electricity cost payments | • Authority to pay tariff at actuals subject to cap on fuel economy |
| Uncertainties around payment for underutilized km | • Payment for underutilzsed km to be at GCC contracted rate |

### Achieving more TCO savings though alternate business models

Apart from a revised GCC model, innovative commercial structuring and contractual relationships as applied internationally could help in achieving step-change improvements.

In fleet aggregator models, the aggregator undertakes the role of fleet procurement, financing and (optionally) maintenance, which allows the transfer of financial, capital cost and technology risks from the operator to the aggregator. Aggregation allows reaching larger scale in terms of number of buses (over 1000 compared to the traditional 100 to 300 levels). Based on a detailed financial assessment, it was found that separating fleet provision from operations using a fleet aggregator model for an intracity 12-m e-bus could potentially offer savings of INR 23 per km (compared to smaller-scale bundled fleet operations and procurement) based on an assumption that it covers an annual distance of 70,530 km.

Similarly, an intracity 9-m e-bus can achieve potential savings of INR 20 per km for an annual operating distance of 66,000 km. Amongst other assumptions, this estimate incorporates facilitation of cheaper financing at 9.5% and availability of OEM discounts for procurement of large numbers of buses by the aggregator. Fleet aggregator-based alternate business models could therefore further improve the TCO cost savings going from the existing GCC model to either a private/market player-led aggregation (15-20%) or national or state-led (20-25%) aggregation. National or state-led aggregation allows for more savings due to potentially greater volumes of aggregation and negotiating power for discounts.

The table below shows the progression of TCO savings for various business models (existing and proposed) along with key enabling levers and the reasons for reduction in TCO costs for 9-m intracity bus operations.

**Table 4.4:** High-potential business models along with estimation and reasons for cost savings
Source: Steer review

| Business model | Key enabling levers | Estimated TCO cost savings (%) | Reasons for TCO cost savings |
|---|---|---|---|
| GCC FAME II | Business-as-usual scenario with small scale bundled fleet operations | 0% | No change |
| Revised GCC Model | Modifications in contracting, tendering and policy aspects | 10-15% | Reduction in risk premia for payment security and other contractual risks |
| Revised GCC with Unbundled Solution | Beyond the Revised GCC solution, unbundling the role of fleet provision from fleet operations | | Reduction in technology and capital cost risk premia |
| Private/market player-led aggregator models | Financially strong OEMs, energy players or financiers who are interested in aggregation and/or investment, along with state payment guarantees | 15-20% | Further reduction in risk premia for payment security; Economies of scale for procurement, maintenance and financing |
| National or State-led aggregator model | Creditworthy government agency with ring-fenced funds for fleet procurement aggregating at the national, state, regional or city level | 20-25% | Reduction of technology risk; Further improvement in economies of scale for procurement, maintenance and financing |

It is to be noted that these TCO savings are dependent on ensuring the implementation of key enabling levers for the alternate business models in question. The quantitative range of estimates provided in the table above for TCO reduction is based on financial modelling run for several scenarios. Assumptions of 20% discounts for large-scale procurement and lowered interest rates of 11% (reduced from 12.5%) were taken as inputs for the alternate business models based on fleet aggregation. Please note these TCO savings may only be expected where these business models are implemented in states and cities with suitable institutional and financial characteristics supported by key action points listed in the following section titled 'Recommendations and Action Plan'.

Likewise, aggregation for private bus purchase will enhance parity, as long as charging infrastructure readiness for both depots and en-route is ensured and range anxiety from technological challenges is addressed.

Companies like Greencell Mobility started exploring economies of scale through large scale e-bus purchase, to lower the capex associated with such option.

### Alternate business models: With fleet aggregation and unbundled energy provision-International experience

Alternate models have been developed based on review of international best examples of e-bus business models such as battery leasing models which demonstrate one of more of the following conditions:

- Evidence for procurement success (irrespective of bus technology)
- Evidence for e-bus procurement success and/or deployment in international city
- Successful and investment-worthy players in the e-bus market space

Source: Zenobe energy


### Zenobe turnkey bus fleet solution

Zenobe in the UK provides bespoke technical and financial solutions tailored to needs of customers including leveraging existing grid supply through battery energy storage systems, smart charging infrastructure, guaranteed green energy supply, 'battery on bus' financing and battery health management to guarantee performance and protect residual value.

Zenobe is currently offering a financial solution to operators where it owns and operates battery storage systems, takes care of batteries on the buses and also manages the depot charging infrastructure. Once the useful life of the battery is over, it uses it for stationary storage.[63]

63 https://www.sustainable-bus.com/news/interview-steven-meersman-zenobe-energy/ accessed on December 2021

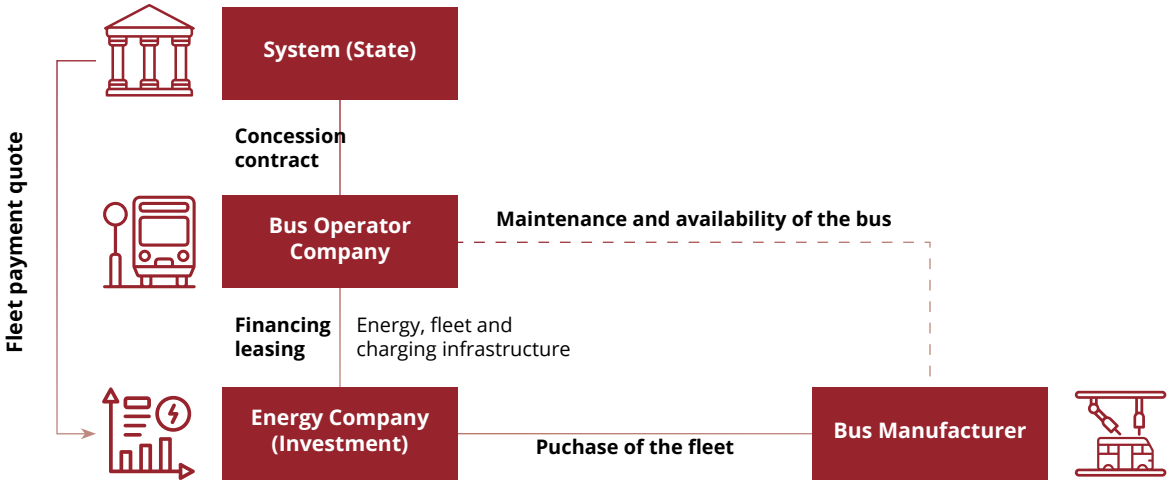
## ENEL-Metbus-BYD partnership in Santiago

Energy providers in Santiago have partnered with private bus operators and bus manufacturers to pilot and deploy e-buses. In this partnership ENEL took the role of both energy provider and fleet provider (financier) for this contract.

**Figure 4.3:** E-buses parked in a depot in Santiago (left); E-bus being charged by ENEL energy infrastructure
Source: ENEL X


After two rounds of pilot e-buses which helped understand changes to capital, operational and maintenance costs for bus operations, Metbus initially introduced 100 e-buses for fleet renewal in place of a closing diesel bus contract of another operator Alsacia. ENEL took the role of both energy provider and fleet provider (financier) for this contract. An after-sales agreement with OEM provided assurance of bus maintenance. Several deployments have followed and as of October 2020, Metbus is running 436 e-buses in Santiago, this not including the hundreds of e-buses that other bus operators currently operate. Therefore, the case of Santiago, in a market-economy with similar emerging-economy challenges, is a clear case for learnings for the Indian context.

**Figure 4.4:** Contractual model in the Metbus-ENEL-BYD partnership for e-bus deployment
Source: Steer representation



The schematic above shows the contractual structure between various stakeholders playing a role in e-bus deployment. The table below shows key findings based on a systematic business model decision tree framework explained in Chapter-1.

**Table 4.5:** Findings from Santiago based on our business model analysis framework
Source: Steer review

| Lever categories | Specifics | Particulars |
|---|---|---|
| **Bankable contract terms** | Payment mechanisms | • Authority directly pays energy provider for leasing contract from contracted rate with operator<br>• Contracts with operators and fleet providers specify that buses will remain in system (with different operators) until debt is paid. This allowed longer debt tenures compared to operation contracts and also resulted in affordable operating cost quotes. |
| | Contract agreements | • Operator paid both for passengers carried (70%) and km operated (30%) as incentive to improve fare revenue and control fare evasions. |
| | Selection criteria | • E-bus introduction (100 BYD in 2018) through increase in operational km for Metbus due to operator Alsacia's closing contract, later followed by a renewal of fleet (183 BYD). |
| | Cost and revenue risks | • In initial introduction, the authority covered the CAPEX difference between diesel and e-bus, whereas in the fleet renewal, the operator renewed the fleet at their own expense.<br>• In the case of fleet renewal, Metbus estimated OPEX savings of $1,800 per month for a 10-year contract. BYD offered lower bus cost ($300,000) in the bigger fleet contracts compared to in the pilots ($450,000) |
| | Infrastructure readiness | • Enel X (earlier Chilectra) has been active since 2011 in setting up charging infrastructure in the city and pilot studies Ministry of Energy regulates grid modifications and e-depot compliance<br>• Charging management software avoids peak periods of electricity demand<br>• E-depots considered as industrial connections for tariffs. |

| Lever categories | Specifics | Particulars |
|---|---|---|
| **Unbundling based on specialization** | Battery | N/A |
| | Fleet maintenance | • After-sales agreement between Metbus and BYD held OEM responsible for electric maintenance of e-buses, charging process and spare parts |
| | Fleet provision | • Energy company (Enel/Engie) financed/leased the bus fleet to operator |
| | Charging (CaaS/PPP/ captive) | • Enel was involved in the installation, power management and providing energy for the charging infrastructure |
| | Depot infrastructure | • Energy provider constructs the e-depot. |
| **Unlocking suitable financing options** | Creditworthy aggregator | • Multinational energy providers Enel and Engie provide fleet and energy delivery. |
| | Private equity | • Enel provided financing for initial set of 100 e-buses. Later, for the fourth PPP onwards, Enel decided to stick to only energy provision and charging infrastructure |
| | Subsidies | N/A |
| | Soft loans | N/A |
| | Non-farebox revenue | N/A |
| **Policy and regulatory support** | Fiscal/ Non-fiscal | • No import duties on e-buses from China through free trade agreement |
| | Commercial lending policies | • Loan rate for TranSantiago was historically 7.8%. Enel offered 7.3% for e-bus financial lease contract after precedent from Engie. |
| | Long-term procurement plan/mandate | • Timing of e-bus transition coinciding with close of previous diesel contracts, and negotiation between stakeholders helped.<br>• E-bus introduction supported TranSantiago's brand transformation and NDC targets. |

### Alternate business models: With fleet aggregation and unbundled energy provision-Application to the Indian context

Three primary business models were considered, based on separation of the role of a fleet provider and achievement of fleet aggregation by the fleet aggregator. The models varied based on which stakeholder took the role of a fleet aggregator. This allocation of responsibility – especially that of a creditworthy fleet aggregator taking the primary financial risk – is critical to the success of these business models. While the primary business models will serve as the core of the framework to be explored for suitable cities, the supplementary business models will have to be worked out in tandem with suitable primary business models. The business models vary in how the institutional, market, regulatory and operational risks are shared. A major trade-off of unbundling is the interface risk occurring across participants in case of failure of one aspect. While solutions have emerged to address this, institutional capacity and capability need to be mature enough to handle conflict that may emerge from such multiparty agreement to consider effective unbundling.

**Table 4.6:** Proposed roles and responsibilities framework across the alternate business models
Source: Steer review and analysis *CaaS = Charging as a Service provider *Real = Real estate player, DFI = development finance institution, PTA = public transport authority, Opr = operator, DISCOM = power distribution companies *Grey cells refer to those that are not mandated under the business model itself. *Players mentioned within braces are optional for that role.

| Theme | | Fleet | | | Energy | | | Financing Instruments | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Business model | Role | Operation | Maintenance | Provision | Charging infra | Grid connections | Depot infra | Leasing | Loan | Equity Capital |
| **Bundled GCC approach** | | | | | | | | | | |
| GCC | | Opr. consortium led by OEM | | | | | | | Bank | Opr. |
| **Primary business models – Fleet provision unbundled** | | | | | | | | | | |
| BM1 | State-led fleet aggregation | PTA/ Opr. | OEM | State | | | | | DFI/ Bank | State/ PTA |
| BM2 | Market player (OEM)-led aggregation | PTA/ Opr. | OEM | | | | | | DFI/ Bank | (OEM) |
| BM3 | Market player (non-OEM)-led aggregation | PTA/ Opr. | OEM | Non-OEM | | | | | DFI/ Bank | (Non-OEM) |
| **Secondary business models – Energy and leasing options** | | | | | | | | | | |
| BM4a | CaaS unbundled as a PPP | | | | CaaS | CaaS/ DISCOM | (CaaS/ Real) | (OEM) | DFI/ Bank | CaaS |
| BM4b | CaaS | | | | CaaS | | | (OEM) | DFI/ Bank | CaaS |
| BM4c | WSA combined with CaaS | | | | CaaS | CaaS | WSA | (CaaS) | DFI/ Bank | WSA |
| BM5 | Battery leasing | | (OEM) | | | | | (OEM-financier partnership) | | |

The table above presents roles and responsibilities that various stakeholders may take in various business models for fleet, energy and financing aspects of the e-bus deployment ecosystem. During implementation, a combination of primary and secondary business models, along with the supporting policy and financing framework, are required to cover various roles. In all the options, battery leasing may be an option if favorable GST rates are offered through policy changes.

To enable formulation of simple contractual agreements where performance risks are passed to suitable players, it is proposed to have back-to-back contracts with only two parties involved wherever possible. The table below presents the key contracts that are proposed to be part of the five high-potential business models, along with the parties involved and their primary responsibilities. The detailed responsibilities, contractual structures, institutional arrangements, risk and associated mitigation measures are covered in a parallel study titled, 'Improving bankability of e-bus procurement in India' by the World Bank Group.

**Table 4.7:** Key contracts and agreements to be part of the five high-potential business models
Source: Improving bankability of e-bus procurement in India, Spoctech and Steer

| | Business model | Contracts/ agreements | Parties involved | Primary responsibilities |
|---|---|---|---|---|
| **Primary – State-led** | **BM1 State agency as fleet aggregator** | **Fleet purchase and maintenance contract** | OEM | E-bus supply and maintenance (Optionally charging infra) |
| | | | State agency/ SPV | Procurement/funding agency |
| | | **Fleet provision contract** | State agency/ SPV | Fleet provider |
| | | | PT authority | Hiring agency, Fleet manager |
| | | **Fleet operations contract** | PT authority | Hiring agency, Fleet manager |
| | | | Private operator | Operations |

| | Business model | Contracts/ agreements | Parties involved | Primary responsibilities |
|---|---|---|---|---|
| **Primary – Private/ market player-led** | **BM2 OEM as fleet aggregator** | **Fleet provision and maintenance contract Fleet provision contract** | OEM | E-bus supply and maintenance (Optionally charging infra) |
| | | | State or PT authority | Payment agency |
| | | | State agency/ funds | Guarantor |
| | | **Fleet operations contract** | PT authority | Hiring agency, Fleet manager |
| | | | Private operator | Operations |
| | **BM3 Market player as fleet aggregator** | **Fleet purchase and maintenance contract** | OEM | E-bus and charging infra seller |
| | | | Market player | Procurement/funding agency |
| | | **Fleet and energy provision contract** | Energy player | Fleet and energy provider |
| | | | PT authority | Payment agency |
| | | | State agency/ funds | Guarantor |
| | | **Fleet operations contract** | PT authority | Hiring agency, Fleet manager |
| | | | Private operator | Operations |
| **Secondary** | **BM4 Charging and depot** | **Energy provision contract** | PT authority | Payment agency |
| | | | Energy player | Charging and depot infrastructure provision |
| | | **Real-estate development contract** | Energy player | Depot space for development |
| | | | Construction partner | Depot facilities Non-energy revenues |
| | **BM5 Battery leasing model** | **Battery leasing contract** | Battery lessor | Battery funding, Battery performance |
| | | | Fleet operator | Payment per km |

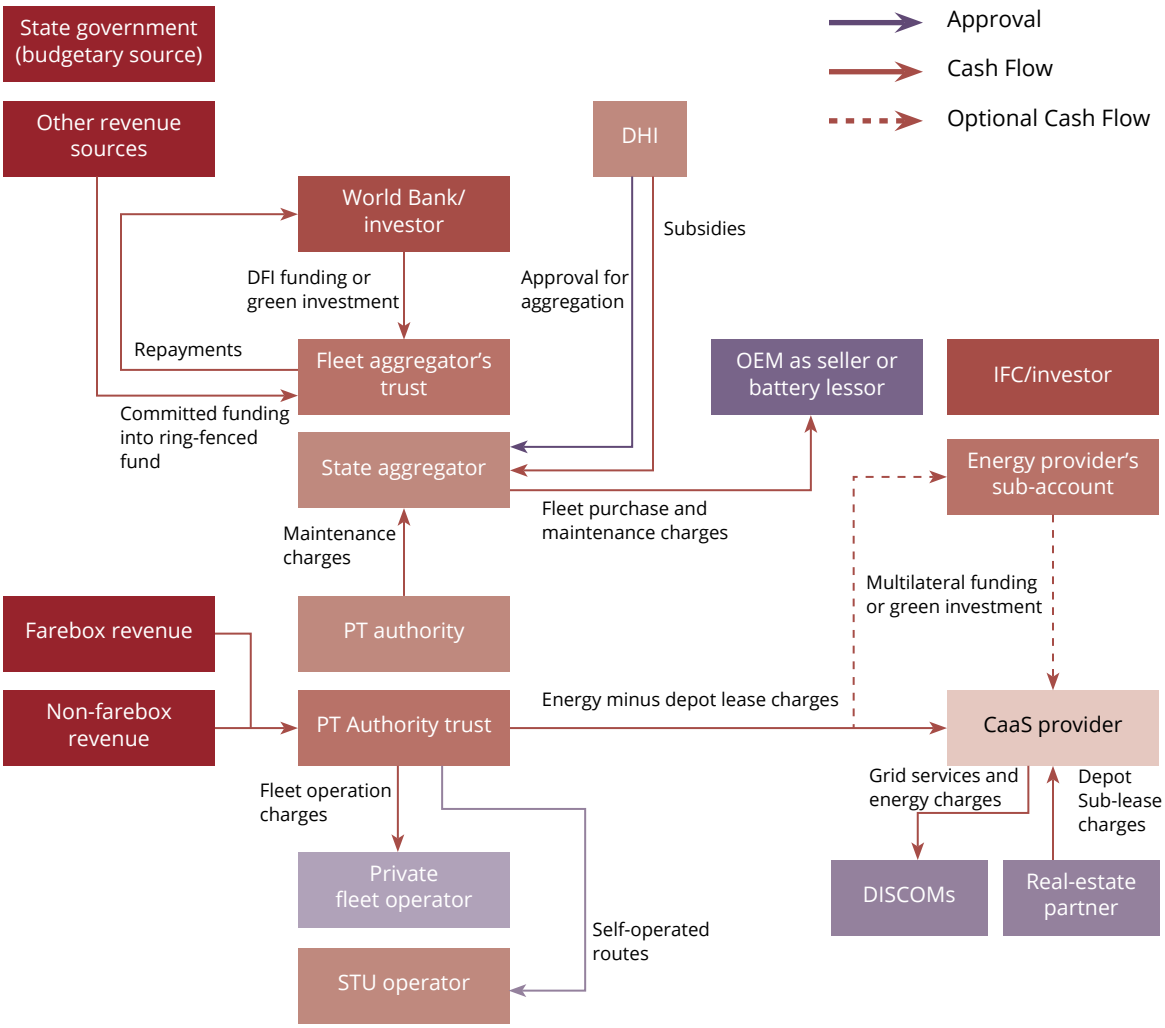
Based on stakeholder consultations, it was found that the capital cost of grid upgrades and e-depot construction may be an obstacle for both public sector DISCOMs and PT authorities that are often cash-strapped and strained for financial resources. The use of unbundled charging infrastructure bringing in private sector expertise and investment could therefore alleviate this issue and help ensure charging infrastructure readiness. The CaaS provider or wayside amenity manager here takes the capital and technological risks of charging infrastructure, grid upgrades and/or e-depots. The table below provides an understanding of the fleet business market, routes, charging type and locations covered by unbundled charging infrastructure models.

**Table 4.8:** Mapping secondary business models with implementation contexts
Source: Steer review and analysis

| Secondary business model | Fleet business | | Routes | | Charging type | | Charging Location | |
|---|---|---|---|---|---|---|---|---|
| | Private | Public | Intra-city | Inter-city | Oppor-tunity | Depot | OD | En-route |
| BM4a | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | |
| BM4b | ✓ | ✓ | | ✓ | ✓ | | | ✓ |
| BM4c | ✓ | ✓ | | ✓ | ✓ | | | ✓ |

As an example, the figure below illustrates the State-led fleet aggregator business model in combination with CaaS options for unbundled charging infrastructure.

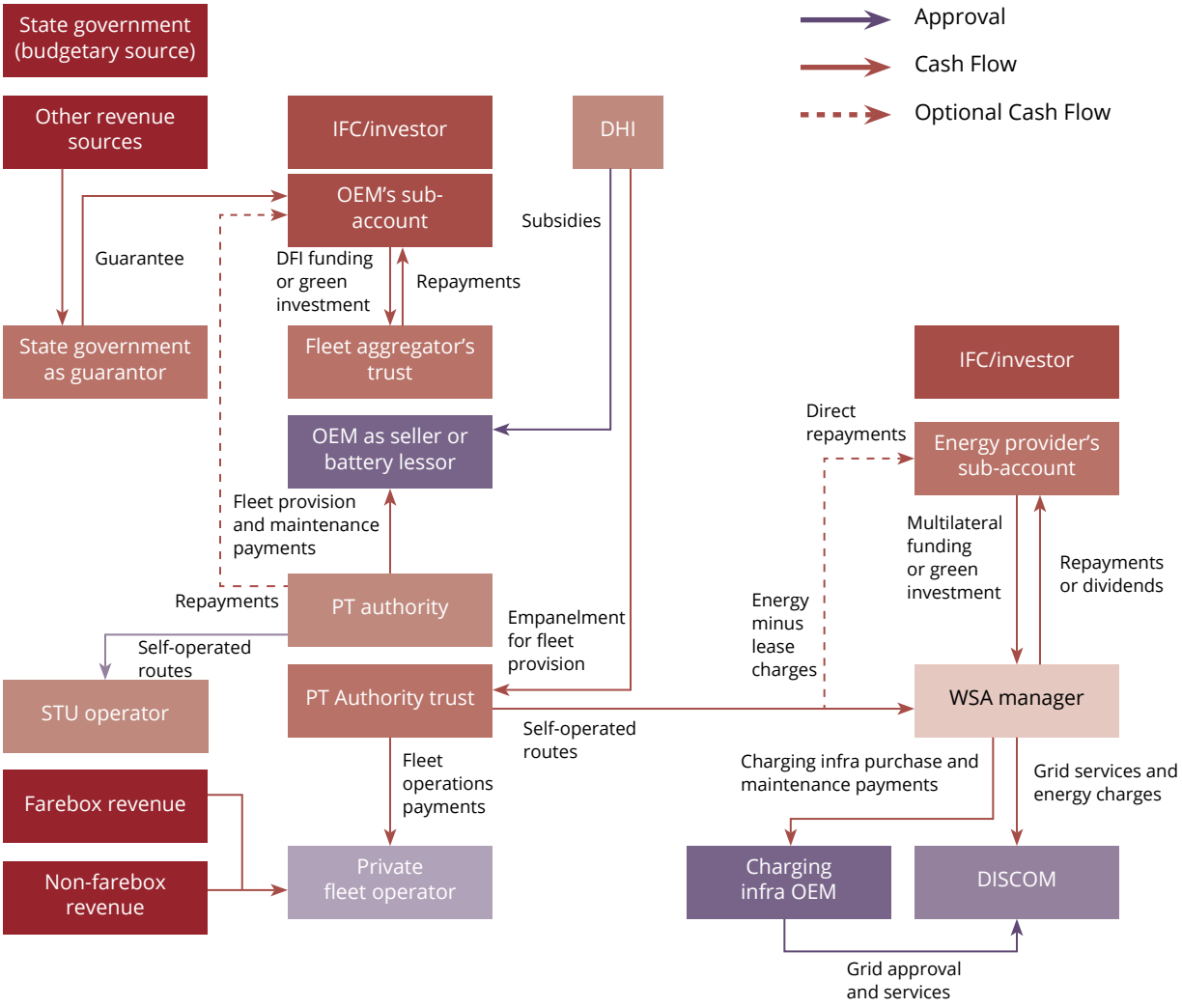
**Figure 4.5:** Business model structure- State agency as fleet aggregator with charging infrastructure unbundled
Source: Steer representation




As explained earlier, the State agency as a fleet aggregator, through favorable funding from a green investor or financing through a multilateral financial institution, procures fleet at an aggregate level from OEMs and ensures availability of e-bus fleet according to agreed schedules to one or more STUs. Apart from procurement and financing, maintenance of fleet may also be aggregated by the fleet aggregator through long-term maintenance contracts with OEMs/suppliers. The STUs may in turn contract the operations of these e-bus fleet through private operators or self-operate. Through a CaaS contract with a specialist player, the STU ensures charging infrastructure readiness in accordance with the charging schedules agreed with the operator. Variants of the CaaS contract adopted may depend on requirements of the STUs, routes undertaken (intracity/intercity), charging type (opportunity/depot) and charging locations (origin-destination or en-route). Likewise, the figure below illustrates a market player-led (OEM-led) fleet aggregator business model in combination with CaaS options for unbundled charging infrastructure.

Similar to the State-led fleet aggregator model, the OEM-led aggregator model allows a market player to take on financial, technological and market risks associated with e-bus procurement. Technological risks are more appropriately shared in this model compared to the State-led model though aggregation potential may be lower. In the case of intercity routes, the CaaS model may involve wayside amenities that may provide charging as an additional service with the help of contracted CaaS players.

**Figure 4.6:** Business model structure- OEM as fleet aggregator with charging infrastructure unbundled
Source: Steer representation



### Technology, charging infrastructure and subsidies for the private sector market

Given that buses serve 38% of the annual passenger km travelled and the private sector bus market makes up 90% of the fleet size with potentially higher investment potential, the private sector bus market is key to achieving fleet electrification targets aligned with the climate change goals of cities, states and the country overall.

*Lowering cost for companies transitioning to e-buses*

Adoption by private operators has been limited by the subsidy design, capital cost and technological fit. Although 35% of the FAME II scheme provides subsidies for e-buses under the GCC model, the private sector bus market is excluded from this incentive. The high capital cost at 30% of the lifecycle TCO also frontload financial risks for operators. Last, performance of e-bus technology in India for different applications such as long distances trips, remains in its early days.

Based on the experience of UK and Latin American cities in scaling up e-bus deployment, leasing of e-buses and/or battery can help overcome the obstacle of high capital for purchase in the case of non-adverse tax treatment. For example, Chile charges zero VAT for e-buses with no import duties, along with exemptions in vehicle emission tax. However, in India, there is higher (18%) GST rate for leasing e-buses compared to purchase (5%) making the option unattractive. Overall, lack of subsidies for purchasing e-buses and adverse tax treatment of leasing e-buses has provided an uneven playing field with the private sector e-bus market at disadvantage, although having the most potential in terms of attracting investments, access to specialist players and bankability.

In order to build trust and incentivize large-scale adoption of e-buses in this key market, it is essential to take policy actions to aid a favorable business case for the private sector market to transition to e-buses through:

- Creating a favorable and consistent tax regime for manufacturing, procurement and operations of e-buses, through coordination between the DHI and state transport departments to reduce or waive taxes from e-buses until a critical volume is reached.
- Balanced subsidy structures that could be extended to the private sector market as well to see visible and sustained electrification of bus fleet. Currently, personal vehicles like cars that are more polluting per vehicle km and have lower occupancy are eligible for FAME capital subsidies. Also, eligibility is limited to the public sector bus market that makes up for about 20% of the fleet size.
- Alternative sources of revenue like feebate schemes that can help fund subsidies for purchase of e-bus and charging infrastructure deployment.

*Suitable business models and policy action for charging infrastructure readiness*

Availability of charging infrastructure is critical to support the e-bus market. However, deployment of charging infrastructure suffers from a lack of program approach and vision for e-bus fleet penetration on specific routes, along with a need to incentivize specialist players with investment potential to enter and kickstart the private sector markets. As charging infrastructure is seen as a niche market involving technology, grid and power aspects apart from being able to work on a service model like fuelling stations, unbundling facilities through policy mandates is key to reduce range anxiety for fleet players entering the e-bus market.

The E-mobility Cell or the public transport department of each State will need to formulate and implement a State-wide program to install depot and en-route charging infrastructure facilities that can be shared between the public and private sector markets. Players like OEMs, energy providers and utility companies with specialist capabilities may be invited to invest in and develop charging stations (en-route) on the highways for intercity markets and e-depots (origin-destination) for both intracity and intercity markets.

- **En-route charging on highways:** Government land earmarked for this purpose may also be provided to charging-as-a-service (CaaS) players at subsidized lease rates who can provide charging services to fleet operators either on a pay-as-you-go model based on pre-booking or subscription model for members. CaaS players may recover energy charges and fixed charges for installation of grid and charging infrastructure through per/kWh charges to fleet operators. Existing informal highway eatery complexes and upcoming NHAI wayside amenities show good potential as potential sites.

*Photo credits: UITP*

- **E-depots in urban areas:** PPP arrangements can be made between private fleet companies and CaaS players for installation and maintenance of grid and charging infrastructure. While this may be suitable for large fleet companies, smaller-sized fleet operators may be benefitted by shared e-depots developed for the private market as STUs will have their own dedicated e-depots either self-managed or through a separate PPP arrangement. Real-estate potential of land and building may also be tapped.

In both cases, the CaaS players ensure energy availability and manage charging for the e-buses, while fleet players like aggregators and operators can focus on commercial and operational aspects of e-bus deployment. Zenobe's customised market solutions in the UK, and ENEL and other energy players providing e-depot services in Bogota (Colombia) are examples from previous international experience. However, it needs to be emphasized that a policy-based approach to pilot and scale-up such infrastructure in the Indian context is key to attract interest and investment from suitable players.

*Unlocking suitable financing options*

Along with the necessary support in the form of subsidies, favorable tax treatment and ensuring charging infrastructure readiness, facilitating access to suitable financing options for the private sector market is essential.

- Priority sector lending status to players involved in e-bus deployment can help especially smaller to medium-sized fleet operators and CaaS players access financing instruments at financial institutions.

- Fleet aggregator models for e-bus deployment separate fleet provision (purchase and ensuring availability) from fleet operation and help reduce cost through achieving economies of scale in procurement, maintenance and financing of e-buses. Separate fleet provision, which transfers the capital cost risk of the e-bus to a financially strong player, appropriately apportions technology, financial and market risks between stakeholders. Investment platforms of fleet aggregators could attract investments from green investors and financial institutions. Leasing options between the fleet aggregator and the OEM could further augment the benefits in a favorable GST scenario.

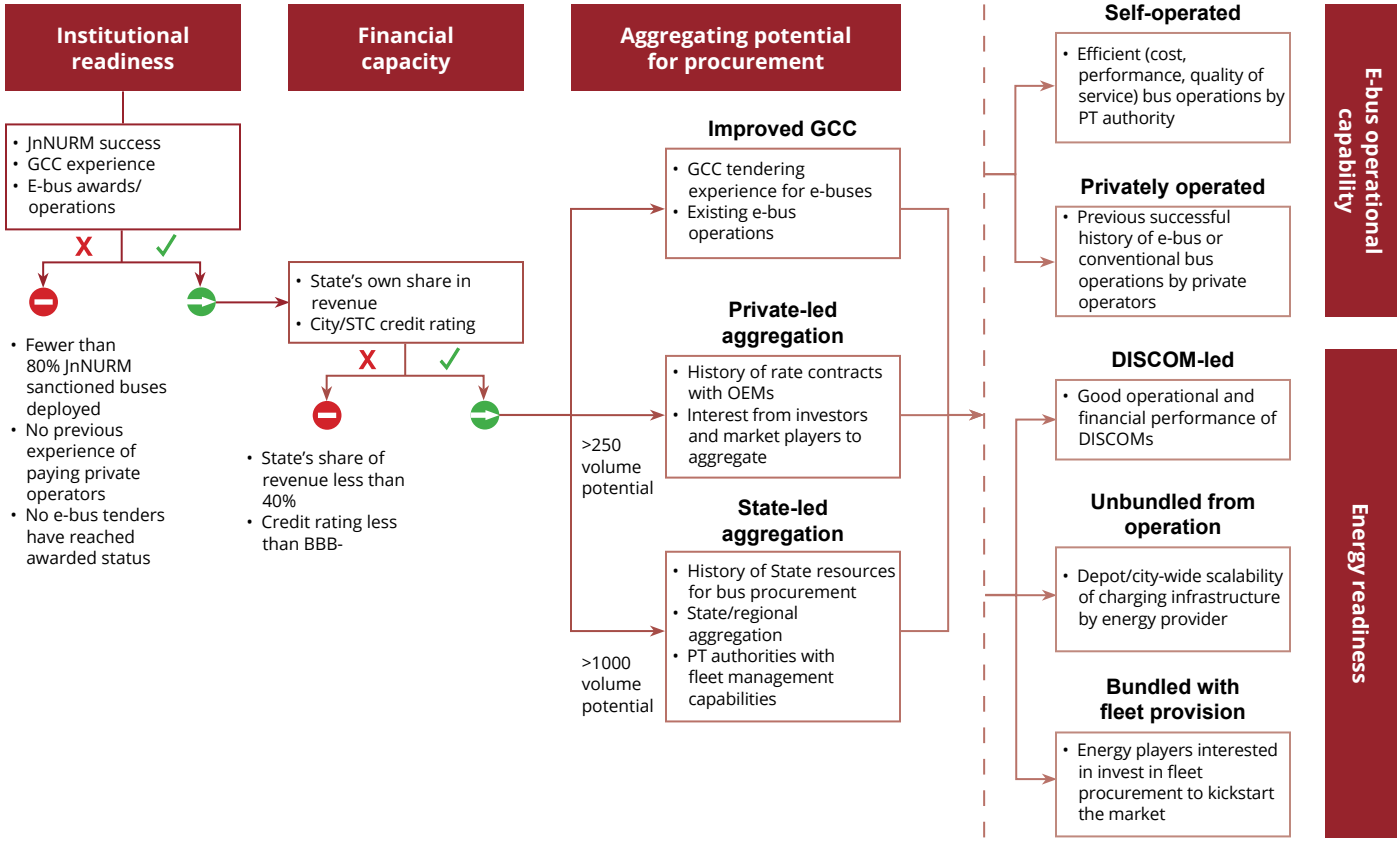
## Recommendations and action plan

Each proposed business model requires certain ingredients in the states and cities of implementation to see improved bankability, commercial viability and scalability in e-bus procurement and operations. Moreover, each state, city or agency may have its own precedents, aspirations and preferences, and they may assess suitable business models using the proposed decision-making framework below which presents a stepwise decision-making flowchart primarily for fleet (procurement and operations) and energy aspects of the e-bus ecosystem. Institutional readiness and financial capacity are requisite for state or city to go forward with decision-making on suitable business models.

Aggregating potential depends on volumes, precedents and institutional/financial characteristics. Overall, the Revised GCC solution could be opted by a variety of states and cities which may or may not have previous GCC tendering or operating experience. The market player-led aggregator business models may be suitable in cases where more than 250 e-buses may be aggregately procured. Potential to aggregate more than 1000 e-buses across cities and routes in the state is suitable for country or state-led aggregation.

For fleet operations, e-bus operational capability may be self-assessed either using performance of previously self-operated routes and markets, or previous successful history of e-bus or conventional bus operations. Energy provision may be led by charging infrastructure OEMs, energy players or private DISCOMs, unbundled as a service/ PPP and/or bundled with fleet provision.

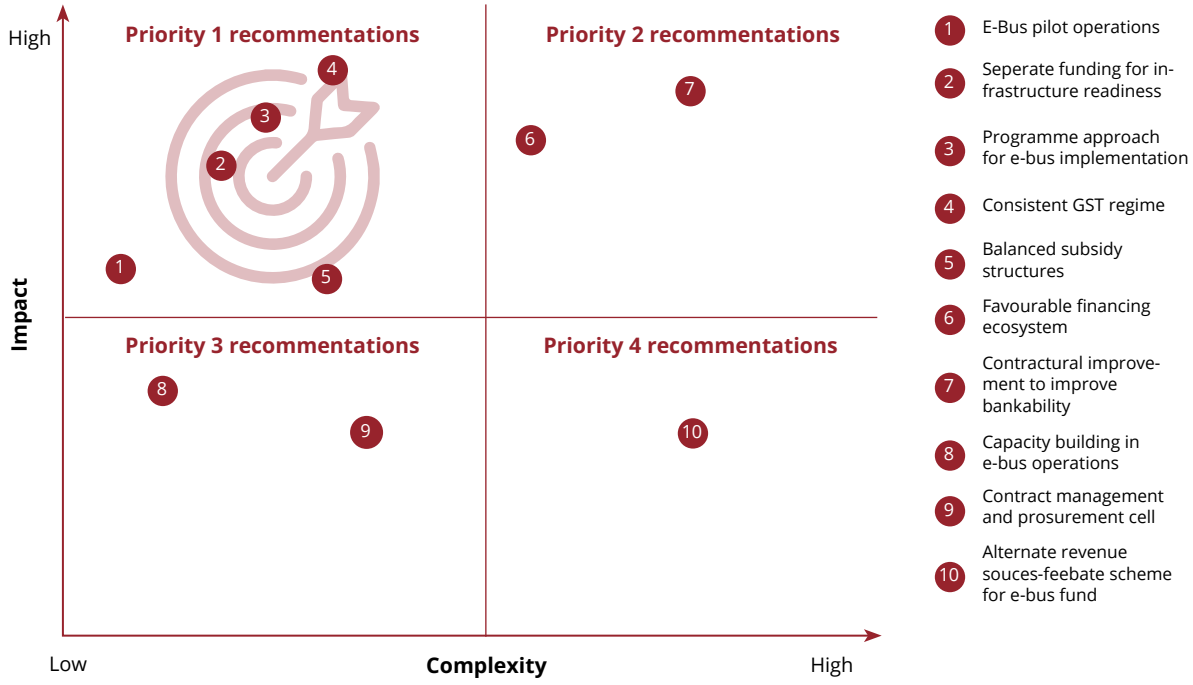
**Figure 4.7:** Proposed framework for decision-making on selection of suitable business models
Source: Steer review



*Action plan prioritisation framework*

In order to develop an action plan for e-buses, detailed stakeholder consultations were undertaken with the OEMs, STUs, private operators and transport departments to assess the barriers in scaling up adoption of e-buses, to understand stakeholders' key concerns relating to existing GCC contracts and the current business model. The action plan recommendations were discussed with central and state government agencies to get feedback on the applicability, impact and ease of implementation of the proposed recommendations. The following figure summarises the priority of implementation for key recommendations.

**Figure 4.8:** Prioritization framework for e-bus action plan recommendations
*Financial solutions to reduce financing cost for EVs has been presented in Chapter 5




While detailed action plan recommendations are presented in Annexure-C, key action plan recommendations required for unlocking key business models and creating an enabling environment for mass-uptake of e-buses are described below:

**Table 4.9:** Action plan roadmap and barrier addressed for e-buses
Source: Steer recommendations

| Recommendation | Description | Barriers addressed |
|---|---|---|
| National level recommendations | | |
| **Programme approach at state level to electrification of bus fleet**<br><br>**Category - Policy and Regulatory** | • Develop an e-bus program for the state or city with multi-year framework agreements between State and participating PT authorities.<br>• The program approach should be adapted to market, institutional, operational and financial characteristics of the cities/ state.<br>• CESL has already initiated this approach under FAME II policy to aggregate demand of e-buses across five cities with over 4 million population. | • Fragmented demand for e-buses from various STUs leads to lack of economies of scale resulting in high capex of e-buses and lack of commercial viability of e-bus business models. |
| **Favorable and consistent tax regime for manufacturing, procurement and operations of e-buses**<br><br>**Category - Policy and Regulatory** | • Consistent GST to be applied across the e-bus value chain including manufacturing, procurement (purchase/ leasing) and operations. | • Higher GST and other taxes add to the high capital cost of e-buses throughout its operating life. |
| **Balanced subsidy structures as part of fiscal measures**<br><br>**Category - Policy and Regulatory**<br>**Category - Funding & Financing** | • In GCC procurement model, hybrid subsidy structures to be followed with operational subsidy component linked to performance of e-bus during the contract period<br>• Subsidies offered under FAME policy to be extended private sector | • Fixed subsidy offered under the current GCC procurement models leads to price distortion in the e-bus market<br>• Not extending capital subsidies to the private sector excludes major part of the market with greater investment potential. |
| **Alternate sources of revenue for e-bus and charging infrastructure deployment**<br><br>**Category - Financial and Funding** | • Feebate scheme with levy of carbon tax on ICE vehicles to fund fleet electrification<br>• Allow commercial exploitation of depot land to generate alternate sources of revenue to improve commercial viability of unbundled charging infrastructure models | • STUs and DISCOMs often are cash-strapped and lack financial resources to fund development of charging infrastructure |
| **Improve bankability of procurement through contractual modifications**<br><br>**Category - Procedural & Procurement** | • Ensure payment security to fleet operators for minimum assured kms via an escrow account arrangement managed by an independent intermediary institution | • Contractual and tendering issues increase risk premia in bid quotes, leading to cancellation or re-tendering of bids |

| Recommendation | Description | Barriers addressed |
|---|---|---|
| | • A step in ensuring payment guarantee has been initiated in CESL tender which includes a payment security mechanism mandating the authority procuring e-buses to either approve the invoice or issue a notice for necessary deductions or adjustments within 30 days from the date of submission, else it would be deemed approved, and operator can approach the Escrow Bank for its clearance.[64] | |
| State level recommendations | | |
| **Capacity-building for STUs, public transport department, aggregator agencies and DISCOMs in e-bus operations and contract management**<br><br>**Category - Governance & Institutions** | • Capacity-building programe for contracting authorities to be mandated before initiation of bid process and release of tender documents | • Many STUs and state departments lack the technical and operational skills for new technologies like electric buses and charging infrastructure for effective contract management |
| **Contract Management and Procurement Cell at State and agency level**<br><br>**Category - Governance & Institutions**<br>**Category - Procedural & Procurement** | • A centralized contract management and procurement cell along with project management units for each cluster of e-bus fleet being procured and operated at a state or STU level<br>• A project management unit with representatives from contractors, PT authorities, State agency (if any), CaaS providers and lessors<br>• Mumbai and Delhi have launched their EV cells recently to accelerate transition and adoption of EVs. | • Contractors including fleet providers, operators, energy or CaaS providers may perceive higher risk in entering into contractual agreements with agencies having a history of non-compliance with contract terms |

64 Clause 22.2.3 and 22.2.4, Amendment No.3 against tender, "Request for proposal for selection of bus operator for procurement, operation and maintenance of 5,450 electric buses and 135 double decker electric buses and allied electric and civil infrastructure on Gross Cost Contract", Open tender, CESL, dated 2 March 2022

| Recommendation | Description | Barriers addressed |
|---|---|---|
| **Separate funding and readiness of charging infrastructure**<br><br>**Category - Funding & Financing**<br>**Category - Urban infrastructure** | • Power DISCOMs to be provided with funding support by respective states governments to deploy charging infrastructure at depots and en-route charging points before procurement stage. | • Lack of charging infrastructure readiness increases risk premium added to the bid quotes in e-bus tenders. |
| **Enable favorable financing ecosystem for e-buses**<br><br>**Category - Funding & Financing** | • Central/state governments to introduce scheme to de-risk lending to e-bus sector (public and private) until 10% of the fleet is electric. | • In the absence of secondary markets, bankers' concerns around residual value of e-buses affect bankability of e-bus procurement and operations. |
| **E-bus pilot operations for mitigation of performance risks, model registration and OEM empanelment**<br><br>**Category - Procedural & Procurement** | • DHI to mandate e-bus pilots in addition to feasibility studies undertaken before release of tender<br>• OEM empanelment to be based on successful registration of piloted e-bus models<br>• The CESL procurement of aggregated demand allows standardization of e-bus specifications and operational parameters reducing performance risks associated with e-bus operations. | • Significantly higher capital cost of e-bus along with lack of evidence on performance reliability contributes to range concerns for operators on the path of fleet electrification. |

## Impact of e-bus penetration

Implementation of the action plan for e-buses can have impacts at multiple levels:

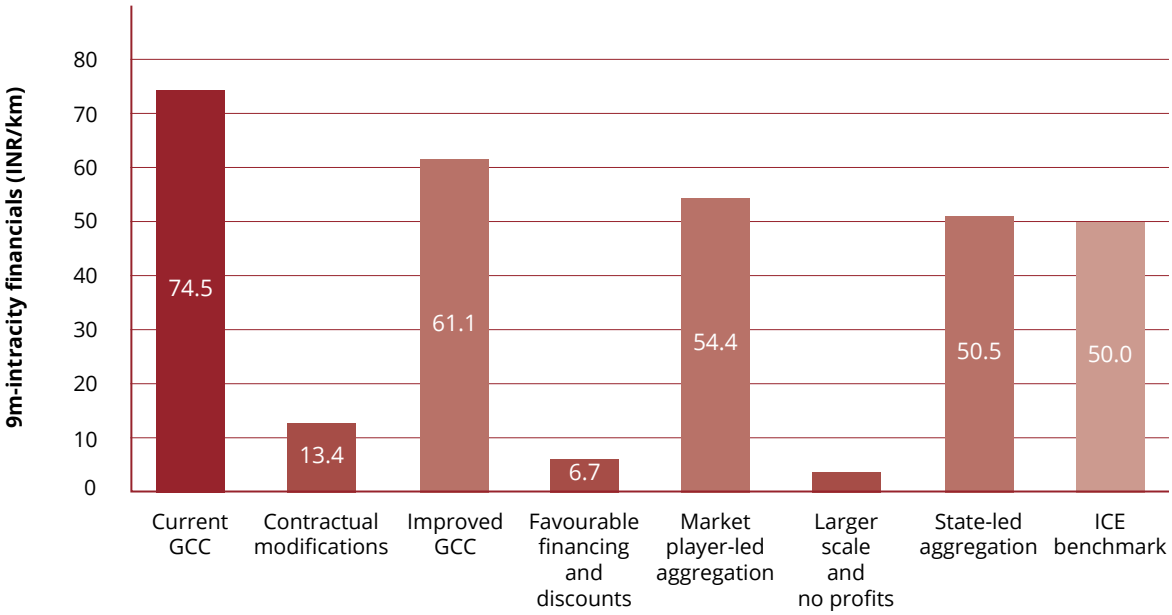
- TCO parity between e-buses and ICE variants
- Improved commercial viability, bankability and scalability of e-bus procurement
- Investments in electrification of the private sector bus market
- Fleet electrification resulting in carbon emission savings

While savings in the Revised GCC solution result from improved contractual terms, additional TCO reduction in the aggregator models result from the following:

- Reduction in risk premia in operator bid quotes that aim to counter payment, technology, capital cost and other risks
  - Payment: Direct lender subaccount payments, escrow account mechanism and/or ring-fenced trust funds
  - Technology: Mileage assurance and/or battery replacement risk on OEM
  - Capital cost: Financially strong player as fleet aggregator
- State-led aggregator with programe approach to fleet moderation can achieve greater economies of scale in procurement, maintenance and financing
  - Procurement: Discounted bus costs for large orders
  - Maintenance: Centralized maintenance arrangement for procured fleet
  - Financing: Cheaper interest rates and guarantees

The chart below illustrates the improved financials and TCO savings for 9-m intracity e-bus, in moving from the existing GCC model to an improved GCC model, and further to aggregator-based business models with continued FAME subsidies.

**Figure 4.9:** Potential TCO improvement across alternate business models with continued FAME subsidy (INR/km)
Source: Steer estimates




The aggregation initiatives that have begun with the CESL tender would pave the way for improving contracting and procurement of e-buses under GCC mode. The e-bus market is likely to grow with improvement in TCO by adoption of action plan recommendations coupled with improvement of ecosystem factors such as:

- The sustained higher price of fuel is expected to switch the modal choices in favor of public transport
- The revival of tourism sector is likely to boost intercity travel demand which would result in improvement of finances of private operators
- Improvement in manufacturing capacities resulting from aggregated public procurement is likely to increase competition among e-bus OEMs and gain from economies of scale resulting in lower upfront costs

Development of en-route charging infrastructure and its availability to private operators is a pre-requisite for adoption of e-buses at a large scale. National Highways Authority of India (NHAI) has a target to install charging stations at 40km-60km on national highways and it is planning to equip about 40,000km with charging stations by 2023.[65] These stations are proposed to be developed as a part of wayside amenities, which would further facilitate adoption of e-buses in the intercity bus market.

65 https://theprint.in/india/governance/e-vehicle-charging-stations-every-40-60-km-40000-km-of-highway-coverage-nhais-2023-target/751104/ accessed on 11 March 2022

The public policy push creating manufacturing capacity and improved availability of charging infrastructure coupled with ease of access towards affordable financing (covered in detail in Chapter-6) would influence improve perception of e-buses and result in increased level of penetration under the alternate scenario. These sales penetration levels have been estimated considering a higher adoption rate by urban public bus operators and the policy and action plan recommendations discussed earlier. These adoptions include the impact of TCO led savings resulting in switching of some of the private sector operators aided by conducive market environment and increased competition in e-bus manufacturing landscape resulting in lowering of upfront costs and higher reliability of product available.

**Table 4.10:** e-bus projection in terms of number of vehicles and as a % of total vehicle annual sales for India in Alternate scenario
Source: Secondary research (FY19-21) and Steer estimates (FY25, FY30)

| Market segment | FY19[66] | FY20 | FY21 | FY25 | FY30 |
|---|---|---|---|---|---|
| e-bus sales | 400 | 600 | 1,850 | 8,000 | 14,000 |
| EV penetration | 1.0% | 1.5% | 11.7% | 18% | 50% |

**Table 4.11:** EV stock numbers and total investment value of e-buses for India in the Alternate scenario from FY23-30
Source: SSteer estimates

| Market Segment | FY23 | FY24 | FY25 | FY30 | Total Investment Value (INR Mn) |
|---|---|---|---|---|---|
| e-bus stock | 15,000 | 23,000 | 31,000 | 98,000 | 1,303,000 |

66 https://jmkresearch.com/electric-vehicles-published-reports/electric-buses-india-market-analysis/accessed on 1st March 2022

## Summary

A rapid uptake of e-buses will play a major role in the decarbonization of transport in India. Achieving rapid TCO parity and unlocking financing for such uptake will require efficiency gains in existing contracting (revised GCC solution with improved contractual terms and guarantees) and leveraging aggregation based on long-term programs such as those initiated with the CESL tender. Aggregation will also require adjusting GST distortions that may limit the competitiveness of associated business models compared to alternative straight purchase and GCC approach. Initial ramp-up and predictable demand associated with aggregation will lower cost, build state and city capacity and enable the development of market player-led aggregator models for private sector bus provision. Since the majority of buses are managed and operated by the private sector, a systematic reduction in transition cost (through feebate and reduced taxes), development of shared charging infrastructure, and access to favorable financing will be needed to accelerate the transition.


*Photo credits: JBM*

# 5.

# Charging Infrastructure

*Photo credits: Ather Energy*

## Introduction

Provision of charging infrastructure is a pre-requisite for EV adoption. This chapter introduces the charging infrastructure ecosystem, starting from the global and national push for its development, along with current market overview in India. The demand for charging infrastructure is presented in terms of the preferred location for charging and associated charger requirements. The various charging locations are residential, office, captive, public and swapping. The supporting charger requirements refer to the electric equipment suitable for installation at various charging locations such as the 15-ampere socket, Type 2 Alternating Current (AC), Bharat Direct Current (DC), Combined Charging system-2 (CCS) charger. The charging infrastructure requirement of each market segment was estimated at a city level and then scaled up to estimate the national level charging infrastructure demand.

The major sections of this chapter are:

- **Market context** presents both global and national state of charging infrastructure with respect to investment requirement, policy support and an overall charging infrastructure development.
- **Charging infrastructure value chain** provides an overview of value chain starting from battery energy storage system to end-user interacting with charging infrastructure to charge EV. It also provides a brief on the charging standards relevant to India market context.
- **Market overview** presents the status of charging infrastructure deployment in the country. It also summarizes the estimated demand for charging infrastructure deployment till FY30 based on the forecasted penetration of EVs across market segments. This section also summarizes the key features and examples of various charging infrastructure business models
- **Market barriers and proposed intervention** given the limited utilisation of chargers due to low penetration levels, the charging business models are currently not viable. An assessment of alternate business models and current bottlenecks influencing their viability and scale-up are analysed. Accordingly, a set of action plan recommendations addressing these bottlenecks are presented.

## Market context

### Global context

The demand for charging network is expected to grow to over 309 million chargers at all locations by 2040 under the 'economic transition scenario' considered by Bloomberg. An estimated 270 million of these would be at home locations. Additionally, 24 million would be required at public locations, and a further 12 million at workplaces, while about 4 million would be needed for charging buses and trucks. A total investment of USD 589 billion is expected to install chargers at all locations globally. The changing needs of the network will evolve by 2040 and vary in each country depending upon where they are in their EV penetration journey.[67]

67 Electric Vehicle Outlook, 2021 Executive Summary, BloombergNEF

Plans to rollout charging infrastructure have become a priority across markets. Transport Environment, a clean energy transport campaign group, estimates that European Union's public charging infrastructure deployment should target 1.3 million public charge points for 2025 increasing to 3 million for 2030, which would require investment of USD 2.1 billion in 2025.[68] China has a vehicle stock of about 4.92 million new energy vehicles by 2020 which includes battery electric, plug-in hybrid and fuel cell vehicles.[69]

To support the charging requirement of EVs nationally, it has invested roughly USD 2.4 billion in improving charging infrastructure till 2020.[70] A study by the International Council on Clean Transportation (ICCT) estimates that to support a stock of 26 million vehicle in the US, public and workspace charging would need to expand to about 2.4 million chargers by 2030 from 216,000 in 2020 which would need investment of about USD 28 billion.[71]

Image Source: https://www.ubitricity.com/in-use/

### Berlin street EV charging infrastructure

Berlin-based start-up-Ubitricity has developed physical and digital infrastructure to upgrade existing streetlights and bollards into charging points in collaboration with the local authorities resulting in an affordable and accessible charging network. A billing system allows users to incorporate the EV charging cost in their electricity bill using mobile electricity contracts and a smart cable that has an integrated electricity meter.

They have also installed about 250 charging points in London. Such an initiative has also been attempted in India by Magenta Power who have successfully installed ChargeGrid Flare EV charger on street light poles at two locations- HPCL outlet in Bandra Kurla Complex in Mumbai and Nitimarg in Delhi. It has announced plans to set up over 1,000 such facilities all over India in the following year. It is enabled with an automated payment gateway through the ChargeGrid app.[72]

68 Recharge EU: How many charge points will Europe and its Member States need in the 2020s, Transport and Environment, January 2020. https://www.transportenvironment.org/discover/recharge-eu-how-many-charge-points-will-eu-countries-need-2030/

69 Driving a green future, A retrospective review of China's electric vehicle development and outlook for the future, Lingzhi Jin, Hui He, Hongyang Cui, Nic Lutsey, Chuqi Wu, Yidan Chu, International Council on Clean Transportation, Jin Zhu, Ying Xiong, Xi Liu, China EV100, January 2021

70 https://www.businesswire.com/news/home/20210524005446/en/14-Billion-Electric-Vehicle-Charging-Infrastructure-Market---Global-Outlook-and-Forecast-2021-2026-Revenue-is-Expected-to-Grow-at-a-CAGR-of-Over-30---ResearchAndMarkets.com accessed on 20th August 2021

71 https://theicct.org/publications/charging-up-america-jul2021 accessed on 20th August 2021

72 ttps://www.kfw.de/stories/economy/mobility/ubitricity-mobile-electricity/ accessed on 20th November 2021

### National context

Government of India has published a policy document, 'Transformative Mobility for All' in 2017 which is spread over three phases- I: 2017-19; II: 2020-23 and III: 2024-32. The first phase was focused on short-term actions to build political and market confidence, followed by developing regulatory incentives and policy measures in phase II and deployment of large-scale charging network while scaling up domestic manufacturing in phase III.[73] Availability of accessible and affordable charging infrastructure is a pre-requisite for mass adoption of EVs. Charging infrastructure needs to be at the core of the future planning for transition to electric mobility.

In India, Department of Heavy Industries (DHI) has sanctioned 2,636 new charging stations to be set-up across 62 cities and 24 states and Union Territories in January 2020. Additionally, Ministry of Heavy Industries and Public Enterprises has sanctioned 2,877 EV chargers on highways and expressways in October 2020. Ministry of Power has also announced setting up of EV chargers across 69,000 petrol stations in India.

India has about 1,640 operational public charging chargers as of January 2022, with the highest proportion concentrated in major cities such as Bengaluru, Delhi and Mumbai.[74] During the transition phase towards EVs, there would be low utilization of chargers due to lower penetration of EVs, owing to which the business models for public charging stations are financially unviable; this restricts flow of private capital investment in the sector and may need initial funding and financial support from central and state governments.

The forecasted EV penetration results estimated under BAU scenario would need adequate deployment of chargers at all locations-residential, office, public and captive facilities for fleet operations. Based on an assumption of 5 charging points per location, about 240,000 public charging stations are required to be set up by 2030 (detailed estimates are presented in the subsequent section).

## Charging infrastructure value chain

While at present there are no universally accepted standards or global benchmarks for the extent to which EV charging infrastructure is required, it is widely considered that EV market growth will only be delivered in conjunction with a clear and visible EV charging infrastructure growth plan. While the numbers of charging points implemented is important, the psychological impact of seeing EV infrastructure installation in an area also has a strong influence on users making the decision to transition from ICE to an EV.

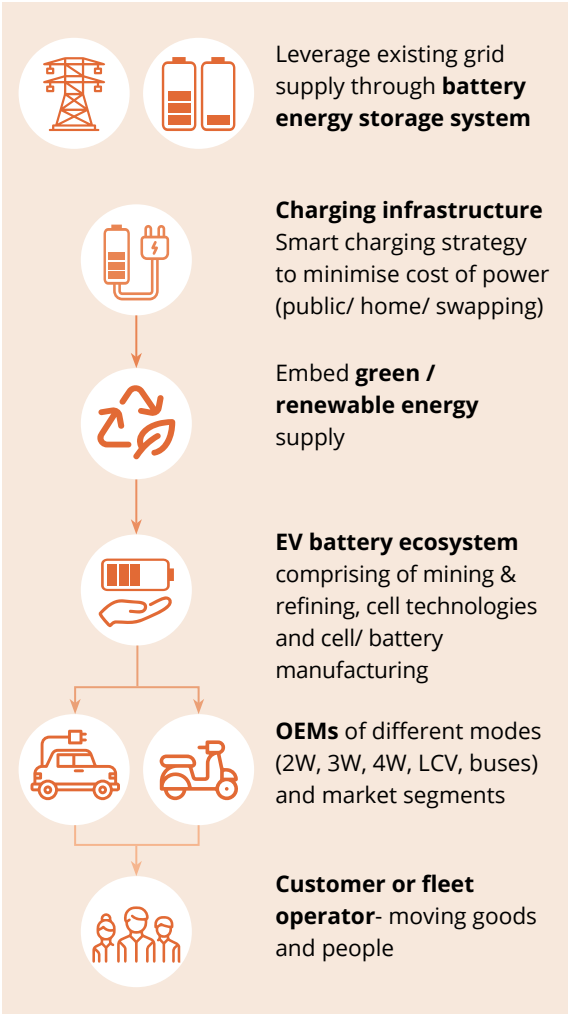
Charging infrastructure is the backbone of any electric mobility implementation. A Battery Electric Vehicle (BEV) is driven by an electric motor supplied with energy entirely from on-board batteries. Provision of an adequate, affordable, accessible and reliable charging network is considered a pre-requisite for the mass adoption of EVs. Therefore, the provision of robust charging infrastructure solutions is key to promote awareness and confidence in vehicle range among prospective EV customers.[75]

73 Electric Vehicle charging infrastructure and impacts on distribution network, Greening the Grid (GTG)-Renewable Integration and Sustainable Energy (RISE) Initiative, A partnership between USAID and Ministry of Power, GOI, June 2020

74 https://www.bloombergquint.com/business/india-ramps-up-charging-in-frastructure-to-spur-adoption-of-evs accessed on 10 March 2022

75 Emerging best practices for electric vehicle charging infrastructure, ICCT, 2017

**Figure 5.1:** EV value chain
Source: Steer representation




The EV ecosystem is evolving and consists of many interconnected actors and business models. The supply side stakeholders for charging infrastructure include OEMs of Electric Vehicle Supply Equipment (EVSE), battery manufacturers, charging network providers and utility companies. The deployment of charging infrastructure requires coordination among multiple stakeholders.

## Charging standards

At present, there is significant variation in the type of charging standards and sockets which are being used to charge EVs. A lack of common charging standards adds complexity and cost in establishing a charging infrastructure model that is in harmony with itself rather than in conflict. India has yet to fully standardize its requirements for public and private charging infrastructure and numerous charging connector standards have been deployed.

The advantages of standardizing on-charging connectors are:

- **Reduction in complexity for OEMs serving the market:** Complexity in manufacturing costs money and complexity reduction saves money, both in manufacturing and component supply.
- **Users' ability to use any charging station:** User experience and trust in transition to EV would be eased. Capital expenditure reduction, public charging locations would only need to cater for a single DC standard rather than the potential four in play in the Indian market, ensuring greater utilization of the available electric charger.

In terms of standards in the Indian context, there are currently only two Bharat Series – BAC001 and BDC001 developed by Electrotechnical Department (ETD). ETD under Bureau of Indian Standards (BIS) has also constituted a committee- ETD-51 for developing standards beyond the present Bharat series. Others are connector protocols or charger types recognised by the public charging infrastructure guidelines issued by the Ministry of Power (MoP) in January 2022. The following table briefly describes the current charging approaches being adopted by India.

**Table 5.1:** Approaches for EV charging stations in India
Source: Charging standards for electrical vehicles (EV)- revised guidelines and standards, Ministry of Power, January 14, 2022; Steer representation

| Type of charger | Charger connector | Charging power (Kilowatt) | Output Voltage (Volts) | Vehicle type |
|---|---|---|---|---|
| **Fast** | Combined Charging System (CCS) 1 and 2 | min 50 kW | 200-750 or higher | 4W |
| | CHArge de Move (CHAdeMO) | min 50 kW | 200-500 or higher | 4W |
| | Type 2 AC Charger | Min 22 kW | 340-480 | 4W, 3W, 2W |
| **Slow/ Moderate** | Type 2 AC Charger[76] | 7.2-11 kW | 150-340 | 4W, 3W, 2W |
| | Bharat DC-001 | 10/ 15 kW | 48/ 72 | 4W, 3W, 2W (10KW)<br>4W (15 KW) |
| | Bharat AC-001 | 3 connecting guns of 3.3 kW | 230 | 4W, 3W, 2W |

## Battery swapping

Battery swapping is mostly applicable where the battery is small and easily accessible and can be separated from the EV, such as in the case of 2W and 3W. In many of these emerging models the battery is not owned by the EV vehicle owner/operator, but by the energy operator who owns, charges and leases the battery to the vehicle operator. Once consumed, the discharged battery can be swapped for the recharged one at the swapping station. The battery swapping stations have charging facilities located at the site itself with either stacks of chargers or individual battery chargers. Taiwan-based Gogoro has been successful in creating a network of swappable batteries for its two wheelers which is accessible 24x7 with an open AI powered and cloud connected platform.

76 https://www.exicom-ps.com/Charging-intro.html?id=divTab508 accessed on 12 November 2020

Image Source: https://www.gogoro.com/gogoro-network/

### Swap and go: Gogoro's swapping solution

Taiwan based Gogoro is an electric scooter company which has been a market leader in the country. It has built an accessible and intelligent energy platform and distribution network of exchangeable smart batteries. Gogoro's network is the largest battery swapping network with over 2,000 swapping stations globally[77]. The company has also entered in a joint venture with Hero Motorcorp Ltd. for bringing the battery swapping solutions for the Hero's EV models in India which would be initially rolled out in Delhi and Bangalore.[78]

In terms of considering charging versus swapping infrastructure, discussions held with various stakeholders highlighted the relevance of the battery swapping options to be particularly relevant for e-3W and e-2W passenger fleet market segments. This is driven by the need to reduce upfront capex and down time during operating hours, thereby increasing the earning potential. For the other vehicle market segments, particularly e-4W and e-buses the OEMs preference is not to separate batteries from the vehicle. Further for e-3W and e-2W freight markets, the range of the existing e-vehicles for the purposes of daily use in terms of kms and the time available to carry out top-up charging during the operating period make charging as the preferred solution over battery swapping. In all market segment, technological and policy changes may rapidly shift balance across options. The swapping policy announced in the 2022 Government of India budget is expected to enhance the competitiveness of battery swapping by creating a level playing field across technologies.

77 https://www.gogoro.com/news/gogoro-network-battery-swapping-can-help-transform-cities/?utm_source=google&utm_medium=cpc&utm_campaign=bb_battery_swap accessed on 20 October 2021
78 https://www.bloomberg.com/news/articles/2021-09-16/battery-swapping-startup-gogoro-to-go-public-in-spac-merger accessed on 20 October 2021

# Current market overview

## Overview

This section provides the current state of charging infrastructure deployment; and maps the charging infrastructure requirement for each market segment. This understanding is incorporated into the market assessment whereby, charging infrastructure requirement is estimated under BAU scenario.

The market assessment results show the national estimate for number of charging points required by each vehicle type, and the type of charger by each location. This indicates the need of charging infrastructure development for both business models- battery swapping and charging stations (captive and public).

## Current charging infrastructure deployment

There are numerous initiatives being taken by both public and private players in deployment of charging infrastructure across the country. The recent announcement by the Department of Heavy Industries (DHI) to deploy nearly 2,700 charging stations across 62 cities under public procurement model is expected to provide a fillip to the pace of public charging network expansion.

The public charging stations sanctioned by DHI are expected to have 5-6 charging points comprising of 2-3 slow chargers (AC001 and Bharat DC001) and 1-2 moderate chargers (Type2 AC) and a selected few fast charger (CCS2). Our assessment of private deployment suggests that most of the charging points have Type2 AC chargers being deployed while the slow chargers constitute a relatively small proportion. The fast chargers are only being deployed by the private sector at very few selected locations at this point, focusing on major urban centers like Delhi, Mumbai and Chennai.

## Market segment charging options

Each market segment presents a different set of characteristics of charging and downtime requirements for EV usage. While the charging standards differ as does the EV battery size and type, each market segment utilizes different charging options depending upon:

- **Requirement and downtime:** EV users want to optimize vehicle charging downtime for the minimum time and cost. For example, operators of commercial EV (e.g. 2W/ 3W) fleets want to maximize on-road time by minimizing charging downtime. As the batteries of these vehicles are often easy to remove from the EV, this mode appears well suited to battery swapping business models. However, the need and extent of the adoption of battery swapping would also depend upon technology, standards and range improvements of the underlying batteries. These options may not be suitable for 4W and buses where there may be need for faster plug-in charging options and where the size, weight and vehicle package of the battery make this more challenging.
- **Availability of charging facilities:** The charging facilities used for the different modes will depend on their use-cases. For example, vehicles purchased for personal use like e-4W would be charged at residential and office locations, while EV fleets can use charging infrastructure at commercial or public charging stations for faster battery swapping and/or provide plug-in charging, as applicable. Combinations are likely to emerge. For example, Ola, the 4W fleet operator has set up fast charging stations in Nagpur along with slow charging points at driver-partners' residences.[79]

79 Ola Mobility Institute


*Photo credits: Statiq*

– For intracity bus services, it is assessed that average route length is less than the range of e-buses and therefore, suitable charging options may involve charging the buses at depots post completion of trip(s) or overnight, whereas an en-route or intermediate charging station is required between origin and destination modes for an intercity trip given the longer route length.

The table below provides a summary overview of EV charging infrastructure by market segment-wide battery attributes and charging requirements.

**Table 5.2:** EV charging attributes market segment-wide
*2W fleet includes passenger and freight; Source: Stakeholder inputs, Steer representation

| Attributes/ Market Segment | 2W-Personal | 2W-Fleet | 3W-Passen-ger Fleet | 3W-Freight | 4W Personal | 4W-Fleet | Bus |
|---|---|---|---|---|---|---|---|
| Typical battery size (kWh) | 1.5-2 | 1.5-2 | 5-7 | 5-7 | 5-22 | 15-22 | 145-350 |
| **Charging time (hours)** | | | | | | | |
| AC-001 | 3-4 | 3-4 | 4-5 | 4-5 | 11-12 | 11-12 | |
| Type 2 AC charger | | | | | 8-10 | 8-10 | |
| Bharat DC 001 (GB/T) | | | 0.5 | 0.5 | 2 | 2 | |
| CCS/CHAdeMO (DC) 50kW | | | | | 0.5 | 0.5 | 4-5 |
| **Charging facilities** | | | | | | | |
| Residential | ✓ | | | | ✓ | | |
| Office | ✓ | | | | ✓ | | |
| Public charging includes captive charging station | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Battery swapping | | ✓ | ✓ | ✓ | | | |
| Depot charging | | | | | | ✓ | ✓ |

The total investment requirement includes the following costs related to installation of chargers

**Table 5.3:** Cost of different charger types
Source: Stakeholder inputs, Steer representation

| Charger type | Cost (INR per charger) |
|---|---|
| 15 Amp | 2,000 |
| AC001 | 3,500 |
| Type2AC- 7kW | 40,000 |
| Bharat DC 001- 10kW | 200,000 |
| CCS2- 25 kW | 700,000 |

**Table 5.4:** Installation costs (As a proportion of charger costs)
Source: Stakeholder inputs, Steer representation; above installation costs are not added for 15 Ampere chargers

| Installation costs | Cost as a proportion of charger cost | |
|---|---|---|
| | AC 001 | Type2AC Bharat DC001, CCS2 |
| Civil work | 5.0% | 10% |
| Installation and Commissioning | 3.0% | 15% |
| Software cost | 2.0% | 5% |

## Market assessment results

Using the outputs of the market assessment exercise for each market segments, a charging infrastructure model has been developed to estimate the number of charging points required by each vehicle type, and the type of charger by each location nationally.

**Figure 5.2:** National charging infrastructure forecast by charger type and location- 2/3W and cars (business-as-usual scenario)
*E-bus penetration in India is largely policy driven and would lead to charger installation primarily at depots as a part of procurement process, therefore estimation of e-bus chargers is not included in the forecasts;
Source: Steer estimates

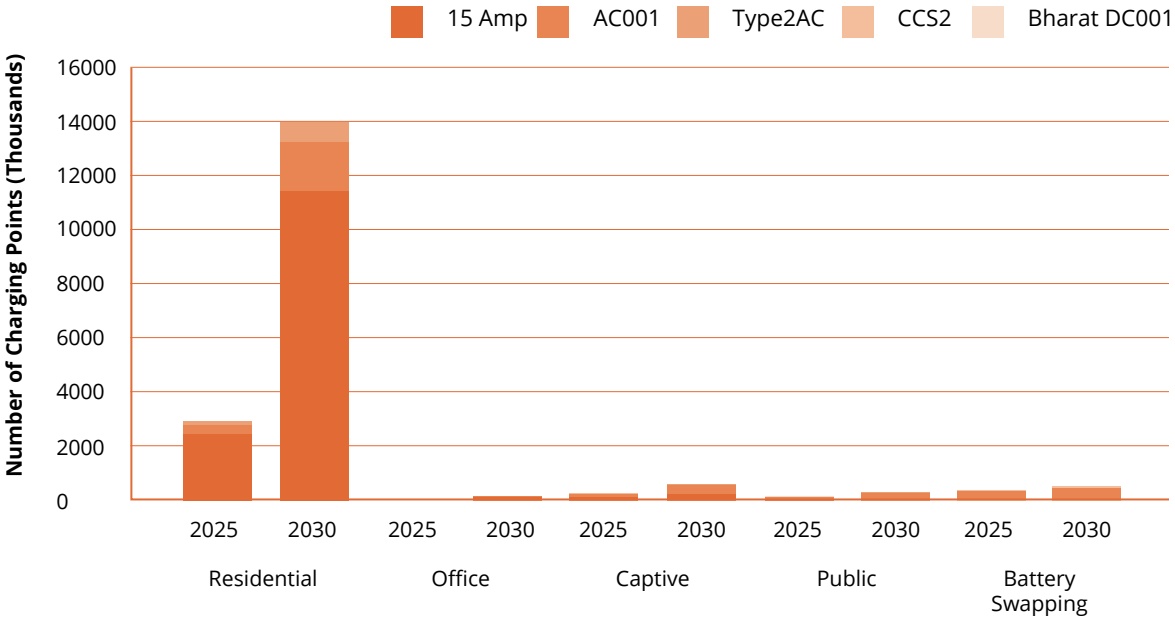


**Table 5.5:** 2030 charging infrastructure forecast- Business-as-usual scenario
(in thousand charger points)
Source: Steer estimates

| Type of Charger | Resi-dential | Office | Cap-tive | Public | Battery Swapping | Total Chargers | Total Investment required (INR Mn) |
|---|---|---|---|---|---|---|---|
| 15 Amp | 11,360 | 50 | 150 | | | 11,560 | 23,000 |
| AC001 | 1,820 | 30 | 370 | 220 | 830 | 3,270 | 13,000 |
| Type2AC | 720 | 20 | 30 | 20 | | 790 | 41,000 |
| Bharat DC 001 | | | 4 | 1 | 90 | 96 | 25,000 |
| CCS2 | | | | | | 2 | 2,000 |
| **Total** | **13,900** | **100** | **554** | **244** | **920** | **15,718** | **104,000** |

As seen in countries with high EV penetration such as US and China, the residential EV charging demand in India contributes the maximum proportion, at about 90% of forecasted charging points to be installed in order to support EV penetration under BAU scenario. This is driven by the 2W vehicle population, which would be primarily charged at home. Majority charging requirements at residential locations are expected to be met from large number of 15 Amp industrial sockets and/or AC001 chargers where e-2W and e-4W users can easily access them at their preferred parking locations requiring a total investment of about INR 67 billion by FY 2030. With most significant increases in the numbers of users looking to charge their e-2W and e-4W using these slow chargers at their residential locations, a clear mandate from the city/state authorities to enable new and existing residential locations to be EV ready (through retrofitting) will become a key enabler.

### Guidance on Accelerating the Construction of Electric Vehicle Charging Infrastructure- China

The State Council of China had issued a guidance for construction of EV charging infrastructure which plans for all new residential construction to be equipped with EV charging facilities, all large public buildings to have 10% reserved parking space for EV charging and development of one public charging station for every 2,000 EVs. It also promotes public-private partnership for installation of chargers in commercial places such as malls, grocery stores, major parking facilities. To support this development, National Development and Reform Commission has published a notice setting out standards and procedures for installation of residential chargers.
City of Shenzhen offers purchasers of EVs, subsidies up to RMB 20,000 (*USD 3,092) for vehicle insurance and installation of charging equipment.[80]
In April 2020, Chinese government decided to invest USD 381 million in EV charging to enable the State Grid company to build about 78,000 charging stations over the year.[81]

80 Electric Vehicle Charging in China and the United States, Anders Hove and David Sandalow, February 2019, Centre of Global Energy Policy
81 How EV Charging Can Clean Up China's Electricity Grid," Barbara Finamore and Hyoung Mi Kim, NRDC, 2020

Under the forecasts outlined above, the provision of public charging is a critical enabler for the EV market growth to continue unabated to gain user confidence for adoption of EVs. Based on user preferences, some studies have claimed that the classic 'chicken and egg' problem between charging and EV adoption can be resolved by deploying public charging first as it is an essential consideration for purchase of an EV.[82] To facilitate EVs adopted under BAU scenario, about INR 4 billion investment would be required in setting up public charging stations. Battery swapping would become a key facilitator for e-2W and e-3W fleet models and would require setting up a dense network of swapping stations. Captive charging locations would contribute mainly for meeting charging needs of fleet businesses across e-2W, e-3W and e-4W vehicles.

## Priority markets

Qualitative analysis of a range of potential business models for providing charging infrastructure was undertaken, building upon the stakeholder feedback and secondary analysis of charging infrastructure market.

Below are some international useful examples of charging infrastructure business models prevalent globally, with their relevance for India.

- **BOO Example – IONITY[83]** network owned and operated in Europe by five vehicle manufacturers (VW, Ford, BMW, Daimler and Hyundai). The creation and funding for the network was provided by a consortium of OEMs to support and create a network of High-Powered Charging network for CCS capable vehicles only. CCS is the most widely supported charging standard in Europe. The locations of the charging stations are sourced by the Ionity team and focused in high traffic locations and where speed of charging is key to the users' needs and therefore drives higher utilization. The network is open for use to any vehicle that can charge using the CCS standard. The consortium also offers preferential membership tariffs available to those you drive the consortiums vehicle product and other selected partners.

  *Relevance in India:* Several OEMs like Ather and Okinawa have started working on providing a network of charging locations for their customers. For instance, Ather Grid installed in cities like Bengaluru and Chennai allow fast charging for its models, however other scooters manufactured by other large e-2W OEMs are still using AC charging for their models. Therefore, they are currently all working to serve their own customer base and not adding to a public provision of charging infrastructure. Currently this cost of providing public charging infrastructure is being seen as a market enabling initiative and is treated as a cost of doing business by most OEMs. As the market sizes increase and larger adoption across large urban centers is experienced, it is likely that some OEMs would come together to offer joint solutions which could be provided by the equivalents of IONITY in India. A key enabler for such business models would be some level of standardization of the battery and charging across multiple OEMs. This is starting to happen in the e-4W market however there is not much progress in the e-2W and e-3W markets in this area.

82 Electric Vehicle Charging in China and the United States, Anders Hove and David Sandalow, February 2019, Center of Global Energy Policy
83 https://ionity.eu/en/design-and-tech.html

- **Infrastructure as a Service (IaaS) – Liberty Charge.**[84] A new and emerging business model in the UK, Liberty Charge is a joint venture between Liberty Global and Zouk Capital (a sustainable infrastructure fund manager) and leverages the network assets and build capabilities of Virgin Media (a Liberty Global subsidiary). The intent of model is that investment is split above and below the ground. Liberty Charge provides the base power and communications that enables charging point operators or local authorities to set up areas where access to off street locations is prohibitive. The charging station operator connects via a plug and play system to the power and connectivity on annual IaaS fee basis reducing the upfront infrastructure cost for CPOs.

  *Relevance in India:* The initial steps in creation of capabilities needed for such a model to exist in India are being taken by involving public sector undertakings like NTPC or REIL in delivering the public charging network investments being led by DHI. As these organizations gain the technical expertise to deal with below the ground and grid connectivity aspects of delivering charging infrastructure facilities, they could evolve over time to let the installation, operations and maintenance of the above ground infrastructure being led by specialists charging infrastructure operators. DISCOMs are not considered as the active participants in this sector due to their wider financial conditions and the focus on managing their existing business better.

- **Infrastructure as a Service (IaaS) - FEV.**[85] Defined by the company FEV as an IAAS model it addresses the fluctuating demand in charging and the need to provide grid reinforcement and transformer stations when the business case is still challenging. The FEV developed prototype has confirmed proof of concept with the energy supplier Uniper producing a mobile fast charging station, that contains a mobile battery storage solution, that can be replaced once the batteries run out (a form of battery swapping). Uniper has an intent to install more than 1300 units across Germany over the next 4 years.

  *Relevance in India:* Sun Mobility is partnering with Kinetic Green and Piaggio in setting up stationary battery swapping stations. They are closest to taking up this business model as the market evolves and the need for mobile charging stations arises.

In India, four key business models are prevalent in space of charging and swapping infrastructure space which are presented in the table below:

84 https://libertycharge.com/infrastructure-as-a-service/

85 https://www.fev.com/en/coming-up/press/press-releases/news-article/article/fev-develops-mobile-power-bank-for-electric-vehicles.html

**Table 5.6:** Business model for charging and swapping infrastructure
Source: Steer representation

### Captive Charging Station

- Fleet operator setting up captive stations for own fleet
- Third-party private operator providing charging services to fleet operators
- **Key driver of viability:** Utilization of chargers
- **Extended/potential uses:** Tie-ups with other fleet operators and offering services to general public
- **Fiscal support required:** Subsidized land and electricity tariff
- Example: Luthium, OLA electric, e-BikeGo

### Public Charging Station

- Commercial EV charging station providing charging on pay per use basis on public locations
- **Key driver of viability:** Utilization of chargers
- **Extended/potential uses:** Provision of amenities to improve viability
- **Fiscal support required:** Capital subsidy for chargers, subsidized land electricity tariff
- Example: EESL, NTPC, REIL

### Battery Swapping Stations

- Third-party private operator providing swapping services to fleet operators
- **Key driver of viability:** Utilization of batteries
- **Extended/potential uses:** Tie-ups with many fleet operators
- **Fiscal support required:** Subsidy on battery sold seperately, reduced GST rate on batteries and battery as a service model
- Example: Sun Mobility, VoltUp, Lithion Power

### E bus-depot charging

- Third-Party charging-as-a-service provider installing and maintaining charging infrastructure
- CaaS subscription models and wayside amenity+services for intercity bus market
- **Key driver of viability:** Commercial use of land/building and packaging with other services like wayside amenities
- **Extended/potential uses:** Availability for use by private fleets during off-peak (day) for buses
- **Fiscal support required:** Concessional land
- Example: Zenobe, NHforEV, NHAI WSA

Residential charging would be primarily used for e-2W charging but will be essential for early adoption of 4Ws as well. Public charging and battery swapping are key enablers to bring confidence in users to adopt EVs. Captive charging would be primarily used in fleet businesses across private vehicle market segments for 2W, 3W and 4Ws. Unbundling charging infrastructure as service for e-buses brings efficiency and will enable viability for fleet operator.

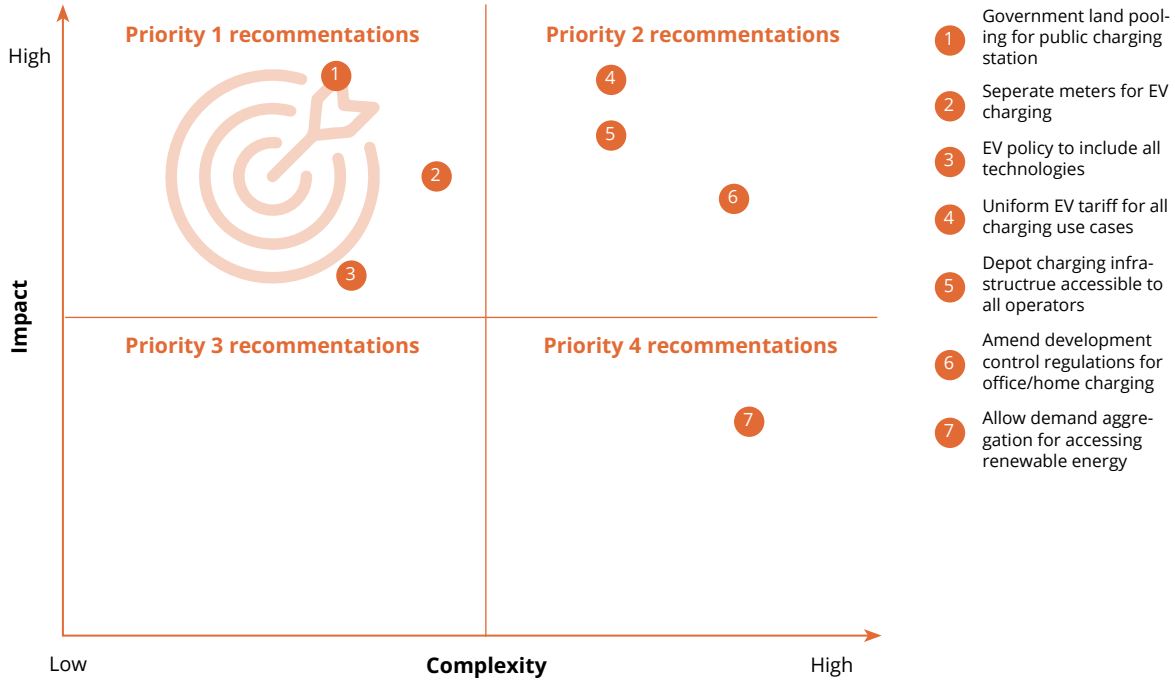
## Market barriers and proposed intervention

### Key action plan recommendations

All business models and market segments of charging and swapping infrastructure such as residential, office, captive, public and swapping stations would play a key role in mass uptake of electric vehicles. For the general public, the priority is to unlock charging at locations where people naturally park already for large number of hours. This should be supplemented by a network of public fast charging facility allaying concerns over range. Action plan steps have been recommended to improve deployment of charging and swapping infrastructure for all market segments. Detailed action plan recommendations for charging and swapping infrastructure are presented in annexure C

As discussed in Chapter-1, the action plan recommendations presented in the figure below were prioritized based on feedback received from implementing agencies at national and state level

**Figure 5.3:** Prioritized action plan recommendations for charging infrastructure
Source: Steer representation




Key recommendations for mass deployment of charging and swapping solutions are presented in the table below:

**Table 5.7:** Action plan roadmap and barrier addressed for charging and swapping infrastructure
Source: Steer representation

| Recommendation | Description | Barriers addressed |
|---|---|---|
| Applicable to all charging business models | | |
| **Provide land at concessional prices in cities for setting up public charging infrastructure**<br><br>**Category - Policy and Regulatory**<br>**Category - Governance and Institutions** | Allow land at concessional rate or provide capex subsidy in form of land provision for setting up public charging stations by state and city authorities | Decrease in capex or opex (rent or lease cost) requirement leading to improvement in commercial viability of a charging station |
| **EV policy to provide level playing field to all charging technologies**<br><br>**Category - Policy and Regulatory**<br>**Category - Governance and Institutions** | EV policy to provide level playing field to all charging technologies. Therefore, FAME or state EV policies to extend capital subsidy to any public charge point operator or battery swapping player under the condition on providing open or shared access to other users | Reduction in upfront capex of setting up a charging or swapping station |
| **Amend development control regulations to enable residential and office charging**<br><br>**Category - Policy and Regulatory**<br>**Category - Urban Infrastructure** | Majority of charging needs would be met at residential and office locations; therefore, State Urban Development Department and local municipalities to adopt the amendments in Development Control Regulations issued by Ministry of Housing and Urban Affairs (MoHUA) for installing charging infrastructure in building premises and core urban areas.[86] | Overcome negative perception towards an EV due to range concerns of a user by improving accessibility to charging solutions |
| **Consistent tariffs for EV charging across public, private, captive and battery swapping facilities in each city**<br><br>**Category - Policy and Regulatory** | Consistent tariffs for EV charging across public, private, captive and battery swapping facilities in each city. The Ministry of Power to consider including in the recently introduced "Electricity (Rights of Consumers) Rules, 2020" the consumer's "right" to have a "choice" to get EV metered connection for charging | Lack of consistent tariffs across different locations impacts commercial viability and scale up potential of fleet and charging station business models |

86 Amendments in Model Building Bye-Laws (MBBL-2016) for Electric Vehicle Charging infrastructure

| Recommendation | Description | Barriers addressed |
|---|---|---|
| Applicable to captive charging models supporting fleet operations | | |
| **DISCOMs to facilitate separate meters at EV charging locations**<br><br>**Category - Policy and Regulatory**<br>**Category - Urban Infrastructure** | State Power Distribution Companies (DISCOMS) to make necessary provisions such as facilitate separate meter or sub-meter to allow charging operators to avail EV charging tariff | Availability of subsidized tariff published by State Energy Regulatory Commissions is not available across different charging and swapping locations |
| **Remove the minimum threshold requirement on contract demand for EV charging**<br><br>**Category - Policy and Regulatory**<br>**Category - Urban Infrastructure** | State Electricity Regulatory Commission (SERC) to remove the minimum threshold requirement on contract demand for EV charging and allow access to renewable energy on charging stations such as solar-rooftop panels and demand aggregation among multiple charging operators | As EV penetration is low in the current market scenario, charging station operators cannot maintain the minimum 1 power MW, restricting use of renewable energy resources on charging stations |
| **Provision of charging infrastructure/depots opened to public and private operators plying intercity route**<br><br>**Category - Policy and Regulatory**<br>**Category - Urban Infrastructure** | State governments to liaise with NHAI to add e-bus charging points on the passenger wayside amenities along national highways which could be accessed by both public and private bus operators. State level plans to be developed for ebus charging. | e-bus TCO in comparison to ICE variants is better on intercity routes due to operational savings realized over longer distances, however the absence of opportunity or depot charging locations along the route limit the adoption of EVs in this market segment |

# 6.

# Financing Solutions

## Introduction

One of the key objectives of the study to assess current EV market conditions and outline a viable market roadmap for increasing uptake of EVs in India. Chapters 2 and 3 of this report have summarised the various market segments and shortlisted business models with the highest potential for scalability. In the earlier chapters, specific action plan recommendations have been provided which may result in the first acceleration required to achieve 30% EV market share in the priority market segments.

This chapter focuses on understanding the challenges and barriers to funding and financing in detail to identify a set of financial options that could be deployed by Indian policymakers to unblock the flow of affordable finance into the EV sector and increase EV penetration for the shortlisted business models beyond baseline/do-minimum levels. These investment options if implemented will act as a second accelerator contributing to the 30X growth to be achieved in shorter time span.

The major sections of the chapter are as follows:

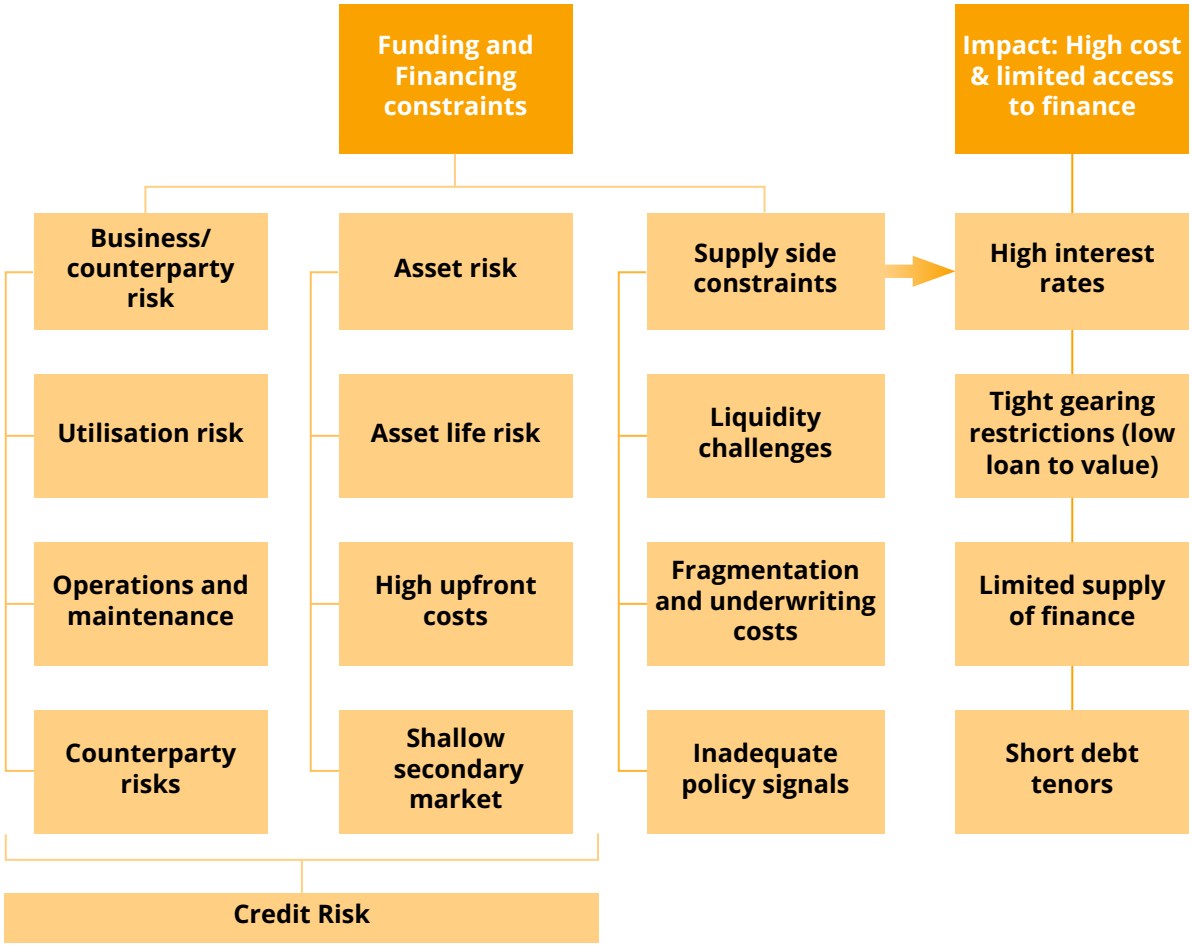
- **Funding and financing barriers** – these are the challenges faced by the selected business models in accessing affordable funding and financing.
- **Identification of financial options** – a range of financial options have been identified that could help reduce some of the funding and financing barriers.
- **Appraisal of financial options** - Each of the financial options are appraised to establish their relative impact on penetration and which options should be prioritized by government.

## Funding and Financing barriers

As is typical with an emerging technology, the current market for EV financing is still in its infancy and is characterised by various funding and financing barriers across the electric vehicle market. These barriers must be overcome to allow much needed investment to flow into the sector which, in turn, can increase the supply of affordable financing to business and individual borrowers.

The funding and financing barriers identified in the figure below are not entirely unique to EV financing and can be seen in the conventional ICE vehicle financing market in India. However, EVs add an extra layer of complexity in terms of credit risk and this is resulting in potentially tighter credit conditions faced by EV borrowers in terms of interest costs and loan-to-value (LTV) requirements.

**Figure 6.1:** Funding and financing barriers
Source: Steer representation




Credit risk is particularly the case with the interdependency with public charging infrastructure which, if underprovided for, can undermine the operations of high utilization business models where EVs have a TCO advantage (e.g. fleet businesses). As such, lenders have to carefully appraise whether the charging interface is effectively managed before making firm commitments, otherwise it may present a business risk that is challenging to manage and could increase credit risk.

Additionally, the asset life of what is a nascent technology is still to be fully discovered and understood by financiers, with unknowns in terms of battery life, uncertain maintenance requirements and a low base of mechanical capacity and expertise to provide effective lifecycle/after-sale maintenance. This means lenders have to carefully consider any additional operations and maintenance costs and what impact this may have on the borrower's ability to meet their debt service obligations. But perhaps more importantly, it can also create uncertainty around residual value and asset life which in any vehicle financing is often the key element of lender security. This is exacerbated by an immature and shallow second-hand market for EVs meaning lenders cannot rely on the market valuations such as those available in the large second-hand market for ICE vehicles.

The relatively higher upfront purchase costs of EVs also present potential challenges to financiers. All other things being equal, higher purchase prices result in larger loan sizes for borrowers. This can be a particular challenge in the light vehicle segments (e-2W/e-3W) where the TCO advantage of EVs is higher but the creditworthiness of potential borrowers is often low and counterparty risk is higher. As a result, borrowers may not be able to access the higher capital required and/or be able to afford the commensurate increase in vehicle deposit and interest rate that is likely to be associated with a larger loan amount.

This situation also presents a challenge for financiers in terms of the additional liquidity required to meet the higher financing requirement. Much lending in the vehicle finance sector is undertaken through thinly capitalized Non-Banking Financial Companies (NBFCs) who are already facing liquidity challenges due to non-performing loans and high underwriting costs. This can result in challenges in NBFCs accessing affordable wholesale funding.

Although, existing policy and regulatory incentives have helped spur activity in the sector, as of early 2021, these are not enough to create enough momentum towards a mass EV shift. Further signs of policy commitment and incentives are needed to transition to EVs which would also boost financiers' confidence in the sector without which the targeted number of EVs on road may not be possible.

## Identification of Financial Options

### Overview

If unaddressed, these funding and financing barriers (and the impact they have in tightening credit conditions for EV financing) will have a detrimental impact on delivering India's target EV penetration rates. In order to drive increased penetration, there needs to be at least parity in the cost and availability of financing between EVs and ICE vehicles.

A laissez-faire approach of allowing the market to gradually adjust to the new technology and the associated financial risks will result in an extended period of adjustment that is unlikely to support the step-change in penetration required by government targets. Policymakers in many countries are faced with this same reality and are having to formulate a catalytic policy response to overcome these barriers and stimulate market growth. Policymakers can adopt a range of financial solutions to support lenders to better understand and effectively manage EV financing risk. For this purpose, a range of these potential financial solutions have been identified in this report to work in the Indian context to unlock the EV financing market, particularly for those business models with the highest potential to increase EV penetration.

*Emerging trends in EV financing*

NBFCs, private and public banks, OEM led captive vehicle financers are key players in the automobile financing. Recently fintech companies have been a niche market segment in digital lending.[87] FinTech companies offer commercial lending through technology and digital platforms and are emerging as significant players in EV financing ecosystem,

87 Mobilizing Finance for EVs in India, A Toolkit of solutions to mitigate risks and address market barriers, NITI Aayog and Rocky Mountain Institute, January 2021

through tie-ups with OEMs, insurance providers, battery manufacturers to create an instalment cum subscription model to make it easier for consumers to buy EVs.[88]

FinTech options are increasingly becoming relevant in EV space as a lot of EVs especially e-2Ws are also being purchased in smaller towns with limited availability of credit from traditional banks. It is also not feasible for NBFCs to be present at most of these places due to high operational costs, whereas fintech companies offer consumer an option to avail credit via a smartphone which can get processed in a short span of time with limited need of documentation verification and past credit history. They are using data driven tools like machine learning algorithms and non-traditional data like psychometrics, SMS and biometrics for underwriting these loans.[89]

Many FinTech companies are using innovative methods for collections including tie-ups with payment banks which allow the customer to deposit cash at any authorised payment point. To secure vehicles which are being financed by these platforms, some fintech companies are embedding IoT devices in the vehicles such that in case of theft they can limit vehicle range through geo-fencing and immobilising the vehicles.

FinTech's enable smaller, higher frequency and more diversified transactions.[90] Innovative financing solutions such as subscription based financing plans, offering bundled services including insurance, service and maintenance, upgrade options etc., being offered in the FinTech space would also act as a key catalyst in boosting EV adoption.

### Identified Options

The financial solutions proposed can be classified into three groups of potential financial options:

- **Direct government funding:** These options involve a direct intervention by government in the form of direct subsidy to EV markets.
- **Debt mobilization:** These options involve leveraging the government's balance sheet to provide indirect funding support aimed at unblocking the flow of debt into the EV sector by providing a backstop to lenders on key risks, therefore improving access to affordable finance.
- **Equity/debt investment:** These are options where new, high-quality capital is deployed directly into the EV value chain to provide the investment required to spur development and further uptake but without any recourse to the government balance sheet. Here the role of DFIs (such as International Finance Corporation) is crucial.

The various financial options assessed in the study are summarized in the table below. All of the options have the objective of reducing risk to lenders and in turn reducing the interest rate costs faced by borrowers.

88 https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/how-fintech-can-provide-innovative-financing-solutions-to-indias-ev-sector/articleshow/78200187.cms accessed on 15 January 2022
89 https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/how-fintech-can-provide-innovative-financing-solutions-to-indias-ev-sector/articleshow/78200187.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst accessed on 15 January 2022
90 https://www.hitachi.com/rev/archive/2017/r2017_01/102/index.html accessed on 15 January 2022

**Table 6.1:** Financial options to address funding and financing barriers
Source: Steer representation

| Option Group | Option | Description | Barriers addressed |
|---|---|---|---|
| **Direct government funding** | Vehicle discount scheme | Government subsidy to OEMs to offer a discounted sale price | High upfront costs |
| | Interest rate subsidy | Government subsidy to allow lenders to offer a lower interest rate | High upfront costs, liquidity challenges |
| | User discounts | Rebate scheme for transport operators per journey/delivery undertaken by EV | Utilization risk, Inadequate policy signals |
| **Debt mobilization** | Wholesale market first loss | First-loss facility to partially absorb losses at the wholesale funding level from NBFC defaults on EV loans. Facility covers a specified amount of loss; thereafter wholesale lender covers losses | Liquidity |
| | First loss guarantee | First-loss facility that partially absorbs lenders losses in the event of default by a borrower. Facility covers a specified amount of loss; thereafter lender covers losses | challenges |
| | Second-loss guarantee | A second-loss facility provides a fixed proportion of losses in the event of default by a borrower. Lender covers remaining proportion of loss | Asset life risk, Shallow secondary market |
| | Public charging PPP | Government tenders a charging station or a bundle of charging stations to be built, financed and operated by private sector supported by government funding support (e.g. availability payments) | Asset life risk, Shallow secondary market, High upfront costs |
| **Equity/debt investment** | Direct lending/ investment | DFIs enter the value chain deploying both debt and equity products to different companies, particularly start-ups so that innovation is catalyzed | |
| | New financing vehicle (NBFC) | A new NBFC / SPV to be created with the sole mandate of providing debt financing for electric vehicles or an existing NBFC would be re-capitalized to provide dedicated and lower-cost EV finance for borrowers | |

An example of first loss facility is presented in the box below:

Source: https://www.nama-facility.org/projects/kenya-small-vehicles-e-mobility/


**NAMA facility -Kenya**

NAMA facility is a multi-donor initiative between German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), UK's Department for Business, Energy and Industrial Strategy (BEIS), Danish Ministry of Climate, Energy and Utilities (KEFM), Danish Ministry of Foreign Affairs (MFA) and European Commission that offers technical and financial assistance to developing and emerging economies in tackling climate change. The KfW Development Bank and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH are commissioned to implement the Facility.[91]

In Kenya, 72% of population is residing in rural areas and has low vehicle ownership rate of about 28 vehicles per 1000 persons. The rapid motorization of the economy presents an opportunity for acceleration of e-2W and e-3W uptake which would also result in reducing potential emissions from the transport sector.
Limited financing is available in electric mobility sector in the country and therefore two initiatives have been implemented under the NAMA facility:

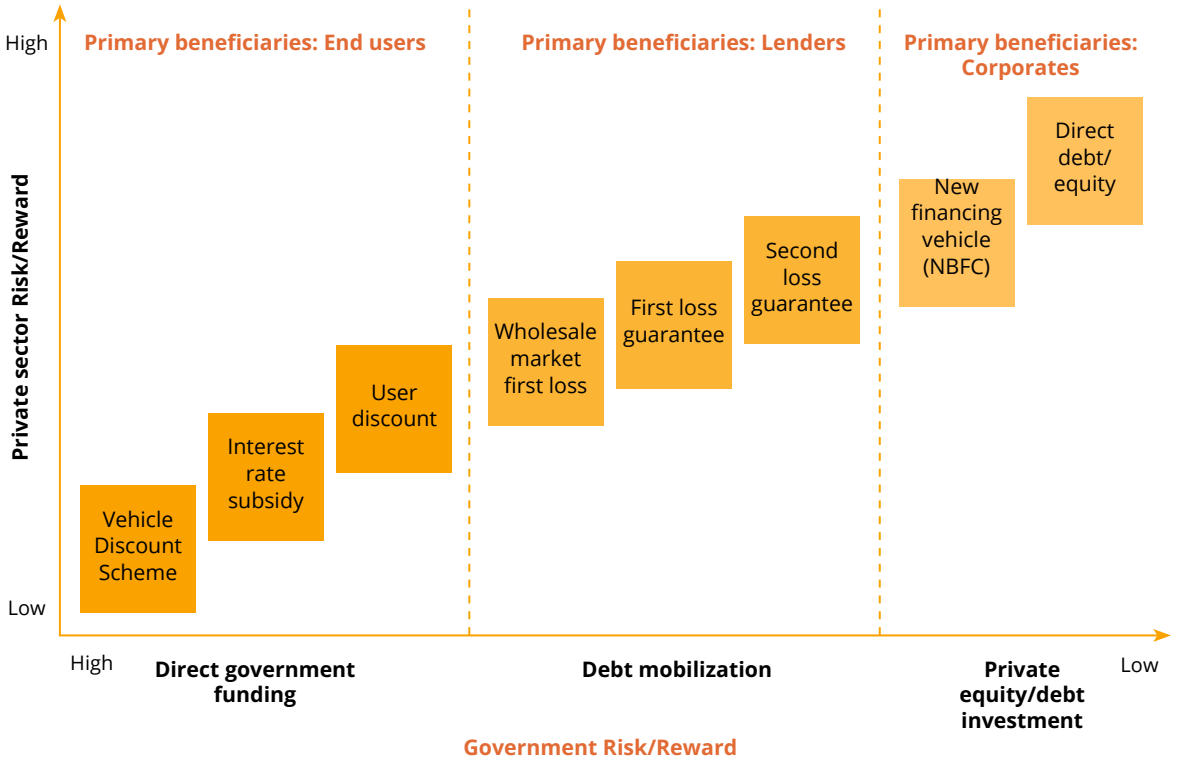
- Second loss partial credit guarantee scheme of EUR 3.5 million has been launched especially for commercial fleets
- First loss credit guarantee scheme of EUR 5.5 million to unlock private sector debt financing for absorbing losses up to the first 10%.[92]

91 NAMA Facility-2nd Interim Evaluation and Learning, Final Report, February 2021

92 https://www.nama-facility.org/projects/kenya-small-vehicles-e-mobility/ accessed on 20th January 2022

The same options are shown graphically in the figure below. This shows how the different options have a different risk allocation between government and the private sector. The direct government funding options have high government exposure and low private sector risk with the intervention predominately targeted at reducing cost to the end user. The debt mobilization options see the government and private sector, specifically lenders, sharing in key risks whilst the private equity/ debt investment options involve corporates taking the bulk of risk with minimal support but still benefit in terms of the availability of new high-quality capital.

**Figure 6.2:** Mapping of Financial Options
Source: Steer representation




## Appraisal of Financial Options

### Introduction

Government funding available to the EV sector is of course finite and policymakers are unlikely to pursue all of the financial options outlined in the section above. Instead, government would need to prioritize its intervention in the sector. The study has therefore appraised each of the identified financial options to establish which of the options provides the best value for money for government. The sections below present the approach adopted in the appraisal exercise and the subsequent results and recommendations.

## Appraisal methodology

Each of the options outlined in the previous section is appraised by assessing its budgetary efficiency (i.e. how many additional EVs will be sold per quantum of government funding invested in each option). To calculate budgetary efficiency for **2/3W and cars,** it is assumed that the government would provide INR 33,750 [93] ($450m)[94] of funding in support of each option to be spread equally across each of the e-2W, e-3W and e-4W markets (i.e. INR 11,250m ($150m) funding for each market). For each option, the choice models developed earlier in the study were used to calculate the increase in EV penetration in the target cities, estimating how a reduction in the interest rate offered to borrowers under each option would in turn reduce TCO and help to improve the wider perception of EV ownership. Each option can then be compared consistently and relatively in terms of its budgetary efficiency – i.e. how many additional EVs would be sold per million dollar of INR 33,750m ($450m) government funding invested.

A similar exercise was also carried for the e-bus market. Here the appraisal exercise assessed the extent to which each option could help in bridging existing TCO gap 11% between conventional ICE buses and e-buses and in turn assessed the total aggregate cost savings achievable across the market through the introduction of each of the financial options.

Using the same analytical framework, the impact of deploying government funding to support the development of charging infrastructure has been considered given its criticality in driving increased penetration and customer perception of EVs. As such, the impact of INR 11,250m ($150m) investment in charging stations is calculated in terms of its impact on private vehicle EV penetration and in turn the budgetary efficiency of such an investment vis-à-vis the financial options. Appraisal of investment options in charging station have considered if those could be viable on a standalone basis or whether government funding would be required. It also identified models that reduce the recourse to government funding.

The detailed approach to the appraisal of the financial options is contained in Annexure D.

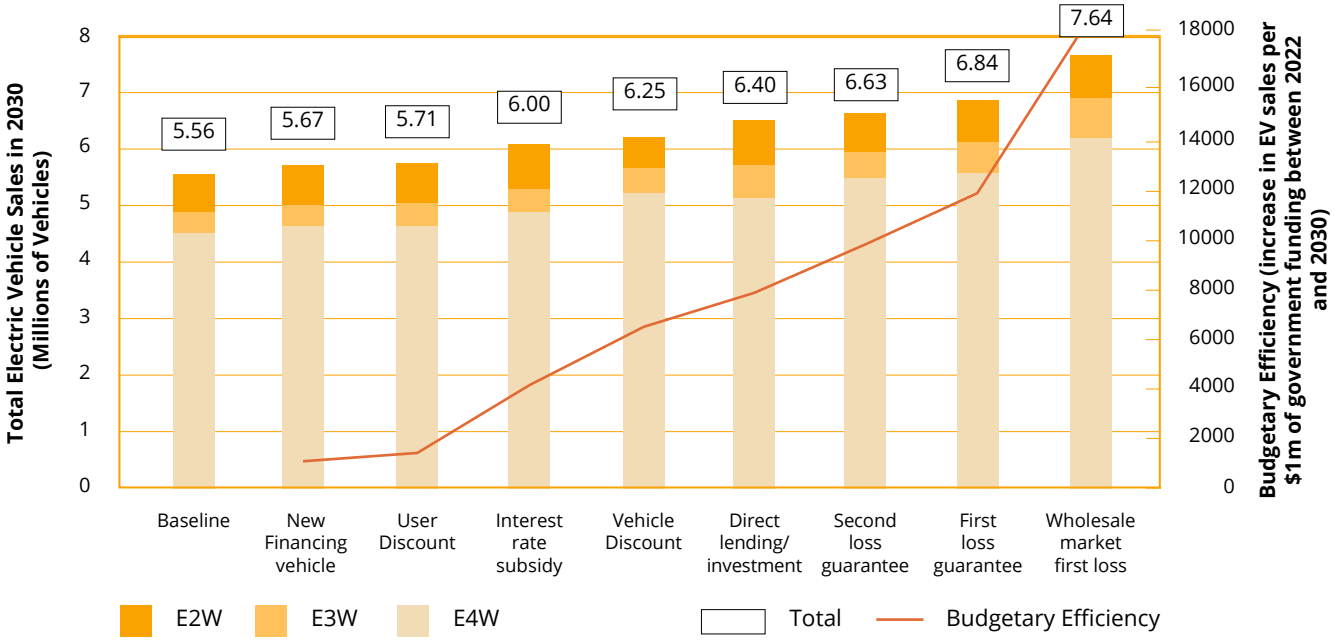
## Option appraisal results

*2/3 W and cars*

As shown in the figure below, for electric 2W, 3W and cars, the options that provide the greatest level of budgetary efficiency are those that mobilize the debt markets by deploying de-risking instruments, whether at the wholesale market level (i.e., a first loss facility made available to those banks funding NBFC vehicle lenders) or in the underwriting of individual transactions (the first loss and second-loss guarantee options).

93 Assumed exchange rate of INR 75/USD
94 For reference, FAME II provides a total outlay of US$1.4 billion.

**Figure 6.3:** Appraising the impact of the financial options – e-2W/e-3W/e-4W by FY2030
Source: Steer estimates




Under these debt mobilization options, a large number of vehicles can benefit from the option because only the expected loss from each vehicle is being funded, whereas under the options that involve direct government funding (i.e. subsidy), often a significant proportion of a vehicle's cost is being funded or financed. In other words, debt mobilization options provide a greater leveraging effect and are therefore more efficient.

To illustrate this point, for a vehicle discount (which in effect is a direct government subsidy) to be effective it is assumed that at least a 15% discount on the vehicle price would be needed. Based on a $1,000 e-2W vehicle, this will require government funding of INR 11,250 ($150) for each vehicle covered by the option. By contrast, the options orientated towards debt mobilization cover only lender losses in the event of default which after adjusting for the recovery (salvage) value of the vehicle and amortization of loans is relatively a small amount (e.g. loss given default for a INR 75,000 ($1,000) e-2W vehicle is estimated to be just INR 2700 ($36) if default occurred 2.5 years into a loan tenor and assuming a recovery value of 40% - a loss to lenders of about 3.5% of a vehicle).

Even with a lower funding cost per vehicle, the impact of these options in terms of the reduction in risk to lenders is significant as it reduces credit risk in several downside scenarios which in turn has the potential to reduce interest rates to borrowers and consequently increase penetration. As shown in the figure above, these options are increasing EV sales significantly against the baseline (i.e. no intervention option) and are the most efficient with each INR 75m ($1m) of government funding invested generating between 12,000 and 17,000 additional vehicle sales over the period 2022 and 2030. In particular, the appraisal exercise shows that the most efficient option is a first loss

facility at the wholesale funding level where banks are provided first-loss coverage on the default of NBFCs active in the EV financing market.

Such an approach could be structured in a variety of ways but in all of its potential forms, its higher impact is attributable to the strong credit substitution effect created by reducing the default risk on NBFCs (which can often be sub investment grade rated). The underlying funding costs of NBFCs often account for a significant proportion of the total interest cost borne by borrowers so any change in the NBFC's funding cost can have a large impact on the final interest offered to borrowers. In comparison the first loss and second loss options provided to underwriting banks will only reduce credit risk margins, which are a smaller proportion of the total interest cost faced by borrowers.

NITI Aayog and the World Bank are exploring the development of a first loss risk sharing facility for banks and NBFCs with a national bank as its program manager. The instrument would act as a hedging mechanism for financial institutions in event of delays or defaults on EV loans. It is expected to mobilize up to $1.5 billion by bringing down EV financing costs. The risk cover would provide greater confidence in lending and improve penetration in priority market segments.[95]

Although less efficient in terms of penetration, increased direct lending and investment from international third-party financiers (such as DFIs) could also have a significant impact, especially if deployed alongside a debt mobilization approach. Each individual investment will not have a systemic impact but the value to each individual firm of equity investment could be significant, including being able to fund market entry and R&D activities. This does not have the same leveraging effect in terms of penetration as the debt mobilization options but can be crucial in stimulating participation from companies focused on the e-mobility sector and in providing a demonstration effect for domestic lenders and investors.

*E-Buses*

The same financing options have been appraised for the e-bus market. The appraisal exercise for e-buses used a different methodology which assessed the extent to which each option could help in bridging the existing TCO gap between conventional ICE buses and e-buses and in turn assessed the total aggregate cost savings achievable across the market as a result of the introduction of each of the financial options. In the case of e-buses, the appraisal exercise, unlike that for 2/3W and cars, does not attempt to estimate what impact an improvement in TCO will have on e-bus sales given that the logit choice models did not incorporate buses and that an elasticity effect in the sector is much more challenging to calculate given that owners during initial phases are often large entities (e.g., government) rather than individuals.

This total cost saving calculation used for the appraisal was based on the number of vehicles covered by INR 11,250m ($150m) investment by government in each option and a set of operating assumptions (e.g. daily running distance, number of annual operating days etc) to establish a total ownership cost saving of the option over a 10 year assumed asset life for an e-bus – see Figure A2 in Annex D for an overview of the calculation methodology.

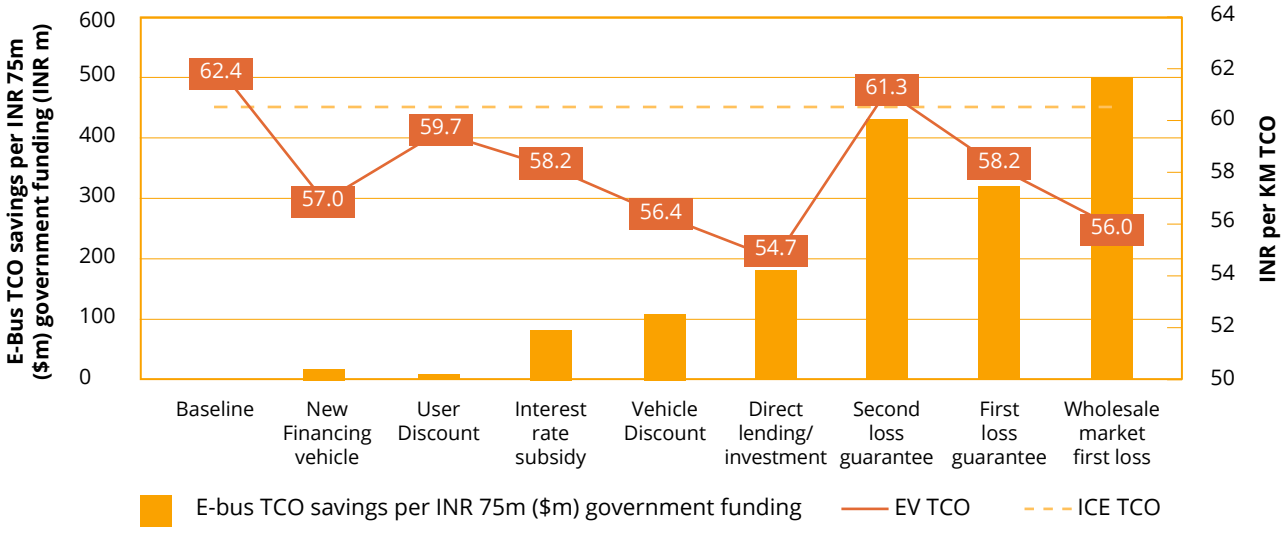
95 Banking on Electric Vehicles in India, A Blueprint for inclusion of EVs in Priority Sector Lending Guidelines, January 2022, NITI Aayog, RMI, RMI India

As with 2/3W and 4W, the options which mobilize debt by providing de-risking (i.e., first loss and second loss facilities) have the largest impact on reducing total aggregate costs in the sector because they not only significantly reduce financing costs (and therefore TCO) but also can cover a large number of vehicles because only the potential losses are covered on the loans which means the funding requirement per vehicle is lower than the options that directly subsidize the bus market.

A first-loss facility at the wholesale funding level is estimated to be the most efficient in achieving ownership cost savings of e-buses. However, the sector will also benefit from lower-cost direct lending and investment from international third parties (including DFIs) who can potentially provide lower-cost financing as well as co-benefits such as setting a demonstration effect for domestic lenders to enter the financing market for buses.

The figure below provides an overview of the appraisal results and shows the level of e-bus TCO savings per $m (INR 75m) of government funding compared to the baseline (i.e., no-intervention). This shows how efficiently each option can deliver a reduction in the cost of owning and operating e-buses over an assumed 10-year asset life. It also shows how TCO per km (INR) for e-buses changes with each option and the extent it closes the gap with the TCO of e-bus ownership. As can be seen the wholesale market option if it was also made available to buses would have the dual benefit of equalizing TCO cost with ICE buses but also because of its leveraging effect can cover more vehicles and hence is also the most efficient option. It shows that loss guarantee mechanisms have the largest impacts on aggregated TCO savings with a ratio of 4 to 6.6 times the level of government support owed to the leverage they provide. On a direct TCO basis per bus impacted, direct lending or investment performs well, albeit on fewer units.

**Figure 6.4:** Appraising the impact of the financial options – -e-buses
Source: Steer estimates



*Charging Infrastructure*

Using the same analytical framework, the impact of deploying government funding to support the development of charging infrastructure has been assessed given its criticality in driving increased penetration and customer perception of EVs.

Appraisal of different financial options shows that if the government invests INR 11,250m ($150m) into a public charging scheme, the TCO benefits would drive a significant increase in electric 2/3W and cars sales when assessed through the study logit choice model with nearly 2 million additional vehicles expected to be sold as a result of the investment. This translates to a budgetary efficiency estimation of 29,000 additional vehicles per INR 75m ($1m) invested. Adding battery swapping facilities at a charging station would add further penetration with an estimated 33,000 additional vehicle sales per INR 75m ($1m) invested. This shows that investment in charging infrastructure is also extremely important in driving increased EV sales and is also an efficient use of finite government resources and compares well in terms of budgetary efficiency with the financial options presented above.

However, with current EV market penetration levels, utilization is expected to remain low during the initial years. This makes charging infrastructure investment unviable for the private participants on a standalone basis. Therefore, public agencies would need to step-in to provide the necessary funding support to promote setting up of the charging stations and to provide affordable prices in-line with home charging.

The table below summarizes the impact of some of the different business models for charging stations.

**Table 6.2:** Appraisal of investment options: Station viability (recommended options)
Source: Steer representation

| Options | Public Charging Scheme (PPP) | Public Charging Scheme (Municipal) | Public Charging Scheme (with Battery Swapping) | Public Charging Scheme (40% Electricity Discount & 75% Capex Subsidy) |
|---|---|---|---|---|
| **Facility Size** | INR 11,250m ($150m) | INR 11,250m ($150m) | INR 11,250m ($150m) | INR 11,250m ($150m) |
| **Increase in EV sales (2022-2030)** | 5.5 Mn | 5.5 Mn | 6.3 Mn | 4.2Mn |
| **Increase in EV sales per INR 75m ($1m) of government funding (2022-2030)** | 29,003 | 29,003 | 33,055 | 22,818 |

## Summary

There are several barriers to increasing the flow of affordable finance to the EV sector. Overcoming these barriers will be crucial in reducing the overall cost of ownership of EVs versus ICE vehicles and in turn increase sale penetration. Policymakers will likely need to intervene to stimulate the financing market by providing funding and/or de-risking support so that the viability of investment in the sector is improved. This will provide the incentive for financiers to participate and enter into in the EV finance market whilst it is still in its infancy and will also have the co-benefit of reducing cost of ownership and increasing penetration. Once more financiers have entered the market, sector risks will become better understood and managed which should remove the need for any long-term funding support.

The analysis in this report showed that the most optimal option for supporting the EV financing market was through mobilizing the debt markets, preferably at the wholesale funding level where underwriting NBFCs could benefit from accessing lower funding costs through a first loss facility operating at the wholesale level (to the benefit of participating state banks). The underlying funding costs of NBFCs constitute a large proportion of the interest cost faced by borrowers and so if this can be reduced, the impact on cost of ownership and subsequently penetration is significant whilst such a facility can cover a large number of potential borrowers because only loss coverage needs to be funded rather than large direct subsidies.

While the financial options presented will drive increased EV penetration across vehicle types, it is important to note that investment in charging infrastructure is also vitally important and also an efficient deployment of government funding to support the sector. Given that government funding is likely to continue to be required to support the roll out of charging infrastructure, this places an extra emphasis on the need to support the financing market efficiently through debt mobilization mechanisms such as the one proposed for the wholesale funding market so that support to both the financing market and the emerging charging market can be maintained.

# 7.

# Impact of Action Plan Recommendations

*Photo credits: Ather Energy*

## Introduction

This chapter provides a snapshot of impacts of implementing recommended action plan steps with financing solutions on EV penetration and TCO improvement. The wholesale market first loss facility is found to have the maximum impact on reducing financing costs (explained in detail in chapter-6) as it reduces lenders/NBFC's funding costs which is often the biggest component of the interest rate faced by the end borrower. Further, the socio-economic and environment impacts of higher EV penetration under alternate scenario are assessed to understand the long-term implications of suggested changes. This analysis does not include estimation of any possible trade-offs from transition to electric mobility on job losses in ICE market, sales reduction in counterpart ICE vehicles and impact on energy sector from decrease in fuel demand. Only direct jobs in fleet and charging businesses are estimated in this report. Other jobs created from EV penetration such as in manufacturing businesses of batteries, powertrain and chargers, and in other related service sectors such as telematics, data analytics, battery recycling and disposal, are outside the purview of the current study. Overall, the economic value addition from transition to EVs would be positive in form of diversification of income earning sources across the value chain.

This chapter is structured as follows:

- **Need to transition towards EVs:** a recap/ summary of all the key aspects that have made EV market development crucial and critical to economic growth
- **Impacts of proposed action plan and financing interventions** across various aspects of EV market and the economy under both- BAU and Alternate scenario. These are impacts on TCO, EV penetration, charging infrastructure requirement, decarbonization, fuel savings and job creation.

## Need to transition towards EVs

India has set-up an ambitious target of achieving 30% EV sales penetration in all vehicles by 2030, with higher targets pursued across specific market segment by NITI Aayog. Over the last decade, there have been efforts by the Government of India to implement favorable policies such as Faster Adoption and Manufacturing of Electric (FAME) subsidy and implementation of Production Linked Incentive (PCI) for National Programme on Advanced Cell (ACC) Battery Storage (NPACC), national mission on Transformative Mobility and Battery Storage along with complementary state EV polices to promote clean and sustainable mobility initiatives.

The need for transitioning to EVs can be understood from the following factors:

- **Climate change targets:** India has committed to cutting its GHG emissions to 33% - 35% below 2005 levels by 2030.[96] Meeting this target would require identifying clear pathways to decarbonize high GHG emitting sectors such as energy and transport.
- **Impact of pollution levels:** India is home to 6 out of 10 of the most polluted cities in the world. WHO estimates 4.2 million lives are lost due to air pollution

96 https://www.carbonbrief.org/the-carbon-brief-profile-india accessed on 20 September 2021

globally.[97] In India, the transport sector contributes to about 13% of total CO2 emissions (IEA 2021), of which land transport sector accounts for 87% of the emissions.[98]

- **Urbanization:** India is growing at a rapid pace in terms of Gross Domestic Product and population, which will lead to higher demand for mobility led by industrial and service sectors. This would have a far-reaching impact on greenhouse gas emissions (GHG), energy demand, infrastructure planning and development.
- **Energy security:** Transport is an energy intensive sector and according to estimates by TERI (2018), it accounts for 24% of national energy consumption out of which 98.5% is met by petroleum products. India's transport sector accounts for 3% of the total diesel consumption in the world.[99] Energy demand associated transport is set to grow with the rapidly urbanizing population. India's crude oil import in FY 20 was about USD 101 billion (Bn).[100]

This report estimates the impact of transition to EVs in the form of reductions in the oil imports bill, decreases in GHG emissions and associated treatment cost savings, market size of electric vehicle market and jobs created.

## Impacts of proposed action plan and financing interventions

This section presents a summary of impacts from adoption of EVs under two scenarios explained in Chapter-1: BAU with continuation of existing EV policies and an alternate scenario with implementation of key action plan recommendations and coordinate efforts from centre and states to move towards higher EV penetration.

The impact of high penetration of EVs may meet other challenges related to creating a robust supply chain for manufacturing EVs and batteries. Currently, India has limited manufacturing capabilities especially related to cell and cell component manufacturing. A clear long-term roadmap developed by the Government with strict enforcement would help Indian OEMs to develop a transition a share of their automotive and component manufacturing towards EVs. The supply chain related issues and risks are outside the purview of the current study and have been discussed in detail in the study titled 'Electric mobility in India, Accelerating Implementation' published by the World Bank Group in April 2021.[101]

### Impact on TCO for each market segment

Based on the action plan recommendations and availability of affordable finance by implementing the wholesale market first loss solution, impact of change in TCO for each market segment was analyzed at a city level. The table below showcases the impact for the city of Mumbai as an example.

97 https://www.weforum.org/agenda/2020/03/6-of-the-world-s-10-most-polluted-cities-are-in-india/ accessed on 20 September 2021
98 Comparison of Decarbonisation Strategies for India's Land Transport Sector, An Inter Model Assessment, NITI Aayog, USAID, SHAKTI Sustainable Energy Foundation, 2019
99 All India Study on Sectoral Demand of Diesel & Petrol. New Delhi: Petroleum Planning and Analysis Cell, Nielsen (2013)
100 https://www.ppac.gov.in/content/212_1_ImportExport.aspx accessed on 20 September 2021
101 Electric mobility in India, Accelerating Implementation, the World Bank Group, ESMAP, April 2021

**Table 7.1:** Impact of policy changes on TCO (INR/km)-Mumbai
Source: Steer estimates

| Market segment | TCO under Alternate scenario | | | | TCO under Business-as-Usual scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | ICE (2022) | EV (2022) | EV (2027) | EV (2032) | ICE (2022) | EV (2022) | EV (2027) | EV (2032) |
| **e-2W Personal** | 4.64 | 4.53 | 4.31 | 4.45 | 4.64 | 4.53 | 4.54 | 4.74 |
| **e-2W Fleet** | 2.65 | 1.71 | 1.55 | 1.54 | 2.65 | 1.71 | 1.59 | 1.60 |
| **e-4W Personal** | 25.91 | 32.99 | 30.08 | 29.17 | 25.91 | 32.99 | 31.14 | 30.58 |
| **e-4W Fleet** | 12.74 | 14.36 | 12.95 | 13.08 | 12.74 | 14.36 | 13.49 | 13.80 |
| **e-3W Fleet** | 6.07 | 4.95 | 4.72 | 4.45 | 6.07 | 4.95 | 4.87 | 4.65 |
| **e-3W Goods** | 9.56 | 7.11 | 6.53 | 6.60 | 9.56 | 7.11 | 6.76 | 6.90 |

Adopting the recommended action plan and financing solutions results in EV TCO improving against ICE equivalents across all the vehicle categories in the proportions presented in the table below:

**Table 7.2:** Improvement in TCO in alternate scenarios vs BAU scena: Mumbai
Source: Steer estimates

| Market segment | EV (2027) | EV (2032) |
|---|---|---|
| e-2W Personal | 5% | 6% |
| e-2W Fleet | 3% | 4% |
| e-3W Fleet | 3% | 5% |
| e-3W Cargo | 4% | 5% |
| e-4W Personal | 3% | 4% |
| e-4W Fleet | 3% | 4% |

Implementation of action plan recommendations improves EV TCO by about 7%-15% by 2032 when compared to the TCO values in BAU scenario across market segments in all selected states. Improved TCO competitiveness against ICE variants is considered while estimating the impact on EV penetration. The above unit TCO reductions calculated for each city are aggregated at a state-level to showcase the impact of implementing action plan recommendations on TCO savings. Furthermore, state-level TCO savings are aggregated based on the state's contribution to total vehicle ownership at a national level. TCO savings are highest in case of personal e-2W due to high levels of penetration of the vehicle category followed by e-4W personal and e-3W fleet (except in case of MP). Annual TCO savings are aggregated to show

the resultant cumulative savings over the years from implementation of action plan recommendations and financing solutions. This results in a cumulative saving of about INR 202 billion by FY2030 at a national level. The results are presented in the table below:

**Table 7.3:** Cumulative TCO savings (in INR million) (Difference in alternate and BAU scenario)
Note: Above TCO savings estimation doesn't include e-buses.
Source: Steer estimates

| | FY23 | FY24 | FY25 | FY30 |
|---|---|---|---|---|
| **Maharashtra** | 500 | 1,600 | 3,200 | 29,500 |
| **Madhya Pradesh** | 100 | 300 | 600 | 5,200 |
| **Tamil Nadu** | 300 | 1,000 | 2,000 | 16,800 |
| **India** | 4,000 | 12,000 | 24,000 | 201,500 |

### Impact on EV penetration

As seen in chapter 2, under the BAU scenario of 5.5 million annual EV sales in 2030 falls short of the 30% targeted penetration by 2030. The alternate scenario includes adoption of the action plan recommendations following a coordinated approach across policy initiatives at central and state level, institutional re-alignment and unlocking of affordable financing to facilitate adoption of high potential market segments across 2W, 3W and fleets resulting improvement of perception factor towards electric vehicles. This results in increasing the annual sales of EVs to about 12 million, resulting in achieving above 50% penetration in 3W segments and about 40% in 2Ws. EV penetration in 4W market segment increases to 27% and the annual e-4W sales increase from 0.6 million in BAU to 1.04 million in the alternate scenario:

**Table 7.4:** EV annual sale projection in terms of number of vehicles and as a % of total vehicle sales of 2/3W and cars for India in the Alternate scenario
*Weighted average across market segments, Source: Steer estimates

| Market Segment | FY25 | FY30 | EV share (FY25) | EV share (FY30) |
|---|---|---|---|---|
| 2W personal | 4,193,000 | 7,818,000 | 22% | 35% |
| 2W Fleet | 2,087,000 | 2,552,000 | 43% | 46% |
| 4W Personal | 199,000 | 899,000 | 5% | 15% |
| 4W Fleet | 37,000 | 148,000 | 12% | 27% |
| 3W Fleet | 206,000 | 325,000 | 60% | 71% |
| 3W Freight | 66,000 | 151,000 | 43% | 52% |
| **Total** | **6,788,000** | **11,893,000** | **29%** | **37%** |

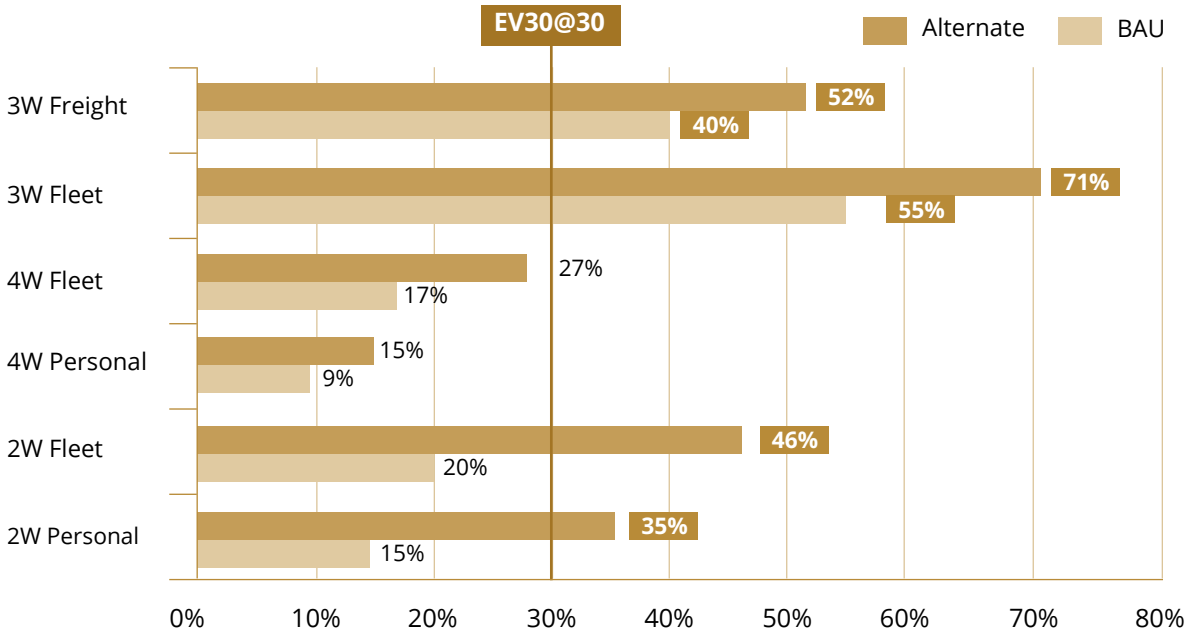
High penetration  Medium penetration  Low penetration

**Table 7.5:** EV stock numbers and total investment value of e-2W, e-3W and e-4W for India in business-as-usual (BAU) scenario
Source: Steer estimates

| Market Segment | EV Stock | | Total Investment Value (INR Million) | |
|---|---|---|---|---|
| | FY25 | FY30 | EV share (FY25) | EV share (FY30) |
| 2W personal | 7,941,000 | 39,781,000 | 935,000 | 4,686,000 |
| 2W Fleet | 3,738,000 | 15,568,000 | 277,000 | 1,156,000 |
| 4W Personal | 389,000 | 3,484,000 | 486,000 | 4,351,000 |
| 4W Fleet | 80,000 | 597,000 | 100,000 | 745,000 |
| 3W Fleet | 896,000 | 2,282,000 | 250,000 | 637,000 |
| 3W Freight | 264,000 | 850,000 | 99,000 | 320,000 |
| **Total** | **13,308,000** | **62,562,000** | **2,147,000** | **11,895,000** |

The comparison in national sales penetration for different vehicles under the alternate scenario is presented in the figure below:

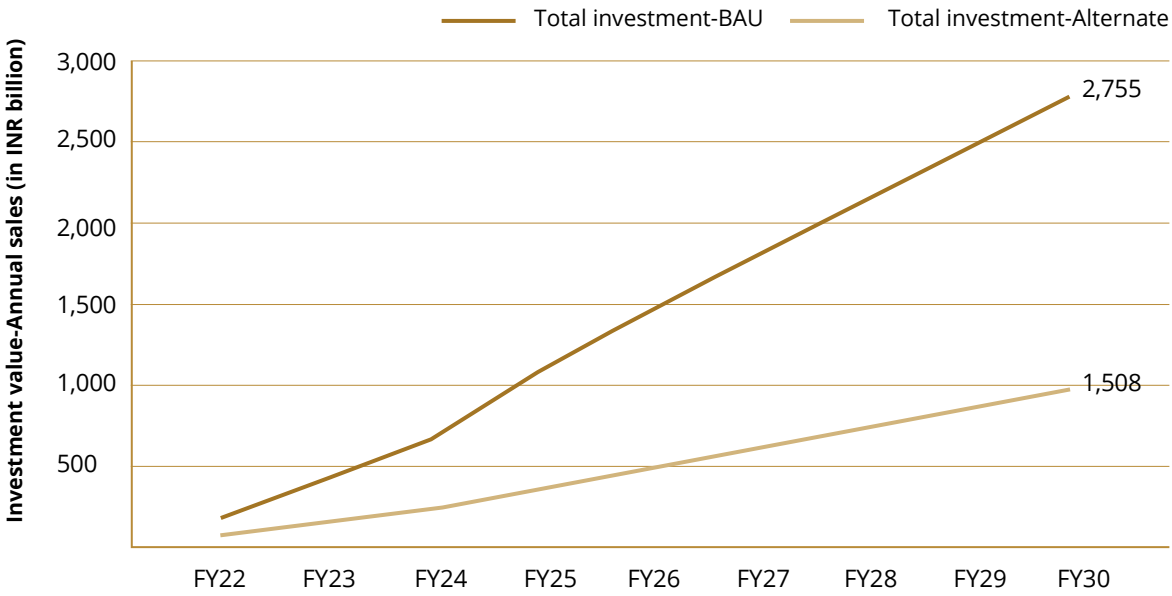
**Figure 7.1:** EV sales penetration- BAU vs Alternate scenario in FY2030
Source: Steer estimates



Alternate scenario presents an opportunity to achieve the target set-out in Clean Energy Ministerial by India to achieve 30% penetration across vehicle segments[102] for 2Ws and 3Ws, which comprise 78% of total annual vehicle registrations in the year FY2021.[103] Maximum impact of increase in penetration is seen on e-3W and e-2W feet businesses which also have the maximum potential for scale-up in the alternate scenario if an enabling environment is provided at a state or city level with affordable financing, favorable policies and removal of regulatory barriers with respect to registration and permits.

The annual investment in EVs for the period FY 2022 to FY 2030 under the two scenarios is presented in the table below:

**Figure 7.2:** Annual Investment in EVs by FY 2030- BAU vs Alternate scenario [104]
Source: Steer estimates




The annual investment value of EV sales in e-2W, e-3W, e-4W and e-buses in BAU is estimated at INR 1,500 billion, which can potentially increase to INR 2,700 billion in FY 2030 under alternate scenario with implementation of action plan recommendations and provision of affordable financing with the wholesale market first loss solution.

102 https://www.cleanenergyministerial.org/campaign-clean-energy-ministerial/ev3030-campaign accessed on 20 September 2021
103 Monthly Vehicle Registration Data for FY 20-21, Federation of Automobile Dealers Associations (FADA), May 2021
104 Market size is only calculated for first time purchase of EVs with fixed batteries. It is calculated as the product of the price an EV and annual number of units sold. We use market prices for the EVs of 2Ws, 3Ws, 4Ws and buses as of FY 2021. The models assumed for EVs also remain the same till 2030; e-2W: 3.3KW for personal use and 1.25 KW for fleet use; e-3W: fixed battery of 7.4KW, e-4W: 21.5 KW and e-bus (9m): 162KW and e-bus (12m): 320 KW.

### Impact on charging infrastructure requirement

Implementation of proposed action plan recommendations across 2/3W and 4W and charging infrastructure market segments would promote higher uptake of EVs, which would increase the requirement for deploying charging and swapping infrastructure across different market segments. Below graph presents the forecasts of need for charging infrastructure deployment under alternate scenario with higher EV adoption.

**Figure 7.3:** National charging infrastructure forecast by charger type and location (Alternate scenario)
*E-bus penetration in India is largely policy driven and would lead to charger installation primarily at depots as a part of procurement process, therefore estimation of e-bus chargers is not included in the forecasts;
Source: Steer estimates

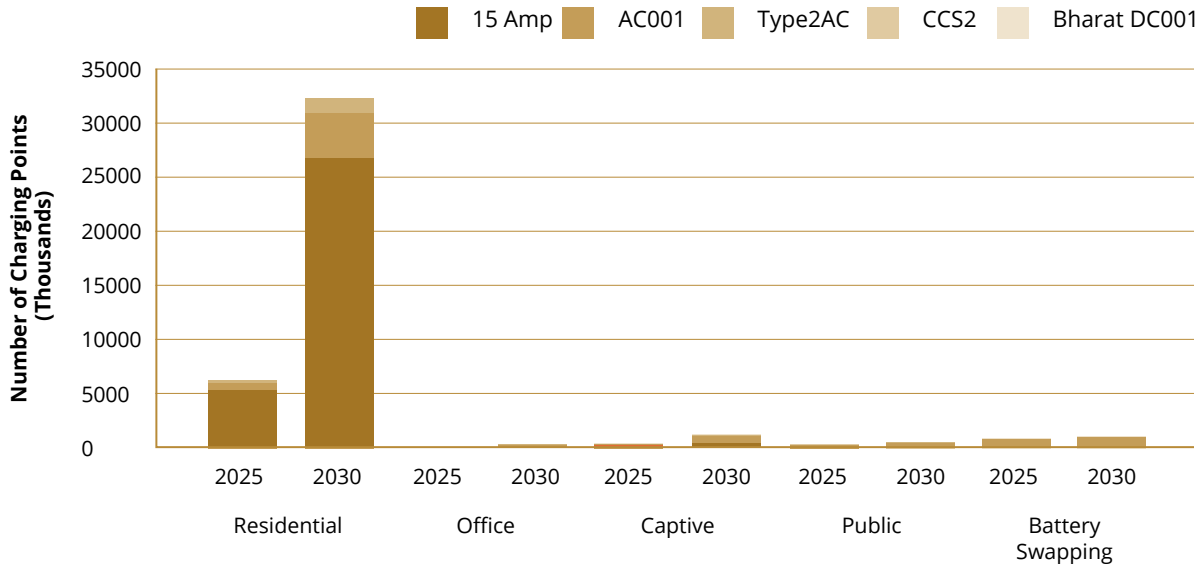



**Table 7.6:** Charging infrastructure forecast for 2030- Alternate scenario (in thousand charger points)
Source: Steer estimates

| Type of Charger | Resi-dential | Office | Cap-tive | Public | Battery Swapping | Total Chargers | Total Investment required (INR Mn) |
|---|---|---|---|---|---|---|---|
| 15 Amp | 27,100 | 120 | 420 | | | 27,640 | 55,000 |
| AC001 | 3,960 | 80 | 620 | 440 | 1,940 | 7,040 | 27,000 |
| Type2AC | 1,220 | 30 | 40 | 40 | | 1,330 | 69,000 |
| Bharat DC 001 | | | 8 | 2 | 220 | 230 | 59,000 |
| CCS2 | | | | 4 | | 4 | 4,000 |
| **Total** | **32,280** | **230** | **1,088** | **486** | **2,160** | **36,244** | **214,000** |

The total charger point requirement increases from 15 to 35 million by 2030 from business as usual to alternate scenario under which higher vehicle penetration may be realised from implementation of action plan recommendations and availability of affordable financing with the wholesale market first loss solution. Unlike global statistics presented in Chapter 6, which focus on charging for cars, the majority of those in India will be low-cost chargers for 2- and 3-wheelers. The total investment required in charging infrastructure at the business-as-usual case is estimated to be about INR 100 billion, increasing to INR 210 billion under alternate scenario by the year 2030.[105]

### Impact on decarbonisation (well to wheel)+(tank-to-wheel )

E-mobility plays a critical role in India's energy and transport transition. While EVs are clean vehicles with zero tailpipe emissions, electricity powering them may be generated from a polluting energy source such as coal or gas power plants. Accordingly, reductions in emissions is best estimated by considering the well-to-wheel emissions. Considering ongoing plans to green the power grid, announced at COP 26 in Glasgow, EVs would still lead to significant carbon savings as compared to conventional ICE vehicles. The decarbonization impact presented in this section is based on a well-to-wheel framework which compares the carbon contribution of ICE and battery operated EVs including the entire lifecycle of energy flow from generation of energy to the total kms driven by the vehicle (well-to-wheel).

*Assumptions for estimation of decarbonization impact*

To assess the impact of action plan recommendations, additional CO2 emissions reduction from higher sales and penetration of EVs (alternate scenario) were evaluated using the following per km CO2 assumptions. Other pollution emissions such as particulate matter (PM2.5), nitrogen oxide (NOx), sulphur dioxide (SO2) and carbon monoxide (CO) are not estimated as a part of decarbonization impact.

**Table 7.7:** Emission norms of different vehicle categories[106]
Source: Appraisal guidelines for Metro rail projects proposals, Ministry of Housing & Urban Affairs, Government of India, September 2017

| Vehicle type | Emission norms (kgCO2/km) |
|---|---|
| **4W (Petrol)** | 0.14 |
| **2W (Petrol)** | 0.03 |
| **3W (Diesel)** | 0.08 |
| **Bus (Diesel)** | 0.79 |

Additionally, the emission factor of electricity generation has been assumed to reduce from the base level of 0.925 kgCO2/kWh in 2018[107] to 0.610 kgCO2/kWh by 2030.[108] The year-on-year reduction in carbon emission due to improvement in efficiency of power plants have been assumed as follows:

105 1 USD is assumed to be INR 75

106 https://mohua.gov.in/upload/uploadfiles/files/Appraisal%20Guidelines%20for%20Metro%20Rail.pdf
107 CDM - CO2 Baseline Database - Central Electricity Authority (cea.nic.in)
108 Understanding the emissions impacts of large-scale vehicle electrification in India, Arijit Sen, Josh Miller, Anup Bandivadekar, Mukesh Sharma,1 Pavan Kumar Nagar,1 Dhirendra Singh,2 and Jennifer Callahan, April 2021

**Table 7.8:** GHG emission standards for electricity generation (kgCO2/kWh)
Source: Understanding the emissions impacts of large-scale vehicle electrification in India, Arijit Sen, Josh Miller, Anup Bandivadekar, Mukesh Sharma,1 Pavan Kumar Nagar,1 Dhirendra Singh,2 and Jennifer Callahan, April 2021

| | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 |
|---|---|---|---|---|---|---|---|---|---|
| **GHG emission factor** | 0.826 | 0.795 | 0.765 | 0.737 | 0.71 | 0.683 | 0.658 | 0.634 | 0.610 |

Treatment cost of INR 500 per tonne has been assumed for estimating the treatment cost savings from reduced carbon emissions across vehicle segments. The following section summaries the impact of action plan recommendations on additional CO2 emissions reduction from higher sales and penetration of EVs (alternate scenario).

56 million tonnes of cumulative carbon savings estimated from transition to EVs from FY 22 to 30

The well-to-wheel annual carbon savings have been estimated to 16 million tonnes in FY 30 which includes the carbon contribution of ICE and battery operated EVs including the entire lifecycle of energy flow from generation of energy to the total kms driven by the vehicle.

To benchmark Steer estimates with comparable studies from other institutes, the annual tank-to-wheel carbon savings have also been estimated and presented in the table below.

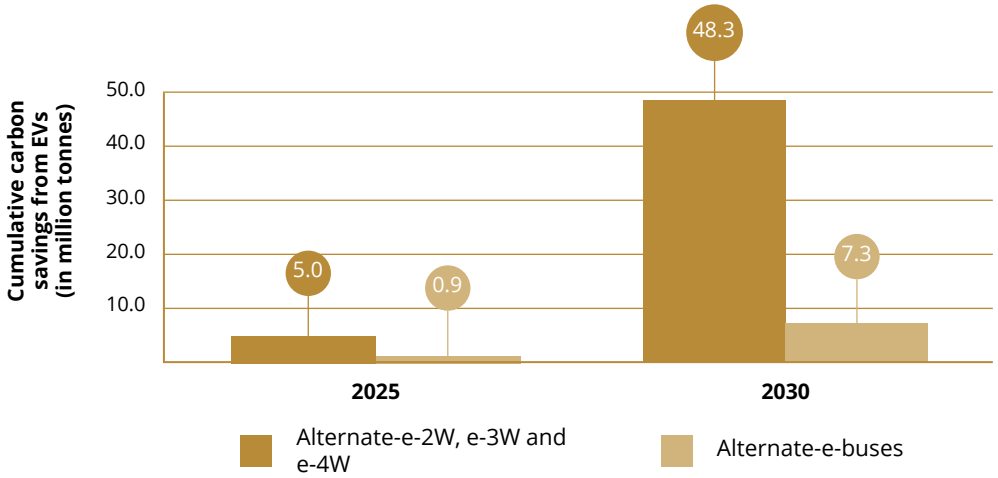
**Table 7.9:** Benchmarking Steer estimates of decarbonization (tank-to-wheel ) under alternate scenario with other studies for FY 2030
Source: Change in CO2 emissions-New Policy scenario(2030); CSTEP, CEEW, IRADe, PNNL, and TERI (2019). Comparison of Decarbonisation Strategies for India's Land Transport Sector: An Inter Model Assessment. New Delhi : TERI; *Steer estimates compared to average emissions across the alternate sources

| Carbon savings | Steer | CSTEP | PNNL | CEEW | IRADe | TERI |
|---|---|---|---|---|---|---|
| Reference emissions 2030 (million tonnes) | 566* | 630 | 376 | 378 | 833 | 615 |
| Electrification of Transport fleet (sales penetration) by 2030 | • e-2W: 38%<br>• e-4W:17%<br>• e-3W: 65%<br>• e-bus: 50% | • e-2W: 30%<br>• e-4W: 3%<br>• e-3W: 50%<br>• e-bus: 10% | | | | |
| Reduction from electrification of transport (%) | 6% | 2.5% | 26% | 1.2% | 6.6% | 8.1% |
| Carbon savings from electrification (million tonnes) | 32 | 16 | 98 | 5 | 55 | 50 |

The Steer estimate implies that electrification of the sector can result in 6% reduction tank-to-wheel carbon emissions from the sector which are estimated at an average of 566 million tonnes by 2030 across various agencies- Center for Study of Science, Technology and Policy (CSTEP), Pacific Northwest National Laboratory (PNNL), Council on Energy, Environment and Water (CEEW), Integrated Research and Action for Development (IRADe) and The Energy and Resources Institute (TERI). Other studies have produced estimates which indicate a wide range of potential savings, with varying contributions from different factors such as mode shift and use of alternative fuels. The Steer estimate appears on the conservative side as it only seeks to estimate direct benefits from EV adoption. EV uptake combined with other decarbonization strategies such as modal shift from private to public or shared transport modes, travel demand management strategies would have a more significant impact in reducing emissions from the transport sector.[109]

The impact of decarbonization is directly linked to vehicle ownership and growth trends in each State and at national level. If action plan recommendations are implemented with the financing solution of a wholesale market first loss facility, it would lead to a cumulative well-to-wheel carbon savings of 56 million tonnes across FY2022-30, saving a treatment cost of INR 28 billion.

**Figure 7.4:** Cumulative carbon savings at national level from increased EV penetration under BAU and alternate scenario across FY2022-30 (Well to Wheel)
Source: Steer representation

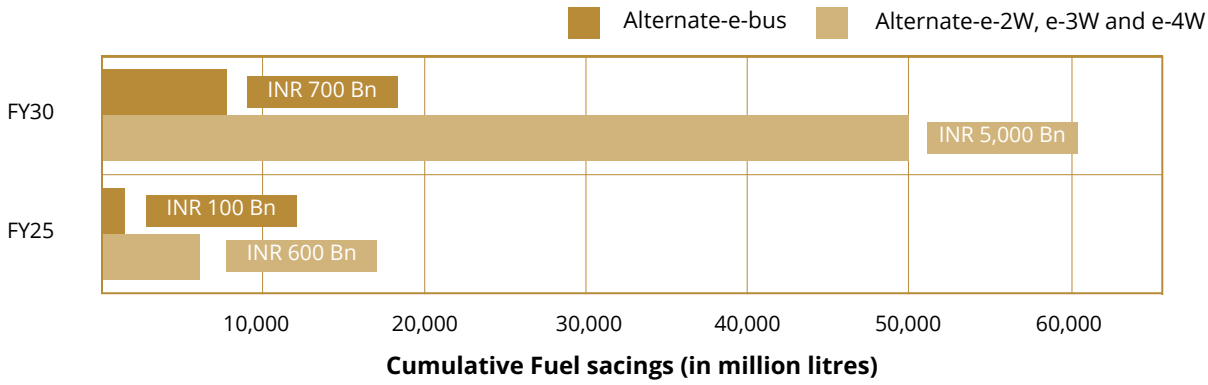



109 Comparison of Decarbonization Strategies for India's Land Transport Sector: An Intermodal Assessment NITI Aayog, USAID, Shakti Foundation, 2019

## Impact on fuel savings

Oil imports constitute about a third of India's total imports in value terms[110]. A national level study by M/S Nielsen for Petroleum Planning and Analysis Cell (PPAC), estimates that 70% of diesel and 99.6% of petrol is consumed by transport sector. In case of 2/3 W and cars, for petrol highest consumption is in 2W accounting for about 61% followed by cars at 34%. Diesel has highest consumption of about 28% by cars, utility vehicles and 3Ws. Buses consume about 10% of total diesel consumption[111]. Fuel savings across modes are considered to result from adoption of action plan recommendations and affordable financing option (wholesale market first loss facility) in the alternate scenario.

**Figure 7.5:** Cumulative savings on fuel (in million litres) and associated import bill (INR Bn) across FY2022-30: Alternate scenario
Value of fuel savings (import bill) calculated assuming a price of INR 95/litre for diesel and INR 105/litre for petrol; Source: Steer estimates



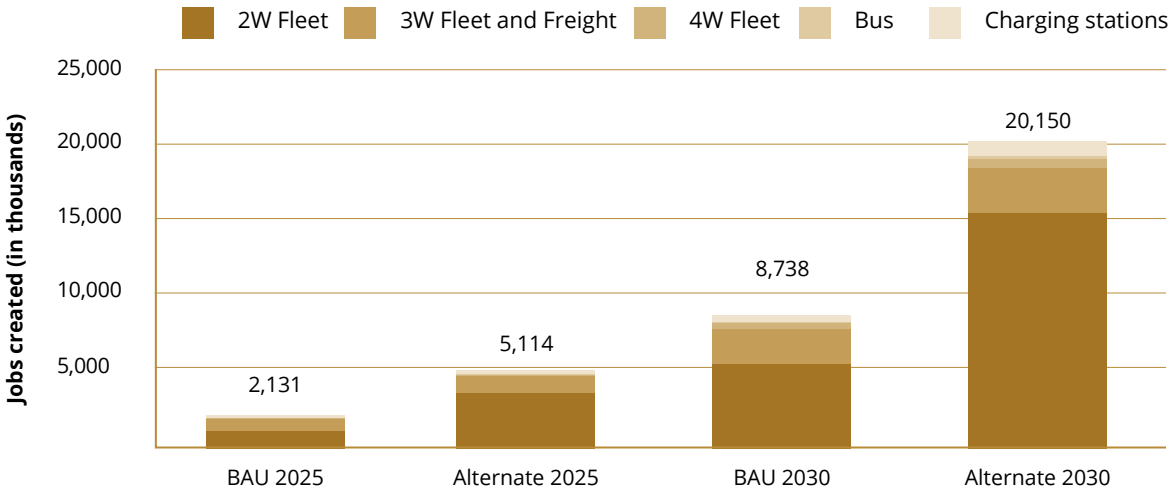

The higher adoption of EVs in the alternate scenario would translate into about 59 billion litres of cumulative fuel saving resulting in about INR 5,700 billion savings in the fuel costs cutting down about 56 million tonnes of carbon during FY22 to FY 30. Fuel savings primarily result from transition to e-2W, e-3W and e-4W. Highest savings results from transition of petrol based 2W which contributes to about 50% of total fuel savings followed by diesel based three wheelers contributing about 30%. EV penetration in e-4W and e-bus segments each result in about 10% of total fuel savings.

110 Indian Petroleum and Natural Gas Statistics 2018-19, Ministry of Petroleum and Natural Gas.
111 https://pib.gov.in/newsite/printrelease.aspx?relid=102799 accessed on 20 September 2021

## Impact on job creation

With promotion of fleet-based businesses in EV market segments, there would be incremental job creation at a national level. Assuming one driver per commercial vehicle and one operator for a charging station operating 5 charging points at office, public or captive locations, there is a potential to generate 20 million jobs in fleet businesses across modes (2/3W and cars and buses) and about 900,000 jobs in charging and swapping businesses by FY 2030.

**Figure 7.6:** Job creation with EV penetration under BAU vs Alternate scenario
Source: Steer estimates



# ANNEXURES

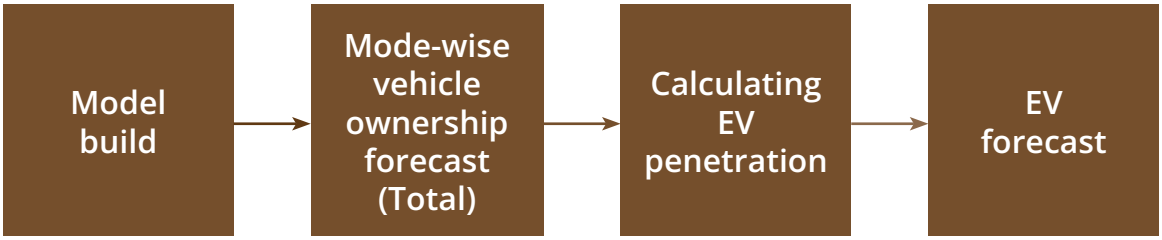

*Photo credits: UITP*

# A. Approach for market and TCO assessment

## Overall approach

A top-down approach has been applied to project EV market size for each mode and market segment (categorized by personal, fleet (shared) and freight/goods). The market assessment involves four essential steps:

**Figure A.1:** Market assessment approach overview




The first step is to build a multi-dimensional EV forecast model for the eight principal vehicle categories:

- Two-wheelers (2W):
  - personal
  - fleet
- Three-wheelers (3W):
  - passenger fleet
  - goods vehicle/ cargo fleet
- Four-wheelers (4W):
  - personal
  - passenger fleet
- Buses:
  - intercity
  - intracity

The forecasting model was built for each of the cities shortlisted in three states: Maharashtra (Mumbai, Pune, Nagpur, Thane, Nasik), Madhya Pradesh (Bhopal, Gwalior, Indore, Jabalpur) and Tamil Nadu (Chennai, Salem, Madurai, Coimbatore, Tirunelveli). E-bus forecast was also done for the state of Kerala (Kochi, Trivandrum, Kozhikode). The model uses FY20 as a base year and includes yearly forecast up to FY40.

The primary socioeconomic drivers considered in the model are Gross State Domestic Product (GSDP), per capita income levels, and population. Additionally, current level of ownership for each vehicle category was also taken as a baseline input for the dependent variable.

Overall vehicle ownership growth was forecasted using econometric analysis with macro-economic and demographic indicators such as income growth, population, and level of motorization (initial vehicle ownership trends).

The overall vehicle forecast projections were further split into ICE and EV vehicle types. The EV penetration has been calculated based on a logit model for which TCO is the key input. The methodology for each of these steps is described in greater detail in the following sections.

### Vehicle ownership forecast

Steer has developed a bespoke approach to forecast vehicle ownership for each city. It links the growth in vehicle ownership (rate per 1,000 people) to the growth in population in the area of influence and of economic activity as represented by city/ district GDP. Vehicle growth cannot continue indefinitely, and a saturation level of ownership is defined. The main inputs used are:

- Population growth;
- City level per capita economic growth; and
- Initial and saturation level for each mode for ownership.

The model formulation to predict vehicle ownership was:

$$VO = \frac{Sw}{1 + e^{a} * e^{(b*growth\ driver)}}$$

Where:

- VO = Estimated vehicle ownership (vehicles/inhabitant);
- Sw = Saturation Level (as per assumptions);
- Growth driver = Per capita (GSDP/ Population) in case of 2-wheelers and 4-wheelers, population in case of 3 wheeler passenger auto and 4 wheeler passenger fleet/ taxi and GSDP for 3 wheeler cargo fleet;
- Pop = Population (million inhabitants); and
- a= intercept; b=slope

The parameters of the model, intercept and slope were derived using historical ownership and growth driver data for the period FY16 to FY20. The current market size (FY20) and estimated growth trend of each market segment over the last 3 to 5 years (subject to the availability of data[112]) were established.

112 Note: In certain cities, especially in Madhya Pradesh, the latest vehicle registration data available is for FY18. We have requested the respective state departments to supply the missing data but for the purposes of this exercise, the FY20 number has been estimated assuming a continuation of past trends.

**Table A.1:** Model assumptions
*The average saturation level assumed for 2-wheelers is 500, however this number varies for the cities that already have a relatively higher existing ownership level.; Source: Steer secondary research and analysis

| Mode | Growth driver | Saturation level, per 1,000 population (baseline assumption) |
|---|---|---|
| 2-wheelers | Per capita (GSDP/population) | 500* |
| 3-wheelers passenger auto | Population | 100 |
| 3-wheelers goods auto | GSDP | 100 |
| 4-wheelers personal | Per capita (GSDP/population) | 250 |
| 4-wheelers taxi / shared | Population | 100 |

This model correlates the vehicle ownership with GDP per capita (GDP per capita for city, to reflect higher prosperity in urban areas), assuming that vehicle ownership grows according to an inverse log function, asymptotic to an estimated "saturation" level per 1,000 population. The saturation level has been benchmarked against the international standards and considers the specific conditions of each city as well.
To reflect the local context the baseline saturation level has been modified depending upon the current ownership levels in the city (substantially higher in some cases than others), and availability of alternate modes of travel such as suburban rail, metro and well-developed public transport which could suppress the level. The saturation level (600-650) for Chennai, Coimbatore, Nagpur, Bhopal and Indore are assumed higher to reflect the relatively higher ownership levels in these cities. The saturation levels have been further compared to average levels observed in major cities of other developing countries, such as Taiwan (650), Indonesia (550) and Malaysia (400)[113].

For the 2-wheelers market, an additional factor affecting vehicle ownership is increase in personal wealth and upward mobility of the growing middle class, which leads to a modal shift from 2W to cars over time. The model also takes into consideration this linkage between 2-wheelers and 4-wheelers—the higher the level car ownership, the lower is the saturation level for 2-wheelers. Therefore, the model estimates future 2W ownership level as a function of base saturation level (500) minus the car ownership level.

The theoretical background behind this formula is the assumption that everyone who has bought a car is no longer a primary potential customer for two-wheelers.

Using the approach defined above, the mode-wise vehicle ownership has been estimated for each selected city. The vehicle ownership numbers are then used to arrive at total vehicle population in each city. The year-on-year difference in the vehicle population is assumed to be the vehicle sales/registration.

113 ttps://www.jstage.jst.go.jp/article/easts/9/0/9_0_541/_pdf/-char/en

*Total vehicle population = Vehicle ownership per 1,000 * Total population*

*Registeration new vehicles = Vehicle population (t)- Vehicle population (t-1)*

### EV penetration

The output from the vehicle ownership model, i.e. the number of new vehicles registered/sold was then split between ICEs and EVs. To calculate the expected EV penetration in forecast years, a fitted logit function was used to estimate market penetration rate at city level. This assessment is different for each mode and market segment and is performed for each city individually. The key input considered for calculating the expected EV penetration is the total cost of ownership (TCO) of a vehicle supplemented by a perception factor.

The perception factor is used widely for vehicle adoption studies to model individual choice probability to choose between exclusive alternatives that maximize his/her utility. The study makes significant attempt to include the objective factors into the assessment of the factors that influence consumer choice towards EV.

Perceptions of EV is driven by multiple factors, including availability of public charging stations, availability of choices among different vehicle models, resale potential/value, EV awareness, driving range per charge, etc. These are likely to change over time and therefore with implementation of favorable policy and regulatory measures, this factor has been improved to showcase increasing confidence in adoption of EVs in the alternate scenario.

The TCO output with market environment and user perception factors to feed into a logit choice model allows us to estimate the share of EVs vs. ICE vehicles in current year and in forecast years of 2025 and 2030.

### TCO analysis (e-2W, e-3W and e-4W)

Total cost of ownership of a vehicle reflects the sum of all costs involved in the purchase, operation and maintenance of a given vehicle during its lifetime. As India is known to be a very price sensitive market, the TCO is a key factor influencing consumer choice.

TCO for different fuel categories has been estimated for each of the market segment in major cities of Madhya Pradesh, Maharashtra and Tamil Nadu. The ICE fuel categories considered for comparison are petrol, diesel and CNG vehicles, as applicable in each market segment. The TCO analysis is performed for five years starting 2020, 2025 and 2030, which allows for the improvement in battery technology and expectations of lower battery costs going forward, partly offset by reduction in government subsidies. Central and state government policies included in the TCO analysis are the releases available in public domain till January 2022.

The following cost categories are considered for TCO analysis:

**Figure A.2:** TCO analysis cost components
Source: Steer analysis

**Capital Cost**

- Ex showroom price
- Taxes
- Incentives

**Financial Cost**

- EMI
- Downpayment

**Operations & Maintenance Cost**

- Fuel Cost
- Maintenance cost
- Battery replacement cost (applicable only for EVs)

Key assumptions for calculation of TCO include the following:

- The TCO of EVs across market segments is inclusive of incentives given under FAME-II as of January 2022. It is considered that government incentives, such as given under FAME-II scheme, would begin to taper by 2027. Accordingly, these incentives are assumed at 95% and 75% of 2022 value in 2027 and 2032 respectively for applicable market, on account of which TCO may slightly increase from 2027 to 2032. This assumption of subsidies does not extend to 4W personal segment as there are no FAME-II incentives offered today for this segment.
- ICE is a mature market, thus its TCO is stable across the years. Any substantial change in TCO of ICE vehicles would be primarily driven by change in fuel prices.

Other cost related assumptions are presented in the table below:

**Table A.2:** Summary of key cost assumptions for TCO analysis
Source: Steer Analysis

| Cost component | Assumption |
|---|---|
| Ex-showroom price and battery related costs | Some of the cost assumptions for each market segment has been benchmarked to existing vehicles in the market:<br>• 4W vehicle: e-Verito, Tata Tigor<br>• 2W personal: Okkinawa iPraise<br>• 2W fleet: Hero Photon LP<br>• 3W passenger fleet: Mahindra Treo SFT<br>• 3W cargo fleet: Mahindra Treo Zor<br>• 3W passenger fleet (swapping): Piaggio ACE |
| Vehicle holding period | 5 years for each market segment |
| Road Taxes | As per State legislation |
| Financing cost | Higher interest rate applicable for EVs as per the market conditions and stakeholder feedback (presented below) |
| Financing tenure | 36 months for each market segment |
| Tariff rate | Tariff rates for the year 2022 are taken as per state regulations, while for 2027 and 2032 tariff rate is assumed across cities is using as a fixed tariff rate of INR 5 per kWh |
| Fuel cost for ICE vehicles | The fuel cost of ICE vehicles, such as that of petrol, diesel, CNG, and LPG/autogas is taken at its one-year average price for the month of January 2022 prevailing in the selected cities, sourced from publicly available data. |

The following table presents the financing cost assumed for TCO analysis:
The average trip length (ATL) of market segments in each city is sourced from

**Table A.3:** Financing cost assumption
Source: Steer Analysis

| | 2W | 3W | 4W |
|---|---|---|---|
| EV | 18.0% | 24.0% | 15.0% |
| Petrol | 15.0% | 24.0% | 12.0% |
| Diesel | | 24.0% | 12.0% |
| CNG | | 24.0% | 12.0% |

comprehensive mobility plan (where available) or peer cities. ATL of selected cities is summarized below:

**Table A.4:** Average Trip Length of Selected Cities (in km)
Note: Based on similar per capital income, ATL in Pune assumed equivalent to Nagpur; ATL in Thane, and Navi Mumbai assumed equivalent to Mumbai; ATL in Madurai assumed equivalent to Salem; ATL in Gwalior equivalent to Bhopal.

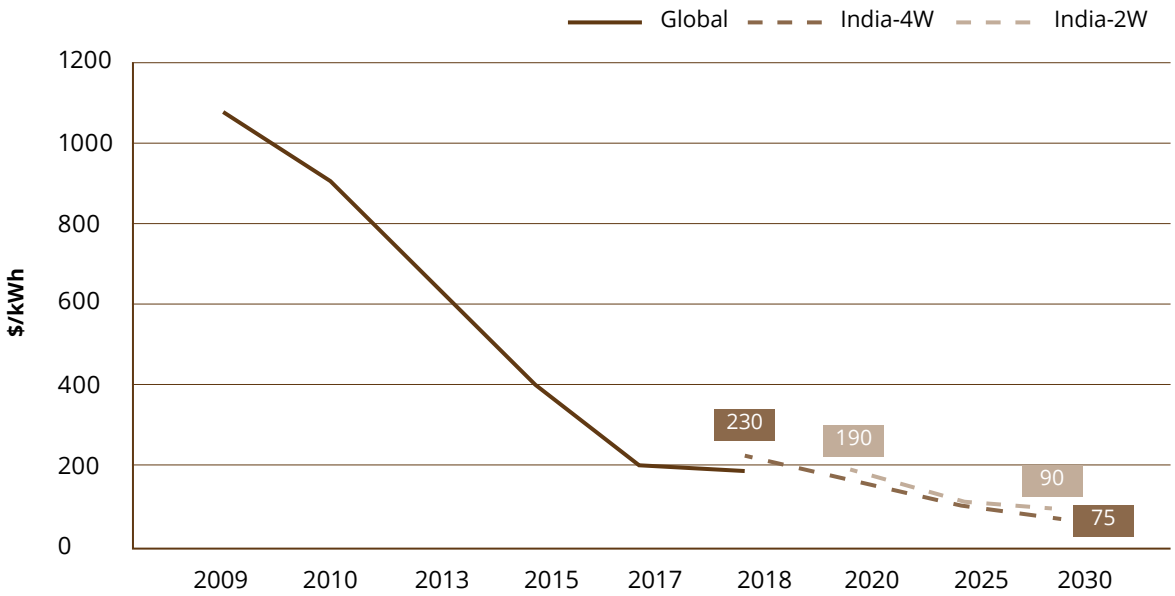
| City | 2W | 3W Passenger Fleet | 4W | Bus |
|---|---|---|---|---|
| Mumbai | 6.5 | 4.3 | 12.0 | 8.5 |
| Nagpur | 8.6 | 5.8 | 10.8 | 13.1 |
| Nashik | 5.0 | 4.4 | 5.7 | 6.0 |
| Chennai | 10.0 | 6.4 | 10.5 | 12.9 |
| Salem | 6.8 | 4.7 | 6.6 | 7.2 |
| Coimbatore | 7.3 | 4.7 | 9.6 | 10.3 |
| Bhopal | 5.8 | 6.1 | 6.0 | - |
| Indore | 5.4 | 3.3 | 5.4 | 15.0 |
| Jabalpur | 5.3 | 4.8 | 8.3 | 8.2 |

## Battery prices

Battery prices constitute about one-third of the total purchase price of EVs currently. Globally, the price of batteries has fallen substantially over the last decade and, with continued innovation in battery technology and increased production scale, the declining price trend is expected to continue. A study by NITI Aayog and Rocky Mountain Institute (RMI) predict that prices could fall to an average $109 per kWh by 2025 and $73/kWh by 2030, from about $180 per kWh today, based on a 19 percent learning rate for current EV battery technology.[114]

If recent ambitions to reduce greenhouse gas are realized, with a growing focus on a shift to an all-electric system, prices may fall even faster than current projections.

**Figure A.3:** Global battery price; India battery prices for 2W and 4W market segments ($ per kWh)
Source: Bloomberg NEF, CRISIL Research, SIAM, NITI Aayog.




Accordingly, and assuming a constant exchange rate of INR 75/USD, the following battery price has been applied in the calculations for TCO:

**Table A.5:** Battery price assumption for the years 2022, 2027 and 2030 (in INR per kWh)
Source: NITI Aayog and RMI[115]

| Market Segment(s) | 2022 | 2027 | 2030 |
|---|---|---|---|
| 2W | 12,000 | 8,000 | 7,000 |
| 3W | 12,000 | 8,000 | 8,000 |
| 4W, Bus | 11,000 | 7,000 | 6,000 |

114 India's Energy Storage Mission: A Make in India opportunity for globally competitive battery manufacturing, NITI Aayog and RMI, 2017
115 India's Energy Storage Mission: A Make in India opportunity for globally competitive battery manufacturing, NITI Aayog and RMI, 2017

Since potential economies of scale are more limited in the 2W segment, the battery price of 2W considered to be higher than other modes—in 2030 it is assumed to be 20% higher.

### TCO: Scenario Analysis

The above TCO is the base case, from which base case EV penetration at India level is estimated. On top of this base case, another alternate scenario was analyzed, to assess the impact of adoption of the action plan recommendations on TCO and level of EV penetration. This scenario impacts the perception factor associated with EVs in the logit function and lead to changes in the level of EV penetration.

**Table A.6:** Key action plan recommendations impacting EV market demand
Source: Steer Analysis

| Particulars | Enabling Factors |
|---|---|
| e-2W | • Amend state level Motor Vehicle Act to classify e-2Ws as transport vehicles and allow them to be registered as commercial vehicles<br>• DoT to mandate targets for inclusion of EVs in commercial fleets |
| e-3W | • Adopt open-permit system to register e-3Ws<br>• Allow permits to be issued to both individual drivers and fleet operator/ aggregators<br>• EV policy to include framework for fast-track approvals of e-3Ws at RTOs<br>• Increase the total permissible number of permits for e-3W in the State |
| Fleet operators | • EV policy to allow demand incentives to be availed by fleet operators/ aggregators |
| Residual scrappage value | • EV policy to include scrappage incentive for replacing old ICE / EV vehicle with EV<br>• Allow scrappage incentive to be availed by fleet operators<br>• Mandate advance recycling fee to be paid equally by the OEM/ dealer and buyer at the time of an EV sale |
| Financing cost of EV | • Offer interest subvention (500 basis points discount on financing cost) benefits to e-2W and e-3W operators and individual buyers |
| EV Fund | • Aggregate funds for incentives offered under EV policy using feebate concept of charging polluting vehicles and sale of fuel |

### TCO analysis (e-bus)

TCO analysis for buses is carried out comparing diesel and e-buses for the following typical air conditioned (AC) bus operations:

- 9-meter intracity AC bus (9-m intracity)
- 12-meter intracity AC bus (12-m intracity)
- 12-meter intercity AC bus (12-m intercity)

The TCO is estimated for 10 years starting 2022 and 2027 by aggregating total expenses per year. The TCO takes into consideration a loan tenure of 7 years, along with a battery replacement between 6th and 7th year of operation, by assuming the replacement at a reduced battery price. Additionally, the bus is expected to undergo annual maintenance, estimated as a per kilometer value.

It is understood that both the battery and overall vehicle platform will undergo technological advancement, along with economies of scale in production and thereby reducing prices. Accordingly, the battery price is expected to reduce through the years, along with a certain reduction in vehicle platform. However, with the technological advancement of the electric vehicle, the reduction in vehicle price is expected to be relatively lower than the battery price reduction. The cumulation of the two is considered to determine the ex-showroom vehicle price in 2027. The analysis also takes into consideration subsidy provided under FAME-II incentives (as offered till January 2022). Since the subsidy applicable is in line with vehicle battery capacity, subsidy is reduced at the same rate as that of battery price reduction in 2027, to compute the 2027 TCO.

It must be noted, from the range of bids received for FAME-II projects, that there is a significant variance in the estimation of TCO value. This variance is on account of limited and differing availability of data on capex prices of e-buses, battery prices, annual reduction in cost of battery and metrics on battery degradation. For the purposes of the TCO analysis presented above certain assumptions have been taken on these input values based on conversations with multiple industry stakeholders and publicly available sources. In particular:

- For 2022 TCO, EV buses prices are taken as per DHI's estimates; intracity diesel buses price assumed to be based on mid-market bus segment, collated during stakeholder feedback; price of electric intercity 12-m bus from BYD . Correspondingly, for 2027 TCO, EV bus prices are a cumulative of a 30% vehicle and 40% battery price reduction.
- For 2022 and 2027 TCO, battery size is taken as per DHI' estimates; subsidy is assumed as per FAME-II incentives (as of January 2022) and daily vehicle running as per FAME-II tenders (as of October 2020).
- Diesel fuel cost is based on one-month average price in Mumbai (publicly sourced[116])
- It is assumed that 90% of the bus price is financed through debt of 7 years
- Staff cost includes the cost of drivers, garage staff, other staff and overheads
- The TCO presented above is a summation of all expenses assumed constant (without inflation) over 10 years divided by kilometres travelled.

Accordingly, the key assumptions to our TCO analysis in given in the following table:

116 https://www.mypetrolprice.com/3/1/Mumbai-Diesel-Price-Chart

**Table A.7:** Key assumptions for TCO Analysis of buses
Source: Steer Analysis

| Parameter | Intracity | | | | Intercity | |
|---|---|---|---|---|---|---|
| | 9-m | | 12-m | | 12-m | |
| | EV | Diesel | EV | Diesel | EV | Diesel |
| Bus price inclusive of battery (INR lakhs) | 2020: 123<br>2025: 84 | 30 | 2020: 175<br>2025: 118 | 45 | 2020: 280<br>2025: 191 | 80 |
| Battery size (kWh) | 162 | | 320 | | 324 | |
| Battery price (INR/kWh) | 2022: 11,000<br>2027: 7,000<br>2030: 6,000 | | 2022: 11,000<br>2027: 7,000<br>2030: 6,000 | | 2022: 11,000<br>2027: 7,000<br>2030: 6,000 | |
| Subsidy (INR lakhs) | 2020: 32<br>2025: 19 | | 2020: 64<br>2025: 38 | | 2020: 65<br>2025: 39 | |
| Daily vehicle running (km/day) | 194 | 194 | 207 | 207 | 300 | 300 |
| Fuel cost (EV- INR per kwH Diesel- INR per litre) | 300 | 76.9 | 8 | 76.9 | 8 | 76.9 |
| Mileage (EV: km/kWh; Diesel: km/L) | | 4 | 1 | 4 | 1 | 4 |
| Staff cost (INR per km) | 18 | 18 | 17 | 17 | 9 | 9 |
| Maintenance cost (INR per km) | 9 | 7 | 9 | 10 | 9 | 10 |
| Financing cost (%) p.a. | 13% | 11% | 13% | 11% | 13% | 11% |
| Useful value at the end of 10 years | 0% | 0% | 0% | 0% | 0% | 0% |

## B. Comparison of India's EV policy with international examples

The table below showcases comparison of FAME II with international examples:

**Table B.1:** Comparison of India's FAME policy with international examples
Source: Steer Analysis

| Country | Fiscal incentives | Non-fiscal incentives |
|---|---|---|
| **India** | **FAME II**[117]: All vehicles (including PHEV and Strong Hybrid) except Buses; uniform demand incentive of INR 10,000 per kWh<br>• For buses, demand incentive of INR 20,000 per kWh is offered<br><br>**Charging infrastructure**<br>• Establish public charging infrastructure with involvement of government agencies, industries and public sector enterprises<br>• For charging e-buses: each buyer would be provided with one slow charger per e-bus and a fast charger for every 10 e-buses as per the guidelines issued by Ministry of Power[118] | MORTH |
| | • **FAME II revised**[119]**:** Partial modification to Scheme document issued on 8th March 2019 with the following changes<br>– Aggregation to bring cost of e-3W at par with ICE counterparts. EESL to aggregate demand for 3 lakh e-3Ws<br>– Aggregate demand for e-buses across 4 of million plus cities- (Mumbai, Delhi, Bangalore, Hyderabad, Ahmedabad, Chennai, Kolkata, Surat, and Pune). EESL would aggregate demand in these 9 cities for remaining e-buses under OPEX model<br>– For e-2W demand incentive increased to INR 15,000 per kWh with a cap of 40% of total vehicle cost | |

117 The Gazette of India: Extraordinary, Part II Sec 3(ii), Ministry of Heavy and Public Enterprises, Department of Heavy Industry, Notification, New Delhi, 8th March 2019
118 Charging infrastructure for electric vehicles- Guidelines and standards dated 14 December 2018; Recently updated to Charging infrastructure for electric vehicles- the revised consolidated guidelines and standards dated 14 January 2022; Ministry of Power
119 The Gazette of India: Extraordinary, Part II Sec 3(ii), Ministry of Heavy and Public Enterprises, Department of Heavy Industry, Notification, New Delhi, 11th June 2021

| Country | Fiscal incentives | Non-fiscal incentives |
|---|---|---|
| **Canada** | • Point of sale incentives of $2,000 to $5,000 for purchase or leasing options on EVs<br>• Ontario: Scrappage incentive program offering $1,000 on purchase of used fully electric or plug-in hybrid electric car<br>**Charging infrastructure**[120]<br>• For EV fast chargers from output of 50kW and above-50% of project costs up to $50,000 per charger<br>• For fast chargers between 20KW to 49KW- 50% of project costs up to $15,000<br>• For level 2 chargers (3.2 kW to 19.2 kW); 50% of project costs up to $5,000 per connector | • Parking fee discount is implemented but with a cap of maximum of 50% of full price<br>• Access to bus lanes |
| **Norway** [121][122] | • Exemption from paying VAT including leased vehicles<br>• Exemption from registration tax<br>• Reduced annual motor vehicle tax | • Free access to toll roads for BEVs<br>• Free parking in municipal lots<br>• Free charging in public charging stations<br>• Access to bus lanes<br>• Funding charging stations<br>• For new buildings a minimum amount of 6% is allocated for electric cars |
| **Germany** | • BEVs are exempted from ownership tax for 10 years | • BEVs are exempt from emission inspection<br>• Lower financing cost at 1%<br>• Preferential or free parking, access to high-occupancy vehicle (HOV) lanes,<br>• and access to restricted traffic zones |

120 Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative- https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/electric-and-alternative-fuel-infrastructure/electric-vehicle-alternative-fuels-infrastructure-deployment-initiative/18352

121 Comparison of leading electric vehicle policy and deployment in Europe; Uwe Tietge, Peter Mock, Nic Lutsey, Alex Campestrini, White Paper; ICCT, GIZ and Federal Ministry of Environment, Nature Conversation, Building and Nuclear Safety, May 2016

122 https://www.eafo.eu/countries/norway/1747/incentives#:~:text=Norway%20%2D%20Other%20Financial%20Benefits,clean%20vehicles%20on%20the%20roads. Accessed on 20 January 2022

| Country | Fiscal incentives | Non-fiscal incentives |
|---|---|---|
| **United Kingdom** | • Grant for electric car at £1,500 with upper price limit on eligible car models at £32,000<br>• Grant on large and small vans at £5,000 and £2,500 respectively[123]<br>• Write down of 100% of purchase price of EVs against corporate tax liability<br>• BEVs costing less than £40,000 are exempted from Vehicle Excise Duty<br>**Charging infrastructure[124]**<br>• EV charger grants under Electric Vehicle Homecharge Scheme to receive a grant of 75% on total purchase and installation costs<br>• EV charger grant for workplaces that covers 75% of total purchase and installation costs capped at maximum of £350 for each socket<br>• On-Street Residential Charge point Scheme (ORCS) to install on-street charging points to be provided to local authorities. One time grant to part-fund (75%) the capital costs relating to the procurement and installation of on-street electric vehicle charge point infrastructure in residential areas | • Free and discounted parking in many towns and cities<br>• Exemption from London's congestion charge |

123 https://www.theguardian.com/environment/2021/dec/15/uk-cuts-grants-for-electric-vehicles-for-second-time-in-a-year#:~:text=The%20grant%20available%20for%20electric,from%20%C2%A350%2C000%20in%20March. Accessed on 20 January 2022
124 https://blog.wallbox.com/ev-and-ev-charging-incentives-in-the-uk-a-complete-guide/ accessed on 20 January 2022

# C. Details of Action Plan Recommendations

## Action plan recommendations- e-2/3 W and Cars

The action plan recommendations for e-2W, e-3W and cars have been detailed in the table below. Several of the states, including Maharashtra, which was closely associated with the formulation of this report, have started to embed such recommendations in their EV policies.

**Table C.1:** Action Plan recommendations and steps for e-2W,e-3W and e-4W market segments
Source: Steer representation

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 1. | **Make GST rates consistent across the EV value chain**<br>**Category:** Policy/ Regulatory<br><br>**Business Model Impacted**<br>e-2W fleet- ride hailing and last mile delivery, e-rickshaw and e-3Ws (passenger and cargo) | • NITI Aayog to propose amendment of the GST bill to ensure uniform and consistent tax rates 0%-5% across the EV value chain including sale of battery separately, battery swapping/ subscription model<br>• GST on chargers is at 5% and GST for charging and battery swapping services is at 18%, reformed GST bill to have consistent tax rates for effective provision of charging services. |
| 2. | **Allow battery swapping / subscription in FAME and State EV policy**<br>**Category:** Policy/ Regulatory<br><br>**Business Model Impacted**<br>e-2W and e-3W ride hailing fleet, battery swapping service provider, battery subscription service providers<br><br>**Best practice:** Delhi EV policy allows sale of vehicle without battery and distributes the purchase incentive between the vehicle owner and energy operator. It is paid only once during the purchase of battery and not for subsequent replacement. Energy operators must register separately with the Transport department. All energy operators have to sign lease agreement with the purchaser for deposit charged for the battery. | • NITI Aayog to recommend revision of operational guidelines under FAME subsidy to allow purchase incentives to be distributed between energy operators and purchaser of EV including aggregators and fleet operators for swappable batteries.<br>• Bureau of Indian Standards (BIS) to define standards for connectors of battery to ensure wider penetration of swapping/ subscription models<br>• DHI to amend FAME II policy guidelines to allow purchase incentives to be split between energy operator and purchaser<br>• DHI to amend FAME II policy to offer higher proportionate purchase incentives to e-3Ws (L5 category) in comparison to e-rickshaws based to their cost differential<br>• DoT to amend the EV policy to allow the vehicles to be sold without batteries and issue the requisite guidelines for registration of energy operators to avail the purchase incentive for batteries |

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 3. | **Categorize 2Ws as transport vehicles**<br>**Category:** Policy/ Regulatory<br><br>**Business Model Impacted**<br>e-2W fleet- ride hailing and last mile delivery<br><br>**Best practice:** MV (Amendment) bill passed by Lok Sabha in 2018 allows states to issue taxi permits to all kinds of vehicles including two-wheelers.[125]<br>In 2019, app-based mobility providers have been included under ambit of MV Act Rajasthan, Mizoram, UP, Haryana, West Bengal, Chandigarh (UT) and Goa have permitted 2Ws as contract carriages. | • Department of Transport (DoT) in respective states to amend MV Act section 66 to grant 'contract carriage' permits to commercial e-2Ws<br>• DoT to allow permits to be issued to app-based aggregators mandating conditions ensuring road safety such speed conditions, provision of first-aid box, GPS device fitted in the vehicle etc.[126]<br>• DoT to mandate a requirement for e-2W fleet operators within cities to have at least 20% of vehicles owned - or under contract (driver owned) - to be EVs and then increase target by 20% per annum (prior year + replacements) |
| 4. | **Registration and permits of e-3Ws at RTO**<br>**Category:** Policy/ Regulatory<br><br>**Business Model Impacted**<br>e-3W fleet- ride hailing<br><br>**Best practice:** Delhi has adopted an open permit system to approved e-autos (L5 category) subject to the cap on number of Auto Rickshaw Permits ('e-auto Permits') fixed by the Supreme Court. These include all passenger 3Ws approved under FAME and additionally may allow vehicles to use swappable Advanced battery. | • Increase cap on registration of L5 three-wheelers complying with emission norms to promote growth of the overall vehicle category and restrict growth of e-rickshaws<br>• DoTs to adopt MoRTH guideline on registering an e-3W without permit requirement and ensure its implementation across RTOs in cities till a target proportion (say at 20% not exceeding the overall registration cap) of existing on-road fleet is comprised of EVs. This target can be increased as part of EV implementation plan adopted by the state including replacement of existing ICE fleet with EVs.<br>• Department of Transport or Industries (as applicable in the states) to amend the EV policy to allow permits to be granted to both individual drivers and corporate fleet operators/ aggregators. |

125 Accelerating corporate adoption of EVs in India, Policy and regulatory recommendations for the Government of India, WBCSD, October 2020
126 Contract carriage permit

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 5. | **Incentivizing transition to EVs through scrapping program**<br>**Category:** Policy and Regulatory<br><br>**Business Model Impacted**<br>e-2W fleet- personal, ride hailing and last mile delivery e-rickshaw and e-3Ws (passenger and cargo) e-4Ws<br><br>**Best practice:** China introduced a national program for promoting voluntary scrapping by users. This involved scrapping all 'yellow-label' vehicles (Euro 0, I and II standards) which are operational since 2005 by 2015. They offered subsidizes based on the condition that the new vehicles purchased from the subsidizes to be at least China IV emission standard compliant.[127] | • MoRTH to include two and three-wheelers in the scrappage policy.<br>• MoRTH to include additional incentives for purchase of EV against certificate of vehicle scrapping (proposed at 5% for buying new vehicles). [128] |
| 6. | **Regulate OEM registration and safety checks of vehicle**<br>**Category:** Policy/ Regulatory<br><br>**Business Model Impacted**<br>e-2W fleet- ride hailing and last mile delivery, e-rickshaws fleets<br><br>**Best practice:** In Delhi, a clearance certificate is required to be obtained by the Transport Department which can only be procured if the e-rickshaw models are in-line with the models cleared by International Center for Automotive Technology (ICAT)[129] | • The Central Motor Vehicles Rules to bring in two wheelers and three wheelers including e-rickshaws under its purview and enforce compliance of ICAT standards for approval of the 2W and e-rickshaw models<br>• DoT in respective states to ensure adoption and compliance of safety norms and standards by amending State MV rules |

127 Survey of Best Practices in Reducing Emissions Through Vehicle Replacement Programs, Francisco Posada, David Vance Wagner, Gaurav Bansal, And Rocio Fernandez, ICCT, CCAC, March 2015
128 Motor Vehicles (Registration and Functions of Vehicle Scrapping Facility) Rules, 2021, MoRTH
129 Analyzing the role of government regulations & intervention in e-rickshaw industry of Delhi, Volume 2, Issue 12, December 2016, International Journal of Management and Applied Science, ISSN: 2394-7926

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 7. | **ZEV mandate for large scale fleet operators**[130]<br>**Category:** Policy and Regulatory<br><br>**Business Model Impacted**<br>e-2W, e-3W and e-4W fleet- ride hailing operators<br><br>**Best practice:** London has set emission norms for all private hire vehicle licenses issued in the state and this includes standards for phased transitioning to ZEVs | • Department of Transport to mandate fleet conversion to EVs for all large ride hailing fleet operators (minimum fleet size of 1000 vehicles) by setting specific conversion targets aiming at 100% conversion in the next 10 years. |
| 8. | **Additional purchase incentives for promoting e-4W**<br>**Category:**<br>Policy/ Regulatory<br><br>**Business Model Impacted**<br>e-4W (personal, employee shuttle and ride hailing)<br><br>**Best practice:** Delhi EV policy offers an additional purchase incentive of INR 10,000 per kWh of battery capacity up to INR 150,000 to registered owners of first 1,000 e-4Ws. | • Nodal agency for EV policy to include additional purchase incentives for e-4Ws up to a target number. It may be compensated from increase in fees on ICE vehicles.<br>• Allow such purchase incentives to be accessed by both fleet operators and individual buyers. |

130 Regulatory pathways for zero-emission vehicle mandates, ICCT, July 2019

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 9. | **Create an 'EV Fund' to aggregate funds for incentives offered under EV policy using feebate concept of charging polluting vehicles and sale of fuel**<br>**Category:**<br>Policy and Regulatory<br>Financial and Funding<br><br>**Business Model Impacted**<br>e-2W, e-3W and e-4W fleet- ride hailing operators<br><br>**Best practice:** Delhi has levied a 25paise cess on sale of per litre of diesel which accrues to Air Ambient Fund and 50% of that amount is transferred to state EV fund. | • State Finance Department to allow levy an environment tax on sale of fuel (diesel or petrol) and/ or a congestion fee to be used for providing financial incentives under the EV policy<br>• Earmark a proportion of EV fund for improving footprint of public charging infrastructure and providing demand incentives to alternate charging models. |
| 10. | **Reduce financing cost for EV**<br>**Category:** Financial and Funding<br><br>**Business Model Impacted**<br>e-2W fleet- ride hailing and last mile delivery e-3Ws fleet (passenger and cargo)<br><br>**Best practice:** The WBG helped in addressing barriers to GRPV (Grid Connected Rooftop PV) by making long-term concessional finance available for deployment of GRPV including capacity building support to regulators, DISCOMS and other state agencies.<br><br>Delhi EV policy has given a 5% interest subvention on loans for EVs if availed from Delhi Finance Corp. | • EV cell/ Nodal agency to foster adoption of innovative approach including risk sharing facilities, buyback guarantee, help to buy approach, interest subvention in collaboration with commercial banks for disbursing lower cost credit to e-3W and e-2W players.<br>• National bank to establish first-loss risk sharing program to unlock access to commercial financing for e-2W and e-3W.<br>• States to fund the additional cost of offering interest subvention scheme from the 'EV fund' set-up in the state.<br>• WBG to partner with large scale commercial banks or NBFCs to open concessional financing line to promote fleet aggregators to adopt EVs.<br>• IFC to co-invest debt/ equity into the EV financing vehicles<br>• IFC to invest to assist in increasing private investment in the sector via debt and equity financing to fleet and manufacturing businesses which would help in crowding in investments |

| S.No. | Recommendation | Action plan steps |
|---|---|---|
| 11. | **Include EV in priority sector lending by banks**<br>**Category:**<br>Policy and Regulatory<br>Financial and Funding<br><br>**Business Model Impacted**<br>e-2W fleet- ride hailing and last mile delivery e-3Ws fleet (passenger and cargo), e-4W (employee shuttle and ride hailing), e-bus (market led models, GCC) | • RBI to classify EV sector as a 'priority sector'<br>• Under the PSI guidelines, RBI to mandate all scheduled commercial and cooperative banks to extend a specified portion of net bank credit (total lending) to EV sector<br>• NITI Aayog has suggested design considerations and guidelines for including EVs as a priority sector. It has proposed alternate portfolios of EV segments to be included for PSL.[131] |

### Key action plan recommendations – e-buses

The action plan recommendations for e-buses have been detailed in the table below. Several of the states, including Maharashtra, Tamil Nadu and Kerala, which have been closely associated with the formulation of this report, have started to embed such recommendations in their e-bus policy or fleet modernization programs.

**Table C.2:** Action plan recommendations and steps for e-buses
Source: Steer representation

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 1. | **Program approach at state level to electrification of bus fleet**<br>**Category:** Policy and Regulatory<br><br>**Business Model Impacted**<br>State-led fleet aggregator model.<br>Market player-led aggregator model<br><br>**Best practice:** CESL has already initiated this approach under FAME II policy to aggregate demand of e-buses across five cities with over 4 million population. | • STUs through a Public Transport Cell to provide demand estimates for fleet requirements and preference of business model to be adopted, to state PT or transport department.<br>• The PT or transport department to aggregate the demand at state level to achieve economies of scale for procurement, operations and/or financing. Department to mandate uniform scrappage policy for ICE buses based on age and km operated required, with additional incentives for timely scrappage.<br>• Either a state agency or a private/ market player to act as the aggregator depending on state or city's institutional and financial characteristics, and volume potential for aggregation. |

131 Banking on electric vehicles in India, A Blueprint for inclusion of EVs in priority sector lending guidelines, Report, NITI Aayog, RMI, RMI India, January 2022

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 2. | **Favorable and consistent tax regime for manufacturing, procurement and operations of e-buses**<br>**Category:** Policy and Regulatory<br><br>**Business Model Impacted**<br>All models with leasing-based procurement<br><br>**Best practice:** Latin American countries like Colombia and Chile, with inspirational evidence of e-bus penetration in bus fleets, had low or waived import duties and taxes on e-buses. | • DHI and state transport departments to liaise with the GST Council to waive or reduce to at-par GST rates for entire e-bus value chain.<br>• Central and state governments to grant 100% exemptions to all e-buses from taxes like road tax, passenger tax, permits, Motor Vehicle tax and vehicle registration fees until 10% of the bus fleet is electric. |
| 3. | **Balanced subsidy structures as part of fiscal measures**<br>**Category:**<br>Policy and Regulatory<br>Financial and Funding<br><br>**Business Model Impacted**<br>All business models related to fleet procurement<br><br>**Best practice:** Chinese cities like Shenzhen that have electrified their entire fleet of more than 16,000 buses have utilized capital and minimum-km-based operational subsidies | • DHI, in consultation with state transport/PT departments, to modify subsidy scheme under FAME to a hybrid structure where capex part is retained to be 2/3rd of existing FAME II subsidy while the remaining 1/3rd along with state/STU subsidy is disbursed over 2-3 years as operational subsidies potentially linked to operational performance<br>• DHI, in consultation with state transport/PT departments, to modify MCA and RfP under FAME GCC to consider fixed subsidy amount irrespective of bidder's quote. |
| 4. | **Alternate sources of revenue for e-bus and charging infrastructure deployment**<br>**Category:**<br>Policy and Regulatory<br>Financial and Funding<br><br>**Business Model Impacted**<br>All business models<br><br>**Best practice:**<br>• Scottish BSOG 'LVC' initiatives<br>• Government of India has proposed a voluntary Vehicle Scrappage Policy in its current Union Budget 2021-22. | • Feebate scheme with levy of carbon tax on ICE vehicles based on emission levels and/or fuel economy can be passed by the State government to e-buses and e-2W, e-3W and e-4W in form of fiscal incentives.<br>• State Industries Department to manage a Credit Guarantee Fund Trust for Green Transport through a SIDBI-equivalent institution that can provide affordable financing for e-buses.<br>• Commercial exploitation of depot land either as charging infrastructure PPP or other models can help accrue additional revenue for the STUs. |

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 5. | **Capacity-building for STUs, public transport department, aggregator agencies and DISCOMs in e-bus operations and contract management**<br>**Category:** Governance & Institutions<br><br>**Business Model Impacted**<br>All models with leasing-based procurement | • The state transport/PT department to organize capacity-building programs for various stakeholders like STUs, identified state-level aggregator agencies and DISCOMs.<br>• The state transport/PT department to mandate completion of training sessions before tender documentation and release.<br>• The state transport/PT department and PT authorities to consider partnerships with multilateral development banks like World Bank for technical assistance on capacity-building<br>• The Ministry of Skill Development and Entrepreneurship (MSDE) to mandate courses related to EV skills/ maintenance in ITIs and Polytechnics to create skilled human resources. The Department of Higher Education to introduce courses related to EV skilling in concerned states. |
| 6. | **Contract Management and Procurement Cell at State and agency level for e-bus services**<br>**Category:**<br>Governance & Institutions<br>Procedural & Procurement<br><br>**Business Model Impacted**<br>Revised GCC model.<br>State-led fleet aggregator model.<br>Market player-led aggregator model<br><br>**Best Practice**<br>Mumbai and Delhi have launched their EV cells recently to accelerate transition and adoption of EVs. | • State transport or PT department to set up a project management unit with representatives from contractors, PT authorities, state agency (if any), CaaS providers, energy providers and lessors. Unit will monitor the following:<br>– Performance of subsidy disbursed against policy objectives<br>– Project operations<br>– Dispute resolution mechanisms<br>• During the contract period, these project management units to report to the Contract Management and Procurement Cell at the state level on contract management parameters |

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 7. | **Separate funding and readiness of charging infrastructure**<br>**Category:**<br>Funding & Financing<br>Urban infrastructure<br><br>**Business Model Impacted**<br>All business models where charging infrastructure is unbundled<br><br>**Best practice:** In Santiago (Chile), energy players like ENEL and Engie have partnered with operators and OEMs to pilot and scale up e-bus penetration in the operators' fleet mix. This not only ensures energy provision for the e-buses but also establishes the energy business for e-buses on a firmer footing. | • State or PT department to mandate e-depot preparedness for state guarantees on contracts which includes en-route charging facilities for inter-city route tenders.<br>• State or PT department to provide financial / VGF support to DISCOMs for developing ancillary infrastructure.<br>• Where charging infrastructure is unbundled with fleet, the PT authority could bring in a charging as a service (CaaS) player to provide end-to-end energy solutions i.e. liaise with DISCOMs, upgrade grid connectivity, procure installation and maintenance of charging infrastructure, and ensure energy availability according to charging schedule for operators<br>• Where charging infrastructure is bundled with fleet, the operator will be responsible for installation and maintenance of charging infrastructure.<br>• State to set up Dedicated Charging Infrastructure Fund (earmarked share from state's EV Fund) at state level for establishment of charging infrastructure including at depots. |

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 8. | **Enable favourable financing ecosystem for e-buses**<br>**Category:** Funding & Financing<br><br>**Business Model Impacted**<br>All business models | • Central government to confer priority lending sector status for lending towards components of the e-bus manufacturing, procurement and operations ecosystem including charging infrastructure.<br>• Central/state governments to introduce scheme to de-risk lending to e-bus sector (public and private) until 10% of the fleet is electric. |
| 9. | **Improve bankability of procurement through contractual modifications**<br>**Category:**<br>Procedural & Procurement<br><br>**Business Model Impacted**<br>Revised GCC model<br><br>**Best practice:** In Bogota, trust funds help TransMilenio in providing ring-fenced payments to contractors – fleet providers, operators, fare collection agencies, etc. – from farebox revenue and budgetary support | • DHI to consult with relevant stakeholders and adopt contractual modifications including on payment security mechanisms, minimum assured km, substitution agreements, operator consortium composition. This role is now undertaken by CESL as part of the revision to the FAME II scheme in June 2021.<br>• State transport department or PT department to enter into support agreements to ensure ring-fencing of farebox revenue and budgetary support.<br>• State government to provide substitution agreements or payment guarantee, optionally using financing support from multilateral development banks like World Bank. |

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| **10.** | **E-bus pilot operations for mitigation of performance risks, model registration and OEM empanelment**<br>**Category:**<br>Procedural & Procurement<br><br>**Business Model Impacted**<br>All models related to operations procurement<br><br>**Best practice:** Santiago's success story in large-scale introduction of e-buses in fleet were based on partnerships between energy player (fleet provider), OEM and private operator. Several rounds of pilots featured in this deployment. | • State transport/PT department in consultation with public/private operators to evaluate routes based on Total Cost of Ownership (TCO). States to allocate most profitable routes like airport shuttles, mofussil routes and inter-city routes with one-way distance up to 200 km for e-bus operations.<br>• State/PT departments to mandate e-pilots in addition to feasibility studies before release of tenders. IFC can support pilots that have a line of sight to larger investments using its early-stage project development product (upstream) |

## Key action plan recommendations- Charging and swapping infrastructure

**Table C.3:** Action Plan recommendations and steps for charging and swapping infrastructure
Source: Steer representation

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| **Common recommendations for all business models** | | |
| **1.** | **Provide land at concessional prices in cities for setting up public charging infrastructure**<br>**Category:**<br>Policy and Regulatory<br>Governance and Institutions<br><br>**Best practice:** Bangalore Electricity Supply Company (BESCOM) has set-up 80 EV charging stations with 126 chargers in Bengaluru. The charging stations are in government office premises such as Bruhat Bengaluru Mahanagar Palike, Bangalore Development Authority, Traffic Transit Management Centres and RTO. This was funded by the Transport Department of the state[132] | • Allow land at concessional rate or provide capex subsidy in form of land provision for setting up public charging stations<br>• Allow charging infrastructure developer to use a percentage of allotted land to open public amenities to improve viability of charging business<br>• State Transport Department to provide VGF either in form of capital or in form of land lease rentals (capped to a maximum value) for short term until a benchmark footprint of public chargers is available in a city<br>• City municipalities to allow public charging operations on government designated land parcels<br>• The exact location details of the station to be shared by the procuring agency in tender details<br>• Urban Development and Transport Departments in state to regularize street parking and include setting up of charging stations as part of parking policy<br>• Smart City mission in state to include plan for deployment of minimum 10% of the available parking spots for setting up of charging infrastructure and including norms of residential charging as prescribed by MoHUA in its residential projects<br>• Municipalities to give fast track clearance on land for setting up charging and swapping stations |

132 https://www.thehindu.com/news/cities/bangalore/bescom-sets-up-80-electric-vehicle-charging-stations/article30743515.ece accessed on 26 May 2021

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 2. | **EV policy to provide level playing field to all charging technologies**<br>**Category:**<br>Policy and Regulatory<br>Governance and Institutions<br><br>**Best practice:** Delhi government has provided a grant of 100% for purchase of charging equipment up to INR 6,000 per charging point for the first 30,000 charging points. Additionally, for public charging stations, it would provide capital subsidy for cost of charger installation to selected Energy Operators. | • Public charging point operator and battery swapping player to be given capital subsidy for purchasing chargers under FAME subsidy conditional to the charging/ swapping station to be open to shared access until a target minimal coverage is achieved.<br>• States and municipal corporations to provide subsidy for setting up charging infrastructure to residents and captive charging providers open to shared access to other users until a target minimal coverage is achieved. |
| 3. | **Amend development control regulations to enable residential and office charging**<br>**Category:**<br>Policy and Regulatory<br>Urban Infrastructure<br><br>**Best practice:** Delhi government has directed all buildings such as malls, offices, hospitals, hotels etc to install charging infrastructure<br><br>BSES has rolled out Digi-Seva Kendra for offering quick, convenient and free single window clearance services to consumers for getting an electricity connection. Such centres may also extend services to charging service providers.[133] | • 75% of charging needs would be met at residential and office locations, therefore it is important to ensure implementation and monitoring of building by-laws mandating installation of charging points<br>• MoHUA guidelines with respect to amendments in Development Control Regulations to be adopted and implemented by state's Urban Development Department and local municipalities.<br>• Department of Industries to amend EV policy to include incentives on setting up chargers at home and office locations.<br>• State Urban Development and Town Planning Department to define the type and configuration to chargers to be installed in buildings as per recommendations by Ministry of Power[134]<br>• EV cell in states to provide single-window clearance facility for setting-up new private charging stations. |

133 BSES Consumer Information Booklet
134 Charging infrastructure for Electric Vehicles-Guidelines and standards, Ministry of Power, December 2018

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| 4. | **Second life of batteries**<br>**Category:**<br>Policy and Regulatory<br>Governance and Institutions<br><br>**Best practice:** Government of UP to provide 50% capital subsidy per annum for 5 years to large, anchor EV Battery Units and service units in form of loan taken for procuring equipment/ machinery for battery recycling subject to maximum ceiling of INR 10 million per annum | • Ministry of Environment, Forest and Climate Change has published rules called 'Battery Waste Management Rules. 2020' for end-of-life disposal, re-use and recycling standards<br>• Under these rules, OEMs and dealers must be registered under Central Pollution Control Board and would be responsible to send collected batteries to recycling units. State Pollution Control boards to ensure adherence and implementation of these rules by all registered OEMs and dealers.[135]<br>• State EV policies to provide incentives for setting up battery recycling plants including capex subsidy, concessional land, GST reimbursement etc. to incentivize setting up these businesses. |
| 5. | **Conduct siting study to identify strategic locations for public charging infrastructure**<br>**Category:**<br>Governance and Institutions<br>Urban Infrastructure<br><br>**Best practice:** The British Columbia Toolkit provides knowledge-based approach and methodology to plan Electric Vehicle Charging Infrastructure sponsored by BC Hydro and British Columbia Ministry of Energy, Mines and Natural Gas[136] | • Cities to undertake charging infrastructure siting analysis to identify the source of power and map it with the mobility needs of the city to identify the strategic locations for setting charging infrastructure<br>• State Urban Development Department to adopt the guidance from Handbook of Electric Vehicle Charging Infrastructure Implementation issued by NITI Aayog and Ministry of Power[137] for selection of charging locations for deployment of public charging stations.<br>• State's Urban Development and Transport department to jointly commission a charging infrastructure siting study for each city including forecast of expected growth of EVs |

135 https://mercomindia.com/india-blueprint-battery-waste-management/ accessed on 27 May 2021
136 https://d2rfd3nxvhnf29.cloudfront.net/legacy/uploadedfiles/playbook-assets/electric-vehicle-charging/public-fleet-electrification-final.pdf
137 Handbook of Electric Vehicle Charging Infrastructure Implementation, Version-1, NITI Aayog, Ministry of Power, Department of Science & Technology, WRI, August 2021

| S.No. | Recommendations | Action plan steps |
|---|---|---|
| **Recommendations for fleet operators** | | |
| **6.** | **Consistent tariffs for EV charging across public, private, captive and battery swapping facilities in each city**<br>**Category:** Policy and Regulatory<br><br>**Best practice:** Tariff concessions under DERC Tariff Schedule for 2019-20 shall be extended to all private charging point operators that are BEVC-AC001 compliant and are connected to the Central Management System (CMS) of the relevant DISCOM[138] | • The Ministry of Power to consider including in the recently introduced "Electricity (Rights of Consumers) Rules, 2020" the consumer's "right" to have a "choice" to get EV metered connection for charging<br>• DoT to amend the EV policy to include uniform tariffs across EV charging players<br>• State Electricity Regulatory Commission to introduce a separate tariff category for EV charging and follow the guidelines on tariff setting issued by the Ministry of Power in June 2020<br>• The EV special tariff to be allowed to any exclusive EV metered connection irrespective of the charging technology (plug-in, battery swapping, wireless, etc.) and the type of charging facility (private, captive, semi-public or public) provided the charging points are properly hardwired to avoid any misuse of the electricity connection for any non-EV purpose<br>• State Energy Regulatory Commissions (SERC) to publish Time-of-Day tariffs to allow captive and personal users to charge their vehicles in off-peak hours and realize savings on electricity costs |

138 Delhi Electric Vehicles Policy, 2020

| S.No. | Recommendation | Action plan steps |
|---|---|---|
| 7. | **DISCOMs to facilitate separate meters at EV charging locations**<br>**Category:**<br>Policy and Regulatory<br>Urban Infrastructure<br><br>**Best practice:** Delhi Electricity Regulatory Commission has notified a policy wherein commercial buildings such as hotels and malls providing EV charging facilities can install a sub-meter and EV tariff rate would be applied based on the units consumed.[139] | • State DISCOMS to make necessary provisions such as facilitating separate meter or sub-meter to allow charging operators to avail EV charging tariff<br>• State DISCOMS to ensure provision of power infrastructure at charging locations<br>• Power DISCOMS in each city to adopt MoHUA guidelines on allowing enhanced power load to residential and commercial units by upgrading its distribution infrastructure with a long-term vision of 30 years. Results from siting analysis to be shared with DISCOMs to plan grid upgradations[140] |
| 8. | **Provision of charging infrastructure/ depots opened to public and private operators plying intercity route**<br>**Category:**<br>Policy and Regulatory<br>Urban Infrastructure | • State governments/ PT cell to liaise with NHAI to add e-bus charging points in the passenger wayside amenities that are being developed on highways in the country<br>• PT cell managing the depot charging infrastructure on intercity routes/ highways to provide real-time information on availability of chargers and allow access to private e-bus operators<br>• State level program to rollout network of charging facilities developed by private sector players providing Charging as a Service to support intercity movement (for buses and 4 wheelers) |

139 https://www.businesstoday.in/sectors/auto/gahlot-appeals-to-malls-hotels-market-complexes-to-install-ev-charging-points/story/433232.html accessed on 27 May 2021
140 Amendments in Model Building Byelaws for Electric Vehicle Charging Infrastructure, MBBL 2016, Town and Country Planning Organization, MoHUA, February 2019

## D. Appraisal Methodology for proposed investment options

### Overview

This activity analyzes a range of investment options to assess their impact on EV penetration and TCO savings. Each of the investment options identified would all undoubtedly have a significant impact on EV penetration and because most of the options are not mutually exclusive, it is likely that, if all of these options were deployed together, the impact would be transformative. However, the reality is that the resources available from government are finite and some degree of prioritization would be required.

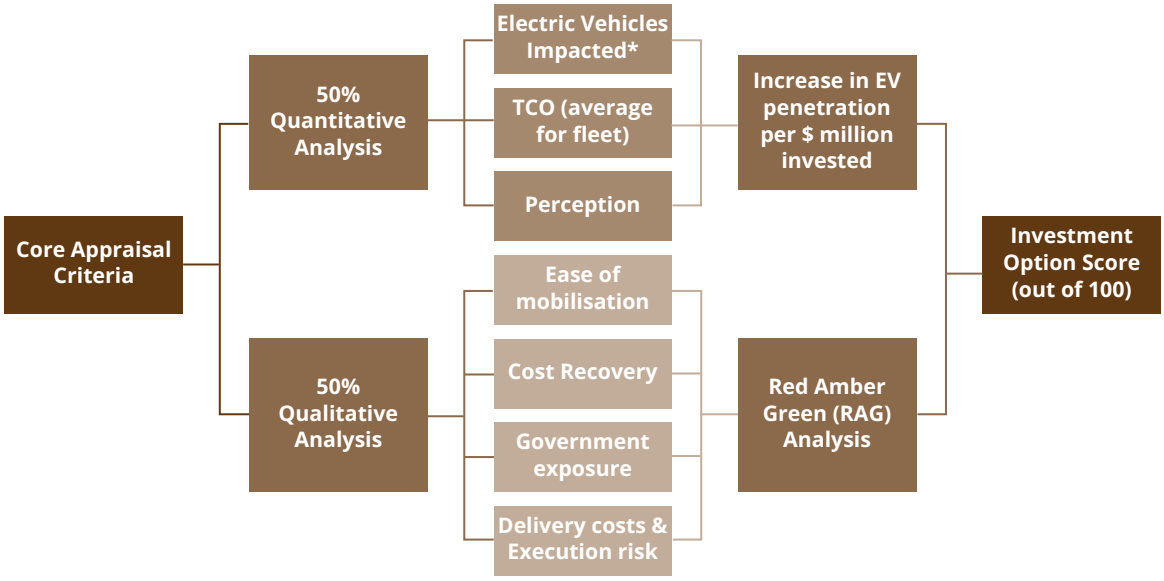
Each investment option is appraised quantitatively and qualitatively. They are analyzed based on a common facility size of USD 150 Million for e-2W/e-3W/ e-4W and e-bus individually to ensure comparability of options across board.

The quantitative impact of each option is estimated as the change in EV penetration that would result from the reduction in TCO and/or improvement in perception of users from reduction of financing costs and/or ease of access to finance. This penetration factor is then used to calculate the increase in number of electric vehicles per million dollar invested.

The qualitative impact of investment options has been analyzed against a set of broader qualitative criteria.

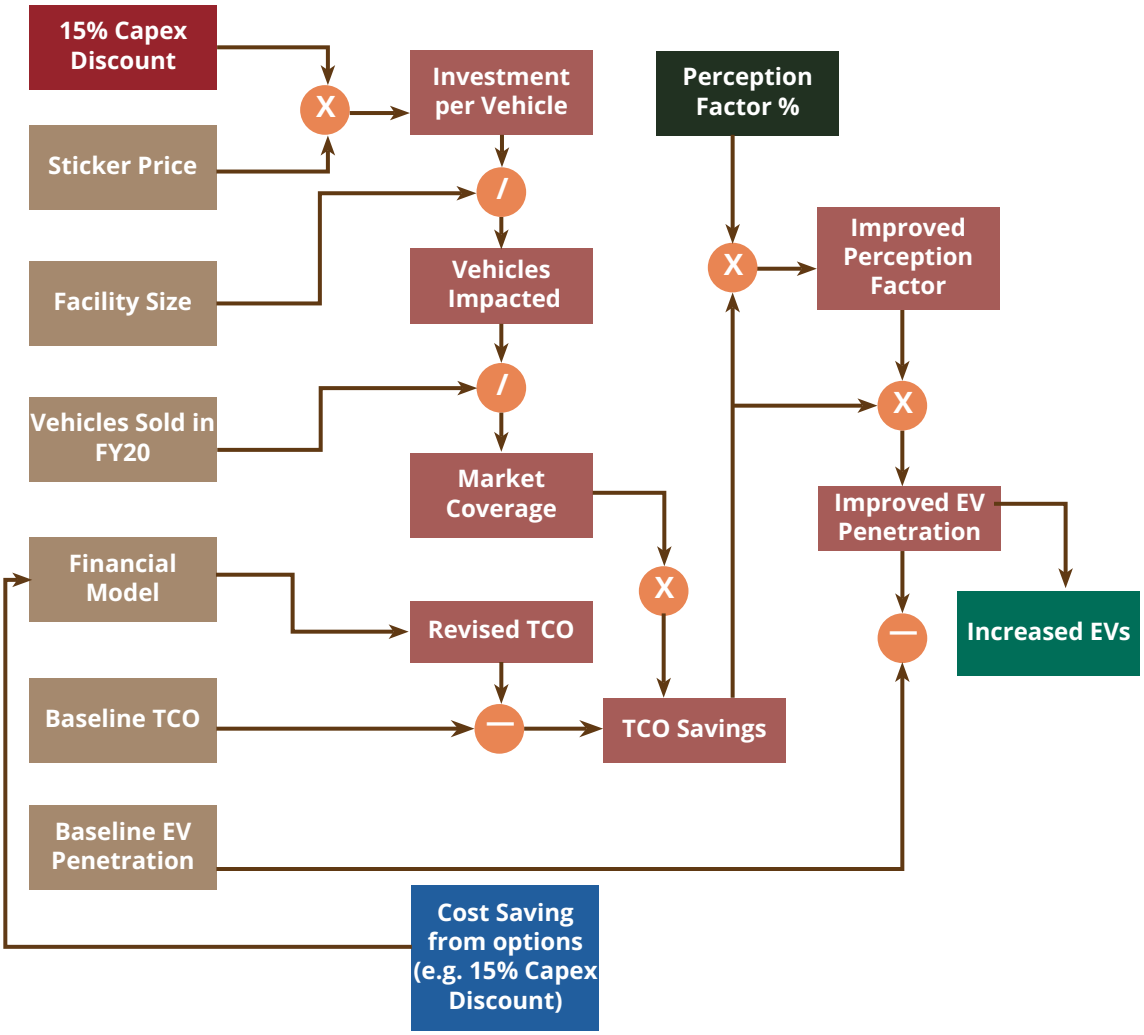
It is important to note that this analysis is only indicative in nature and a feasibility level of study and market sounding would be required to form a more definitive view of the impact and challenges of implementing any of these options.

**Figure D.1:** Appraisal approach for investment options
Source: Steer Analysis



One of the appraisal criteria is a quantitative analysis, built on TCO and perception factor. This page elaborates on its implementation.

**Figure D.2:** Logical Calculation Flow (Vehicle Discount Scheme as an example)
Source: Steer Analysis




## Legends

Estimated quantification of the venefits from investment option. This is used as an input to the financial model to calculate the improved TCO

Estimated investment per vehicle. This parameter is used to calculate the vehicles which can be covered by the facilities

Static Inputs into the calulations. These parameters will not change from investment option to investment option

Calculations in the model to arrive at the increase in electric vehicles with interventions

Estimated % of TCOs to be considered as an improvement in the perception factor

Model Output

X
Calculations used in the model

### Quantitative Criteria: E 2W / E 3W / E Cars

EV penetration is calculated on the basis of the market assessment model created for estimating the unconstrained demand. Based on the improvements in the total cost of ownership for electric vehicles (by reducing cost of the vehicles or the financing costs, based on the investment option) and the improvement in public perception towards the electric vehicles (considered as a proportion of the TCO based on assumptions noted on the quantitative approach page), the model calculated an expected growth in EV penetration by 2030 over and above the baseline growth.

### Quantitative Criteria: E-Bus

To analyze investment options proposed for e-bus, the TCO analysis developed in Module 1 of the study has been used to estimate the extent to which the option will bridge the delta in TCO from the baseline ICE cost levels.

This is quantified as "USD Savings per Million dollar" which is the gap covered by the investment option between the baseline TCO for an e-bus and the revised TCO for the impacted vehicles under the investment option

The benefits from the investment option are used to estimate the improvement in e-bus TCO from its e-bus baseline TCO to cover the gap between ICE and EV costs

Difference of this baseline TCO & revised TCO under the investment option are then multiplied with the total kilometers travelled by the bus over its lifetime (1.02 Million Kms) to quantify the difference over the life of vehicle. It is then multiplied with the number of vehicles impacted with the investment option to quantify "USD Savings per million dollars invested".

A score is then awarded according to the savings in e-buses per million dollars invested [TCO saving per e-bus x no. of buses impacted by scheme x total distance covered by vehicle over lifetime / Facility size (USD 150 Million)] The business model which is widely accepted is the public transport model where the buses are run on state identified routes and the demand risks are borne by the public authority. Given the nature of the business, perception factors cannot be considered. Users are deemed to opt for the available service and, for modelling purpose, would be indifferent in their choice as long as the ticket prices are not increased significantly by the government.

### Quantitative Criteria : Charging Station

To implement charging stations, each

investment option has been analyzed both qualitatively and quantitatively from the perspective of increasing EV penetration improving financial viability for the charging station operators.

The appraisal methodology for analyzing EV penetration reviews the impact for e-2W / e-3W and e-4W using the methodology noted in the section above for e-2W / e-3W and e-4W. No impacts are assumed for e-buses as they are assumed to be charged in their respective depots.

To analyze the viability of operating a charging station for private participants, an expected return of 10% is assumed on the investment.

The options are run by keeping the expected returns constant and reducing the price to be charged per unit of electricity to maintain viability. The aim of this is to reach

a price comparable with the cost of a typical residential charging

The EV penetration analysis assumes that the electricity cost will remain at par with their current costs and will not vary with the implementation strategy of the charging station. Thus, provision of a subsidy or a price / interest rate cut will not impact the EV penetration. These options will just improve the viability of the charging stations at a lower price per unit of electricity

### Qualitative Analysis

For each of the proposed options, qualitative appraisal has been undertaken where each investment option has been scored on a Red-Amber-Green (RAG) basis against a set of following four criteria.

- Mobilization: How to minimize government funding to maximize and mobilize private finance (i.e. efficiency of the option)
- Cost recovery: Whether investment can be recovered so that the capital can be recycled (i.e. effectiveness of the option)
- Government exposure: The liabilities incurred by the government (i.e. fiscal impact of the option)
- Delivery costs & execution risk: The ease with which the option can be introduced (i.e. the deliverability of the option)

Each option is scored against each of these criteria. If the option scores red against a criteria, it receives 0 points; amber 5 points and green; 10 points.

### Appraisal Approach Examples

This page illustrates the application of the

appraisal approach & methodology to arrive at the final penetration results using two of the proposed investment options

**Table D.1:** Key assumptions for TCO Analysis of buses
Source: Steer Analysis

| | | Scoring Methodology | | |
|---|---|---|---|---|
| **Criteria** | **Description** | **Red (0 Points)** | **Amber (5 Points)** | **Green (10 Points)** |
| Mobilization | Extent to which option mobilizes private capital and reduces the funding requirement of government | Does not directly mobilize private capital | Directly leverages private capital via guarantee or government support | No government support required |
| Cost Recovery | Extent to which option can be withdrawn and costs recovered when market maturity is achieved | Investment capital unlikely to be recyclable | investment returns possible but high risk/reward | Investment capital can be recycled and existed at profit (if successful) |
| Government exposure | Extent to which option exposes government balance sheet to both direct and contingent liabilities | Direct and contingent liabilities with central government ("on-blance sheet") | Contingent liabilities with government (e.g. sovereign guarantee) | No government recourse ("off-balance sheet") |
| Delivery costs & execution risk | Extent to which option imposes transaction/set-up costs | Option involves creation of new entities/counterparts | Existing counterparts but interacting with innovative funding and financing mechanism | Standard underwriting process with existing borrowers |

The applications and thus the implications of each investment option for the stakeholder can be understood as a graphical depiction. In the example shown here, first loss facility takes the first hit in case of a default thereby making the lenders risk free until a certain level of recovery rate. The lenders will feel much more secured and hence lower the rates.

**Table D.2:** Wholesale Market De-risking instrument
Source: Steer analysis

| | |
|---|---|
| **Market Offering** | **Lender is assured a cover up to 20% of outstanding loan balance** |
| **Facility Size** | E 2W: $150 Mn / E 3W: $150 Mn / e-4W: $150 Mn<br><br>USD 450 Mn in Total |
| **Vehicles Impacted 7.6 Million** | Facility Size / Investment per vehicle, investment per vehicle equals lower of 20% of the outstanding loan balance and loss given default (outstanding loan balance less salvage value which is 40% of the sticker price) |
| **Market % Impacted** | Vehicles Impacted / Total vehicles sold in FY 20 pan India |
| **Un-adjusted TCO Improvement** | Credit margins become 1.2% & bank rating improve by 1 basis point (B-) making interest rate come down by 8%. |
| **Adjusted TCO Improvement** | Market % Impacted x Un-adjusted TCO Improvement<br>Goes through in the calculations |

| | |
|---|---|
| **Perception Factor improvement** | 75% of the TCO improvement is assumed to be applicable on the perception |
| **Overall ΔEV Penetration 7.6%** | Based on the Adjusted TCO & Perception Factor calculations |
| **18,600 EVs per USD Million Invested in the investment option** | Based on the Overall penetration & Facility size |

**Table D.3:** Second Loss Facility
Source: Steer analysis

| | |
|---|---|
| **Market Offering** | **Lender is assured 20% cover up to 20% of outstanding loan amount** |
| **Facility Size** | E 2W: $150 Mn / E 3W: $150 Mn / e-4W: $150 Mn<br><br>USD 450 Mn in Total |
| **Vehicles Impacted 6.6 Million** | Facility Size / Investment per vehicle, investment per vehicle equals 20% of the lower of 20% of the outstanding loan balance and loss given default (outstanding loan balance less salvage value which is 40% of the sticker price) |
| **Market % Impacted** | Vehicles Impacted / Total vehicles sold in FY 20 pan India |
| **Un-adjusted TCO Improvement** | The credit margins will become 4.90% making complete interest rate come down by 1.3%. |
| **Adjusted TCO Improvement** | Market % Impacted x Un-adjusted TCO Improvement goes through in the calculations |
| **Perception Factor improvement** | 65% of the TCO improvement is assumed to be applicable on the perception |
| **Overall ΔEV Penetration 3.7%** | Based on the Adjusted TCO & Perception Factor calculations |
| **9,600 EVs per USD Million Invested in the investment option** | Based on the Overall penetration & Facility size |

**Figure D.3:** Appraisal approach & methodology to arrive at the final results for e-bus using "Wholesale market de-risking instrument" as an example
Source: Steer Analysis

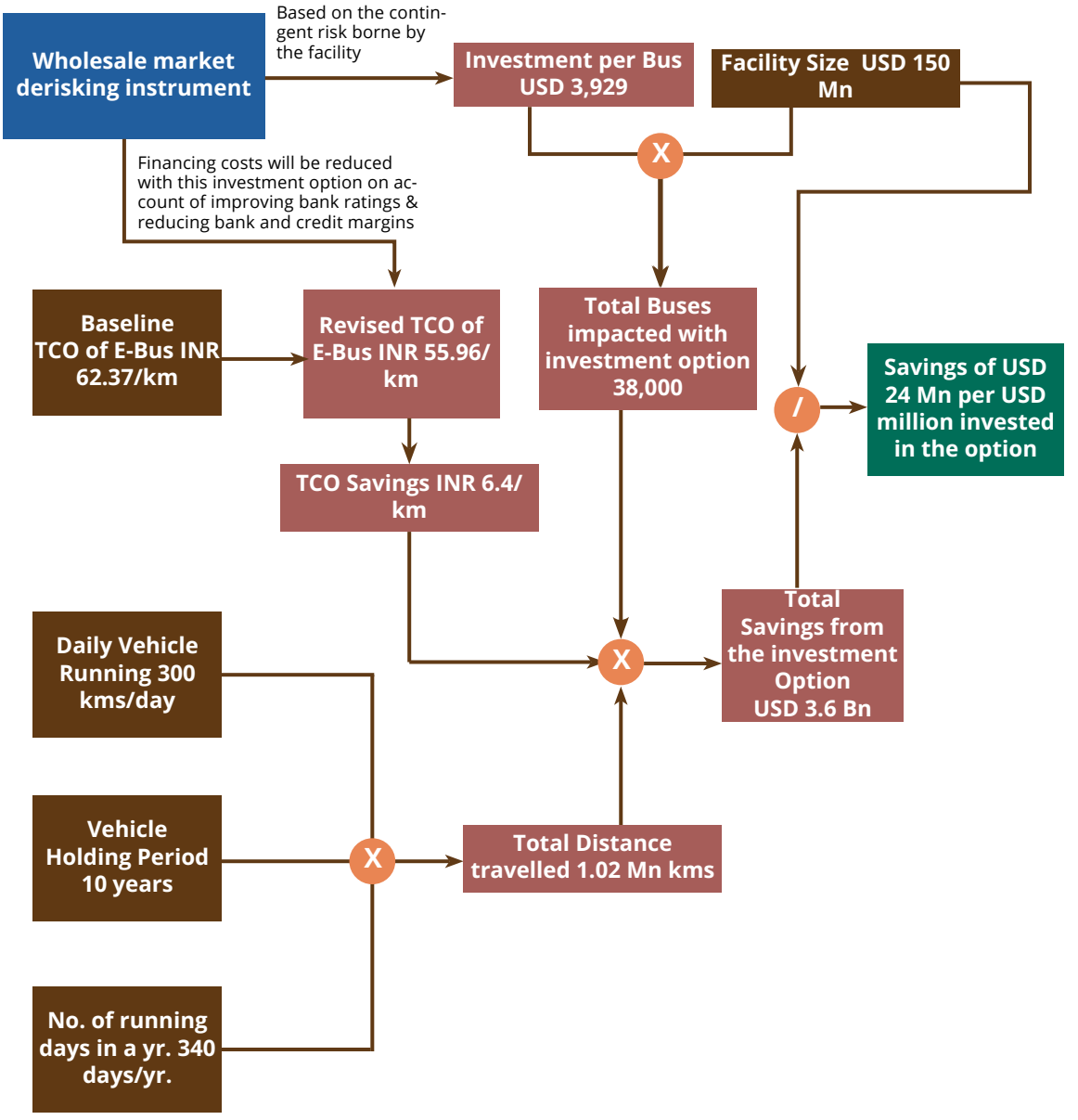


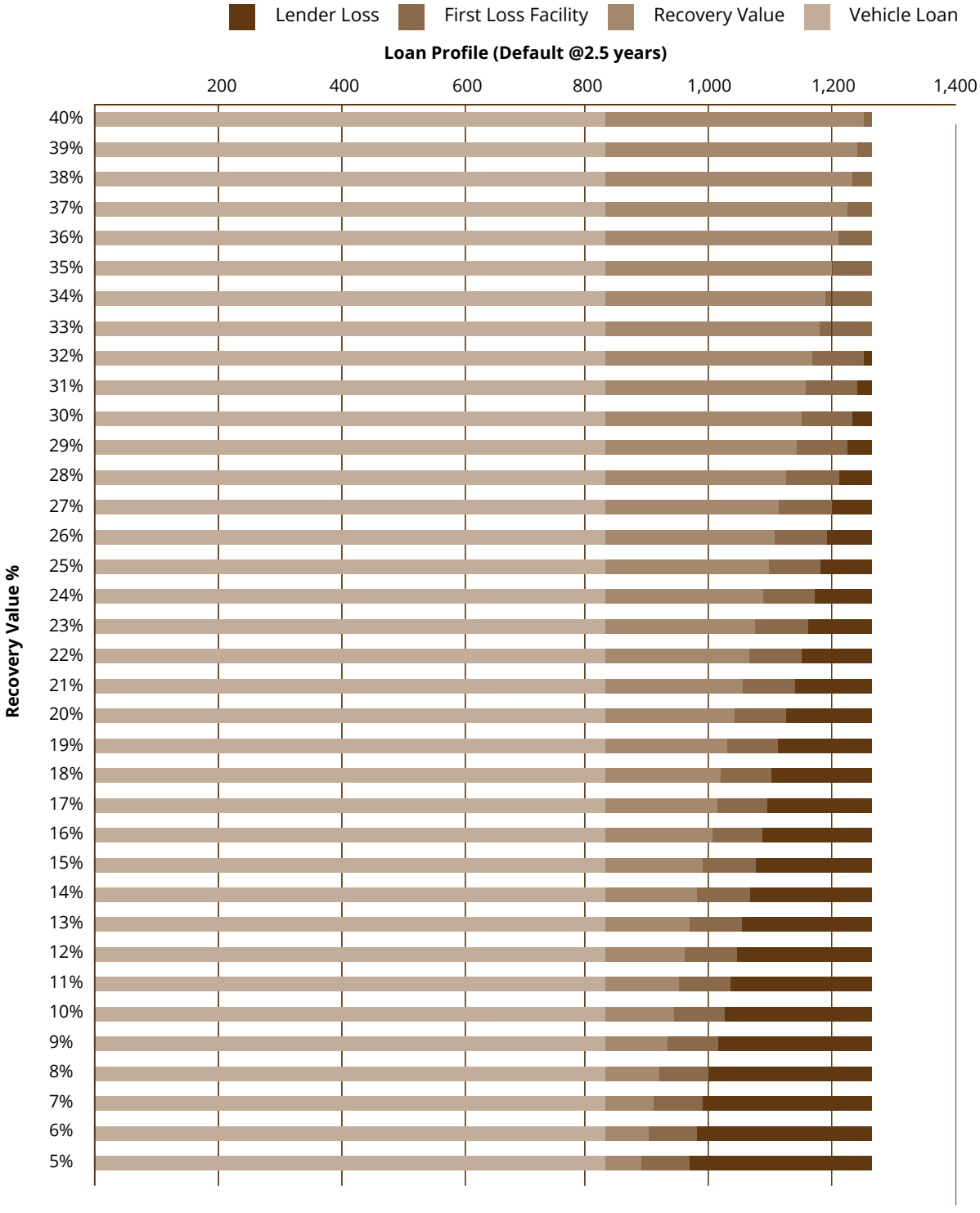
**Table D.4:** Investment Option Assumptions - First Loss Facility Illustrtaion
Source: Steer representation

| | Investment per Vehicle | Benefit to Vehicle | Percaption Factor % |
|---|---|---|---|
| **Vehicle Discount Scheme** | 15% of the sticker price considered as the capex discount | 15% lower capex is input in the financial model to calculate TCO | 50% of TCO savings considered as perception factor improvements |
| **OEM Expansion** | The difference in manufacturing costs of ICE & EV considered as investment per vehicle | 10% lower capex is input in the financial model to calculate TCO | 15% of TCO savings considered as perception factor improvements |
| **Interest Rate Subsidey** | difference in in terest expenses under base case & with 5% lower interest rate considered | 5% lower financing cost is input in the financial model to calculate TCO | 50% of TCO savings considered as perception factor improvements |
| **Buyback Guarantees** | Min. of 20% Loan outstanding at 2.5 yrs. & outstanding loan less salvage calue (40%) is considered | 5% lower financing cost is input in the financial model to calculate TCO | 75% of TCO savings considered as perception factor improvements |
| **Dedicated EV Financing Vehicle** | 80% of sticker price (Loan) is considered as investment per vehicle | 6.64% lower financing cost is input in the financial model to calculate TCO | 15% of TCO savings considered as perception factor improvements |
| **Public charging scheme (PPP)** | Charging capacity of new station is adjusted with charging speed & charge/vehicle to calculate vehicles | infra capex and opex is removed in the financial model to calculate TCO | 85% of TCO savings considered as perception factor improvements |
| **Second Loss guarantees** | 20% of min. of 20% loan outstanding at 2.5 yrs. & outstanding loan less salvage value (40%) is considered | 1.3% lower financing cost is input in the financial model to calculate TCO | 65% of TCO savings considered as perception factor improvements |
| **User discounts** | The % savings on the TCO from the investment option is used as a proxy to calculate the investment | 3.2% lower financing cost is input in the financial model to calculate TCO | 65% of TCO savings considered as perception factor improvements |
| **Wholesale market derisking instrument** | Min. of 20% Loan outstanding at 2.5 yrs. & outstanding loan less salvage calue (40%) is considered | 8% lower financing cost is input in the financial model to calculate TCO | 75% of TCO savings considered as perception factor improvements |
| **Direct Lending/ Investment** | The difference in manufacturing costs of ICE & EV considered as investment per vehicle | 7.6% lower financing cost is input in the financial model to calculate TCO | 30% of TCO savings considered as perception factor improvements |

The applications and thus the implications of each investment option for the stakeholder can be understood as a graphical depiction. In the example shown here, second loss facility provides a cushion in case of a default thereby making lenders bear lower risks. The lenders will feel much more secured and hence lower the rates.

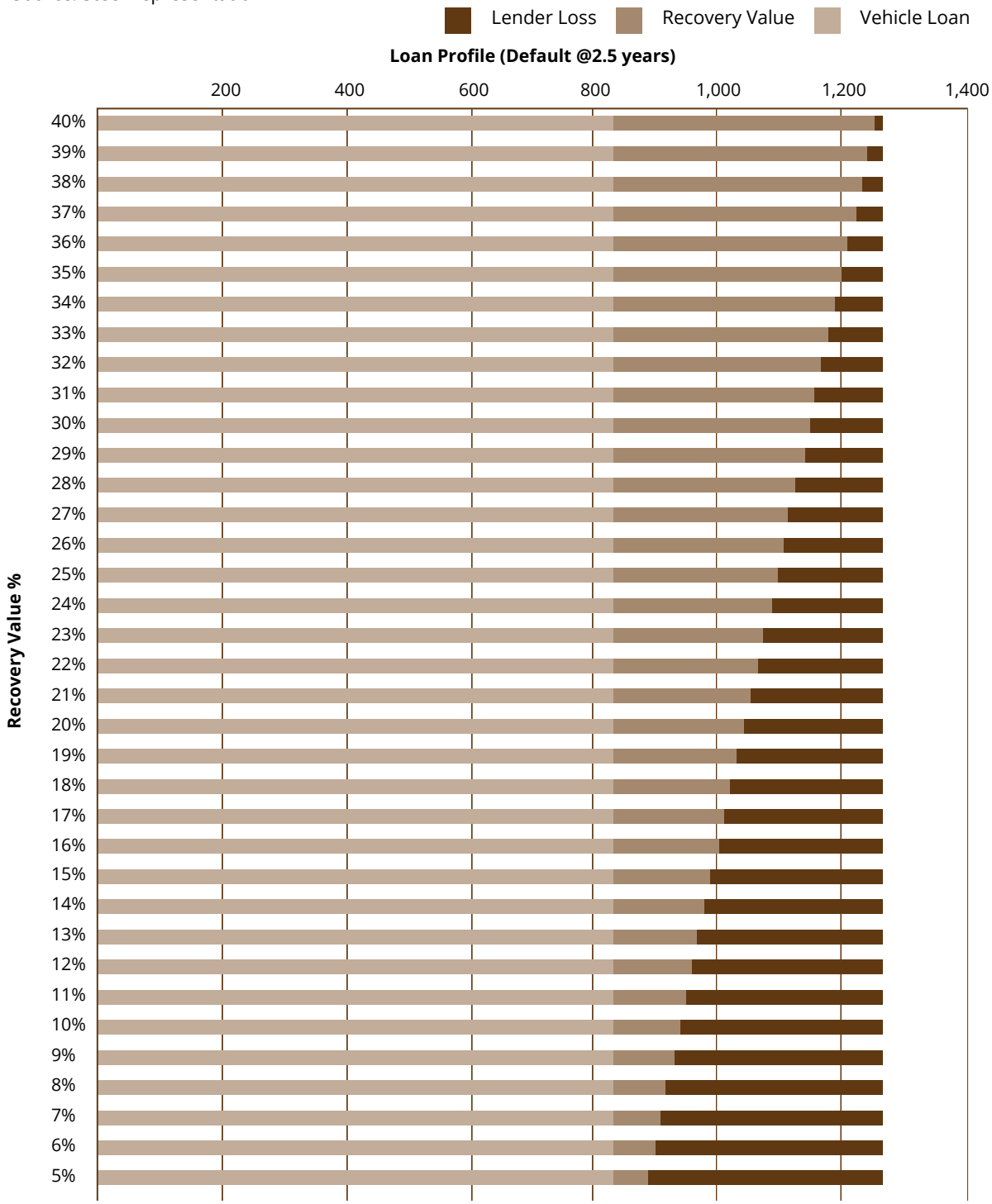
**Lender needs to bear default losses post the recovery value falling beyond a**

**Figure D.4:** Lender Loss Profile As the Recovery Value Decreases (First Loss Facility)
Source: Steer representation



## Benchmark lender loss profile without any facilities (Lender losses from inception)

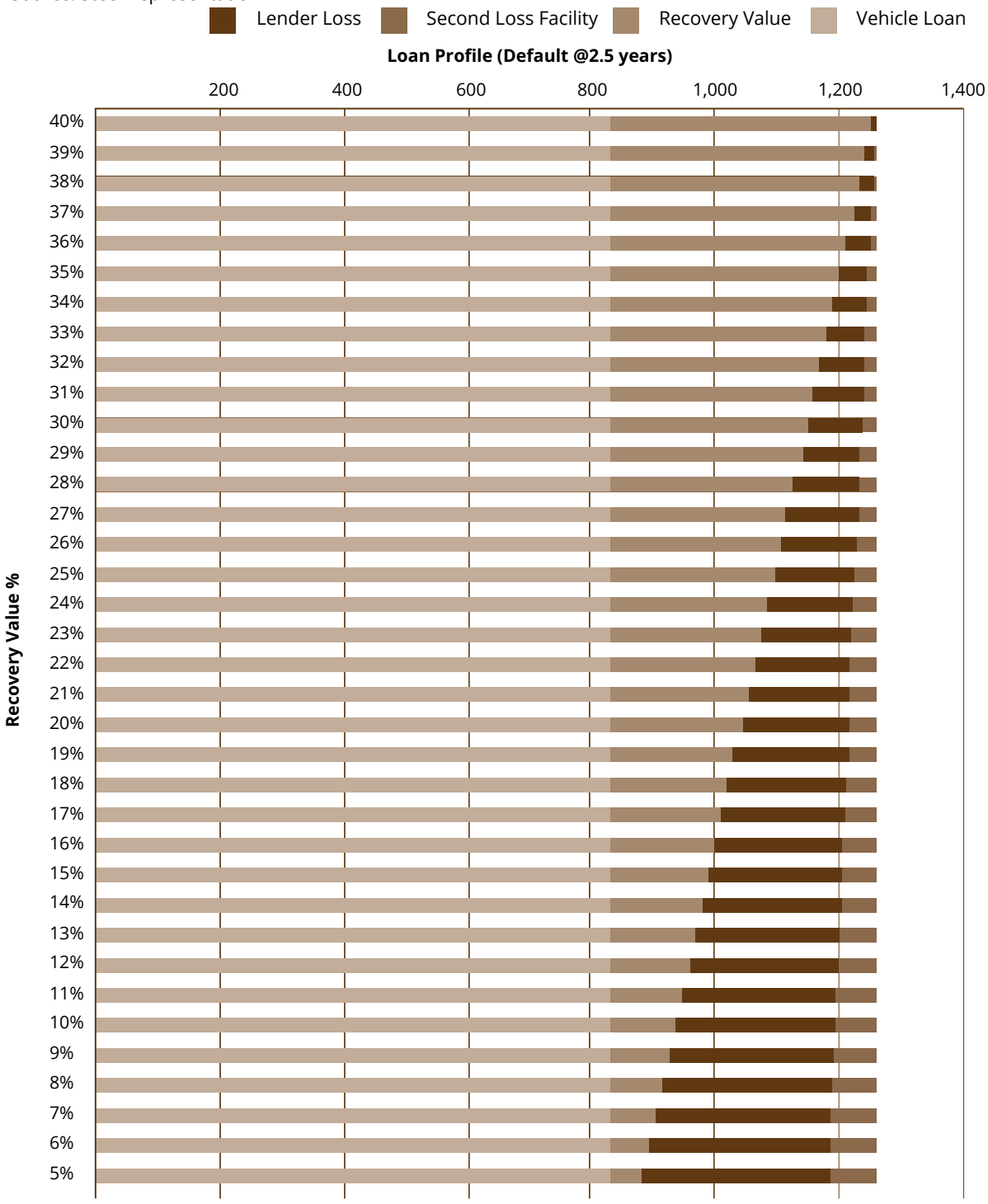
**Figure D.5:** Lender Loss Profile As the Recovery Value Decreases (No Facility)
Source: Steer representation



### Second Loss Illustration

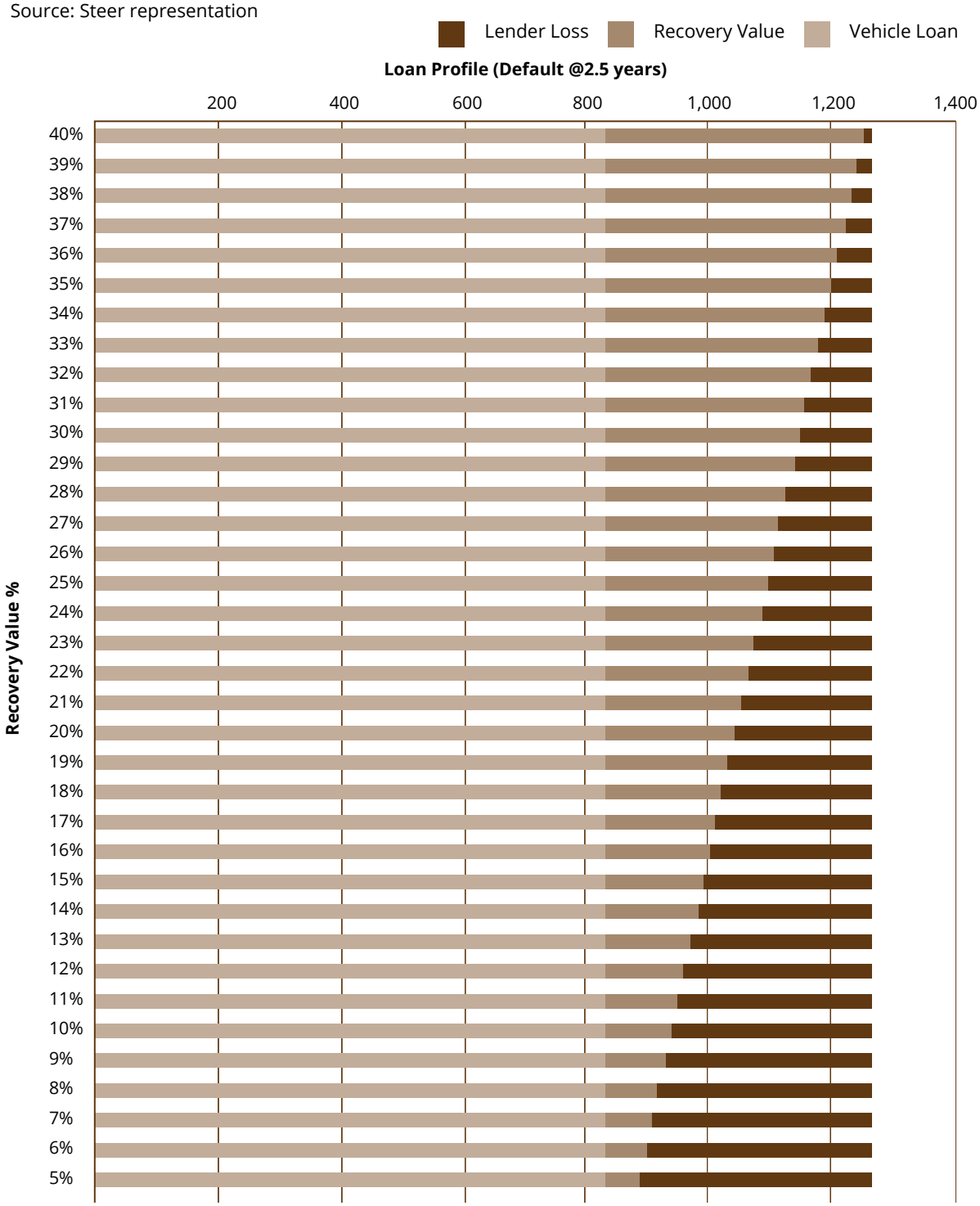
The applications and thus the implications of each investment option for the stakeholder can be understood as a graphical depiction. In the example shown here, second loss facility provides a cushion in case of a default therby making lenders bear lower risks.

**Figure D.6:** Lender Loss Profile As the Salvage Value Decreases (Second Loss Facility)
**Lenders get a buffer to the quantum of the default losses**
Source: Steer representation



## Benchmark lender loss profile without any facilities (Lender losses from inception)

**Figure D.7:** Lender Loss Profile As the Salvage Value Decreases (No Facility)
Source: Steer representation



## E. Approach for Stakeholder consultation

Stakeholder engagement was both central and key to deliver outputs under the project. The list of stakeholders consulted during the assignment included government agencies at central, state and city level as well as market players covering the entire EV value chain from OEMs to charging point operators and battery manufacturers for each vehicle category from the supply side and fleet operators and 3PL players from the demand side.

**Figure E.1:** List of stakeholders consulted during the project
Source: Steer representation

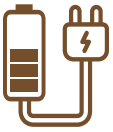
### Vehicle OEMs

- Ather Energy
- Zypp
- Okkinawa
- ReVolt

- Altigreen
- Mahindra Electric
- TATA Motors
- Clean Motion

- TATA Motors

### Charging Infrastructure (Market)



- Siemens
- Exicom
- Panasonic
- NTPC
- Okaya
- EESL

### Fleet Operators/Aggregators

OLA, Li, bigbasket, MERU

### Financing Institutions

**Commercial Bank**
- IDBI

**NBFC**
- Mannapuram

**Fintech**
- OTO capital
- Revfin
- Zest Finance
- Three-Wheel United
- Shell foundation

### Government Agencies

**Central Ministries**
- NITI Aayog
- Ministry of Heavy Vehicles & Public Enterprises
- Ministry of Road Transport & Highways
- Ministry of Housing & Urban Affairs

Steer team organized one-on-one consultations with market players on demand and supply side to understand key policy, regulatory, legal, procedural, procurement and funding related barriers to adoption of EVs. These consultations were also central to understand the modalities and conditions for success of high potential business models. The key assumptions for analyzing the financial feasibility of selected business models were also vetted through relevant stakeholders during one-on-one consultations.

The action plan roadmap was developed based on the identified issues inhibiting uptake of EVs and solutions required for allowing the business models to be taken up at a large scale. A series of consultations were held on the draft action plan recommendations with the State and National government agencies to get feedback on the applicability, impact, and ease of implementation of the proposed recommendations. Ground level experience and network of our on-board industry advisors (Anil Arora-Clean Motion, Tarun Mehta-Ather Energy and Sivam Sebastian-CharIn) was also instrumental in developing implementable action plan recommendations.

The following table provides a list of stakeholders consulted for feedback on the action plan recommendations:

**Table E.1:** List of consultations held on action plan recommendations
Source: Steer representation

| S.No. | Name | Designation | Company/ Department | Date |
|---|---|---|---|---|
| **National Consultations*** | | | | |
| 1. | Sudhendu Jyoti Sinha | Adviser Infrastructure Connectivity and electric mobility | NITI Aayog | 23 June 2021 |
| 2. | Anil Srivastava | Principal Consultant & Mission Director | National Mission on Transformative Mobility and Battery, NITI Aayog | 15 December 2020 |
| **State Consultations** | | | | |
| 3. | Ashish Kumar Singh | Principal Secretary | Transport and Home Department, Government of Maharashtra | 29 January 2021 |
| 4. | Satish Sahasrabudhe | Ex-Additional Commissioner of Transport | Transport Department, Government of Maharashtra | 8th and 25th February 2021 |
| 5. | Pooja Kulkarni | Special Secretary | Finance Department and State Government of Tamil Nadu | 17 March 2021 |
| 6. | Raj Cherubal | CEO | Chennai Smart City | 8 March 2021 |
| 7. | K. Nandagopal | Chief Engineer | TANGEDCO | 16 March 2021 |

| S.No. | Name | Designation | Company/ Department | Date |
|---|---|---|---|---|
| **Financial Institutions** | | | | |
| 8. | Rev Fin | Founder and CEO | Rev Fin | 16 December 2020 |
| 9. | Zest Money | Ex. Senior Manager | ZEST Money | 16 February 2021 |
| 10. | Dhiraj Agarwal | Sr. Vice President and CEO TW an EV Businesses | Mannapuram Finance Limited | 17 December 2020 |
| 11. | Aparna Mangla | India Regional Manager | Shell Foundation | 22 December 2020 |
| **OEMs** | | | | |
| 12. | Anil Arora | CEO | Clean Motion | 9 February 2021 |
| 13. | Vijay Medikonda | DGM Sales and Marketing | Olectra | 16 March 2021 |
| **Charging Infrastructure** | | | | |
| 14. | Sivam Sebasan | Managing Director | CharIN | 17 March 2021 |
| 15. | Akshay Ahuja | Business Development Manager | EXICOM | 5 January 2021 |
| **Fleet Operators** | | | | |
| 16. | Prasanna Patwardhan | Chairman and Managing Director | Prasanna Purple Mobility Solutions Ltd. | 15 March 2021 |

*2 national consultations were held during the project which were organized by the World Bank group virtually. The participating organizations included NITI Aayog, DHI, MoRTH, MoHUA, selected states and Cities, DHI, World Bank, IFC, ESMAP and MOLO representatives


THE WORLD BANK


ESMAP
Energy Sector Management Assistance Program