



Powering an affordable EV revolution in emerging Asia

The \$1.3 trillion opportunity for
private capital to reshape the
future of global transport



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1

Introduction

The mobility sector is both a springboard into wealth creation, employment, and personal freedom, but also traditionally a major source of global emissions. Electrification, however, offers the chance to decouple the benefits of mobility from environmental harm.

By Nakul Zaveri, Souleymane Ba, Steve Howard, Suman Mishra, Pulkit Khurana and Siddarth Sikka

The electric mobility revolution is sweeping all global markets, but in Asia's emerging economies its social, environmental and human health dimensions have added urgency.

Mobility has been shown to improve access to healthcare, broaden employment opportunities, dramatically increase school enrolments, and is also a major source of direct employment for many emerging consumers.¹ For women, access to mobility has an even more magnifying effect on equality of opportunity. One in six women around the world do not look for work for fear of being harassed in transit.² In a recent study, 50% of women in Chennai, India reported being sexually harassed whilst travelling on public transport.³ In Indonesia, a similar proportion of women report assaults on public transport⁴, while in Bangladesh the number is as high as 84%.⁵

These realities are prompting a wave of new vehicle ownership across emerging markets, with millions of people every year saving and borrowing to buy their first vehicle, be that a scooter, three-wheel commercial vehicle, or passenger car. But coupled with this story of social impact comes the challenge of a world facing a growing climate crisis. In Europe and the US, mobility contributes to a huge proportion of greenhouse gas emissions – between 25-30%, compared with 10% in Asia.⁶ A surge in internal

combustion engine (ICE) vehicles across Asia would mean a major blow to global warming efforts, as well as potentially accelerating the decline in air quality and human health.

Thankfully, entrepreneurs from across emerging markets are already working to fix this. In India, now the world's largest consumer of electric three-wheeler vehicles, new giga-factories are being established across the country to manufacture over 1.5 million electric vehicles.⁷

Across Asia's emerging markets, new financial and subscription models for vehicle ownership are eliminating the challenge of higher upfront costs for electric vehicles and making them as much as 40% cheaper to use across their lifetime than fossil fuel incumbents. And a range of enabling infrastructure is being quickly spun up by the private sector – from battery swapping models to charging stations – that improve both the ease and convenience of owning an electric vehicle, alongside adding new demand and investment for grid connected renewables.

Across the emerging markets of South Asia and Southeast Asia, \$1.3 trillion in cumulative capital will be needed to power the EV revolution to 2030.⁸ The story of electric mobility across Asia has decades to run, but at this crucial point, with billions of emerging consumers rising into the middle classes, the role of private capital to accelerate this transition in a more sustainable way is more critical than ever before.

1 UNESCAP 2017, Roads to Equal Access: the Role of Transport in Transforming Mobility

2 World Bank, Transport Overview: Development news, research, data

3 AWARE 2017

4 Jakarta Post, Sexual harassment on public transportation in Indonesia second only to the street, survey, 2019

5 ISB 2019, A Study of Women Harassment in public transports in Bangladesh

6 McKinsey Global Energy Perspective, World Bank

7 Care Edge Ratings, EVs Revving Up Despite Roadblocks, January 2024

8 LeapFrog modelling based on IFC, A Green Reboot for Emerging Markets, 2021

Image opposite: A switch to EVs can catalyse increased earnings for last-mile delivery drivers using platforms such as Grab.



2 The climate case for an emerging market electric mobility revolution



Vietnam is the second largest motorcycle market in all of Southeast Asia.

As incomes rise, emissions will amplify without rapid investment in electric mobility.

In the next 30 years, the emerging markets of Asia and Africa could account for up to 80% of population growth and 50% of GDP growth globally. This rising force of low-income consumers is by some estimates projected to bring four billion people into the consuming classes, as countries like Vietnam, Thailand, Indonesia, Kenya, Nigeria and India continue to experience strong economic growth.

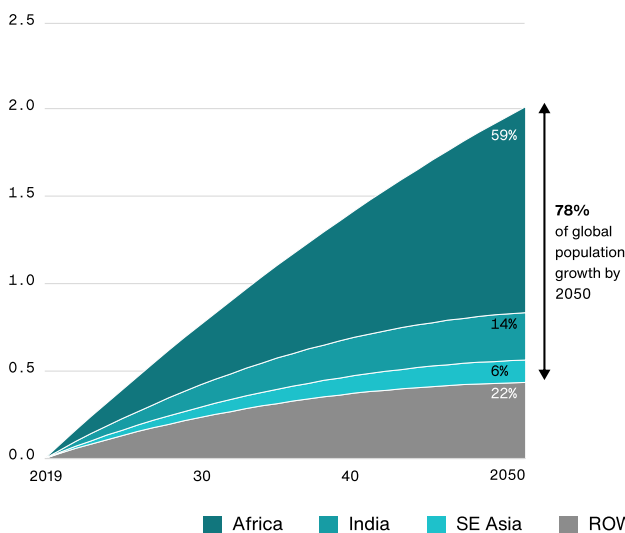
With incomes rising rapidly, so will the appetite for personal mobility. In India's last financial year (counted as the 12 months ending March 2024), Indians bought over 28 million vehicles⁹, 12.5% more than the previous year. In Indonesia, motorbike sales grew 19.4% last year, topping six million units. This compares with 15.5 million in US auto-sales across 2023.¹⁰ These trends are likely to continue, with evidence suggesting low-income consumers have highly elastic demand for mobility as their incomes improve. For instance, an Indian consumer earning under \$12 a day spends only 7% of their income on mobility, while those earning more than \$80 a day spend 21% on average.¹¹

Whether these consumers choose an electric vehicle over an internal combustion engine (ICE) vehicle largely comes down to cost. In recent years, a range of enabling activities, from scaled up manufacturing, to innovative finance, EV-specific insurance products, government subsidies and improved charging infrastructure, have seen Asia's electric vehicle demand surge across all categories.

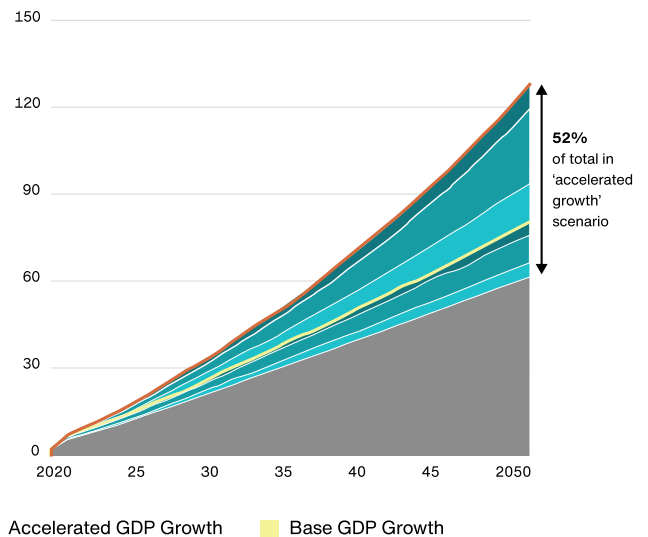
Accelerating this adoption is an important mission. In Asia, which currently accounts for 42% of the world's greenhouse gas emissions, mobility remains only a small component of the overall emissions mix, at around 10%. But in wealthier regions – like Europe (25%) and the United States (30%) – mobility emissions have skyrocketed as incomes rise and internal combustion vehicles proliferate. Avoiding this fate in Asia is essential to limiting global warming.

Emerging Asia/Africa accounts for 80% population and 50% GDP growth within 30 years

Population Growth, billions



GDP Growth, \$ trillion



Note: GDPs in Real 2015 dollars; Growth assumptions are based on favourable demographics, acceleration of digitalisation, consumer spending, business investment, job creation and productivity gains.

Source: McKinsey Global Energy Perspective, World Bank

⁹ SIAM, Auto Industry Sales Performance Q4, April 2024

¹⁰ Automotive Dive, GM, Hyundai and other top automakers report record US sales in 2023, January 2024

¹¹ McKinsey Global Institute, World Data Pro, Euromonitor

However, the story of the Asian electric mobility revolution has not simply emulated the trajectory of markets like Europe and the US. Instead, the ecosystem supporting these improvements in price and quality demonstrate how heterogeneous the electric mobility transition is becoming across wealthy and emerging markets.

The mobility sector is also a compelling one for impactful climate investment because of its potential to trend towards zero emissions over time. Unlike sectors such as agriculture and the built environment, the technological solutions to decarbonise mobility at scale already exist.

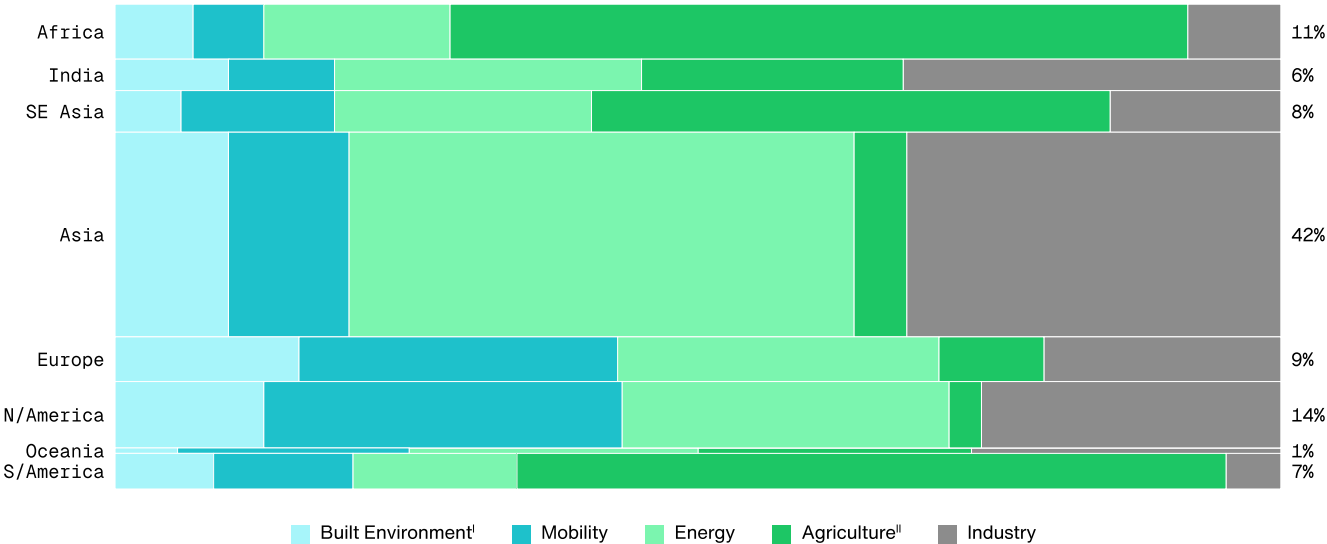
Today, an electric scooter in India emits 36-68% less CO₂ than a petrol scooter, and electric three-wheelers 33-38% less than a petrol equivalent.¹² As India's grid connected renewables increase, electric vehicles will become even greener, and the mobility sector could feasibly achieve close to zero emissions under aggressive investment scenarios by 2050.

EV adoption has accelerated dramatically in emerging markets over recent years, and stands at a critical inflection point, presenting a compelling call to action for climate focused investors. Both rising incomes and falling EV costs make it possible for hundreds of millions of consumers to switch to electric vehicles in emerging markets over the next decade.

India, the world's third largest auto market, already accounts for 60% of global electric three-wheeler sales (580,000 units in 2023, an increase of 65% year-over-year), and ranks second behind China for sales of e-scooters (880,000 units in 2023, an increase of 40% year-over-year).¹³ In China, EV market share is likely to reach 45% this year¹⁴, indicating the runway for growth that lies ahead for less wealthy economies.

Greenhouse gas emissions by sector and region (GtCO₂e)

2019 GHG emissions by region and sector, GtCO₂e



I. Built Environment includes emissions from Buildings and waste management sectors II. Includes emissions from LULUCF sector

Source: McKinsey Global Energy Persepective, World Bank

12 Clean Air Task Force, Transport Sector GHG Reduction for India, November 2022

13 International Energy Agency, Global EV Outlook 2024, April 2024

14 International Energy Agency, Global EV Outlook 2024, April 2024

Image opposite: Drivers in Thailand can access subsidies for new EV passenger car purchases as much as \$2,900 per unit.



To deliver on this potential, green capital needs to accelerate its support for all parts of the EV ecosystem across Asia. While subsidies like Indonesia's \$455 million electric motorcycle subsidy programme and India's Faster Adoption and Manufacturing of Electric Vehicles (FAME II) programme have helped recent sales momentum, cost and convenience is also promoting adoption. Local entrepreneurs who understand domestic demand for affordable vehicle segments like electric scooters, three-wheeler taxis, and light commercial vehicles, have already attracted significant global capital, and will require further support for decades to come.

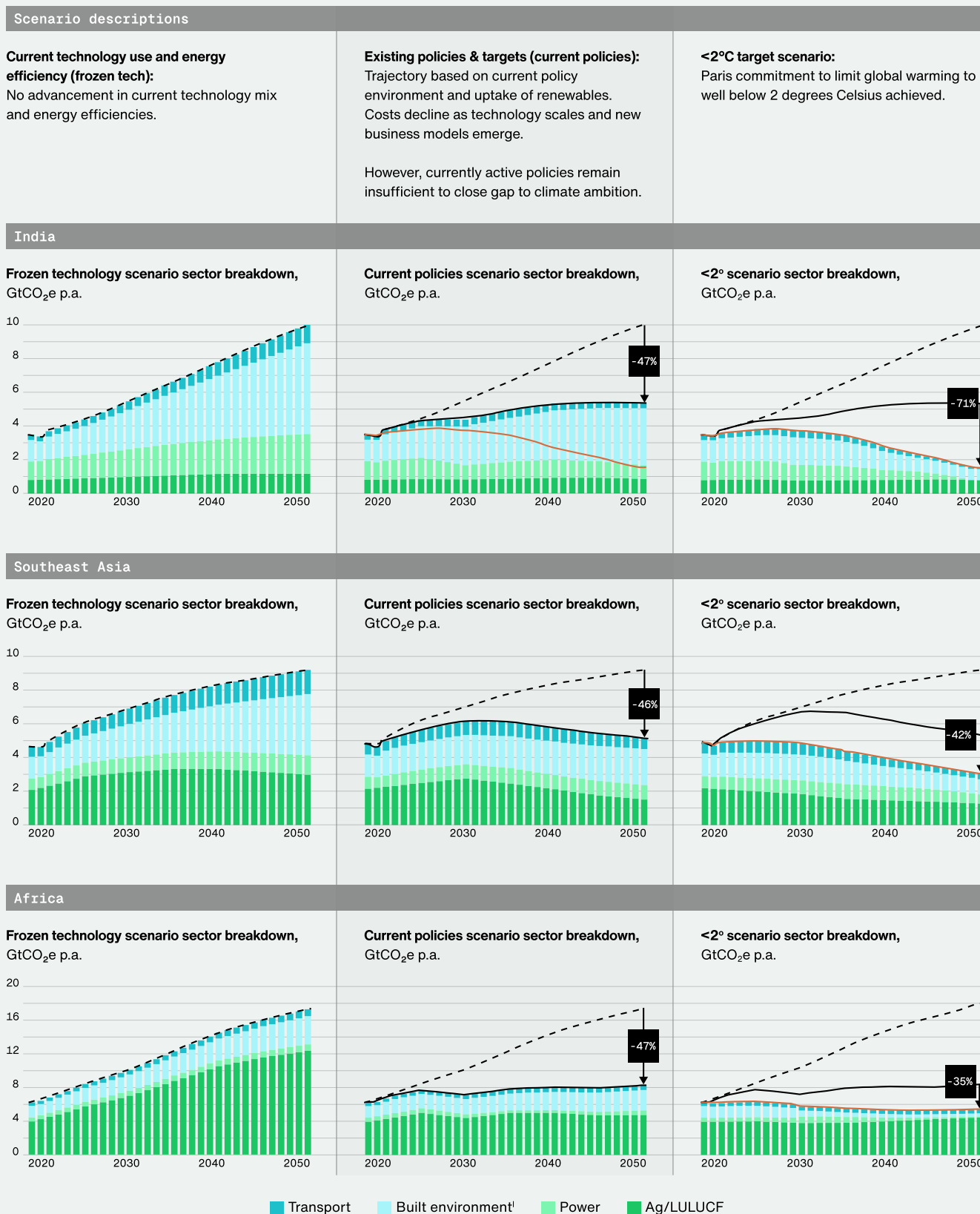
Climate investors can help support and accelerate the electric mobility revolution not only through investments in Original Equipment Manufacturers (OEMs), but through funding for critical enabling infrastructure like battery swapping stations and charging networks.

Financial services companies like vehicle leasing and lending businesses, auto-insurance providers, and new vehicle-as-subscription models, are also accelerating adoption and deserve investment.



Jakarta is trialling an initial fleet of 100 electric buses, with a goal to electrify the city's entire fleet by 2030.

Emerging market mobility sector could trend to zero emissions by 2050



Source: McKinsey Global Energy Perspective, World Bank. Note: Ag/LULUCF = Agriculture, Land Use, Land-Use Change and Forestry

3 The investment opportunity for an emerging market electric mobility revolution



EV charging station in Central Java, Indonesia.

Electric vehicles have already reached tipping points of cost, convenience and reliability.

Private capital markets can support low-income consumers to invest in electric mobility solutions by funding and scaling the critical parts of the EV ecosystem, pursuing profit with purpose in some of the world’s fastest-growing markets.

While virtuous, these investments also increasingly make sound commercial sense. As technology improves, and manufacturing capacity scales, the upfront cost of electric vehicles across all segments has plummeted.

Breaking down the components of these cost savings, or “green discounts”, for electric vehicles provides compelling evidence of the increasing advantage of these vehicles over incumbent ICE competitors. Key constraints to adoption like upfront capital costs, range anxiety and related infrastructure penetration issues, are being rapidly addressed across all segments.

Momentum is most evident in two- and three-wheeler vehicles, where battery swapping and charging companies like Ather, Sun Mobility, and Battery Smart¹⁵ are delivering

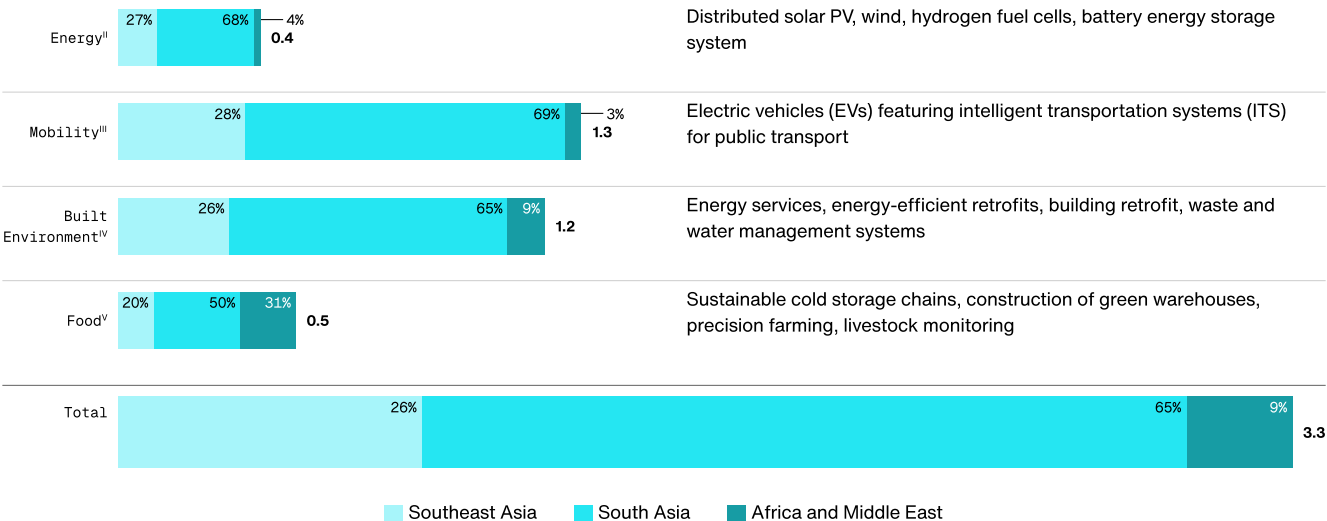
tech-enabled, distributed solutions that allow for the quick and convenient charging of EVs.

Other businesses that increase access and amplify take-up of EVs, including vehicle-as-a-subscription companies such as Yulu and Kinto One, are also helping to spread higher upfront capex costs across the lifetime of ownership, allowing purchasers to lower their monthly repayments.

EV OEMs such as Ola Electric have also been successful due to a first-mover advantage in the nascent electric two-wheeler market in India, where ICE incumbents have been slow to electrify.¹⁶ While government subsidies have helped its initial ramp up, a compelling product portfolio and competitive prices have put the company on a strong trajectory to scale up, even with subsidies pared down or removed (e.g. FAME II subsidy ended in March 2024).

Mobility’s projected \$1.3 trillion green capital demands to 2030 outstrip other sectors

Cumulative investments by sector and by region^I, \$ trillion, 2020-2030



Example investment themes

Distributed solar PV, wind, hydrogen fuel cells, battery energy storage system

Electric vehicles (EVs) featuring intelligent transportation systems (ITS) for public transport

Energy services, energy-efficient retrofits, building retrofit, waste and water management systems

Sustainable cold storage chains, construction of green warehouses, precision farming, livestock monitoring

^I Southeast: Indonesia, Philippines, Vietnam. (We have excluded estimated investments in China from the IFC's figures by assuming China's investment share equivalent to its share of the region's projected GDP growth in the period 2020-2030 GDP, or 79%.); South Asia: Bangladesh, India, Africa and Middle East: Egypt, Jordan, Morocco, Cote d'Ivoire, Nigeria, South Africa; ^{II} Energy includes: renewable energy and scale up distributed generation and storage; ^{III} Mobility includes: low carbon airlines and shipping and green urban transport; ^{IV} Built environment includes: low carbon municipal waste and water, buildings for energy efficiency; ^V Food includes: Scale climate-smart agriculture

Source: LeapFrog modelling based on IFC, A Green Reboot for Emerging Markets, 2021

¹⁵ LeapFrog is an investor in Battery Smart
¹⁶ Temasek is an investor in Ola Electric

The consequences of falling prices, and improved enabling infrastructure, suggests decades of rapid growth for EV sales in South Asia and the development of a broader EV ecosystem as complementary products such as insurance and credit adapt to the unique properties of EVs. Greater curb weight, lower noise, instant torque and magnified fire and explosion risk, for example, have created a new risk pool for EV insurers.¹⁷

In India, EVs have already reached price tipping points for two- and three-wheeler EVs, under a total cost of ownership model factoring in lower running costs, lower maintenance charges, and subsidies.¹⁸ Two- and three-wheeler EVs in Africa are also expected to reach similar tipping points later this decade, although a transition to electric buses and mini-buses remains further away.

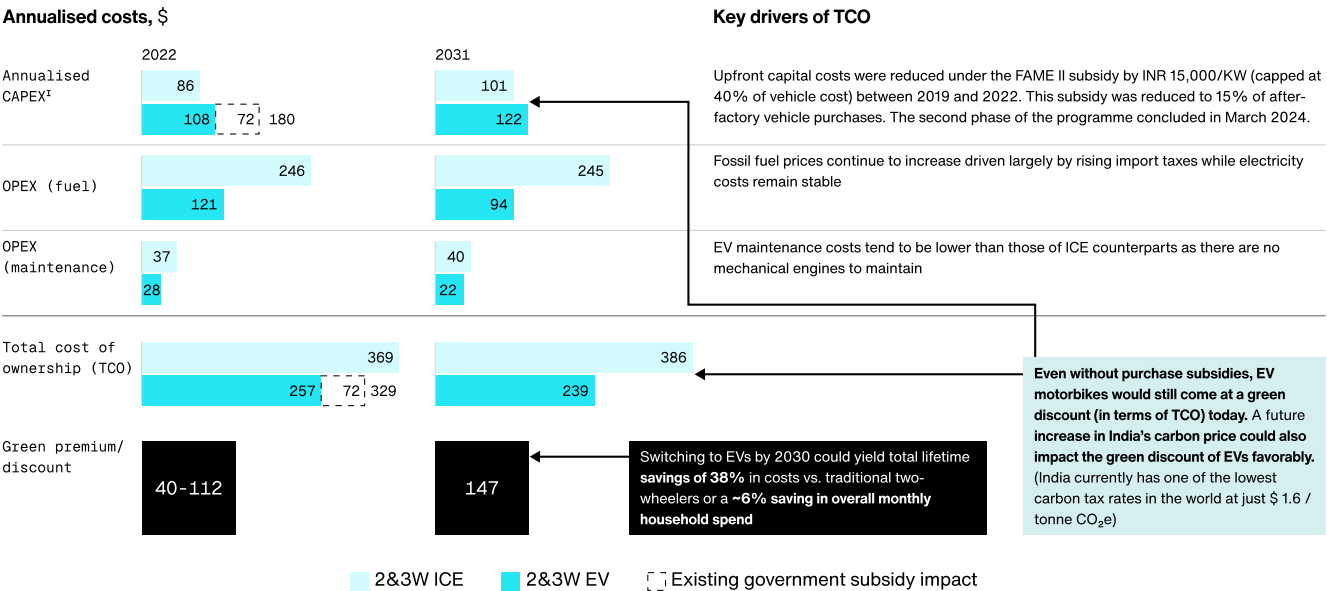
Several externalities can affect the pace of this transition. Subsidies and other government support for the electrification of mobility have played a meaningful role across multiple markets to propel EV adoption, with programmes in Philippines, Indonesia, Thailand, and India boosting demand. For instance, until March 2024 Indian EV

purchasers were able to receive up to 40% rebates under the FAME II programme.

African nations are also beginning to follow suit, with roadmaps for electrification in several markets, as well as municipalities in countries like Kenya and Nigeria placing large orders for electric bus fleets in urban centres.

Broader government policies to support domestic EV manufacturing also continue to help accelerate manufacturing scale and lower costs. These include measures like the India Production-Linked Incentive scheme, which offers incentives to domestic producers of critical EV components like lithium-ion batteries and electric drive trains.

On a total cost of ownership model, electric two- and three-wheelers are already cheaper than ICE equivalents in India



Source: McKinsey Transition Finance Model, McKinsey Center for Future Mobility, 2022, McKinsey India Mobility Consumer Survey (n=1,199), press research

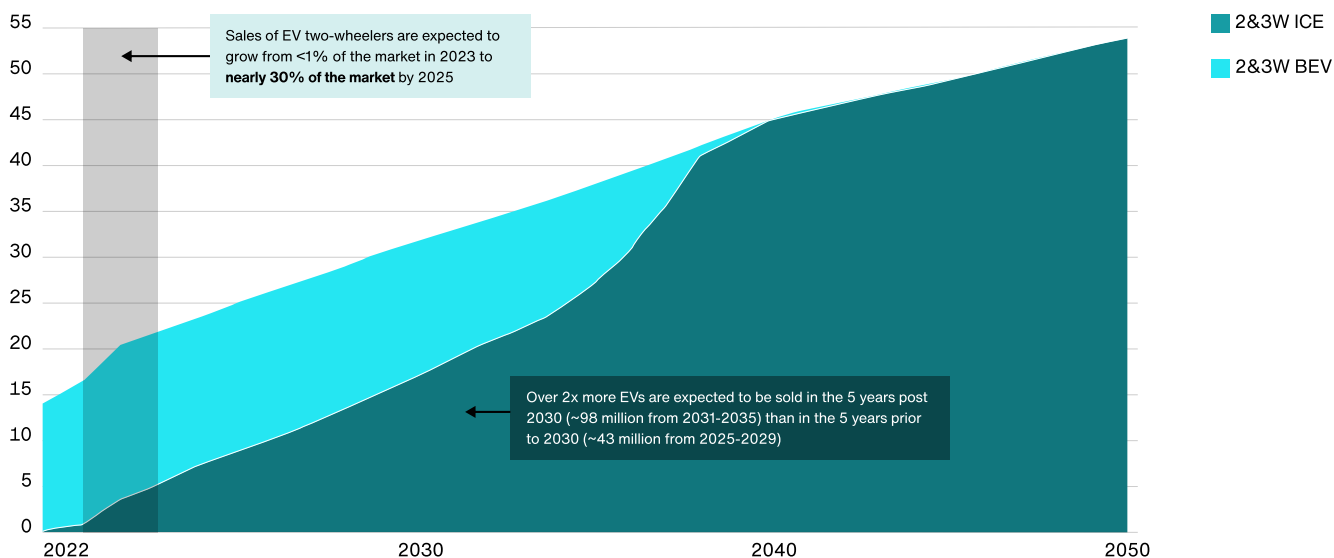
17 Swiss Re, Gearing up for the electric vehicles ecosystem, 2023
18 McKinsey Transition Finance Model, McKinsey Centre for Future Mobility, 2022, McKinsey India Mobility Consumer Survey, press research
Image opposite: Sales of EVs in the Philippines reached more than 10,000 units in 2023.



A BR/Powering an affordable EV revolution in emerging Asia

EVs could represent 47% of India's two- and three-wheeler sales by 2030 with investment in infrastructure and government support

Total sales of two- and three-wheelers,
millions of vehicles



Source: McKinsey Transition Finance Model, McKinsey Center for Future Mobility, 2022, McKinsey India Mobility Consumer Survey (n=1,199), press research

The high cost of fossil fuels has also supported recent EV adoption, with electricity prices remaining relatively stable in many emerging markets even as petrol and diesel prices spike due to global conflict and currency fluctuations linked to rising global interest rates.

Countries like Angola and Nigeria recently ended long-standing fuel subsidies (Nigeria spent \$9.7 billion to subsidise gasoline in 2022¹⁹), leading to 200-300% increases in pump prices for gasoline²⁰, and further improving the economics of EV ownership.

As governments around the world see the economic benefits of investing in grid-connected renewables over the cost of providing ongoing fossil fuel subsidies, the electric mobility revolution is likely to gain further momentum.

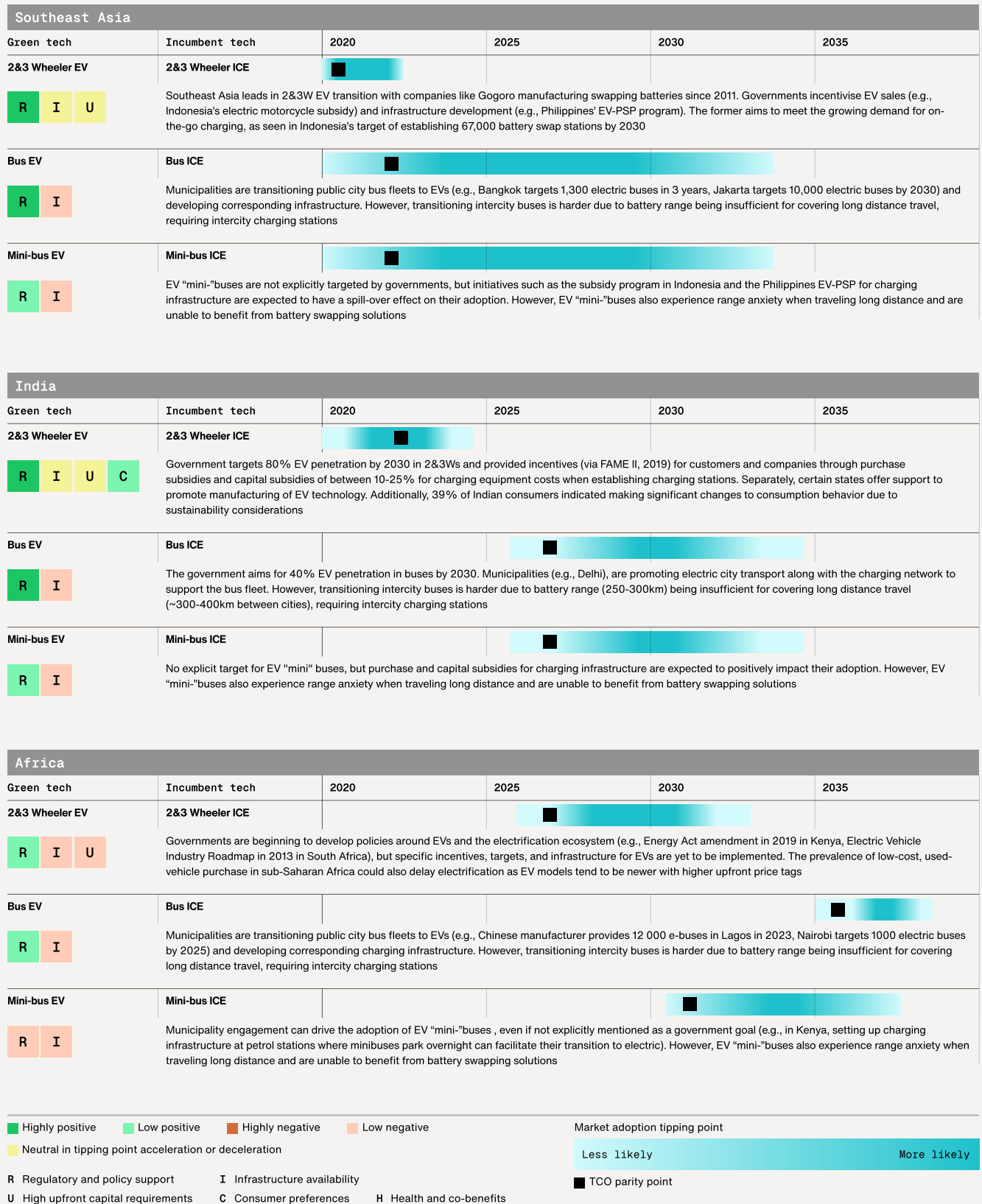
Where private investors are concerned, however, price tipping points need to have been reached for capital to be deployed at scale. In this report, we have included two case studies – Mahindra Last Mile Mobility and Battery Smart – that show fast-growing business models attracting private capital to deliver low-cost electric mobility.

These businesses both hail from India, perhaps the most innovative market for low-cost electric mobility. Working in three-wheeler EV manufacturing and charging infrastructure, they are examples of the emerging market entrepreneurs pioneering new product segments and infrastructure models to deliver affordable, clean mobility to the world's four billion emerging consumers.

¹⁹ Reuters, Nigeria's NNPC spent 10 billion on fuel subsidies in 2022, January 2023

²⁰ Bloomberg, Angola cuts fuel subsidy, following Nigeria in boosting pump prices, June 2023

Emerging market mobility sector could trend to zero emissions by 2050



Source: LeapFrog Investments internal analysis

4 Case Study:

Mahindra Last Mile Mobility

Scaling EV production to serve
all income levels



Devkanya Pandey, from Madhya Pradesh, India, drives her Mahindra Treo Yaari e-rickshaw, which she uses for her business and to drop her kids at school.

4.1 The Model

Three wheelers have seen a significant increase in electrification in India. Auto rickshaws (in the L5M passenger auto category) made up 19.8% of all three-wheelers purchased in the year ending June 2024, up from 7.3% in the year to June 2022.²¹

Mahindra Last Mile Mobility, a subsidiary of multinational conglomerate Mahindra Group, is the leader in this segment, with 57.2% market share, supported by its three domestic manufacturing facilities. It currently manufactures a range of passenger vehicles (three-wheelers) and commercial cargo carriers (three- and four-wheelers), selling through a network of over 800 touchpoints, and exporting to six countries.

Mahindra Last Mile Mobility has played a pivotal role in shaping and scaling the industry through substantial investments in product development, adding robust sales/service channels, as well as building an ecosystem of charging infrastructure and financing solutions. Additionally, Mahindra is the first in its category to secure certification under the government's Production Linked Incentive (PLI) scheme, promoting local production of EVs.

India's EV story and Mahindra Last Mile Mobility's commitment to electrification has attracted investment from marquee global investors including the IFC

(International Finance Corporation, World Bank Group) and NIIF's (National Investment and Infrastructure Fund) India-Japan fund.

India is already the world's largest electric three-wheeler market, and Mahindra believes the country is uniquely positioned to achieve full electrification of the category. Projections are for the rate of electrification to reach ~40-50% by 2027, creating the scale and critical mass needed for complete electrification.²² This rapid adoption is supported by strong consumer willingness to switch from ICE vehicles because of economic advantages and improved driving experience.

For frequent commercial users, switching to an EV also helps boost income by approximately 20% on average, and contributes to a quieter and more comfortable driving experience. These benefits have seen first-time buyers – including women and youth segments – alongside upgraders, attracted to electric three-wheelers. The majority of EV customers – around 70% – are first-time buyers from low-income backgrounds.

“India is already the world's largest electric three-wheeler market and is uniquely positioned to achieve full electrification of the category.”



Dara Khosrowshahi, CEO of Uber Technologies, centre, drives a Mahindra Last Mile Mobility Treo Plus SFT electric three-wheeler in Gurugram, India, in February, 2024.

²¹ Parivahan Sewa, Vahan Dashboard, 2024

²² SIAM data including all electric 3Ws, L5+e- rick/cart for FY24

Electric three wheelers deliver positive impact across climate, economy, social and human health dimensions

Enhanced Energy Security

- Decreases reliance on imported fuel
- Potential oil import savings of ~\$1.3 billion through electrification of three-wheelers only by 2030²³



Reduced CO₂ Emissions

- Emissions reduction of ~1.65 million tonnes of CO₂ over lifecycle (accounting for India's grid) for 100,000 EVs²⁴
- In line with India's Net Zero commitment and decarbonising transportation



Socio-Economic Potential & Livelihood

- 20% additional monthly income through higher savings²⁵
- Ease of operations promotes employment and inclusivity. ~8% purchased by women²⁶



Improved Public Health

- Every 100,000 EVs can avoid ~32 tonnes of fine particulate matter (PM2.5) over vehicle's lifetime²⁷
- Three-wheelers EVs can improve health due to lower noise, vibration and harshness



Source: Mahindra

²³ 80% electrification in 3W-L5 segment by 2030; Life of vehicle - 6 Years

²⁴ CO₂ and NO_x emissions calculated as per Niti calculator on e-amrit-nti.gov.in

²⁵ Monthly earnings of INR 30K and additional savings of 5-6k per month

²⁶ Data for a leading EV OEM in India

²⁷ Niti Ayog Report: Banking on Electric Vehicles in India

4.2 Accelerating to 2030: Enablers and blockers

Achieving 100% electrification of the three-wheeler segment would result in emissions reduction of 1.65 million tonnes of CO₂ over the lifecycle of ~100,000 EVs (accounting for India’s grid). However, despite many benefits, higher upfront costs of EVs remain an issue, with ICE vehicles still roughly two-thirds the cost.

Indian banks have also been slow to understand the segment, with 65% of EV financing coming from non-bank lenders, which can attract higher downpayments and interest costs. Approximately 70% of sales are from first-time buyers, who often have limited credit history. Mahindra believes that continued government support is required to achieve full electrification by 2030. However, this must be supplemented by affordable financing through priority sector lending (PSL) to help low-income buyers reap the rewards of lower total cost of ownership for EVs. With access to cheaper global green funds, non-bank lenders can increase their support for EV loans. Manufacturers, including Mahindra, are also working to de-risk these loans.

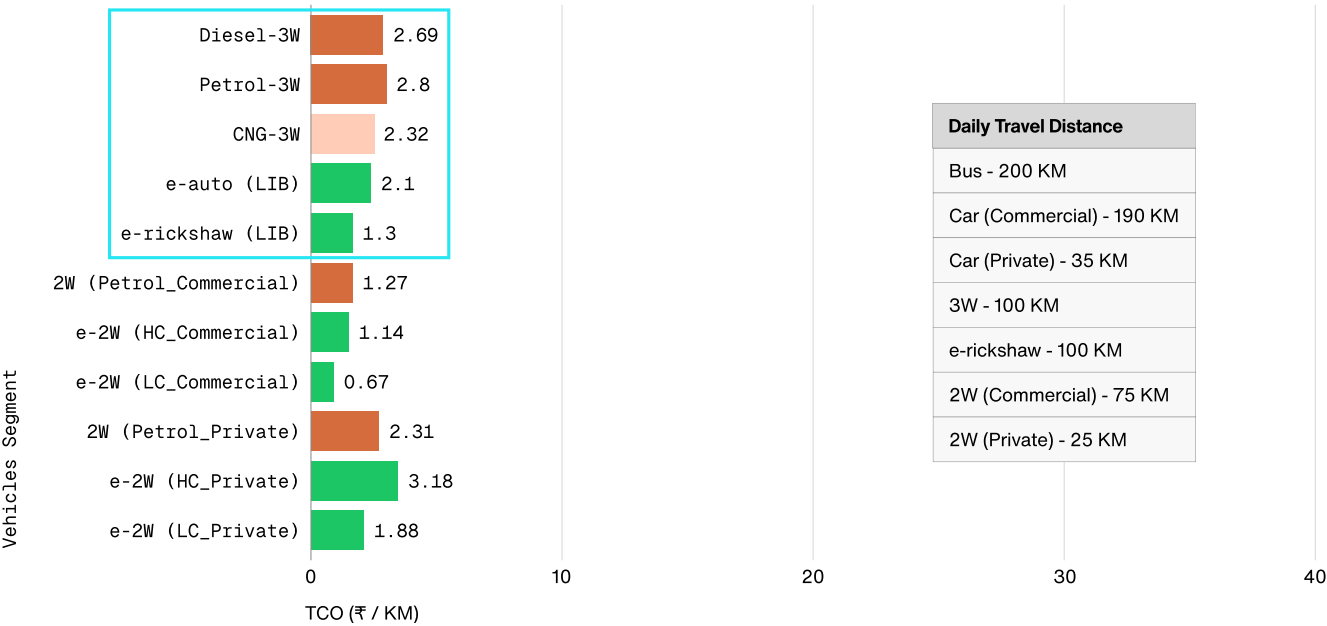
The telematics of modern EVs allow for superior tracking and monitoring of vehicle health, performance, and utilisation, and can even be used to locate and immobilise

vehicles. This data can be used by lenders and insurers to lower costs to customers.

EVs offer a higher (when compared with ICE vehicles) 60-month standard warranty that extends beyond the current maximum tenure of EV auto-loans (48 months). Secondary market sales value for these vehicles is also being bolstered by tie-ups within the EV ecosystem, from dealers, battery recycling companies, and fleet aggregators.

Enhancing metropolitan charging and parking infrastructure is also key to achieving full electrification of the segment and can benefit immensely from private investment. Finally, maturity within the battery recycling industry, which currently lacks scale, can help more clearly establish fair value for end-of-life batteries, and help lower costs for EV customers.

Total cost of ownership per kilometre by vehicle segment



Source: WRI India, Total Cost of Ownership (TCO) Evaluator, 2024. Note: All TCO numbers are without financial incentives and without electric vehicle supply equipment (EVSE) costs included. TCO analysis, disaggregated for different vehicle segments (over a ten-year holding period) at typical travel distances assumed for each segment

5 Case Study:

Battery Smart

Eliminating range anxiety and downside with decentralised battery swapping



Battery Smart founders Pulkit Khurana (left) and Siddharth Sikka.

5.1 The Model

Battery swapping providers such as India's Battery Smart are making the transition to electric two- and three-wheeler vehicles more convenient and cost-effective by using a Battery-as-a-Service model. With more than 1,100 swapping stations across 30+ cities, Battery Smart is India's largest battery swapping network and has been at the forefront of the battery-swapping movement. Every day the company's network is helping avoid 500 tonnes of CO₂e, while removing range anxiety and making the transition to electric mobility more accessible.²⁸ To date, Battery Smart has powered more than 1.5 billion electric kilometres, equivalent to more than 200,000 tonnes of CO₂ avoided.

The Battery-as-a-Service model enables two-minute battery swaps which mimic typical re-fuelling times and empower EV drivers to save time and cover greater distances. Users then pay a regular subscription fee (daily, weekly or monthly) to service providers for battery services throughout the vehicle's lifetime.²⁹ This model decouples the battery costs from the upfront vehicle costs, removing as much as 40% of the cost of the vehicle and helping to drive greater EV adoption.³⁰

This is especially important for India's more than one million last-mile workers, many of whom rely on such vehicles for their livelihoods. EVs currently account for 20% of India's last-mile delivery market, tracking towards the government's

target of 30% vehicle fleet electrification by 2030.³¹ Battery Smart is building a dense network of swap stations to ensure EV drivers are always within a one-kilometre radius of a station, with zero wait time. The company's unique, partner-led model leverages collaboration with micro, small and medium enterprises (MSMEs) to set up its swap stations on existing real estate, across Tier 1, Tier 2 and Tier 3 cities in India, providing attractive income generation opportunities alongside hassle-free setups and robust tech support. To date, partners have generated more than \$12.7 million in income, flowing through to local economies and contributing to the growth of small business. The company's asset-light strategy has driven rapid scalability, currently catering to more than 50,000 customers and with a goal to onboard 100,000 customers to its network by 2025.

As the company scales, it also takes on the responsibility of educating partners, drivers and consumers on EV safety measures, battery management and handling and ensuring the latest safety norms are adhered to. Battery Smart has partnered with local grocery delivery service Zepto, with plans to deploy more than 10,000 new vehicles by March 2025, and with food delivery app Zomato, committed to 100% EV adoption by 2030. Service fleets additionally benefit from added earnings and savings due to zero downtime, that would not be possible with a conventional fleet of electric vehicles.

“The Battery-as-a-Service model decouples the battery costs from the upfront vehicle costs, helping to drive greater EV adoption.”



Battery Smart's network of swapping stations provide battery swaps in less than two minutes.

²⁸ Lifecycle assessment basis, average based on vehicle type and displacement fuel

²⁹ NITI Aayog, Battery Swapping Policy - draft, 2022

³⁰ LeapFrog modelling

³¹ Economic Times, Battery Smart partners with Zepto to provide access to 1000+ EV battery swapping stations, 2024



5.2 Accelerating to 2030: Enablers and blockers

By 2030, India's vehicle count is projected to grow to 200 million two-wheelers and 12 million three-wheelers.

Traditional battery charging requires high upfront expenditure and downtimes of between three and four hours, which can dissuade drivers to switch to electric alternatives, especially for commercial use. The lack of park and charge facilities, especially in Tier 1 and Tier 2 cities, is also a hurdle.

To overcome this challenge, Battery Smart has developed a unique interoperable battery that is compatible with most electric two- and three-wheelers. These swappable batteries are around 2 to 2.5 kWh in capacity, and weigh between 12 and 15 kilograms. The smaller batteries result in lower weight of the EV, yielding better energy efficiency and greater range on the available charge.³²

An electric two-wheeler is designed to run with one or two such batteries, whereas vehicles such as e-rickshaws and e-autos can be fitted with up to four such batteries, depending on their energy consumption and range requirements.

As the EV market matures, operators also face the challenge of technological change. Battery cell technology generally takes 10 to 20 years to undergo significant change, often starting with chemistry level developments and leading to battery improvements that can have a long gestation

period, especially when commercialisation is considered. For Battery Smart, the life cycle of their swappable batteries is between five and six years, ensuring that the company can stay aligned with evolving technology. By continuously incorporating the latest updates they are able to effectively eliminate potential gaps and consistently offer customers the most advanced technology.

Until recently, the government of India supported EVs with purchase incentives linked to battery size under the Faster Adoption and Manufacturing of Electric Vehicles (FAME) schemes. However, these have not extended to EVs meant for battery swapping, as they are sold without pre-fitted batteries.

In recognition of the value of battery swapping for certain users, this might be addressed by extending future FAME subsidies to EVs sold without pre-fitted batteries, and it might be designed such that a portion of the incentive could be availed by the EV manufacturer and the rest could accrue to the battery swapping operator.³³

	Lead Acid Batteries	Battery Smart Swappable Batteries
Weight	120kg (four batteries)	25kg (two batteries)
Range	30-40 Kms	60-70 Kms
Charging Time	7-8 Hours	Zero
E-Rickshaw Life	Battery acid wears down rickshaw	No damage from battery
Maintenance	Half-yearly replacement cost	Zero maintenance liability
Earning Potential	\$8 - \$9.50 per day	\$14 - \$15.50 per day

³² ICCT, Charting an agenda for battery swapping for two-wheelers in India, 2022

³³ ICCT, Charting an agenda for battery swapping for two-wheelers in India, 2022

Image opposite: Thailand has the highest motorcycle ownership rate across Asia, with ~87% of households owning at least one motorcycle.

6 Conclusion

As the electric mobility revolution picks up speed across Asia, investors have a critical role to play in scaling and supporting the key enablers and accelerators underpinning change.

The two case studies in this paper highlight the challenges ahead, and the multipronged action that can speed up this transition.

There is no doubt that reconfiguring an industry as complex as mobility around a new power source will have some unexpected twists. But thus far, a mix of entrepreneurial energy, innovative finance and insurance, committed investors, government support, and consumer appetite for change, have helped support incredible progress in the move away from ICE vehicles.

This paper has focused on two Indian case studies, where the electrification of mobility is perhaps at its most interesting inflection point with huge surges in sales across electric scooters and three-wheelers. Mahindra Last Mile Solutions and Battery Smart present a blueprint for what is required across global emerging markets to drive this transition, and at price points that serve the realities of low-income consumers.

Tapping the full decarbonisation potential of the mobility sector, and deploying up to \$1.3 trillion by 2030, means supporting more of these types of companies, as well as encouraging interoperability and network effects of scale and efficiency across all segments: from vehicle manufacturers and charging infrastructure, to secondary markets for vehicles and batteries, and the enabling auto finance and insurance providers.

There are multiple points of entry for investors seeking to support this wave of climate-positive change, depending on their expertise, risk appetite, and regional focus, combined with the prospect of very attractive returns for those prepared to back winners in this rapidly shifting mobility ecosystem.

And while wealthier nations have been swept up by a wave of excitement around new EV passenger cars, sending companies like Tesla and BYD into the top tier of vehicle manufacturers by market capitalisation, emerging markets are following a different path that not only opens doors to vehicle ownership for low-income families, but may well help pioneer new categories of EVs that play a role in the future mobility mix of developing markets as well. These could include fleets of smaller, low-cost last mile vehicles to bridge the gap between public transport and private residences for urban commuters, or subscription models for commercial vehicles that deliver previously unheard of economies of scale and decarbonisation benefits and upend the cost structure of global freight and delivery.

The future is yet to be written, but what is certain is that the electric mobility revolution in emerging markets is following its own unique path – one rewarding for investors, people and the planet.

Image opposite: India has more than 12,100 public EV stations throughout the country.

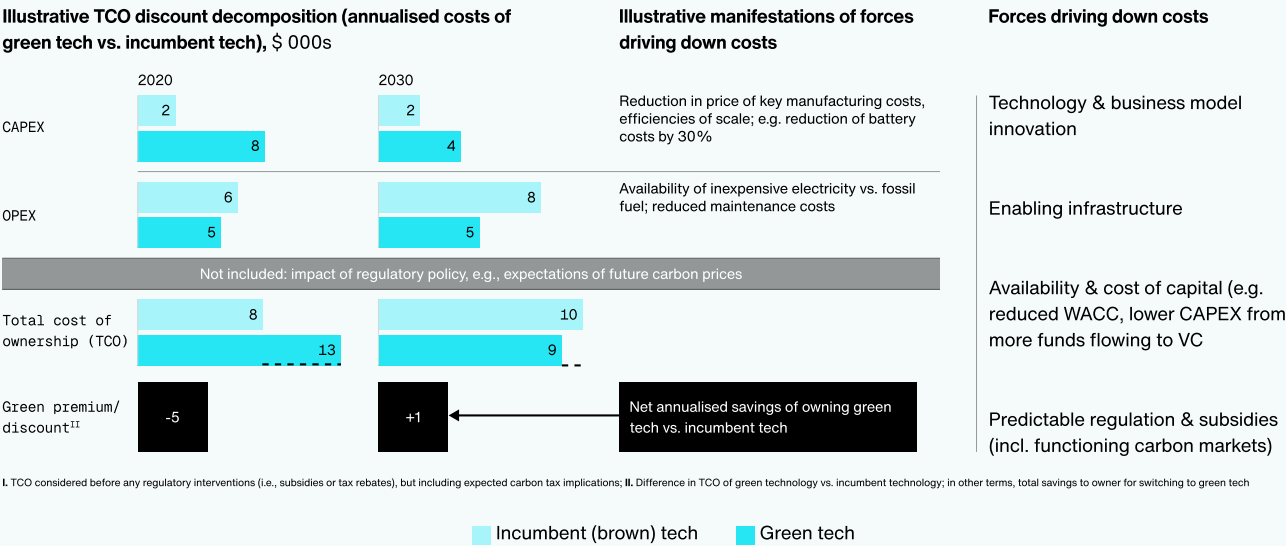


7

Appendix

7.1 Methodology

Calculating green discounts: actions by investors, operators, and policy makers are driving down costs



7.2 Reference List

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“With billions of emerging consumers rising into the middle classes, the role of private capital to accelerate the electric mobility transition is more critical than ever before.”

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