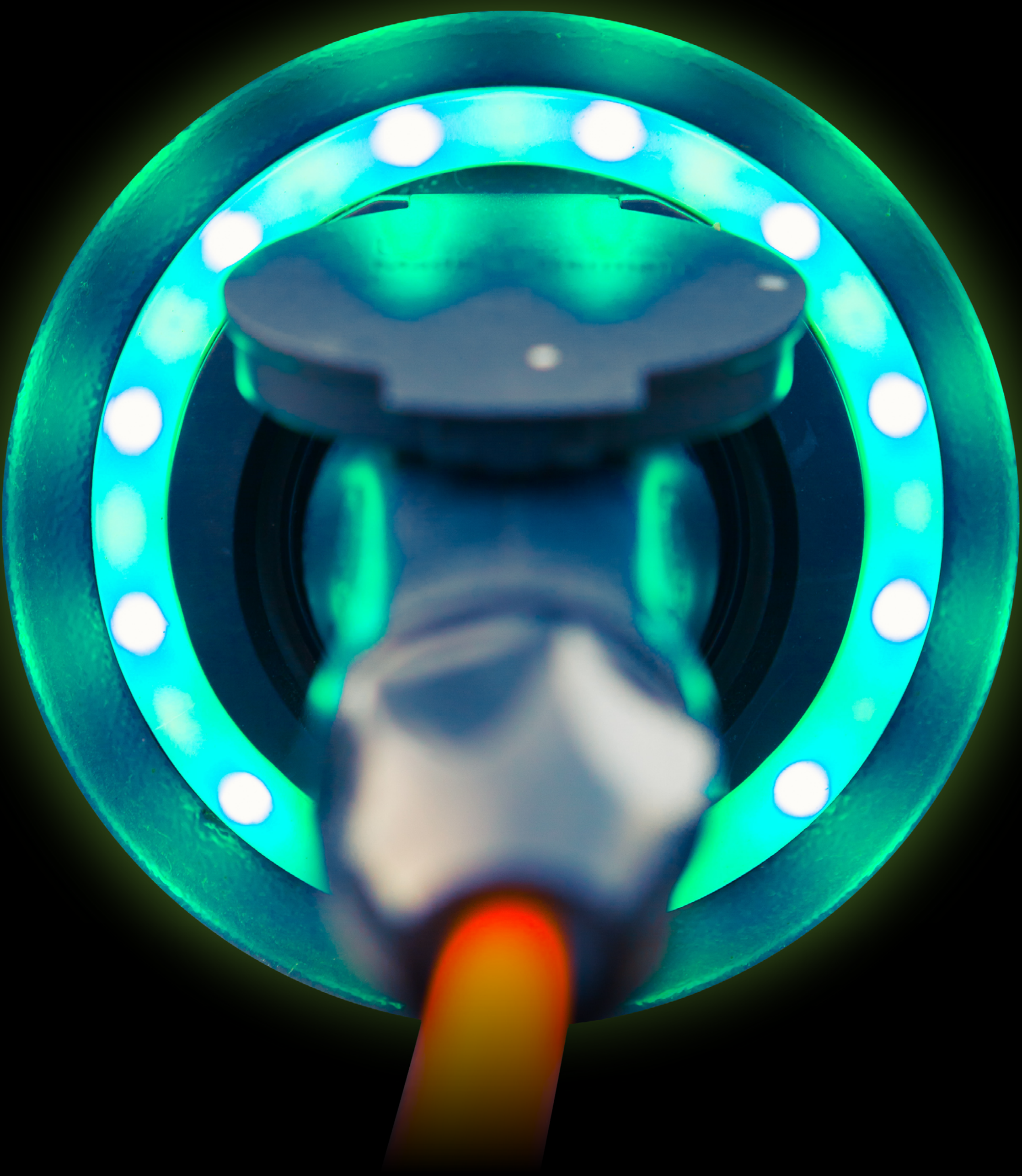
Deloitte.



Driving toward zero emissions

Renewable-powered charging infrastructure for India's Electric Vehicles

September 2024

Table of contents

Background

The urgency to limit global temperature rise to 1.5°C above pre-industrial levels is now more critical than ever. Sectors are urged to reduce their Greenhouse Gas (GHG) emissions. The transport sector poses one of the most significant challenges to climate policy. Decarbonising transportation is crucial for meeting global sustainability goals, aligning with climate targets and mitigating severe climate impacts.

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

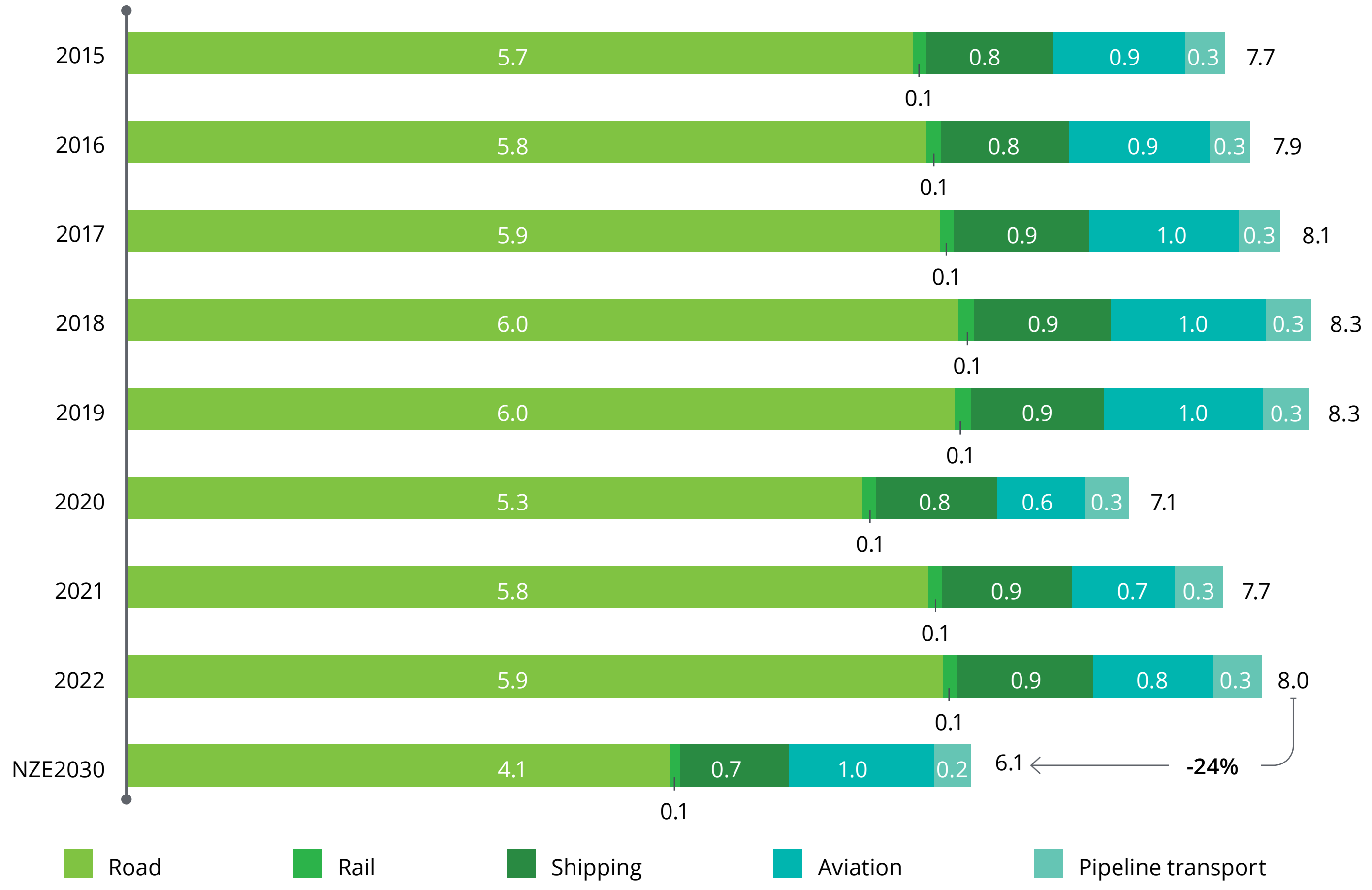
Transportation sector's role in global climate action

The Paris Agreement, adopted in 2015, set a clear target to limit global warming to 1.5°C. Corporations worldwide play a vital role in addressing the impacts of climate change. This ambitious goal requires significant reductions in GHG emissions across sectors. Corporate commitments to net-zero emissions are integral to this effort. The "Business Ambition for 1.5°C" campaign, launched in 2019, calls for companies to set science-based targets aligned with a 1.5°C pathway. Over 1,000 businesses globally have committed[1] to achieve net-zero emissions by 2050, demonstrating the critical role of business leadership in driving this transition.

The transport sector is an important enabler of economic growth and a significant contributor to global GHG emissions. The mobility of people and goods is fundamental to modern societies and the global economy. Transport is crucial for international trade, the development of global production chains and the functioning of energy systems. The transportation sector in developed countries currently accounts for approximately 30 percent of global Carbon dioxide (CO_2) emissions.[2] According to the World Bank, in a business-as-usual scenario, emissions from the transport sector could grow by up to 60 percent from today's levels by 2050.[3] Developing countries such as India face the dual dilemma of ensuring affordable access to mobility while ensuring the lowest possible carbon footprint.

Decarbonising the transport sector is crucial for several reasons, including its significant role in reducing GHG emissions, enhancing energy security, improving air quality and generating economic benefits such as jobs in the Electric Vehicles (EVs) manufacturing and allied sectors and sustainable urban development.

Figure 1: Transport sector emissions distribution 2022–2030 (GtCO2e)[4]



[1] https://zerotracker.net/
[2] https://www.weforum.org/agenda/2024/04/multi-fuel-infrastructure-network-transport-heavy-industry-energy-transition/
[3] https://www.worldbank.org/en/topic/transport/overview#:~:text=Domestic%20and%20international%20transport%20already,by%202050%20if%20left%20unchecked.
[4] https://www.iea.org/energy-system/transport

According to 2022 data from the IEA, road transport is responsible for approximately 73% of the transport sector's global CO_2 emissions.[5] The transport sector as a whole accounts for ~23% of global CO_2 emissions, making it a significant contributor to greenhouse gas emissions.[5.1] Achieving alignment with the Net Zero Emissions (NZE) Scenario necessitates reducing transport emissions by approximately 25 percent, bringing them down to around 6 $GtCO_2e$ by 2030,[6] despite expected increases in demand. This reduction will rely heavily on the swift transition to electric road vehicles.

A switch to alternative fuels in the transport sector is required to meet the 2030 targets per the NZE Scenario. This transition is essential for achieving the deep cuts in GHG emissions needed to align with global climate goals.

Asia Pacific: Rising transport demand and potential impact on climate

Per a World Economic Forum (WEF) report, the Asia Pacific region accounts for more than 50 percent[7] of global emissions, with the transport sector accounting for more than 10 percent of the total emissions.[8] The energy demand from the transport sector in the APAC region has increased by more than 40 percent in the last ten years[9] and is expected to increase by~40 percent by 2050 in a business-as-usual scenario.[10]

Since 2010, the region has been responsible for increased transport-related CO_2 emissions, contributing about two-thirds of the global rise in transport fossil CO_2 emissions.[11] China and India are the primary drivers behind the APAC region's rising demand and corresponding emissions. According to the Asian Transport 2030 Outlook report, road freight accounts for most transport-related CO_2 emissions, contributing approximately 86 percent, and is projected to remain the primary source.[12] In most Asia-Pacific countries, road transport, including passenger vehicles and freight transport such as trucks, dominates overall transport emissions. Under a business-as-usual scenario, passenger and freight transport demand could increase by 150 percent[13] from 2015 to 2050. As demand rises, integrating urban freight activities within cities will become increasingly crucial for developing low-carbon urban freight solutions. In South-East Asia alone, urban freight is projected to double between 2015 and 2030.[14] The need to develop low-carbon urban freight and transport, including last-mile delivery, provides an opportunity to electrify urban passenger and freight demand.

Electrification as a strategy for decarbonisation of the transport sector

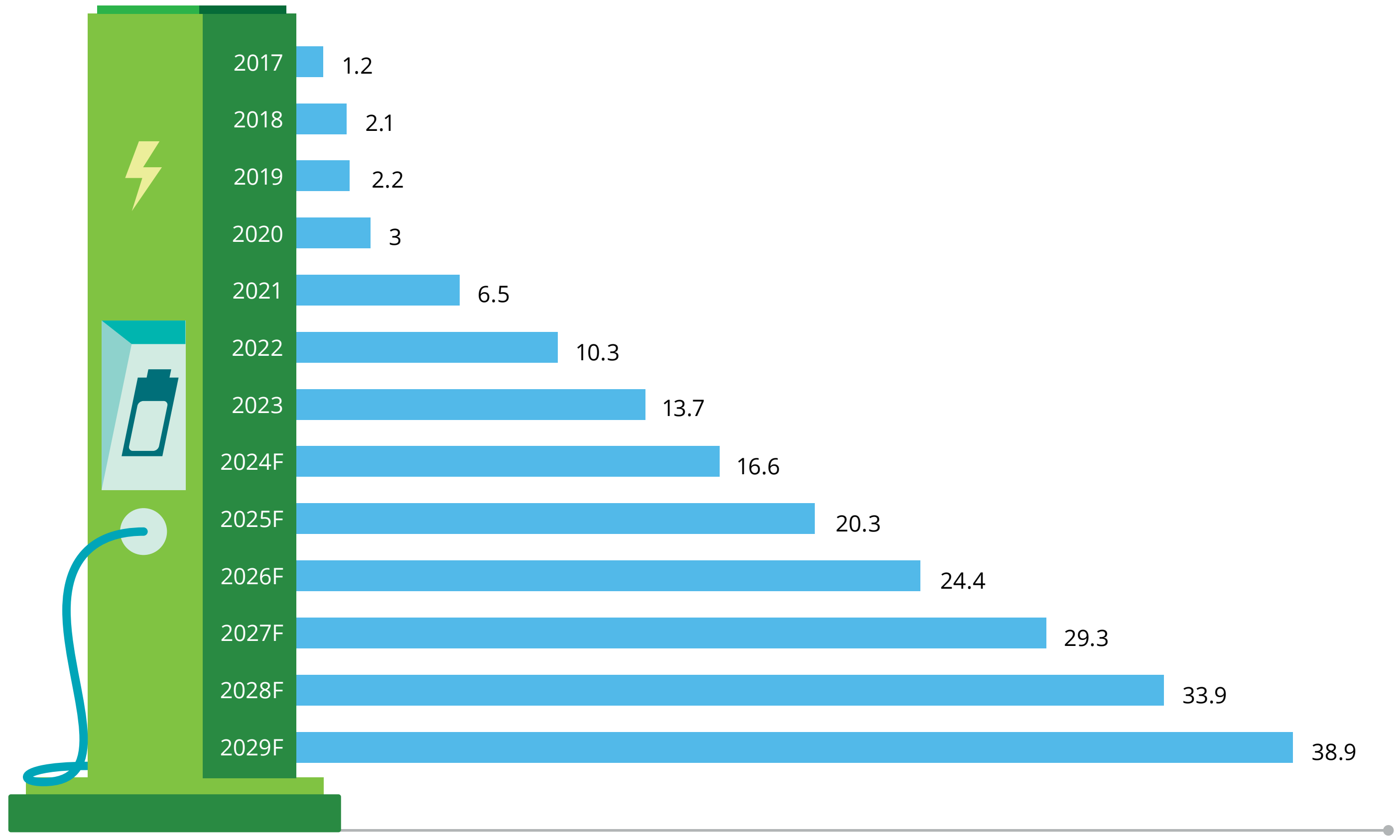
Globally, countries are adopting stricter fuel emission norms for vehicles and increased adoption of low-carbon fuels, biofuels, synthetic fuels, hydrogen-based fuel cells and low-carbon electricity to decarbonise the transport sector. The electrification of the transport sector is widely seen as an effective method for reducing dependence on petroleum products and minimising the environmental impact of transportation. Battery Electric Vehicles (BEVs) are emerging as the best alternative across transport categories, particularly for Passenger Cars (PCs) and Light Commercial Vehicles (LCVs), due to their higher efficiency compared with hydrogen-based Fuel Cell Vehicles (FCEVs). BEVs are projected to achieve significant market penetration, with PC demand growing and EVs reaching 14 percent of car sales in 2022.[15] In contrast, hydrogen-based vehicles face limitations due to the large battery size required for Heavy Commercial Vehicles (HCVs), longer recharging times and increased costs. Additionally, they contribute to higher overall CO_2 emissions due to lower energy efficiency, making BEVs the more efficient and cost-effective solution for decarbonising the transport sector.

Hence, electrification offers the dual benefits of reduced GHG emissions and decreased dependency on oil imports, enhancing energy security.

[5] https://www.iea.org/data-and-statistics/charts/global-co2-emissions-from-transport-by-sub-sector-in-the-net-zero-scenario-2000-2030-2
[5.1] https://www.iea.org/data-and-statistics/charts/global-co2-emissions-by-sector-2019-2022
[6] https://www.iea.org/energy-system/transport
[7] https://www.weforum.org/agenda/2023/04/how-corporate-asia-sits-at-the-centre-of-the-climate-crisis-but-also-its-solution/
[8] https://www.iea.org/regions/asia-pacific/emissions#what-are-the-main-sources-of-co2-emissions-in-asia-pacific
[9] https://www.iea.org/regions/asia-pacific/efficiency-demand
[10] https://www.statista.com/statistics/1081631/apac-energy-demand-in-the-transportation-sector/
[11] https://asiantransportoutlook.com/documents/70/ATO_COP28_Climate_tracker_-_final.pdf
[12] https://asiantransportoutlook.com/documents/11/Asian_Transport_2030_Outlook_Nov_2022.pdf
[13] https://www.unescap.org/news/call-papers-transport-and-communications-bulletin-asia-and-pacific-no93-low-carbon-transport#:~:text=Total%20passenger%20and%20freight%20demand,regional%20and%20global%20climate%20action.
[14] https://www.itf-oecd.org/sites/default/files/docs/itf-southeast-asia-outlook.pdf
[15] https://www.iea.org/energy-system/transport

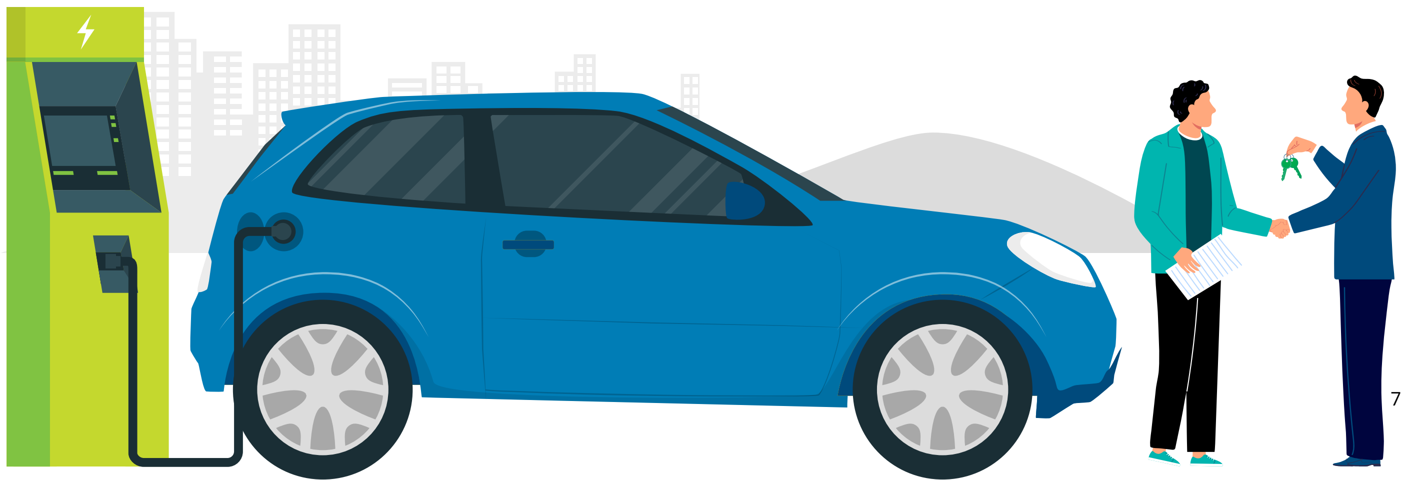
Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

Figure 2: Global EV sales 2017–2029 (Million Units)[16]



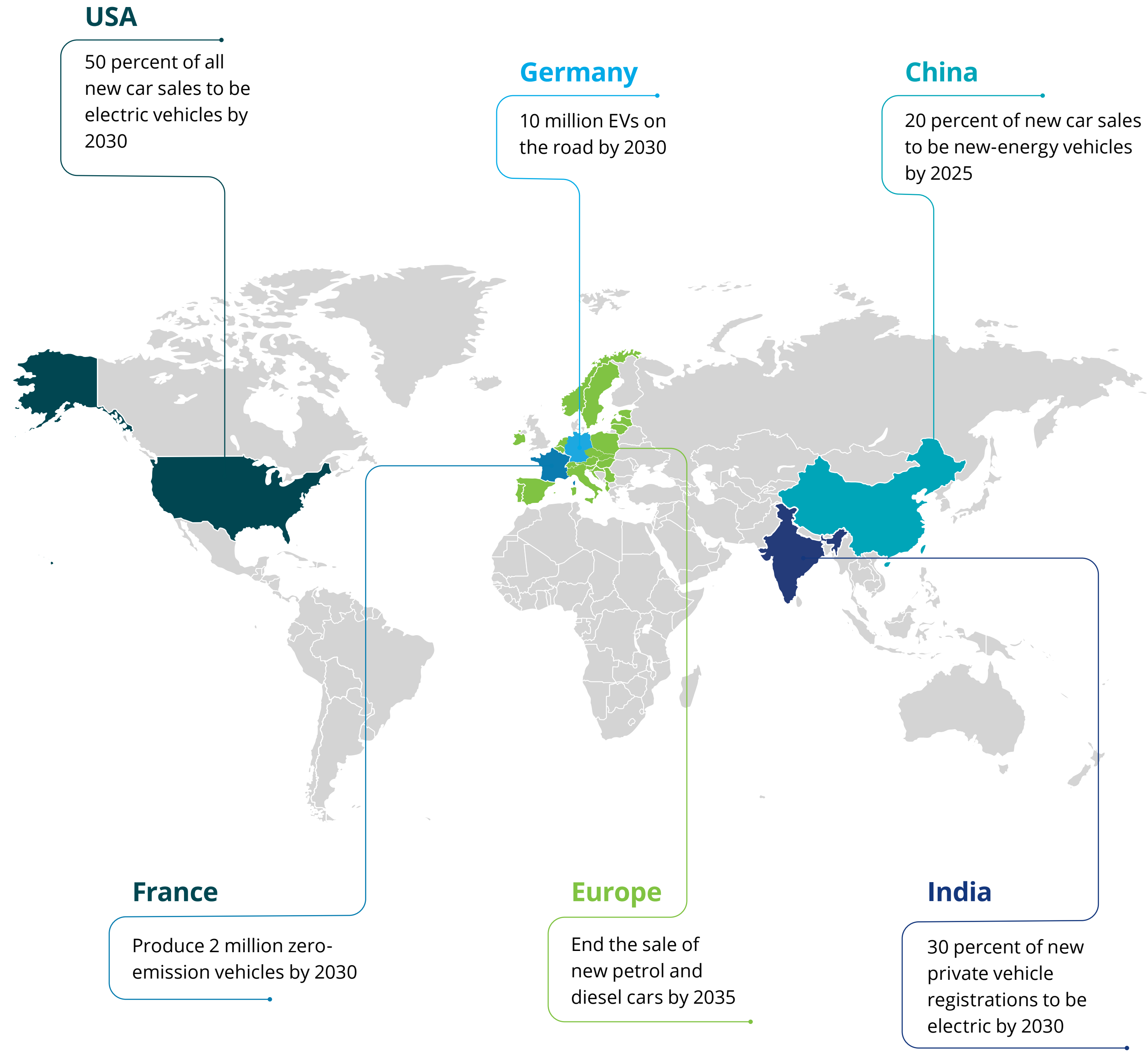
The IEA report (Fig. 2 above) shows that annual EV sales globally increased by 12.5 million units from 2017 to 2023. Under current policy settings, global electric light-duty vehicle sales are expected to reach 40 percent by 2030 and nearly 55 percent by 2035.[17] This trend underscores the potential for electrification to play a crucial role in achieving global climate goals.

[16] https://www.statista.com/statistics/665774/global-sales-of-plug-in-light-vehicles
[17] https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf



This growth in EV sales globally is supported by ambitious EV targets set by various countries, as shown in the following infographic:

Figure 3: Snapshot of EV targets taken by major automotive markets

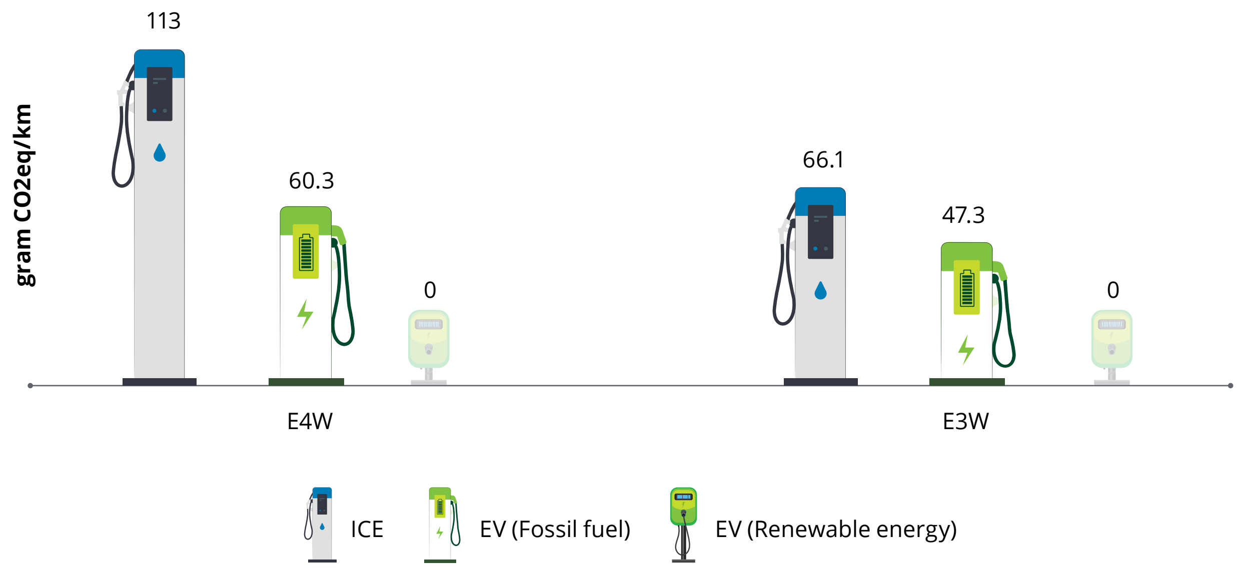


These national targets drive the global surge in EV sales and support the transition to a more sustainable transport sector.

Environmental benefits of EVs

Electrifying vehicles enhance transportation efficiency, cut GHG emissions and reduce reliance on fossil fuels. Therefore, electrification of mobility is essential for decarbonising road transport, as passenger cars and vans contribute more than 10 percent of global energy-related CO_2 emissions.[18] EVs offer a cleaner alternative to traditional Internal Combustion Engine (ICE) vehicles, leading to modest reductions in transportation's environmental impact by reducing GHG emissions and lowering emissions when powered using Renewable Energy (RE).

Figure 4: India's operational emission comparison[19]



The emissions avoided by EVs can range from 100 to 270 grams of CO_2 per kilometre compared with an ICE vehicle.[20] However, emissions from fossil fuel-based electricity generation for EV charging can significantly offset this emission reduction. In India, the emission reduction due to fossil fuel-based EV charging is dependent on the Grid Emission Factor (GEF) (0.71 kgCO2e/kWh),[21] which is directly proportional to the grid's conventional and renewable power mix. Therefore, establishing a RE-powered Electric Vehicles Charging Infrastructure (EVCI) is crucial to maximising the possible emissions reduction due to the adoption of EVs. EVCI could act as distributed energy storage to integrate RE into the grid and off-grid energy systems (Battery to Grid).

[18] https://www.iea.org/energy-system/transport/cars-and-vans
[19] Deloitte Analysis
[20] Deloitte Analysis
[21] CEA

India’s EV growth story

Transportation emissions have increased faster in developing regions such as India compared with North America and Europe, driven by rising incomes, increased car ownership and improved transportation infrastructure.

The automobile industry is one of the main pillars of the Indian economy, contributing over 7 percent to the country’s GDP.[22] India's average vehicle penetration is 66 vehicles per thousand people, which is very low compared to advanced economies, where the range is between 233 vehicles per thousand people in China and 845 vehicles per thousand people in the US.[23] Road transport accounts for around 12 percent of India’s energy-related CO_2 emissions and is a key contributor to urban air pollution.[24]

India’s road transport sector predominantly relies on diesel and petrol. Total petroleum consumption reached 233.2 Million Metric Tonnes (MMT) in FY2023–24.[25] Over the past decade, diesel consumption has risen by 29.6 percent, from 69.1 MMT in FY2012–13 to 89.6 MMT in FY2023–24. Additionally, motor spirit/ petrol consumption has surged by 135 percent, from 15.8 MMT in FY2012–13 to 37.2 MMT in FY2023–24.

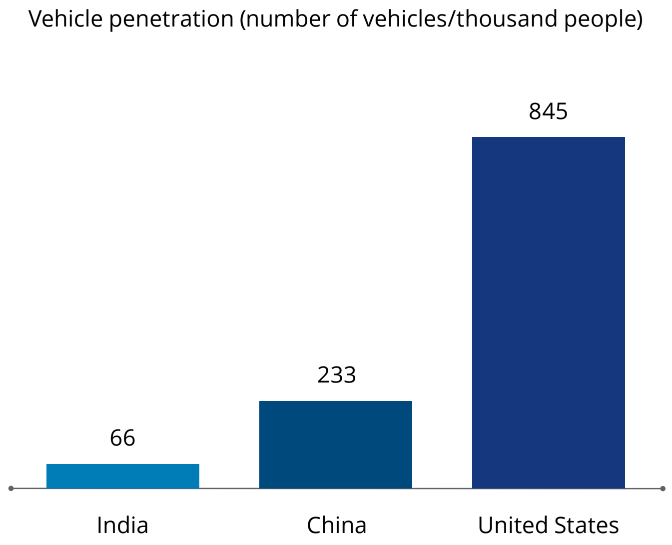
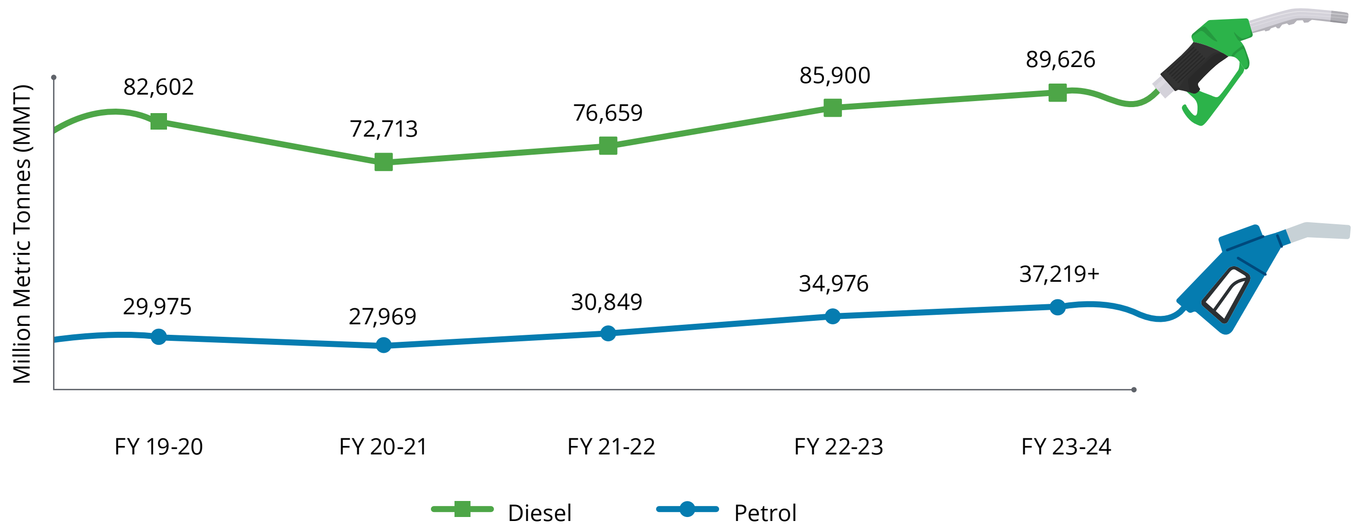


Figure 5: Increase in fuel consumption from FY20 to FY24

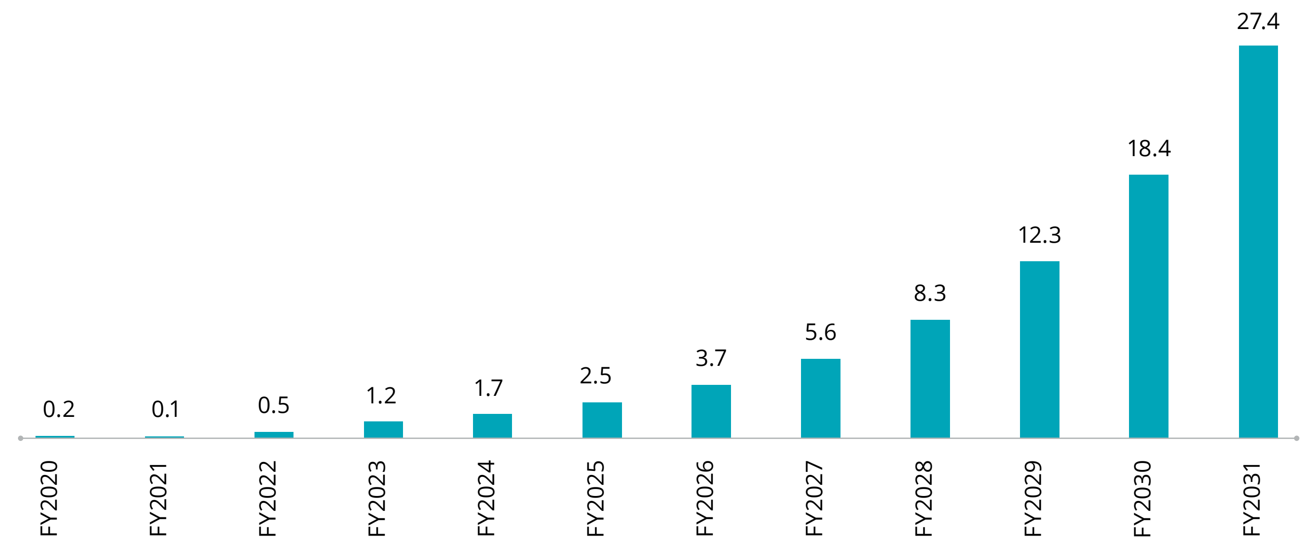


India transports approximately 4.6 billion tonnes of freight annually, with 71 percent of this freight being carried by road transport. This contributes to roughly one-third of the nation’s diesel consumption.[26] In 2020, last-mile delivery for e-commerce in India accounted for about 50 percent of delivery transport CO_2 emissions, resulting in around 500,000 tonnes of CO_2 emissions.[27] Given the continuous growth in petrol consumption and the annual increase in freight transported, last-mile delivery-related emissions have risen.

India is poised to become one of the largest EV markets in the world by 2030, with the market expected to grow at an average annual rate of 49 percent between 2021 and 2030.[28] India promotes EV adoption by implementing favourable policies, regulations and schemes such as Faster Adoption and Manufacturing of Hybrid and EVs (FAME) and National Electric Mobility Mission Plan (NEMMP). The goal is to achieve 6–7 million sales of hybrids and EVs year-on-year from 2020 onwards.

[22] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/feb/doc2023217160601.pdf
[23] https://www.ceicdata.com/en/countries
[24] https://iea.blob.core.windows.net/assets/06ad8de6-52c6-4be3-96fc-2bdc3510617d/TransitioningIndiasRoadTransportSector.pdf
[25] https://ppac.gov.in/consumption/products-wise
[26] https://jmkresearch.com/wp-content/uploads/2024/04/E-Trucks-Market-in-India-Whitepaper-Mar-2024.pdf
[27] https://clean-mobility.org/wp-content/uploads/2022/07/Secret-Emissions-of-E-Commerce.pdf
[28] https://www.investindia.gov.in/sector/automobile

Figure 6: Actual and projected EV sales in India (FY2020-FY2031) (Million units)[29]

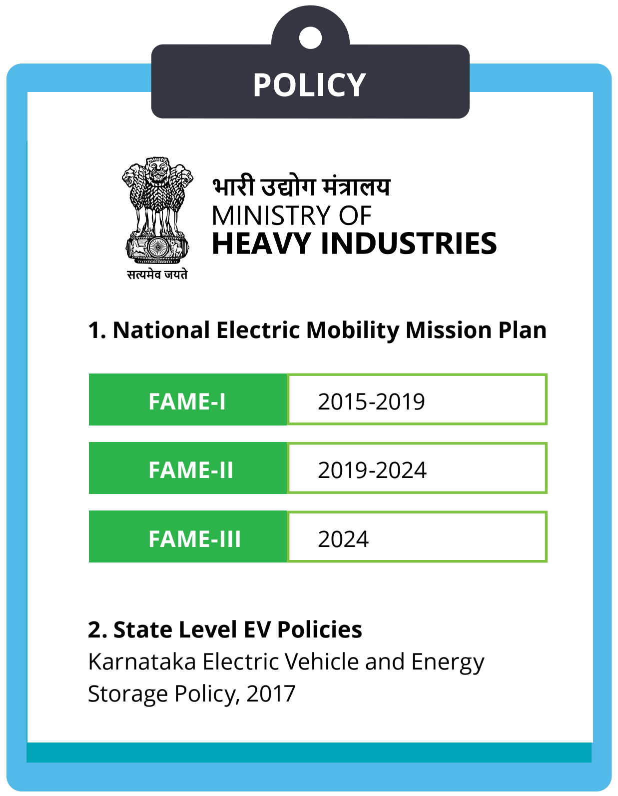


There is a significant disparity in capital expenditures between electric and ICE vehicles, with Electric Four-Wheeler passenger vehicles (E4Ws) costing approximately twice as much as their ICE counterparts. Similarly, e-buses are about 1.5 to 2 times more expensive than diesel buses, depending on specifications. However, subsidies and substantial government support from central and state authorities have enabled Electric Two-Wheelers (E2Ws) to reach price parity with their ICE equivalents.

Policy-driven growth

The government of India and various state governments have developed policies and notified various regulations and schemes to provide much-needed impetus to the adoption of EVs. The key initiatives include the National Electric Mobility Mission Plan (2013), the implementation of the Faster Adoption and Manufacturing of Hybrid and EVs (FAME) schemes (FAME I - 2015–2019) and (FAME II - 2019–2023), the Production Linked Incentives (PLI) scheme (2021) and the National Charging Infrastructure guidelines.

By providing fiscal incentives in 2013, the National Electric Mobility Mission Plan 2020 (NEMMP) set the foundation for the government to prioritise electric mobility, aiming to increase the adoption of electric and hybrid vehicles in India. The FAME scheme was implemented in two phases. It offered upfront capital subsidies and incentives for purchasing EVs, establishing charging infrastructure and bolstering R&D in the EV domain. To incentivise the demand for EVs, the scheme allocated US$1.25 billion for upfront subsidies and developing a robust charging infrastructure. India has made tremendous progress in adopting EVs, yet the target of 6–7 million hybrid and EVs per annum remains distant by a substantial margin (~5 million gap in vehicles as of 2023).[30] The fiscal incentives and subsidies were extended to exhaust the existing allocation of the proposed outlay under the FAME II scheme.



[29] https://vahan.parivahan.gov.in/vahan4dashboard/
[30] VAHAN Dashboard

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

The central government has completed the preliminary draft for the third iteration of the FAME scheme (FAME III), earmarking a tentative budget between US$1.5 to US$3.5 billion.[31] The Ministry of Heavy Industries (MHI) has received in-principle approval of US$1.2 billion for the FAME scheme. This draft indicates that the government's focus is on augmenting demand and supply through incentives to bolster the EV ecosystem. Additionally, the framework for FAME III outlines a strategic plan to nurture the EV industry over the next two years.

State-level EV charging tariffs and provisions for procuring RE at competitive rates can reduce the EVs' operational costs, enhancing their appeal to consumers and fleet operators. Around 30 states and Union territories have implemented EV policies. In addition, measures such as implementing draft-battery swapping policies and launching National E-bus programmes aim to boost EV sales in India.

Market dynamics

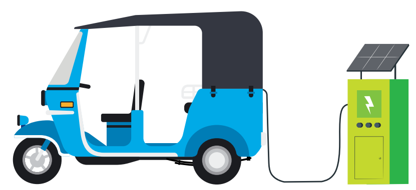
The market dynamics of EVs in India show a varied adoption rate across different vehicle segments. Two-wheelers have gained traction due to their affordability and lower Total Cost of Ownership (TCO) than ICE vehicles. Three-wheelers are popular for last-mile logistics, driven by their cost-effectiveness and corporate sustainability commitments. However, four-wheelers face slower adoption rates due to limited options and higher prices than ICE vehicles.[32]

4W

The E4W segment has seen lower adoption rates in India. Options for passenger E4Ws are limited yet fast-growing. These vehicles are priced at a premium compared with ICE vehicles. This high price has largely been attributed to the limited presence of domestic auto component manufacturers.

2 percent | **80,443**

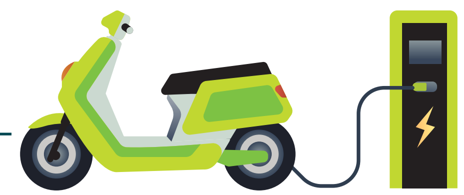
3W



E3Ws are a popular option for last-mile logistics and intra-city cargo. Given the high usage factor of these vehicles, their TCO is comparable to that of ICE vehicles in a relatively shorter time. Moreover, corporate commitments to sustainability have accelerated the adoption of these vehicles.

22 percent | **6,32,779**

2W



Scooters and motorbikes are the preferred transport choices for most Indians, given their affordability and ease of use. The intra-city use-case and lower TCO compared with ICE vehicles of E2Ws and E3Ws make a strong case for the success of these segments in the Indian market. The FAME-II scheme has provided generous subsidies for E2W customers, reducing the cost of these vehicles by up to 20 percent, thus making the adoption of E2Ws a more attractive proposition.

5 percent | **9,48,447**

Vehicle penetration (As of FY2024)

Annual sales (Nos)(FY2024)

[31] Ministry of Heavy Industries
[32] https://vahan.parivahan.gov.in/vahan4dashboard/vahan/view/reportview.xhtml

EVCI growth story[33]

India supports the global EV30@30 campaign, which targets 30 percent new EV sales by 2030. To achieve the Indian government's target of EV30@30, amounting to 80 million EVs, the country will need a total of 3.9 million public and semi-public charging stations, ensuring a ratio of 1 station per 20 vehicles.[34] This infrastructure is crucial to support the dramatic rise in EV adoption. The current ratio (approximately 1 charging station per 135 EVs) is lower than the global ratio (1 charging station per 6 to 20 EVs);[35] this shortage in charging stations could push India to be 40 percent behind its EV 30@30 vision. Following are the three key obstacles hampering the growth of EVCI in India:

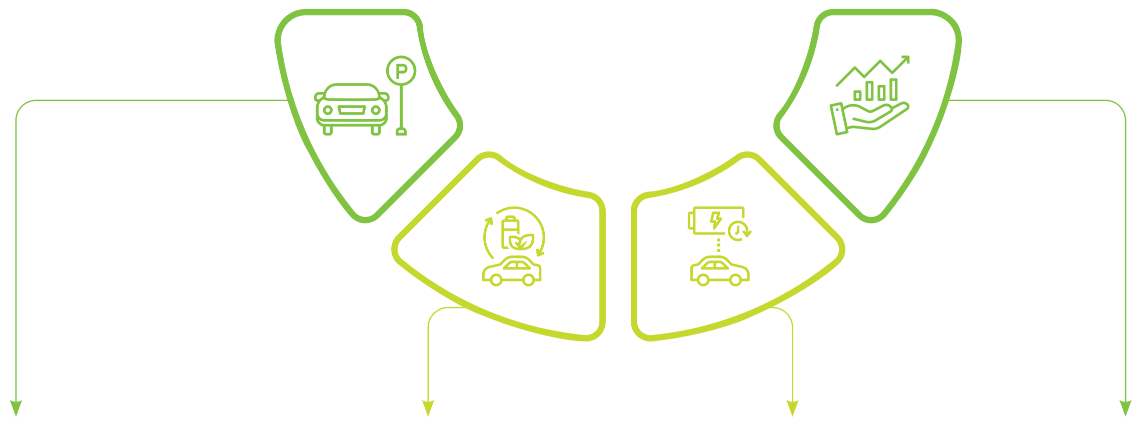
India's current shortage of public charging infrastructure, combined with businesses' reluctance to invest in EVCI due to high initial capital costs and a lack of awareness about the benefits, exacerbates range anxiety (A typical E2W has a range of 86–115 km, an E3W has a range of 125-146 km and an E4W has a range of 143–400 km) among prospective EV owners. This reluctance spans Charge Point Operators (CPOs), who face substantial investments in setting up fast-charging stations, retail stores, small business owners and Resident Welfare Associations (RWAs), who are concerned about the significant capital outlay required and may be unaware of the potential benefits these stations could bring to their businesses.

Factors such as uncertainty in charging station usage rates, high operating costs (including land rentals) and the strain on electricity distribution companies to create additional infrastructure pose challenges for operators. These issues deter investment in establishing charging stations, especially when the number of EVs on Indian roads is insufficient to allow operators to achieve a return on their investments. This reduces consumer confidence in EV reliability and private sector investment in charging infrastructure.

India's geographical diversity necessitates varied EV charging infrastructure solutions tailored to population densities, complicating installation and maintenance, especially in rural areas with fewer EVs.

[32] https://jmkresearch.com/electric-vehicles-published-reports/accelerating-transport-electrification-in-india-by-2030/
[34] https://jmkresearch.com/electric-vehicles-published-reports/accelerating-transport-electrification-in-india-by-2030/
[35] https://www.alvarezandmarsal.com/sites/default/files/2022-10/Electric%20Vehicle%20Report_A%26M%20India.pdf

To overcome these obstacles, key initiatives are proposed in the following areas:



Incentivise businesses, parking lots and RWAs to install EV charging stations while enhancing collaboration between the Ministry of Power and BEE to establish a comprehensive nationwide EV charging network.

Integrate RE into EV charging infrastructure using various methods based on space availability, contractual demand and financial feasibility, such as Open Access, Renewable Energy Certificates (RECs) and rooftop installations. This approach will reduce the cost of charging EVCIs by using the lower tariffs associated with RE sources compared with grid electricity, thus enhancing sustainability.

Development and deployment of fast charging technology to reduce EV charging times, alleviating range anxiety; extending subsidies for fast-charging infrastructure under state EV policies can also help develop a robust network of fast-charging infrastructure.

Promote private sector investment in EV charging infrastructure by using initiatives such as the FAME scheme. For instance, under this scheme, the Ministry of Heavy Industries (MHI) has allocated US$95 million as a capital subsidy to the three Oil Marketing Companies (OMCs) under the Ministry of Petroleum and Natural Gas (MoPNG) for the development of 7,432 public EV charging stations.

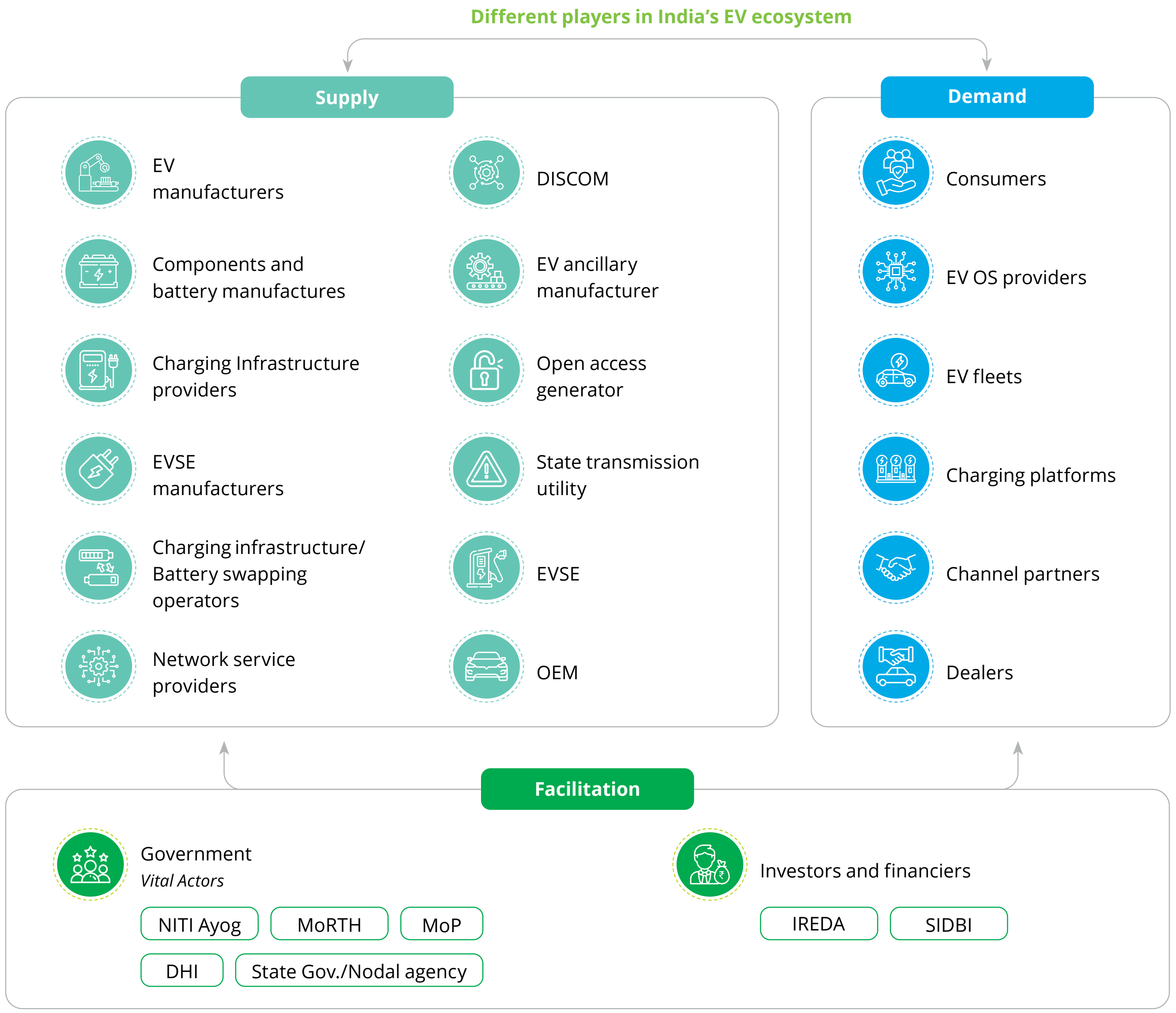
Navigating challenges in the EV ecosystem

As outlined above, the Indian EV ecosystem is rapidly evolving, driven by growing environmental awareness, government policies and the push for sustainable transportation. However, for the EV ecosystem to grow, CPOs and Demand Side Organisations (DSOs) must navigate challenges through strategic collaboration and innovative business models.

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

Fundamental challenge of setting up EVCIs: Interdependency of DSOs and CPOs.
The current state of the EV system has its own set of challenges, that obstruct the adoption of EVs among consumers and organisations in India. These challenges include unavailability of adequate EV charging stations, slow development of charging infrastructure, higher cost of vehicle ownership, battery scrapping and management. For companies committing to fleet electrification, these challenges become even more critical since a convenient charging infrastructure often determines where EVs are deployed, enabling them to transition towards EVs. For CPOs, deployment areas depend largely on where EV demand is evident and the specific requirements, such as charger type, power needs and future growth potential. The challenges of EV adoption for companies are significant, and various supporting players are involved in this ecosystem (detailed below). Organisations, specifically those engaged in last-mile delivery and logistics businesses rely on deploying EV charging infrastructure to increase the adoption of EVs for their activities.

Figure 8 : Illustrative snapshot of India's EV Ecosystem



Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

The driving force for EV adoption is the demand side of the EV ecosystem, and commitments from demand-side companies act as a major catalyst for change. Business sustainability commitments play a large role in driving the EV transition. In India, leading logistics organisations, last-mile delivery companies and ride-hailing aggregators are integrating EVs into their fleets. Large companies want to reduce their scope 3 emissions[36] by switching to EVs for employee commutes.

To facilitate the EV transition, automotive Original Equipment Manufacturers (OEMs) play a pivotal role in driving the feasibility of this transition. As of mid-2024, from a TCO perspective,[37] E2Ws and E3Ws have achieved cost parity with their ICE counterparts leading to the rise in all-electric fleet providers in these two segments. While this parity has not been achieved in the E4Ws, adopting these vehicles has improved as OEMs are introducing more affordable variants, which can make a longer-term economic case. The battery in an EV is its most expensive component, accounting for ~40 percent of the total cost of an EV. Hence, the affordability of an EV is directly proportional to the affordability of a battery, which hinges on the evolution of battery technology.

For services such as last-mile logistics and ride-hailing, where vehicle costs significantly affect bottom-line profits, the upfront investment in EVs is a major decision. Although EVs offer lower operating costs than ICE vehicles, the lack of a mature charging infrastructure undermines these benefits by making charging inconvenient for drivers and delivery agents/executives.

On the supply side, CPOs are crucial for supporting the broader electrification of commercial fleets. EV charging time ranges from 3 to 10 hours, depending on the vehicle and charger type. This time, especially for business-critical operations, means an operation downtime and a significant challenge. For companies, ensuring convenient access to charging locations is vital. Charging at home or on company premises can be problematic due to space constraints, difficulty in owning and procuring land due to limited and expensive real estate, especially in tier 1 cities, installation issues and unstable electricity connections. Therefore, businesses prefer to depend on CPOs for dedicated charging areas near demand hotspots. This also mitigates many operational issues and offloads responsibilities from the companies to the CPOs.

The cost of electricity is a major expense for operating an EVCI. Since electricity prices are regulated, local and national electricity regulatory agencies play a critical role in the feasibility of sustaining charging infrastructure. For lowering the operating cost of the EVCIs, CPOs usually avail electricity connection under the separate EV charging pricing slab provided by various Electricity regulators in various states. Karnataka Electricity Regulatory Commission (KERC) has notified the LT6 (Low Tension) category specifically for EV charging, which provides electricity at a subsidised tariff to consumers for charging EVs. To support the growth of EVCIs, CPOs rely on government agencies such as IREDA and SIDBI for EVCI financing, as well as loans from banks and other financial institutions. The anticipated demand heavily influences the viability of an EVCI. Limited guaranteed demand restricts the scale of investment and is a key consideration for financial institutions. As repurposing established charging infrastructure is difficult, CPOs must accurately forecast demand and consider various factors, such as charging time, charger type and usage, before setting up an EVCI. These considerations are essential for ensuring the long-term feasibility and effectiveness of the EVCI.

Business operating models and pricing mechanisms

As demand patterns tend to vary with respect to the types of consumers, the operating model and pricing mechanisms deployed by the CPO can vary. The key drivers for the choice of operating model are based on the quantum of demand, charging behaviour, land availability and requirement for scaling.

[36] Scope 3 emissions are indirect emissions from a company's value chain, including suppliers and product use.
[37] https://evyatra.beeindia.gov.in/tco-calculator/

Figure 9: Operating models segregated by land ownership.

Land ownership types

Government land

	Government-owned and operated	**Public Private Partnerships (PPP)**
	Area Development Authorities (ADA) or Urban Local Bodies (ULB) provide the land and oversee the EVCI. Revenue generated is shared among the involved entities.	Collaboration between CPO and land-owning government agencies. CPOs collect charging fees from EV users and share the revenue with the related land authorities
Pros	Broad coverage with government support and ease of land acquisition	Ease of land acquisition and tailored to high-demand areas with private expertis
Cons	Slow to adapt due to bureaucracy	Potential focus on profitability over equity

Fuel station

	Petroleum company/pump owned EVCI	**OEM collaborations with petrol pumps**
	Petroleum organisations or fuel station owners set up and operate EVCI co-located with fuel stations	Original Equipment Manufacturers (OEMs) either own or collaborate with fuel station owners to set up EVCIs
Pros	Strong demand in high-traffic locations	Strategic placement of EVCIs based on vehicle sales data
Cons	May neglect low-demand areas	Limited to areas with significant OEM presence

Consumer on-site installation

	Consumer owned installation	**CPO owned installation**
	CPO installs and transfers ownership of EVCI to consumer (fleet provider, malls and commercial office)	CPO owns, installs and operates EVCI for the end consumer (fleet provider, malls and commercial office)
Pros	Lower tariffs compared to public charging options	Low installation costs for the end user
Cons	High upfront costs for installing infrastructure	Relatively high tariff and scalability limited to land available on-site

Independent CPO owned EVCI hubs

	Charge only EVCI	**Charge and park EVCIs**
	CPO sets up the EVCI for pure-play charging services. Revenue to be collected from EV users through charging fees, which include all cost elements plus a margin	CPO sets up EVCI for parking and charging services. Ideal for commercial users who are looking for overnight parking services
Pros	High scalability with independent operations	Attracts higher demand with dual services
Cons	May neglect low-demand areas	Risk of EVCI being used primarily as a parking

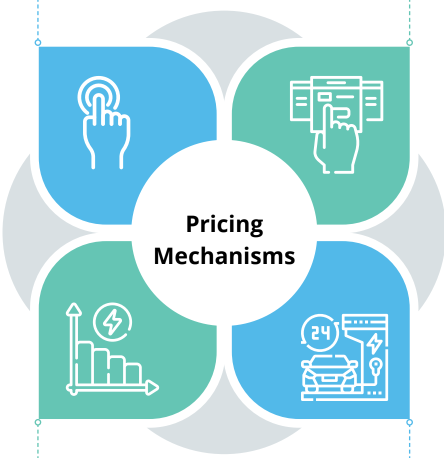
Figure 10: Pricing mechanism overview

Pay-per-use pricing

- Users charged based on the energy consumed during each charging session, measured in kilowatt-hours (kWh).
- This approach ensures that users pay only for their electricity, which is ideal for occasional or variable charging.
- This model is particularly suitable for users who charge their vehicles infrequently or in varying amounts, as they can manage their expenses more effectively and avoid the need for long-term commitments.

Subscription pricing

- The plans are pre-defined and time-based with fixed usage, such as monthly, six-month, or annual subscriptions.
- This model caters to users who need regular access to charging facilities, such as fleet operators, cab operators or frequent commuters.
- Subscribers benefit from predictable costs and often enjoy reduced rates compared with pay-per-use pricing. This model is advantageous for both the provider, who gains financial stability, and the user, who benefits from a simplified and economical charging solution.



Usage/Consumption pattern-based pricing

- Tariff slabs are based on the user's charging behaviour and consumption patterns.
- This model can offer different pricing tiers based on the total energy used or the frequency of charging sessions.
- This approach accommodates various user profiles, from high-frequency users to those who charge less and more often and helps to balance the cost burden based on actual usage patterns.
- It also provides flexibility to adjust pricing in response to changing consumption trends.

Charging hour differential pricing

- Tariffs will vary based on the time of day when the charging occurs. Rates are typically lower during off-peak hours and higher during peak times.
- This model encourages users to charge their vehicles during less busy periods, helping to manage demand and optimise infrastructure use.
- This pricing strategy benefits the provider by adding a premium for peak demand hours and the user by offering cost savings for off-peak charging.

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

Challenges for commercial charging infrastructure

Following are some of the challenges that operating an EVCI presents beyond those posed by the interdependency of DSOs and CPOs outlined earlier:

High initial capital investment: Recovering high capital investments remains a significant challenge for CPOs, as usage rates tend to be low due to long charging durations. For example, a 3.3 kW charger has 3–4 hours of charging time, leading to lower throughput and longer customer waits. This poses a challenge for CPOs as the number of vehicles charged during the day is limited and nighttime downtime further reduces usage.

High cost of land acquisition: The high cost of land acquisition can deter the selection of optimal locations for charging stations, resulting in higher tariffs for charging. The high cost of land rentals/leases prevents CPOs from setting up EVCIs in high-demand areas. This indirectly leads CPOs to opt for locations with lower land rental costs, which do not have sufficient demand. This results in lower usage of the EVCIs, affecting their profitability.

Requirement of dedicated EVCI: Ride-hailing and third-party logistics companies rely heavily on vehicle uptime, necessitating on-demand charging facilities. Despite the availability of public stations, these companies prefer dedicated infrastructure to control charging schedules, avoid peak-time congestion and ensure operational efficiency and predictability.

Dependency on fossil fuel-intensive grids: The shift to EVs has not reduced the overall carbon footprint in India as companies still rely on fossil fuel-heavy grids. This reliance persists despite substantial investments, undermining the environmental benefits of transitioning to EVs.

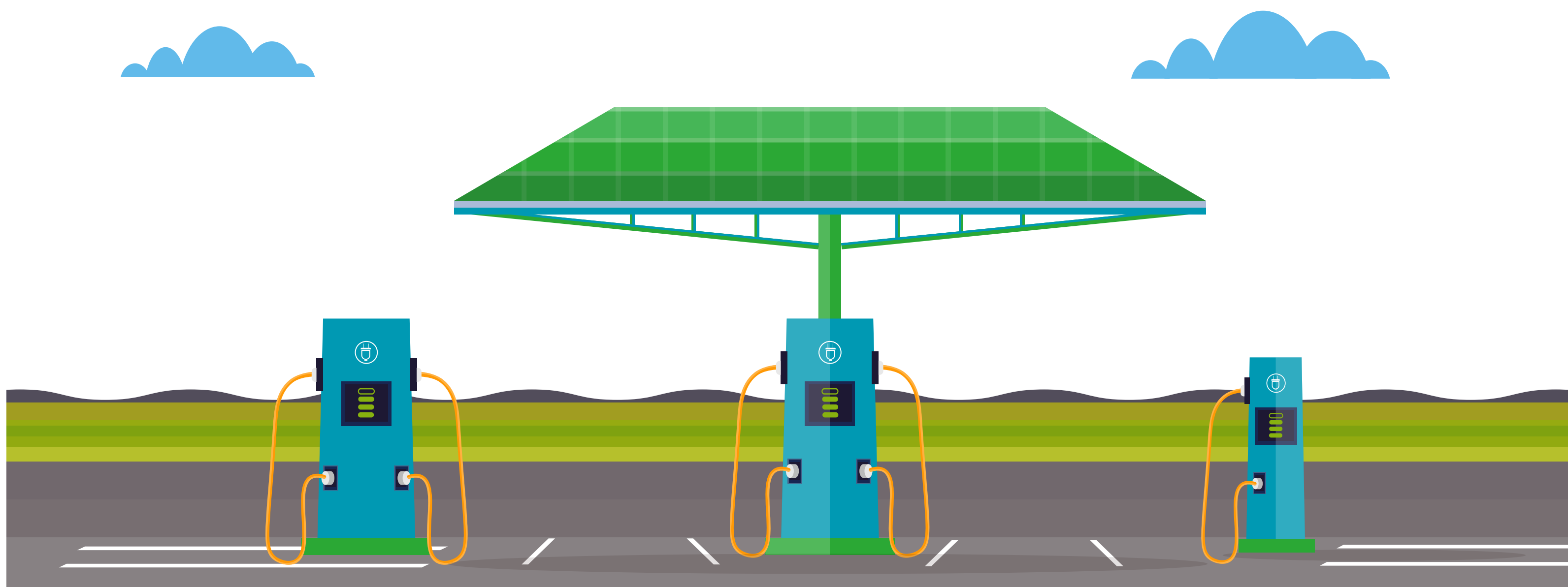
Collaborative approach as a proposed solution

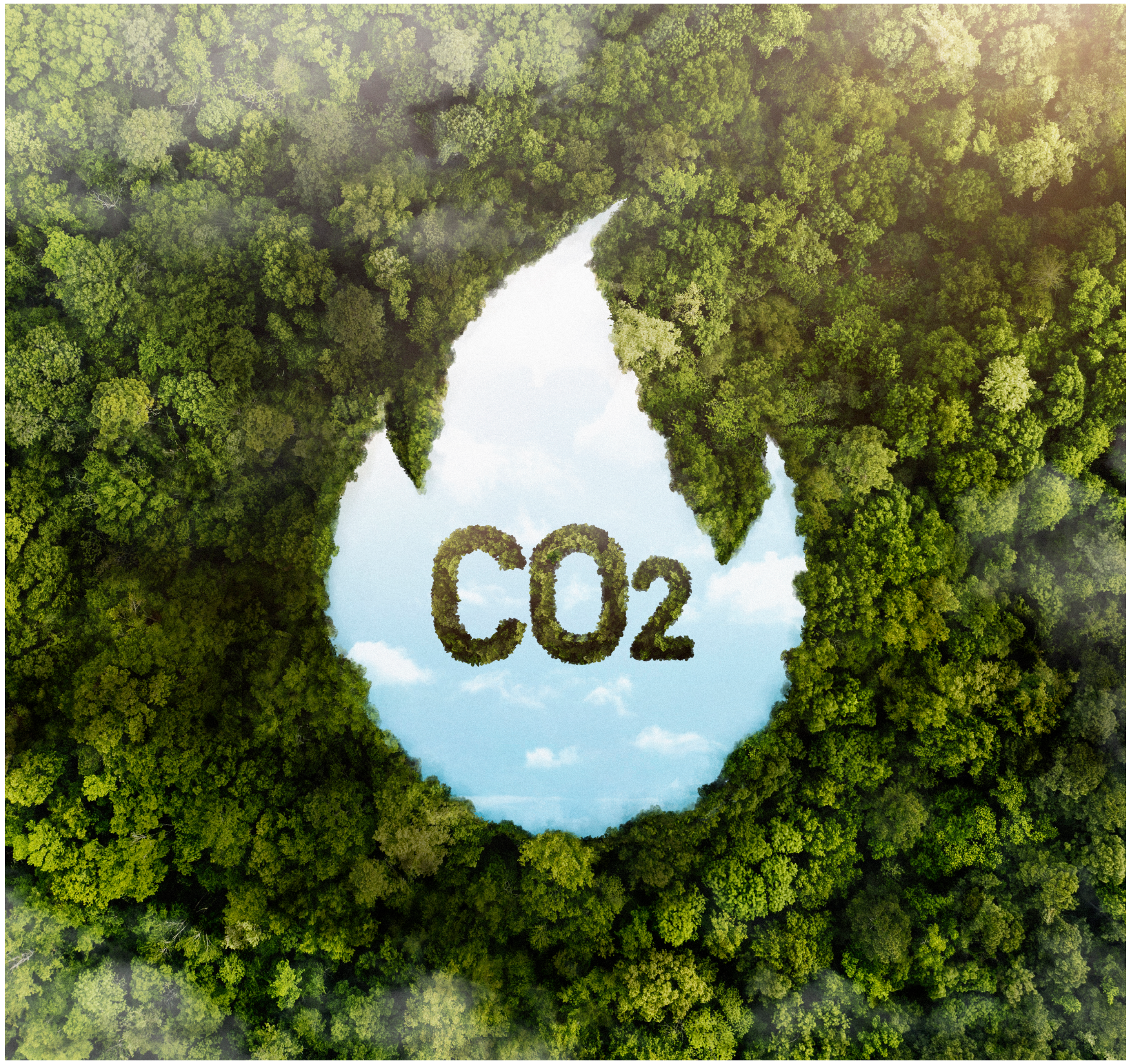
A collaborative approach between companies can significantly mitigate CPOs' challenges in managing their EVCIs.

Aggregation of demand: By collaborating with multiple companies, CPOs can diversify their client base, reducing reliance on any single company for demand. This diversification ensures high usage rates across different time slots during the day, making the EVCI viable even if demand from one sector fluctuates. For example, ride-hailing services may use the infrastructure during the day, while last-mile delivery services may use it at night. A shared charging network used by various logistics companies, ride-sharing services and businesses can increase usage frequency, enhancing the infrastructure's economic sustainability.

Strategic location planning: Collaboration can lead to more strategic placement of charging stations. Companies can pool data on their operational areas to identify high-demand locations, ensuring that charging stations are where they will be used adequately, enhancing user convenience. Large-scale EVCI projects benefit from pooled resources, allowing for more comprehensive and strategic planning.

Setting up of dedicated EVCI: Joint efforts can facilitate the establishment of dedicated EVCIs that offer priority access, security services, essential amenities and dedicated parking slots. This tailored approach addresses the specific needs of different user groups, providing a more reliable and convenient charging solution.





Case in point: JOULE

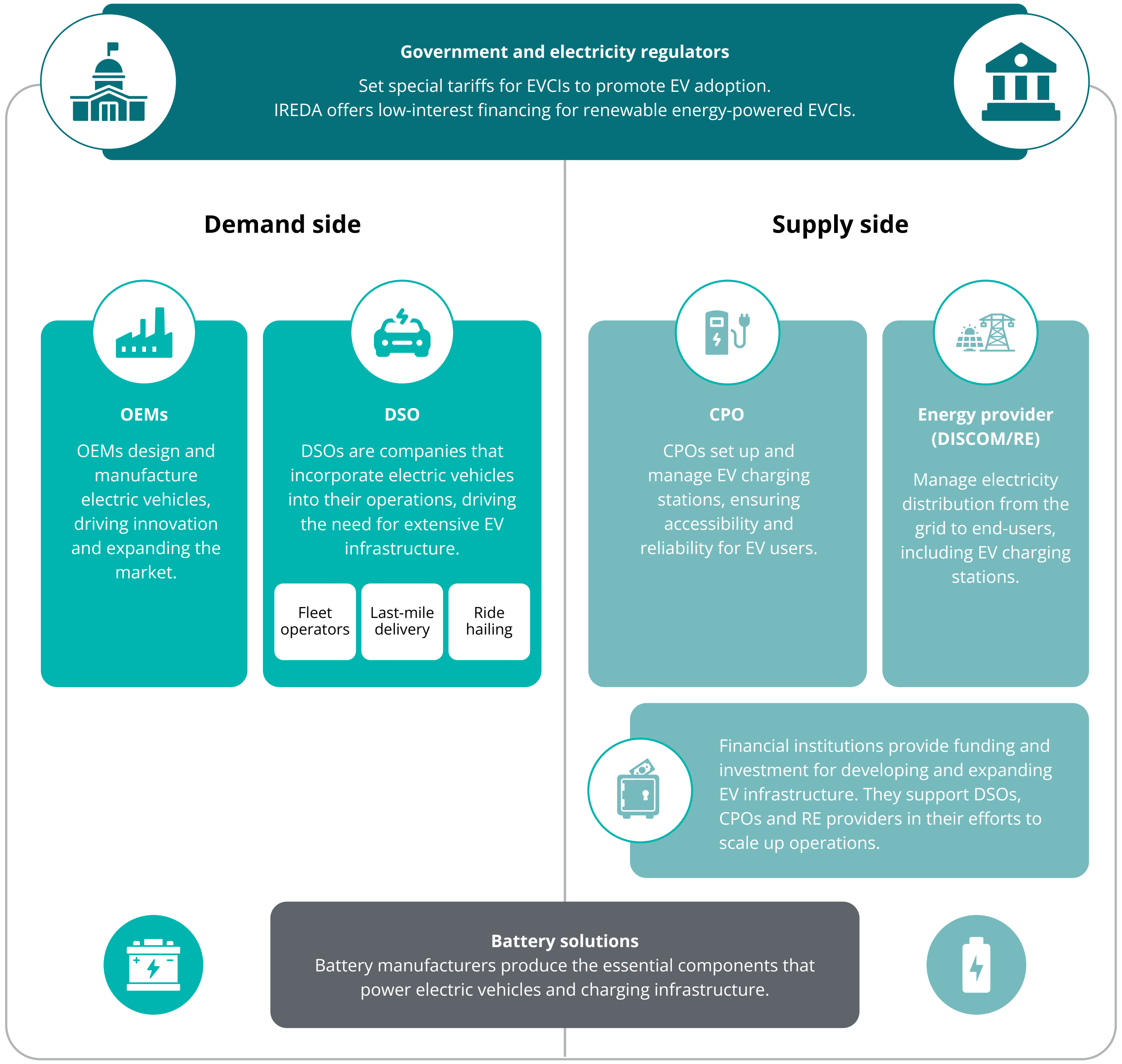
About JOULE

The Joint Operation Unifying Last-mile Electrification (JOULE) is a joint action project led by The Climate Pledge (TCP). The Pledge is a commitment to achieve net-zero carbon emissions by 2040, uniting the world's top companies to accelerate joint action, cross-sector collaboration and responsible change. Signatories from various industries, including manufacturing, materials, power generation and healthcare, commit to regular reporting, carbon elimination and neutralising remaining emissions with credible offsets.

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

The JOULE project exemplifies TCP's commitment to collaboration, bringing together private entities such as last-mile delivery companies, corporates, RE producers and charge point operators to establish a common EV charging network in Bengaluru. To facilitate the implementation of JOULE, TCP has engaged Deloitte Touche Tohmatsu India LLP (DTTILLP) as a Strategy and Project Management Consultant, working collaboratively with TCP, its signatories and think tanks. The project developed a network of renewable-powered EV charging infrastructure in Bengaluru. By facilitating resource pooling and addressing EV adoption challenges, JOULE maximises EVs' environmental benefits and supports participating companies in their emission mitigation efforts.

Figure 10: Pricing mechanism overview



Objective and theory of change: Integrating renewable energy with EV charging

The environmental benefits of EVs are enhanced when the vehicles are charged with RE sources. India's coal-fired electricity generation peaked in January 2024, reaffirming its position as the world's second-largest coal consumer after China. Emissions from coal generation during this period amounted to 104.5 MMT of CO_2.[38] India's grid emission factor currently stands at 0.71 kgCO2e per kWh, reflecting gradual improvements driven by the increased integration of RE over the past decade. Compared with internal combustion engines, EVs charged by fossil fuel-based electricity avoid 53 gCO2e/km, while those charged by RE avoid 113 gCO2e/km,[39] resulting in an additional 87 percent emission avoidance.

How was this achieved?

JOULE initiative proposed a structured implementation programme which involved the following key steps:

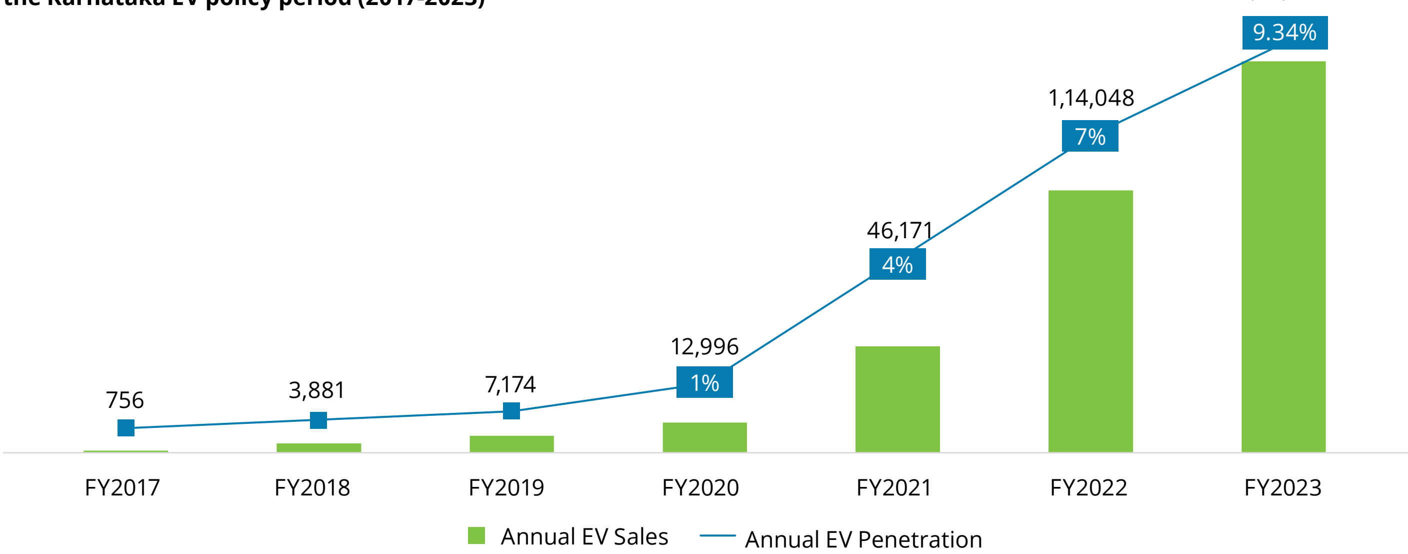
- Analysing the current regulatory landscape in Karnataka
- Demand assessment and identification of optimal locations for setting up EVCI
- Selection of business models for cross-usage of resources
- Onboarding the CPO that met the requirements of various participating companies
- Integrating renewable energy into EV charging infrastructure.

Karnataka's EV landscape: Policy, regulations, insights and implications

Due to Karnataka's favourable regulatory environment, the JOULE project selected Bengaluru as the launch site. The state's EV policy targets 30 percent of new vehicle registrations to be electric by 2025 and aims to expand public charging stations tenfold within the same timeframe. Furthermore, Karnataka's special EV tariff (the lowest in India) reduces operational costs and aligns with the policy's strategic emphasis on incentivising charging infrastructure.

Karnataka was the first Indian state to roll out an EV Policy in 2017 to accelerate the country's adoption of Electric mobility. This policy positioned the state as the preferred destination for investors interested in developing EV and battery manufacturing enterprises. In 2020, EV sales in India and Karnataka were around 1 percent. However, by FY24, Karnataka's EV sales surged to 9.66 percent[40] of total vehicle sales, surpassing the national average of 6.5 percent.[41]

Figure 12 : Growth in the total number of EVs in Karnataka vs Increase in EV adoption rate during the Karnataka EV policy period (2017-2023)



[38] https://www.reuters.com/markets/commodities/indias-coal-fired-electricity-output-emissions-hit-record-highs-2024-03-12/
[39] Mattoo R and Saxena P. (2023). Fuel Efficiency Improvement and Emission Standards in Road Transport. New Delhi, India: The Energy and Resources Institute.
[40] https://jmkresearch.com/electric-vehicles-published-reports/whitepaper-top-5-states-ev-adoption-trends-in-india/
[41] https://jmkresearch.com/6-5-of-total-vehicles-sold-in-india-in-2023-were-evs
Figure 12- VAHAN Dashboard

Karnataka envisions becoming a hub for EV production, driving significant adoption of EVs, encouraging the use of RE in charging the EV charging infrastructure and fostering a robust ecosystem encompassing manufacturing, research and infrastructure development.

The Karnataka EV policy has four major targets

1. Bengaluru's autorickshaws, cab aggregators, corporate fleets, and school buses/vans will achieve 100 percent electrification by 2030.
2. BMTC, KSRTC, NWKSRTC and NEKRTC to introduce 1,000 E-Buses during the policy period.
3. E-commerce and delivery companies in Bengaluru will phase in the replacement of their fleet of two-wheelers and three-wheelers with EVs by 2030.
4. Mini Goods Vehicles (3W and 4W) in Bengaluru will gradually transition to EVs to achieve 100 percent electric mobility by 2030.

To maximise Karnataka's Renewable Energy (RE) potential, the state introduced a new RE policy for 2022–2027, with key objectives set by the Government of Karnataka (GoK) as follows:

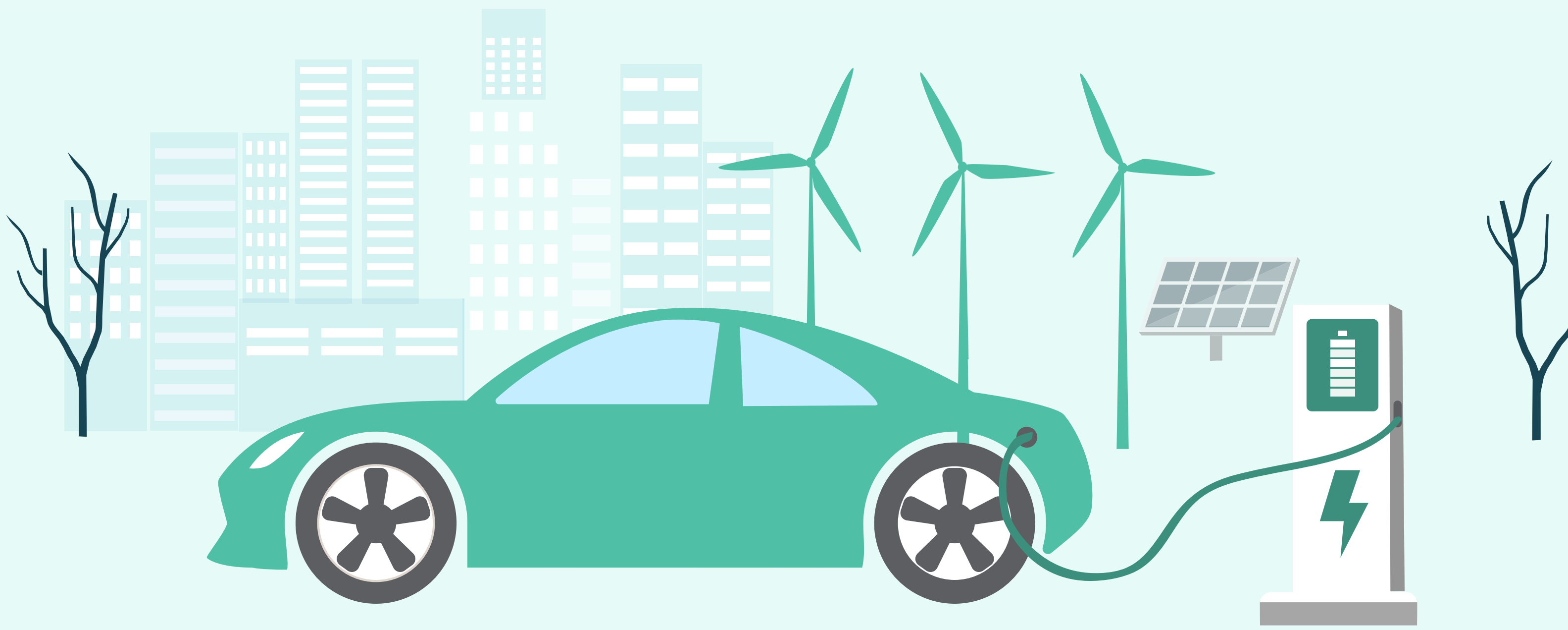
1. Facilitate the development of 10 GW of additional RE projects, with or without energy storage systems, including 1 GW of rooftop solar PV projects
2. Attract investment in the RE sector to drive state economic growth and fully tap into Karnataka's RE potential
3. Develop RE parks, including hybrid parks, and promote wind-solar hybrid projects
4. Encourage private sector participation in the transmission network and Green Energy Corridor (GEC) projects
5. Promote the adoption of EVs and decarbonise the transportation sector by using clean RE
6. Create a robust energy storage market to support grid integration of RE and enhance grid stability

Additionally, to support the transition to RE, the minimum contractual demand required to access RE through the open access mechanism has been set at 100 kW.

Demand assessment and identification of optimal locations for setting up EVCI

Under the JOULE initiative, outreach activities were conducted to engage demand-side players and secure commitments for deploying EVCI. These players included large IT organisations, entities engaged in last-mile delivery logistics, ride-hailing aggregators and e-commerce platforms. Based on their climate commitments, potential to offset/reduce their GHG emissions and other social benefits, organisations agreed to provide the much-necessary demand, leading to their onboarding as DSOs under JOULE.

A comprehensive survey was conducted among the demand-side participants, and responses were collated and analysed to identify the current EV penetration, anticipated demand for EVs and the optimal location for setting up EVCI to facilitate their charging.



Key factors that influence EVCI locations

Adequacy of public and signatory-owned EV charging infrastructure

Proximity to public EVCI: The insufficient charging options near the signatory's operational hubs influence the need for dedicated EVCI, ensuring accessible and efficient charging for EV fleets.

Lack of dedicated EVCI: Despite available public stations, the preference for dedicated infrastructure arises from the need for control over charging schedules and avoiding peak time.

The scale of signatory operations

The high order volume at work centres dictates the demand for EVCI. The need for efficient charging solutions increases with higher operational activity to support an active fleet. The scale of operational activity at a work centre determines the number of vehicles plying in that region.

EV adoption among partner's fleets

Assessing the EV penetration rate of the fleets in the vicinity of operational hubs is crucial. Low EV adoption rates may indicate insufficient charging infrastructure, emphasizing the need for targeted EVCI deployment. This approach aims to foster increased EV usage and support sustainable fleet operations.

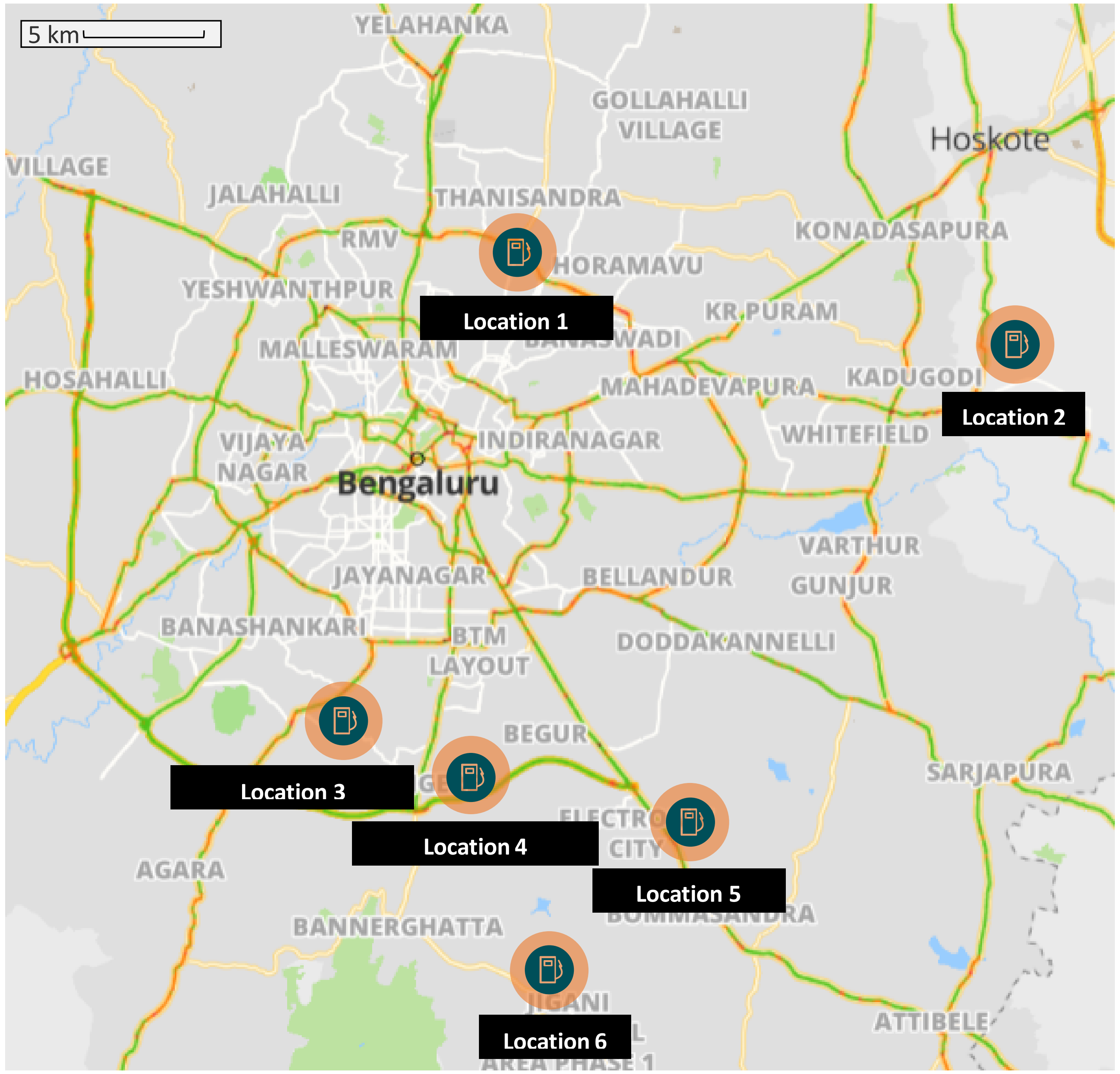
Optimum EVCI locations

Considering the above factors, six optimal locations for setting up EVCIs were identified in Bengaluru.

While the project is estimated to support about 5,500 EVs in Bengaluru by 2030 (based on expected demand), it is able to service about 9,500 EVs at full capacity.

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

Figure 13 : Identified EVCI locations



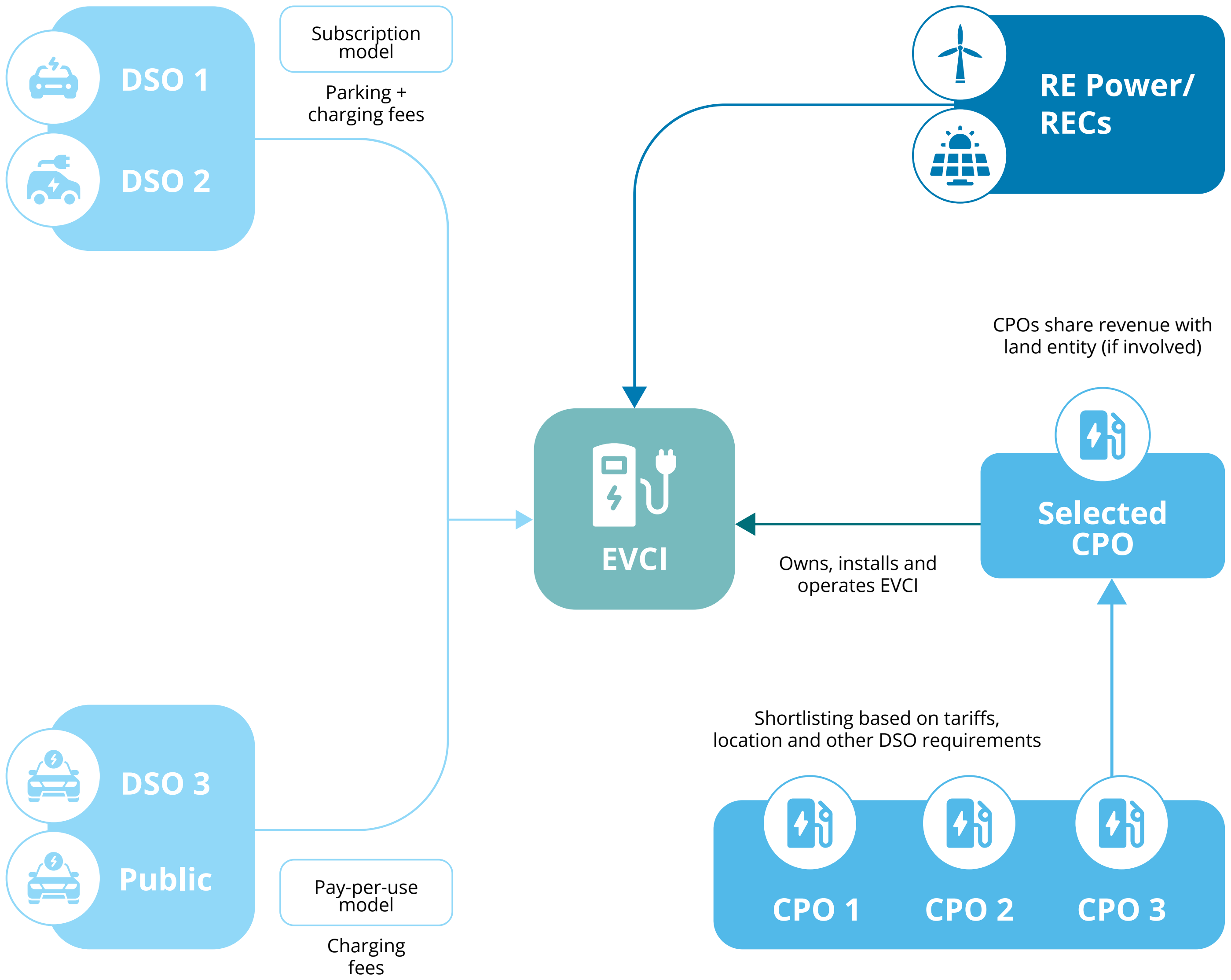
Model for implementation and onboarding of CPO

Various operating models were considered to identify the best fit for the project's objectives. These models were selected based on their ability to create synergies with key stakeholders, including CPOs, Delivery Service Providers (DSPs) and fleet executives. The chosen operating model and pricing mechanism were well-suited to the organisation's needs due to specific project requirements, such as overnight parking for vehicle charging, minimal daytime charging needs and a defined monthly energy consumption target. This approach ensured the selected model was the optimal fit for the project and the organisation's operational goals.

Operating model: CPO-owned EVCI with parking and charging options
In this model, CPOs own and operate EVCI, including parking and charging facilities. This setup caters to last-mile fleets, ride-sharing companies and employee commute fleets, providing dedicated, reliable charging spaces. For these commercial users, the EVCI offers crucial benefits such as safety, reliability and the convenience of integrated parking.

Pricing mechanisms: Subscription and pay-per-use
This model uses a subscription-based approach for anchor customers, offering a fixed number of monthly charging units (measured in kWh) for a set fee. Customers must pay for the full subscription amount regardless of usage. If additional units are needed, they are provided at a premium rate. A pay-per-use model applies to other users, allowing flexible charging without a subscription.

Figure 14 : Illustration depicting the JOULE project-specific operating model and pricing mechanism



DSO: Demand Side Organisation, CPO: Charge Point Operator, EVCI: Electric Vehicle Charging Infrastructure, RE: Renewable Energy

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

After the selection of the operating business model, CPO selection and onboarding were carried out through an EOI process as shown below:

EOI
Float an EOI with project-level details to CPOs to seek proposals

Proposals
Receive proposals from CPOs

Clarifications
Compilation of queries from CPOs about the EOI and sharing responses. Conduct meetings with CPOs to communicate timelines of the JOULE project and request clarifications on the project proposals if needed

Evaluation
Create a quantitative and qualitative scoring mechanism based on modalities of JOULE

Shortlisting
Scoring of proposals and shortlisting of CPOs for the JOULE project. Shortlist CPOs with the highest quantitative and qualitative scores

Tariff negotiations
Negotiate the tariffs based on the demand in different locations, availability of an anchor customer and business model agreed upon between CPOs and the demand side organisations

Onboard to JOULE
Onboard the CPO after the supply and demand side organisations reach an agreement; if required, onboard the second CPO after the first EVCI is established

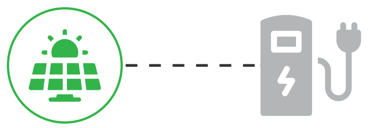
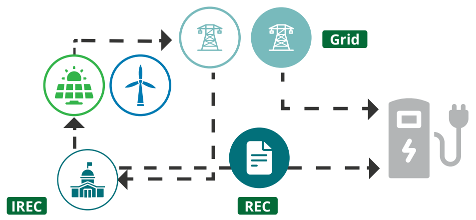
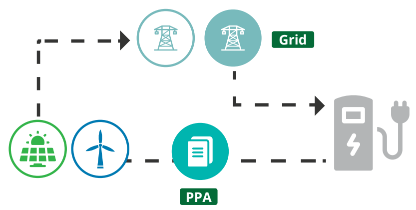
In addition to the steps outlined in the EOI process, delivery service providers conducted demand aggregation on behalf of the CPOs. Subsequently, CPOs collaborated to determine optimal pricing, balancing the DSOs' expectations while ensuring the CPOs' financial viability.

Driving toward zero emissions Renewable-powered charging infrastructure for India's Electric Vehicles

Integrating renewable energy into EV charging infrastructure

Integrating RE sources to power the EVCI is imperative to achieve a Zero Emission Vehicle ecosystem. The three RE procurement models that were evaluated for this project are on-site generation through rooftop solar installations, Green Energy Open Access (GEOA) and Renewable Energy Attributes (RE certificates (RECs)).

Figure 14 : Modes of RE procurement considered for the JOULE Project

Renewable Energy Procurement options		
Below 100kW		**100kW and above**
Rooftop Solar	**Renewable Energy Certificates**	**Open Access**
		
Mechanism options Installing solar panels over EVCI station to procure renewable energy. **Pros:** Reduced energy cost, energy independence. **Cons:** High Initial capital costs, intermittent energy production, additional O&M costs, limited by the size of station and area availability.	**Mechanism options** A CPO can buy a REC to claim the environmental benefits of renewable energy generation, even if you are not directly using that energy. **Pros:** Cost efficient (compared with owned installation), traceable, easy to deploy, provides flexibility. **Cons:** Market volatility, regulatory and policy risks.	**Mechanism options** Under open access, CPOs can directly purchase energy from generators or the open market instead of distribution companies. **Pros:** Direct access to RE provider, cost savings and reduced carbon footprint. **Cons:** Market fluctuations, regulatory and policy risks.

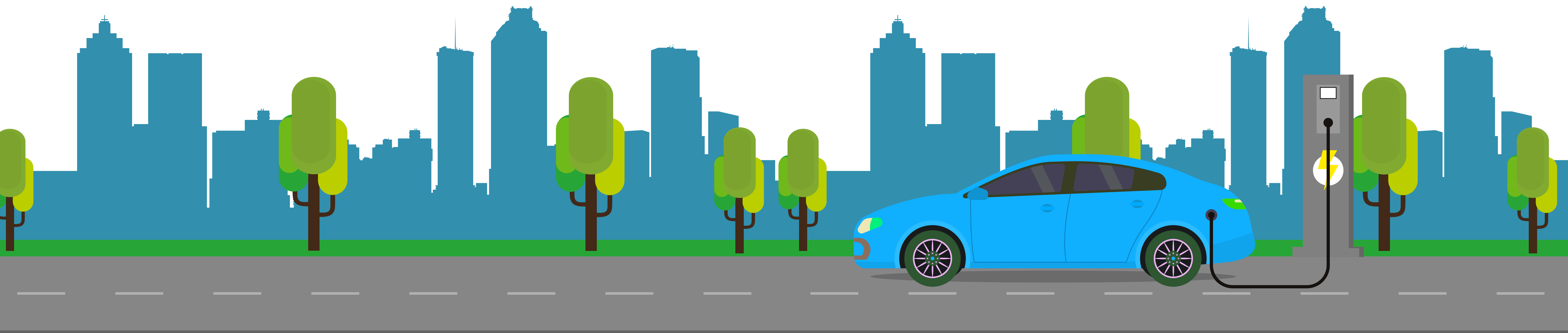
JOULE impact

The JOULE project is a groundbreaking initiative designed to revolutionise urban mobility by creating a self-sustaining, scalable and replicable model for renewable-powered EV charging infrastructure. This initiative drives collaboration among diverse stakeholders, facilitating the widespread adoption of zero-emission vehicles while ensuring mutually beneficial outcomes for those involved. JOULE sets a new standard by integrating RE to power the EV infrastructure, achieving significant emission reductions and eliminating reliance on fossil fuels.

Figure 15: Anticipated outcomes of the JOULE project

- Transitioning 5,500 EVs to Zero Emission Vehicles by 2030 with the potential to service an anticipated demand of 9,500 additional vehicles at full capacity.
- Estimated emission reductions of 25,700 tCO2e by 2030
- Delivery of 6.2 MW of Green Power by 2030 to meet the projected demand
- Approximate fuel savings of 11,200,000 liters
- JOULE is projected to generate 185 full-time employment opportunities
- Estimated investment of US$2.65 million towards the project.

JOULE's self-sustaining, scalable model offers mutual benefits, including improved operational efficiency, reduced emissions and lower costs. Importantly, this model is designed for scalability across various cities and regions, ensuring that we can effectively meet diverse local needs. This collaborative approach addresses challenges such as demand usage, high capital investment land acquisition and the need for dedicated charging facilities.



Call to action: Accelerating to decarbonise last mile transport

The road transport sector is responsible for 12 percent of India's energy-related CO_2 emissions, contributing to air pollution. To reduce global GHG emissions by 45 percent by 2030, compared with 2010 levels,[42] in line with the Paris Agreement, an urgent shift to ZEVs is essential.

Addressing these goals requires a bold approach to planning and deploying a comprehensive EV charging infrastructure. At Deloitte, we are committed to accelerating the deployment of charging infrastructure and collaborating closely with stakeholders in our roles. We urge others to recognise the vital role of EV infrastructure in achieving emission reduction targets. This significant challenge demands global, coherent investment in charging networks.

Moreover, the project underscores the need for various stakeholders to come together to tackle the complexities of establishing a robust EV charging infrastructure. Government bodies, private enterprises and organisations with the same goals play pivotal roles in this ecosystem. Their collective effort is essential to overcoming barriers, such as regulatory hurdles, financial constraints and technological advancements. By fostering an environment of shared goals and mutual support, JOULE enhances the feasibility of widespread EV adoption and sets a precedent for future sustainable initiatives.

To build on this vision and effectively address the challenges, several strategic actions and commitments are necessary across different stakeholder groups:

Policy makers and regulators

- Continued capital subsidies for EVs and EV charging equipment
- Standardised and favourable EV tariffs across states
- Exemption of road tax and registration charges for EVs and introduction of low-interest loans
- Reduced minimum contractual demand for EVCIs under the open access mechanism
- Enactment of a battery-swapping policy to expand battery-swapping stations nationwide
- Incentives to develop domestic capabilities for battery manufacturing
- Provision of concessional lease rentals for setting up charging and battery swapping stations in cities
- Waivers for low-cost renewable energy connections
- Provision of incentives for vehicle scrappage and retrofitting
- Development of zero-emission commercial vehicle zones
- Setting targets for phasing out internal combustion engine(ICE) vehicles

Corporates (Demand side organisations, CPOs and EV OEMs)

- Increased commitments and actions towards achieving net-zero emissions, particularly by electrifying delivery fleets
- Programmes to incentivise EV adoption among employees and service providers
- Development of EV charging stations in office parking lots and empty spaces
- Installing rooftop solar panels in office premises to power EV charging points
- Enhanced value chain collaborations for joint climate initiatives
- Introducing an internal carbon pricing mechanism to promote green transport
- OEMs incentivising dealers for EV sales
- OEMs focusing on range and performance, reducing non-essential features to achieve price parity with ICE models
- Joint go-to-market strategies for EV OEMs, CPOs and battery-swapping companies to address diverse customer segments
- OEMs enhancing software capabilities to improve power delivery, optimise battery management and extend battery life
- CPOs collaborating with housing societies and retail partners for access to high-traffic sites

[42] https://www.un.org/en/climatechange/net-zero-coalition

Connect with us

Rohit Berry
President
Strategy, Risk & Transactions
Deloitte South Asia
rohitberry@deloitte.com

Charu Gupta
Executive Director, Sustainability & Climate
Strategy, Risk & Transactions
Deloitte India
charugupta@deloitte.com

Shailesh Tyagi
Partner, Sustainability & Climate
Strategy, Risk and Transaction
Deloitte India
shaileshtyagi@deloitte.com

Contributors

Aditya Parchure

Parthib Choudhury

Piyush Yadav

Rohit Bhonagiri

Sachin Sharma

Shuchi Malhotra

Vrithik Mehta