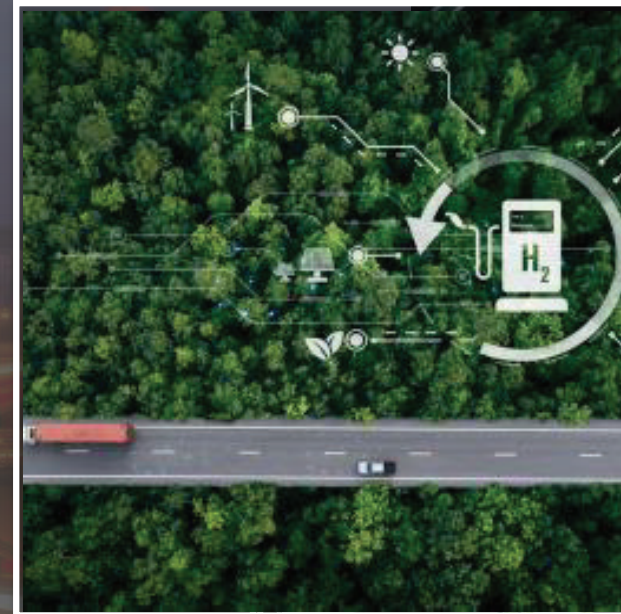


# Fuels of Future 2.0

*“Converging Towards  
Greener Growth”*

January 2024





**Disclaimer:**

This report is jointly prepared by ASSOCHAM & ICRA Limited. We have taken utmost care to ensure accuracy and objectivity while developing this report, based on information available in the public domain. The views and opinions expressed herein do not constitute the opinion of ICRA Limited & ASSOCHAM to buy or invest in this industry, sector or companies operating in this sector or industry and is also not a recommendation to enter into any transaction in this industry or sector in any manner whatsoever.

## Foreword



As we stand at the crossroads of environmental stewardship and energy security, it is imperative that we prioritize the development and adoption of cleaner, more sustainable fuels. The shift towards renewable energy sources, such as solar, wind, and hydro power, is already underway, but our journey does not end there. To truly usher in a new era of energy, we must address the evolution of new and transportation and industrial fuels as well.

India's commitment to reducing carbon emissions and combating climate change is commendable. Biofuels are expanding their reach by utilizing organic materials like algae, crop waste and even municipal solid waste to generate energy. These materials not only reduce our dependence on non-renewable resources but also offer a potential solution to waste management challenges.

Furthermore, the potential of hydrogen as a clean fuel source cannot be overlooked. Hydrogen fuel cells offer a versatile and zero-emission alternative, with applications across various sectors, including transportation, industry, and power generation. Establishing a supportive regulatory framework, encouraging private sector investments, and promoting research in hydrogen production technologies will be instrumental in harnessing the full potential of this fuel.

As we look ahead, the transition to electric vehicles (EVs) presents a promising avenue. Investing in robust EV infrastructure, incentivizing electric vehicle adoption, and fostering research and development in battery technology will be pivotal in realizing a greener transportation ecosystem.

With initiatives Atmanirbhar Bharat, like Ethanol Blended Programme, Green Hydrogen Policy, FAME Scheme, New Electric Vehicle Policy, Coal Gasification by Government of India is helping country strengthen its energy security in etc. As we embark on this transformative journey, concerns like Infrastructure changes, feedstock availability, technological advancements, skilled labour, and policy reforms are crucial components in the transition to these new fuel sources.

In conclusion, the future of fuels in India lies in our collective ability to embrace innovation, invest in green technologies, prioritize sustainability, and will present an invaluable opportunity for stakeholders, policymakers, industry leaders, and experts to converge, and deliberate the course for a robust, responsible, and innovative ecosystem for new future fuels in India.

**Deepak Sood**  
Secretary General  
ASSOCHAM



## Foreword



Air pollution, especially particulate matter, poses a serious challenge for air quality in India. The country's vehicle parc is expanding rapidly with over 21 crore vehicles estimated to have been on road in FY2023, and this number is only expected to increase going forward. It is, thus, imperative to significantly reduce the release of particulate matter from vehicles plying on the road. Several regulations on the subject have come into force in the last few years, and emission norms are only expected to get stringent going forward, especially in the light of India's environmental pledges in various forums. As against the NOx emission requirements of 3,500 mg or lower per kWh in BS IV, BS VI 2.0 stipulates NOx emission lower than 1,200 mg/kWh. Similarly, particulate matter emission thresholds are also stringent with progressive tightening in BS VI 2.0 against that in BS IV. Compared to the first standard in 1991, permissible emission thresholds have been slashed by over 90% in BS VI 2.0.

Different strategies have been adopted by nations globally to reduce automobile emission. While China and Europe are largely focused on electric vehicles (EVs), Brazil's focus is on ethanol blending and flex fuel vehicles. USA and India, on the other hand, look at co-existence of multiple alternate powertrains.

India has adopted a three-fold approach to reduce automobile emission, starting with the periodic tightening of emission regulations. Technology changes adopted by automobile OEMs to improve fuel efficiency and reduce emission have also contributed to reduction in particulate matter from internal combustion engine (ICE) vehicles, as older vehicles get replaced by newer ones. Further, the share of alternate powertrains like EVs, hybrids and compressed natural gas (CNG) vehicles has also been increasing over the years. ICRA expects the share of alternate powertrains to be closer to 30% of new vehicle sales by CY2027.

Focussing on India, multiple alternate powertrain options are being explored by industry players for lowering emission. However, EVs, hybrids and CNG vehicles are likely to witness significant growth, while meaningful adoption of hydrogen and flex-fuel vehicles is still some time away. Multiple factors, including a favourable policy environment, lower total cost of ownership (TCO) vis-à-vis ICE vehicles and increasing number of models are likely to support EV penetration. However, high import dependence, lack of adequate charging infrastructure and cautious financing environment remain challenges. Given that only 20-30% of EV components are localised,

there is immense potential for developing the domestic component ecosystem. The Central Government's production-linked incentive (PLI) scheme and various State Government policies have accelerated EV component investments. Hybrids, viewed as an intermediate step in passenger vehicles, can switch between electric and normal driving modes and help resolve the range anxiety issue. Also, hybrids have a 30-35% higher fuel efficiency compared to a pure gasoline vehicle, and this is likely to mitigate the upfront price differential issue to a large extent. Enhanced adoption of hybrids is likely over the next 3-4 years in passenger vehicles.

Favourable TCOs, improving CNG fueling infrastructure and new model launches by the OEMs will continue to aid consumer acceptability for CNG and drive penetration. However, limited availability of CNG fuel stations currently, especially in rural areas albeit on an increasing trend, and lower horsepower and slower acceleration compared to petrol/diesel variants remain key concerns.

Usage of flex-fuel vehicles has multiple benefits besides reducing vehicular emission. Ethanol is economical compared to petrol from a fuel cost perspective, aiding in controlling excess sugar supply in the country and 2G ethanol is likely to support the end-use of agri-crop waste. However, a substantial ramp-up in ethanol availability would be needed, raising concerns on food security and feed-stock availability. Also, the running cost of flex fuel-based vehicles is expected to be approximately higher by 30% compared to gasoline vehicles, owing to lower fuel efficiency. Thus, meaningful adoption of flex fuel vehicles is still some time away in India.

Hydrogen is available in abundance, its refuelling time is relatively quick and the range is comparable to ICE vehicles. However, lack of availability of adequate hydrogen refuelling stations currently makes it inconvenient for users, compared to traditional gasoline or diesel vehicles. Also, while not much land is required for production compared to biofuels, hydrogen production is an expensive process. Reduction of this cost is vital for making hydrogen vehicles more economically viable. Further, hydrogen is highly flammable and requires careful handling and storage. This is one of the key challenges currently for mass adoption of hydrogen-powered vehicles, and establishing protocols for safe storage, usage and transportation of hydrogen is critical.

**Mr. Shamsher Dewan**

Senior Vice President & Group Head - Corporate Ratings  
ICRA Limited



## Table of Contents



Overview of vehicular emission in India



Indian auto industry's approach to lower emission



Alternate fuel technologies



Opportunities from electrification



Key takeaways

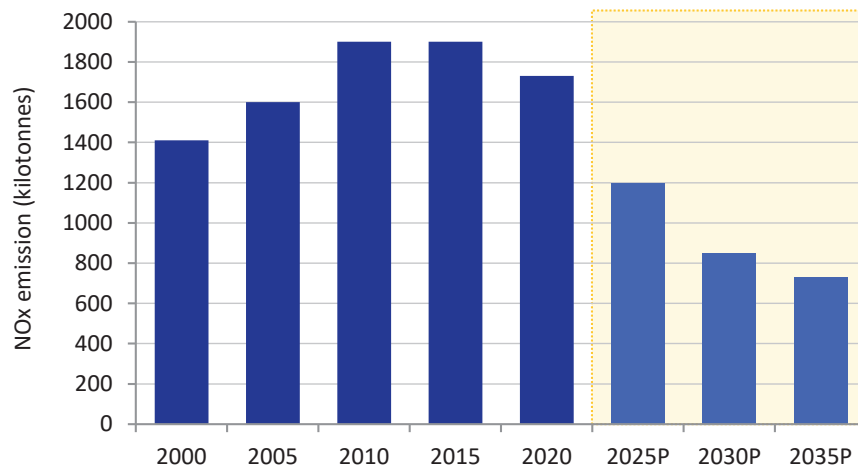
## Overview of vehicular emission in India

*Lower emission to facilitate achievement of India's net zero goals*

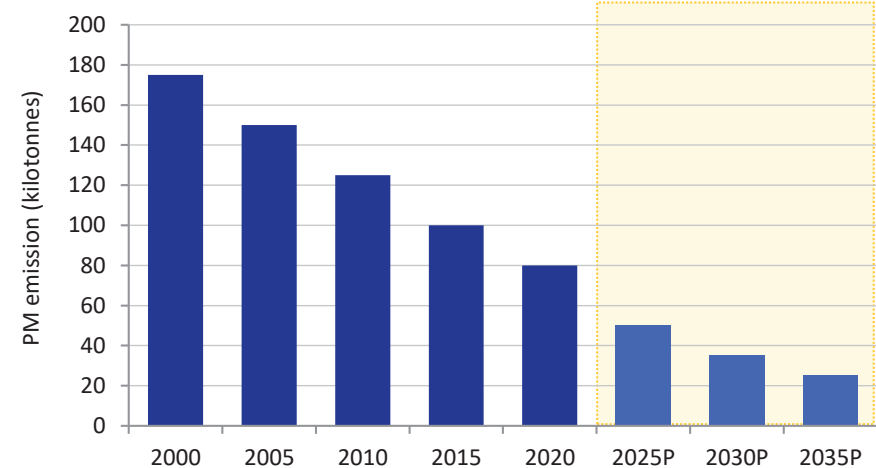


## Emission from on-road vehicles is increasingly gaining importance in India

**Exhibit: Trend in NOx emission from on-road vehicles in India**



**Exhibit: Trend in PM2.5 emission from on-road vehicles in India**

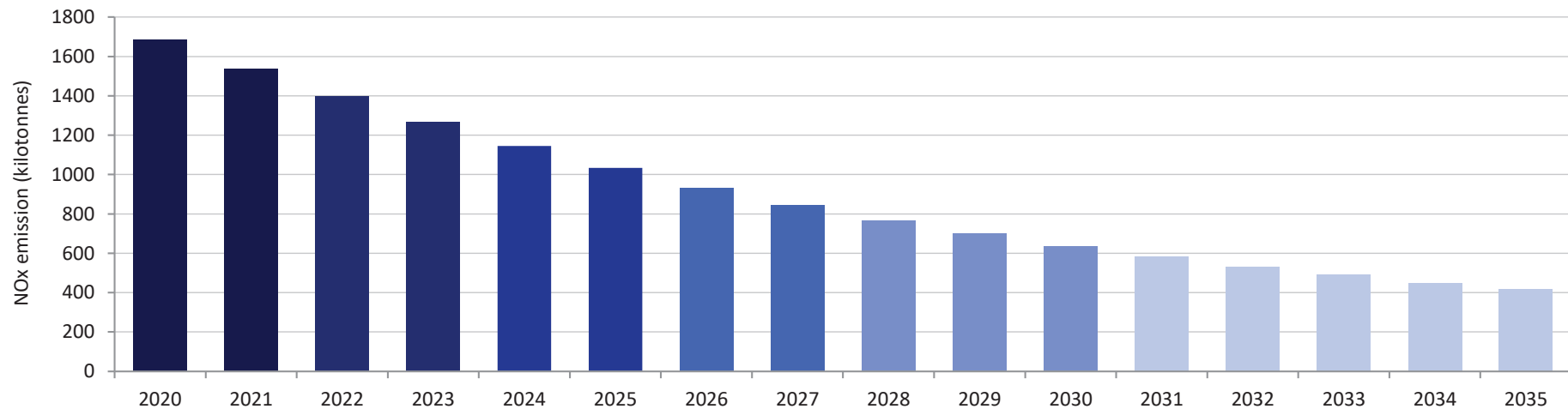


- Air pollution, especially particulate matter, is a serious challenge in India, and pollution from vehicles is a significant factor in the nation's air-quality problems.
- The country's vehicle parc is expanding rapidly with over 21 crore vehicles estimated to have been on road in FY2023, and this number is only expected to increase going forward.
- It is imperative to significantly reduce pollution and release of particulate matter from each vehicle plying on the road. Several regulations have come into force for this in the last few years, and it is only expected to get stringent going forward.

Source: ICCT and ICRA Research

## Focus on emission reduction is visible globally as well

**Exhibit: Trend in NOx emission from on-road vehicles in EU**



- Europe has been a front-runner in reducing vehicular emission through periodic regulatory tightening, both on emission from ICE vehicles and increase in usage of alternate fuel vehicles, including electric vehicles (EVs).
- Vehicular NOx emission in Europe is expected to reduce further going forward.

Source: ICCT and ICRA Research

## India's environmental pledges expected to accelerate reduction in automobile emission

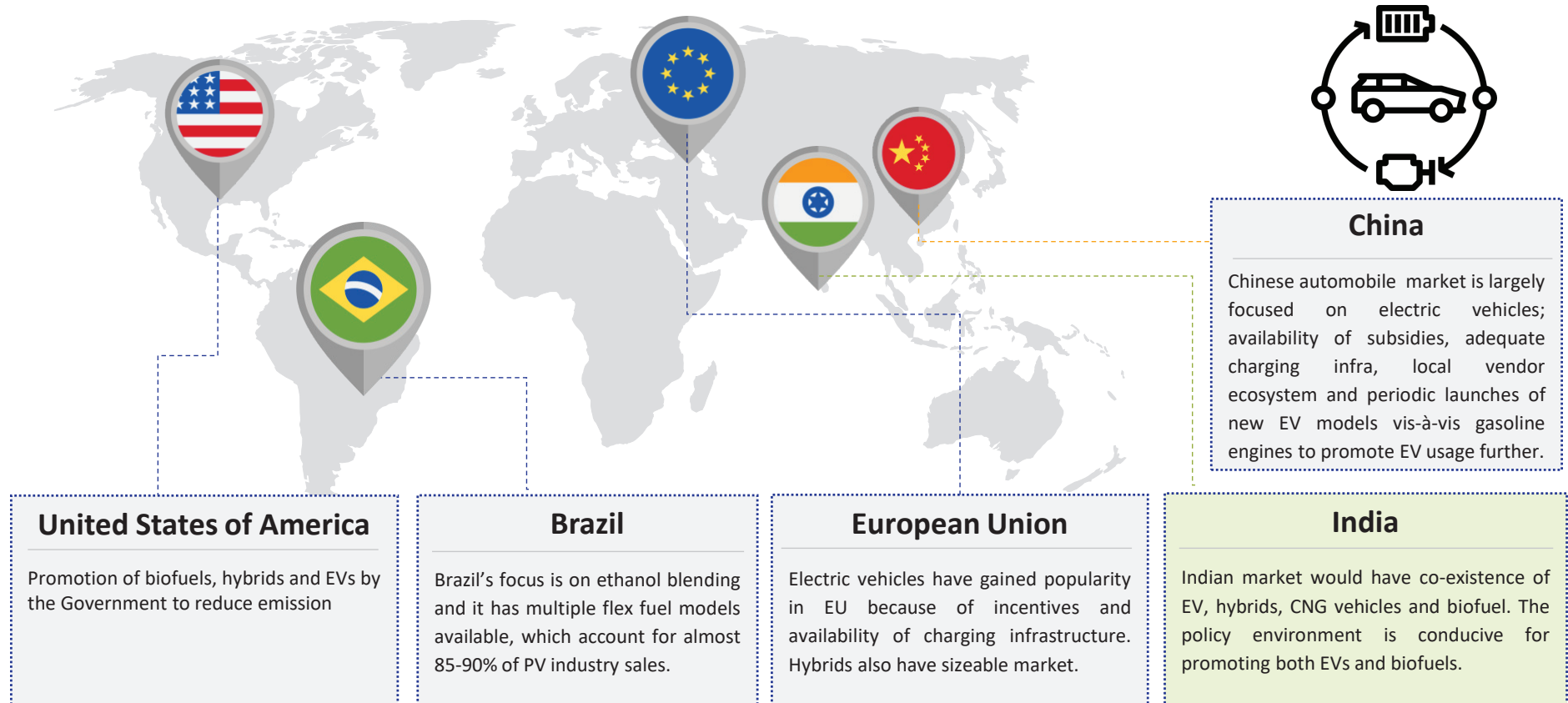
Exhibit: India's announcement at the various environmental summits



	India to cut emission to net zero by 2070	
	50% of energy from renewable sources by 2030	
	Reduce total carbon emission by 1 billion tonne and emission intensity (amount of greenhouse gases per unit of GDP) by 45% by 2030	
	500 GW non-fossil electricity capacity to be built by 2030	
	Global Biofuel Alliance launched at the G20 Summit in 2023, with the aim of boosting supply and demand for biofuels	

Source: ICRA Research

## Different strategies adopted by nations globally to reduce automobile emission



Source: ICRA Research

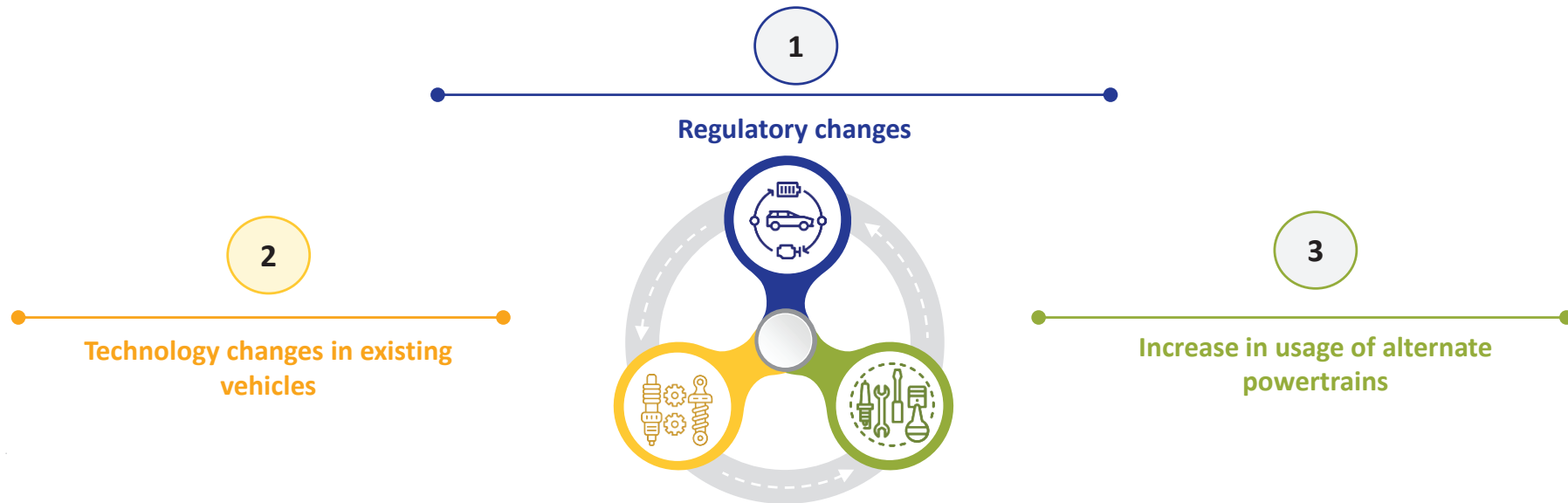
## Indian auto industry's approach to lower emission

*Progressive tightening of emission norms and technology changes have aided reduction in vehicular emission*



## Three-fold approach adopted in India to reduce automobile emission

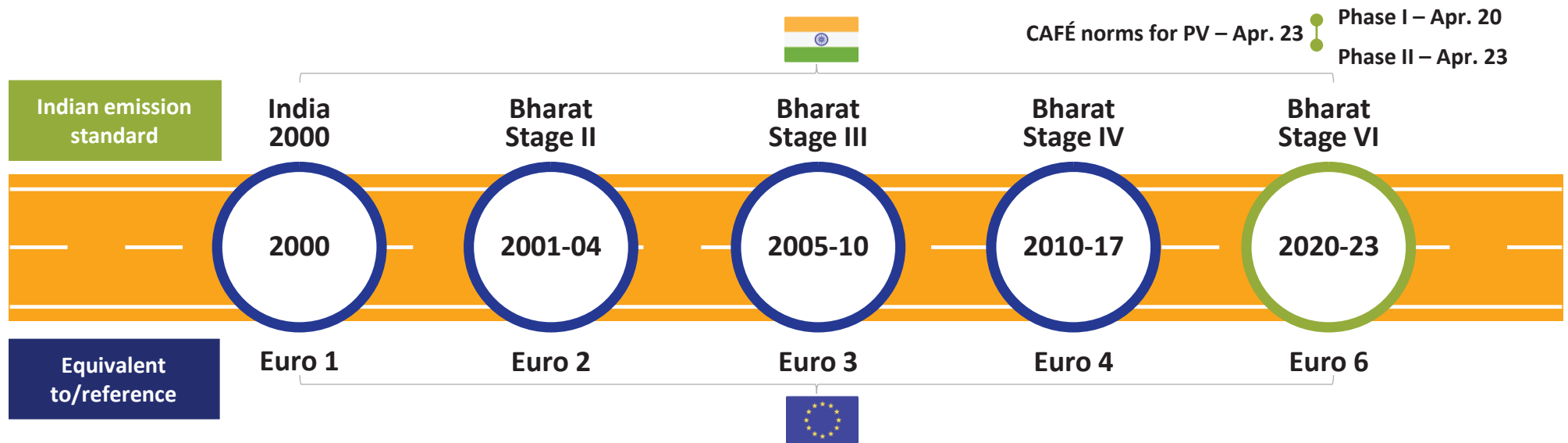
Exhibit: Various approaches adopted in India to reduce vehicular emission



Periodic tightening of emission regulations and technology changes adopted by automobile OEMs to improve fuel efficiency and reduce emission have contributed to reduction in particulate matter from ICE vehicles as older vehicles get replaced by newer vehicles. Also, share of alternate powertrains like EVs, hybrids, CNG vehicles, etc. has also been increasing over the years.

## Emission norms have become stringent over the years, and the trend will continue

Exhibit: Timeline of implementation of emission standards in India

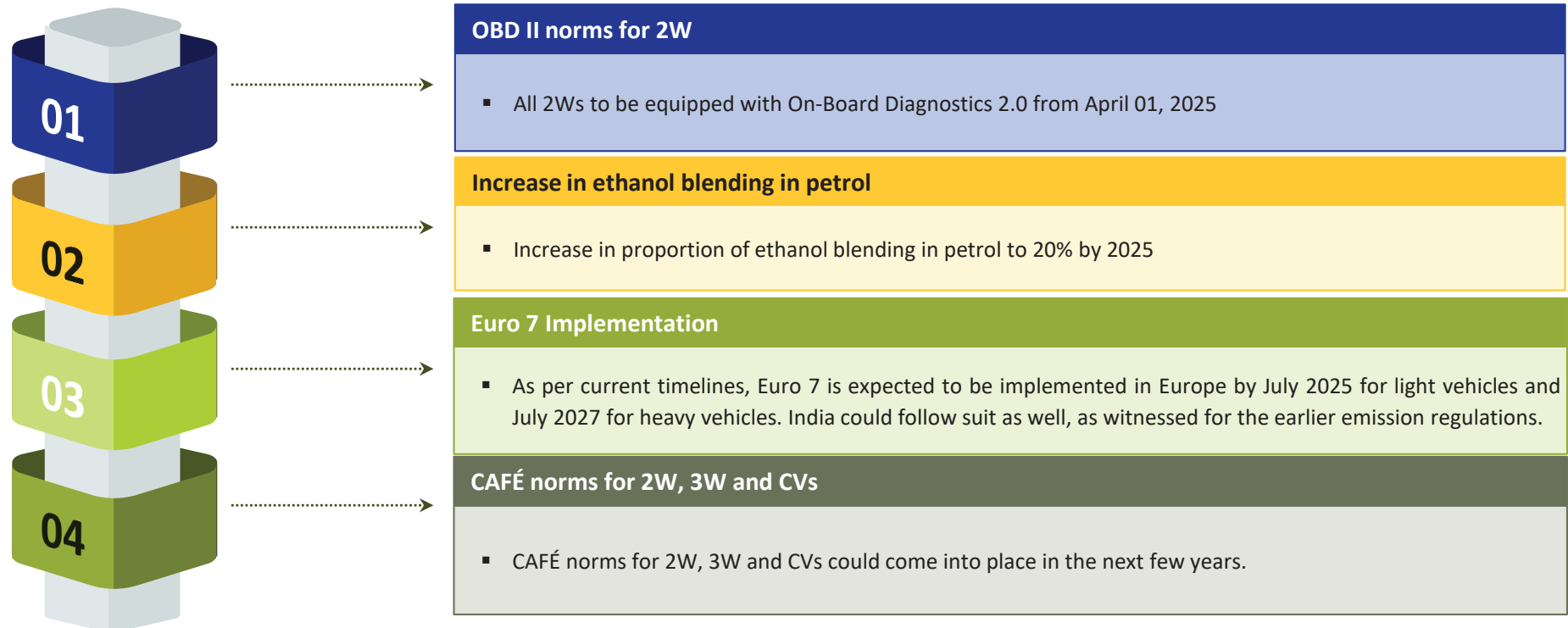


As against NO<sub>x</sub> emission requirements of 3,500 mg or lower per kWh in BS IV, BS VI 2.0 stipulates NO<sub>x</sub> emission lower than 1,200 mg/kWh. Similarly, PM emission thresholds are also stringent with progressive tightening in BS VI 2.0 as against that in BS IV. Compared to the first standard in 1991, emission thresholds have been slashed by over 90% in BS VI 2.0.

Source: ICRA Research

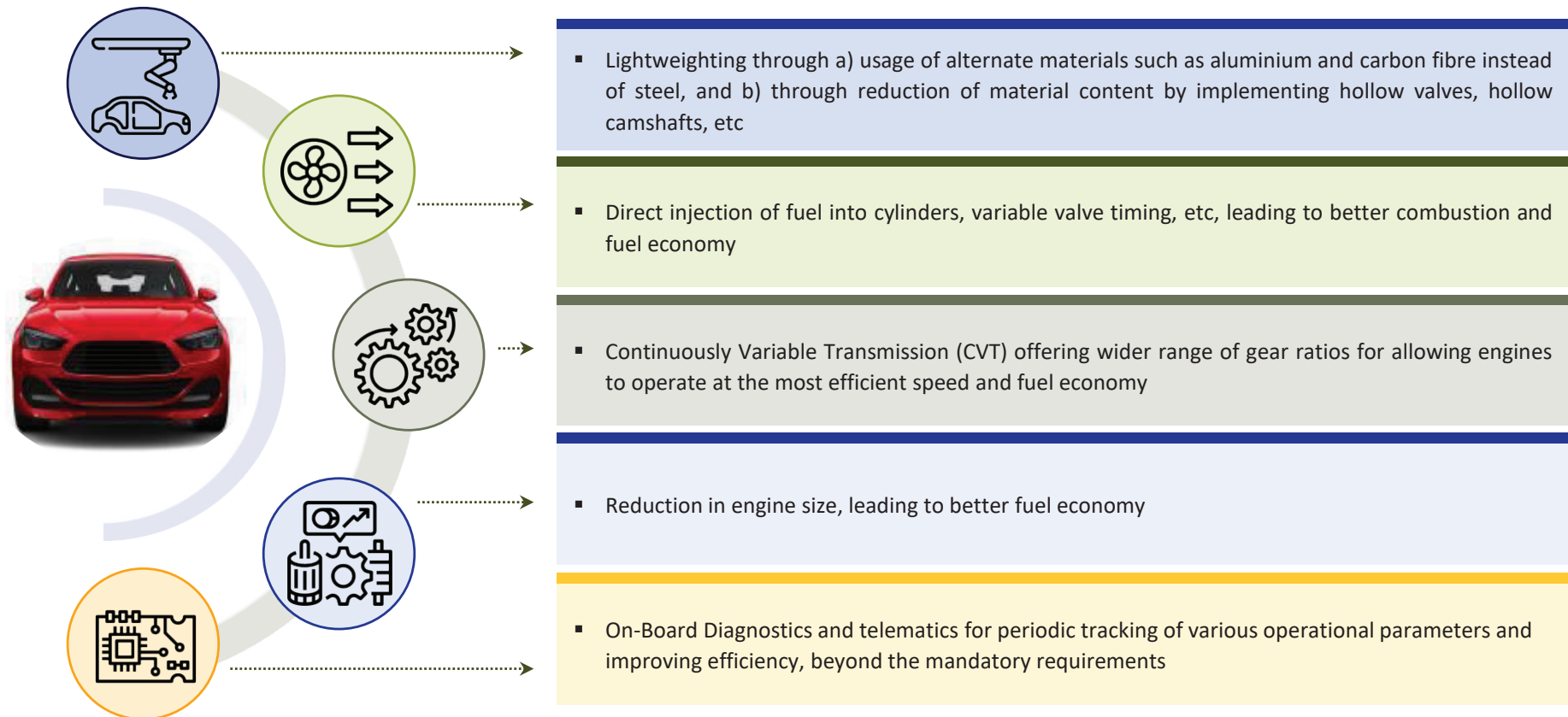
## Some other emission-related regulatory changes could also be in the anvil

Exhibit: Potential emission-related changes that could come in the next few years



Source: ICRA Research

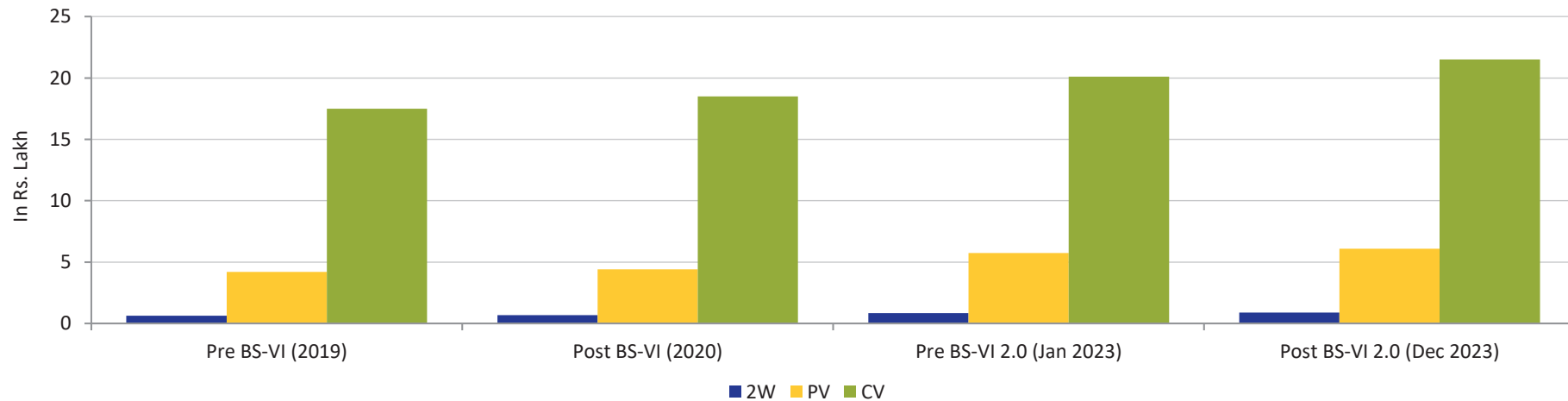
## Automakers have implemented several technology changes for fuel efficiency



Source: ICRA Research

## Emission-related changes have led to higher content per vehicle and rise in vehicle cost

**Exhibit: Trend in vehicle prices in the last few years**



- The changes implemented in vehicles in the last few years, both regulatory and voluntary, have been predominantly focused on two aspects – emission and safety.
- The changes have resulted in higher value addition and increase in content per vehicle, and engine component manufacturers have benefitted from the same.
- The higher content per vehicle, has in turn, led to increase in vehicle costs, with component suppliers passing it on to the OEMs, who have in turn passed it on to consumers.
- Prices of PV and 2W have increased by 40-45% since 2019 while that of CV has increased by 20-25%. While this has significantly stemmed from the aforesaid changes, part of the increase can also be accounted to the inflation pass-through.

Source: ICRA Research

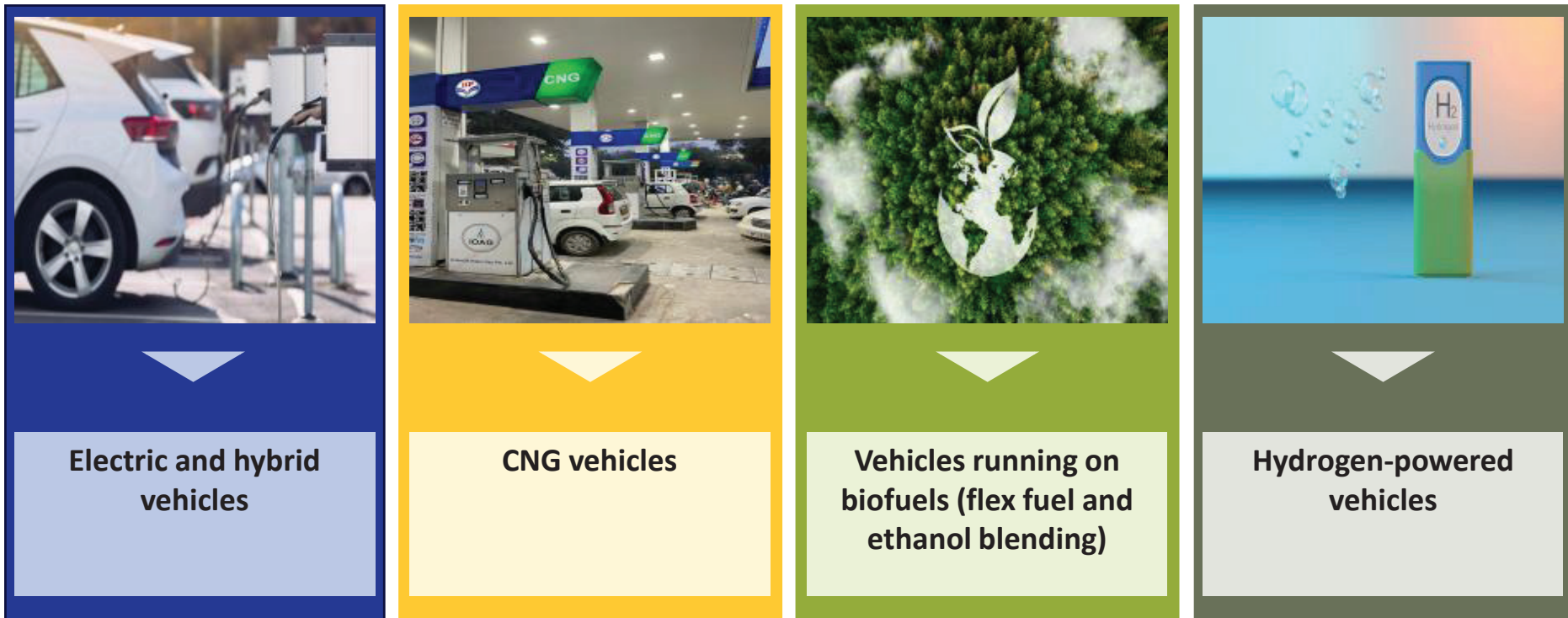
## Alternate fuel technologies

*Share of alternate powertrains including EVs to rise over the years; ICRA expects it to be close to 30% of new vehicle sales by CY2027*



## Multiple alternate powertrain options available for lowering emission

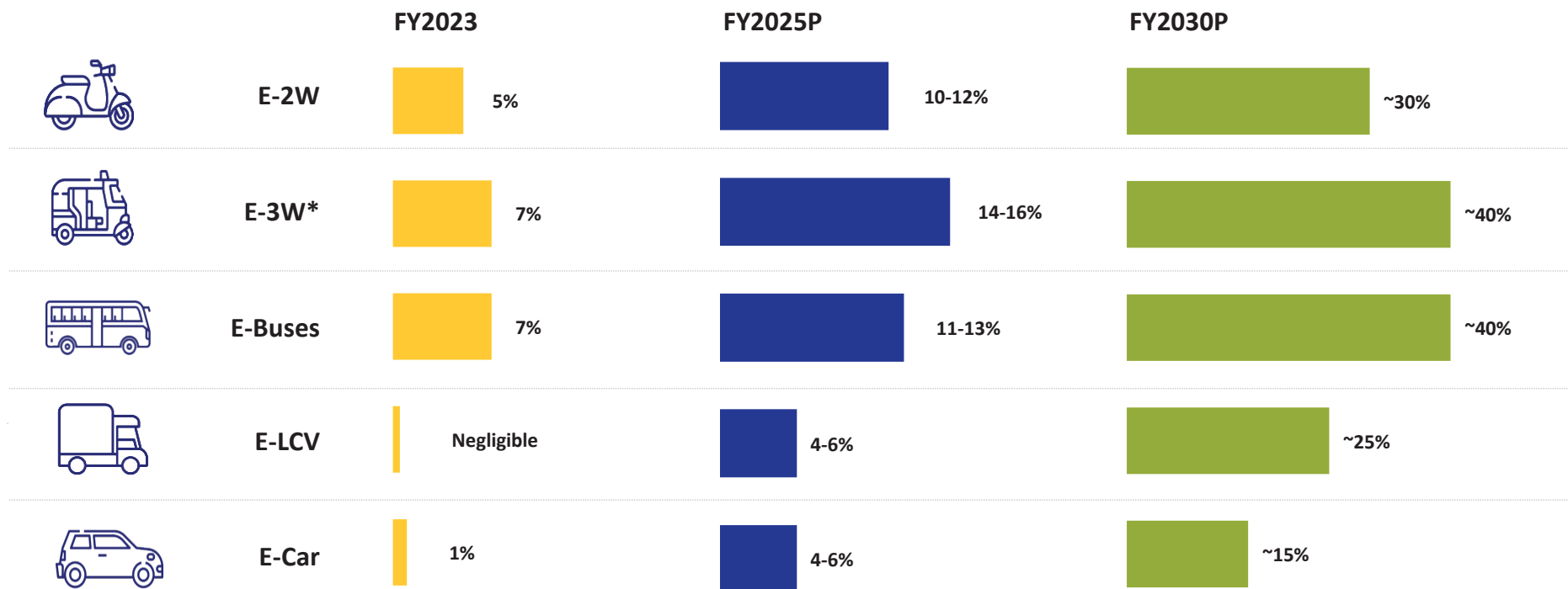
Exhibit: Alternate powertrain options



Source: ICRA Research

## EV penetration across segments to increase exponentially

Exhibit: Estimated trend in electrification across segments

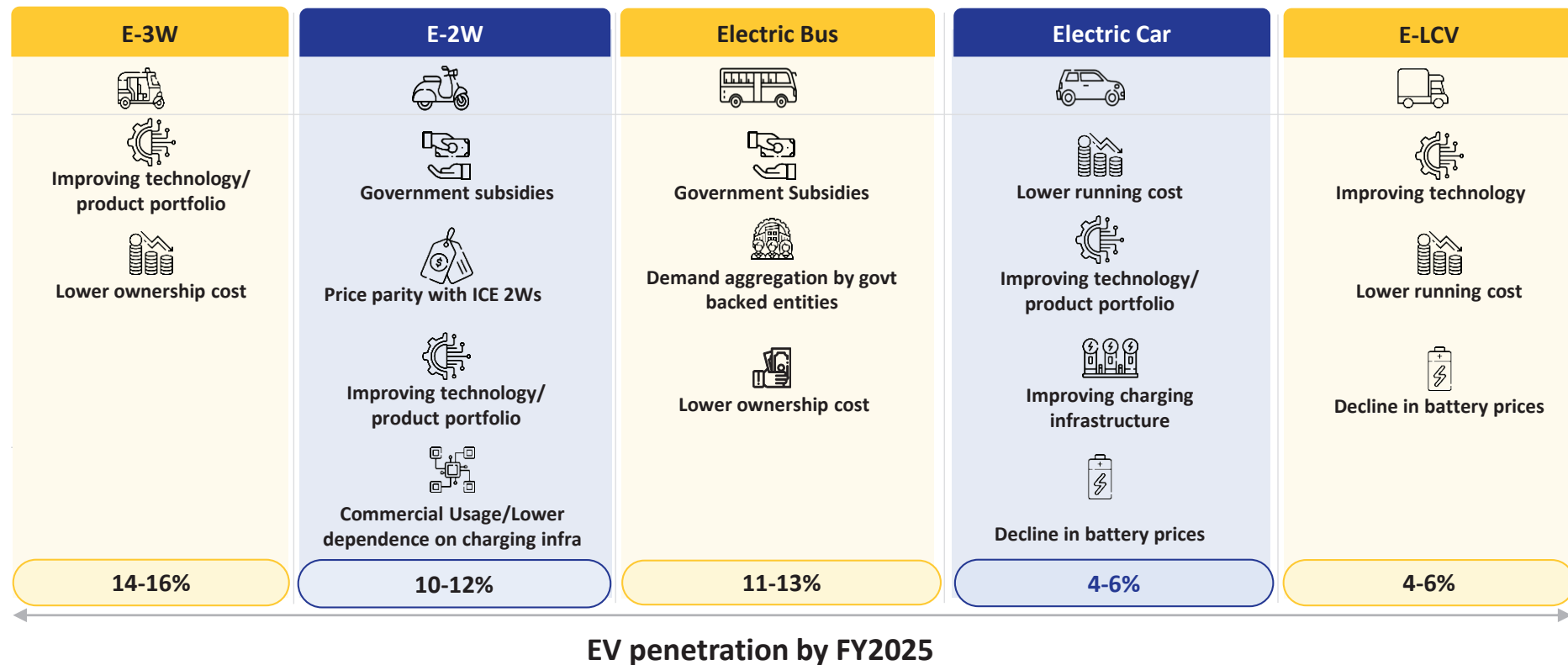


Source: ICRA Research; Note – Penetration measured in terms of new vehicle registrations

\*Excludes rickshaw segment, which is already electrified to large extent

## Confluence of factors to support EV adoption over the medium term

Exhibit: Key growth drivers for electrification across all segments



Source: ICRA Research

## Government measures at the core of India's EV transition



Schemes	Auto PLI Scheme	FAME-II	PLI ACC	State EV Policies
Outlay	Rs. 25,938 crore	Rs. 10,000 crore	Rs. 18,100 crore	Incremental incentives for demand generation, industrial development and charging ecosystem

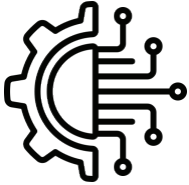





Government efforts to enhance EV adoption through policy support have been instrumental in increasing the electric vehicle adoption over the past few years. In addition to the outlays under the aforementioned policies, which are aimed at capability development and driving demand, the Government has been also focused on improving the charging infrastructure across the country to help address range anxiety concerns related to EVs.

Source: Government of India, ICRA Research

## Challenges to enhanced EV adoption, however, continue to exist

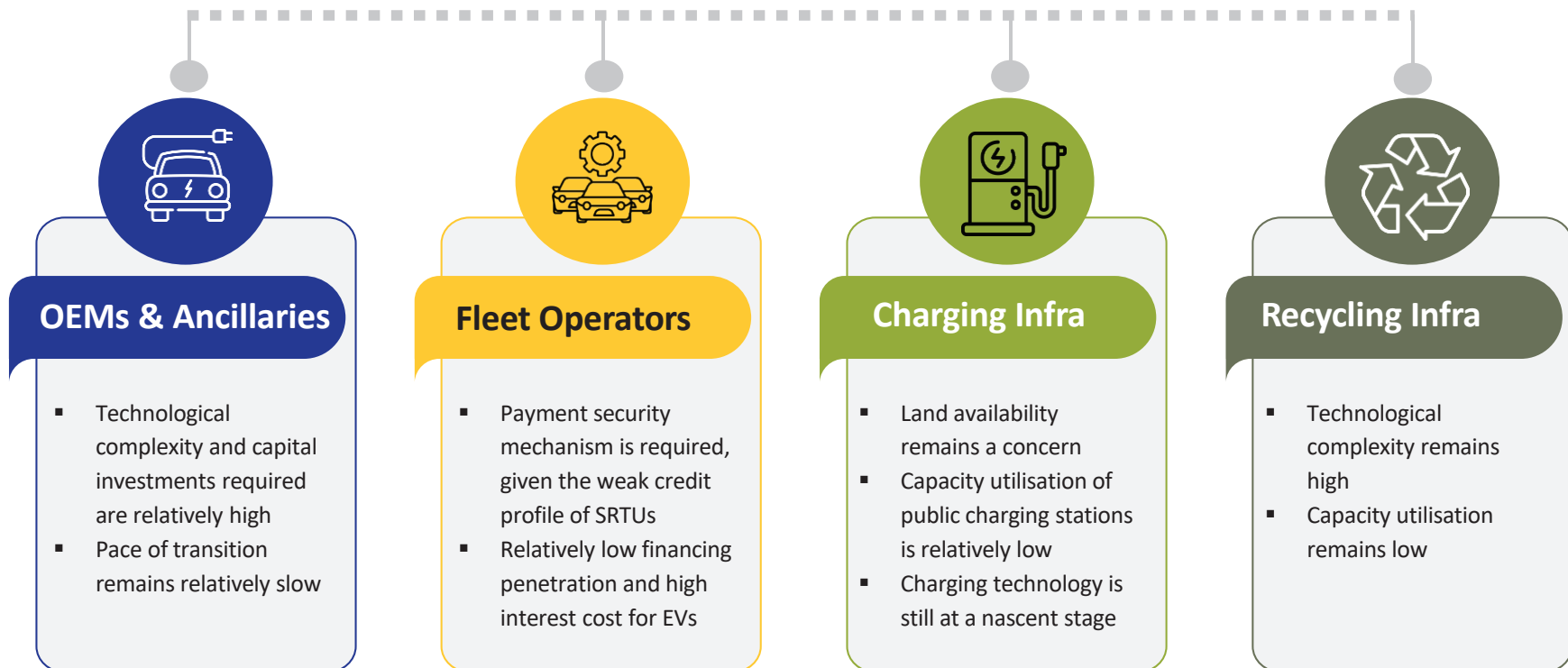
Exhibit: Key challenges for increase in EV adoption

Product development/ Technology	Consumer awareness	Range anxiety	Financing
			
High import dependence, especially for battery cells. Only 20-30% of the EV supply chain is currently localised and significant increase in domestic manufacturing is critical	There is lack of awareness on TCO and long-term benefits vis-à-vis ICE	Lack of adequate EV charging and battery swapping infrastructure, albeit on an improving trend	Still at a nascent stage; lenders are cautious as residual value of EVs still remains a concern

Source: ICRA Research

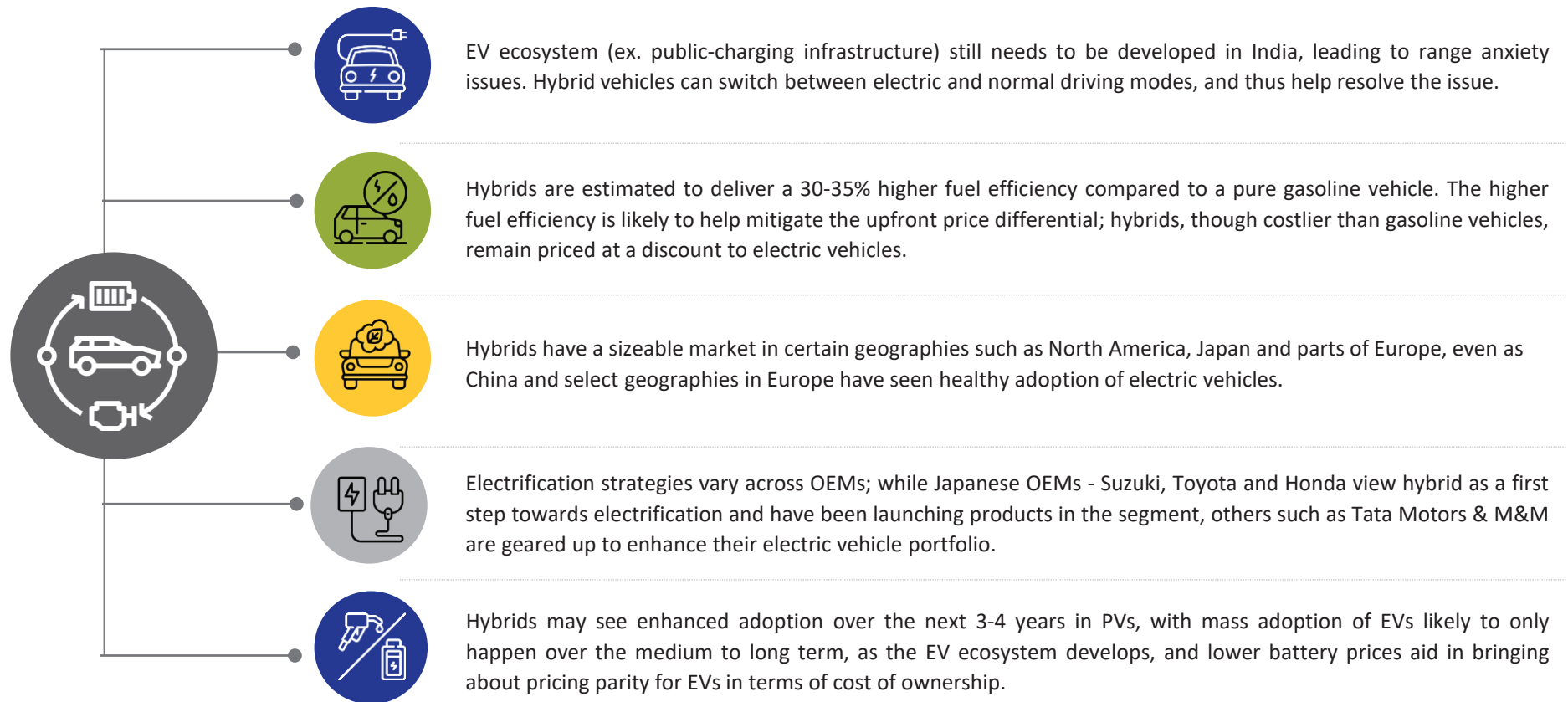
## Key concerns need to be addressed by various stakeholders

Exhibit: Challenges to be addressed by various stakeholders to increase EV adoption



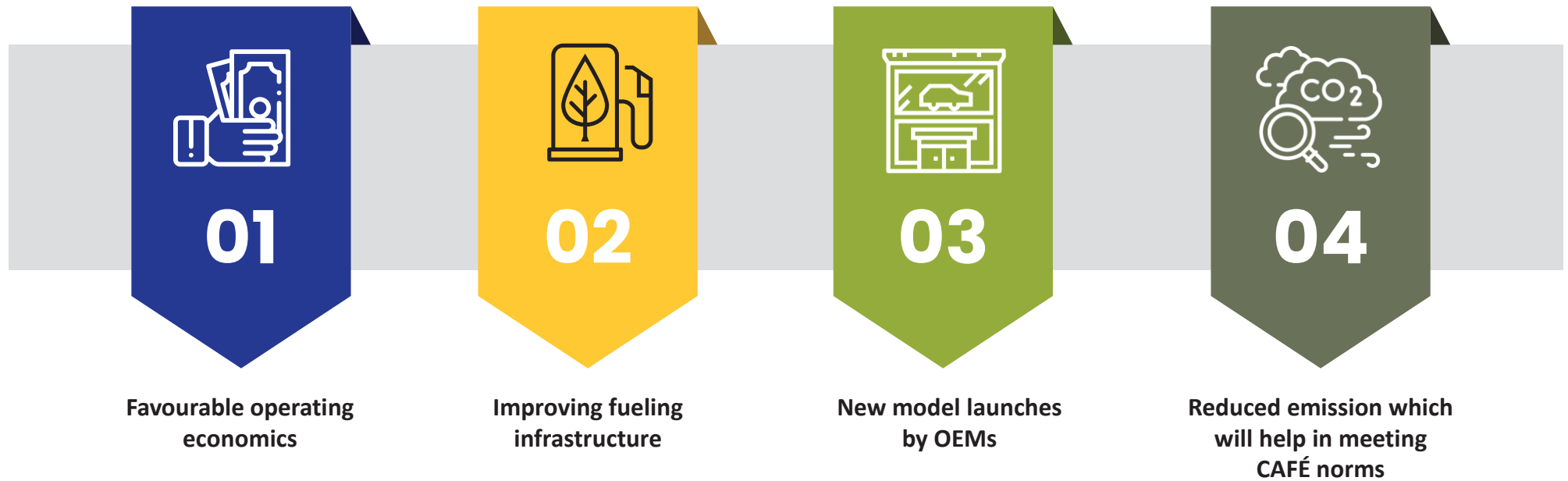
Source: ICRA Research

## Hybrids viewed as an intermediate step in passenger vehicles



Source: ICRA Research

## CNG vehicles will continue to gain traction

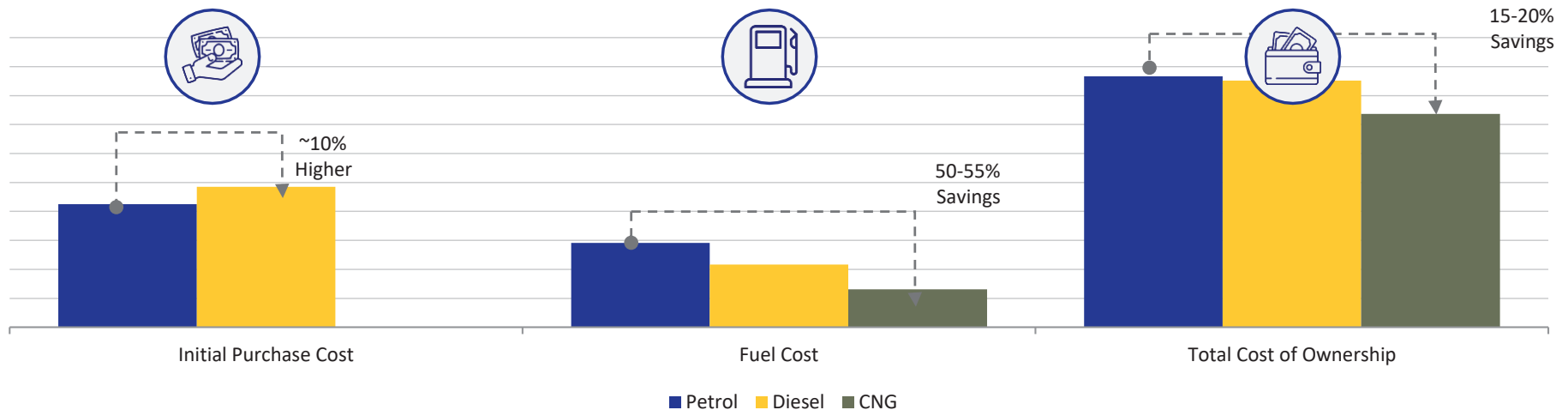


Favourable TCOs, improving CNG fueling infrastructure and new model launches by OEMs will continue to aid consumer acceptability for CNG and drive penetration. Further, CNG-based vehicles also help in reducing emission vis-à-vis petrol vehicles and help in meeting CAFÉ norms. However, limited availability of CNG fuel stations currently, especially in rural areas albeit on an increasing trend, and lower horsepower and slower acceleration compared to petrol/diesel variants remain key concerns.

Source: ICRA Research

## TCO of CNG vehicles lower by 15-20% compared to petrol passenger vehicles

Exhibit: Comparison of total cost of ownership between different types of powertrains in passenger vehicles







Despite higher upfront cost, lower running costs, aided by a superior mileage, significantly lower the Total Cost of Ownership (TCO) for CNG-powered vehicles.

Source: ICRA Research

## Usage of flex-fuel vehicles has multiple benefits besides reducing vehicular emission

### Exhibit: Key advantages of adopting flex-fuel vehicles

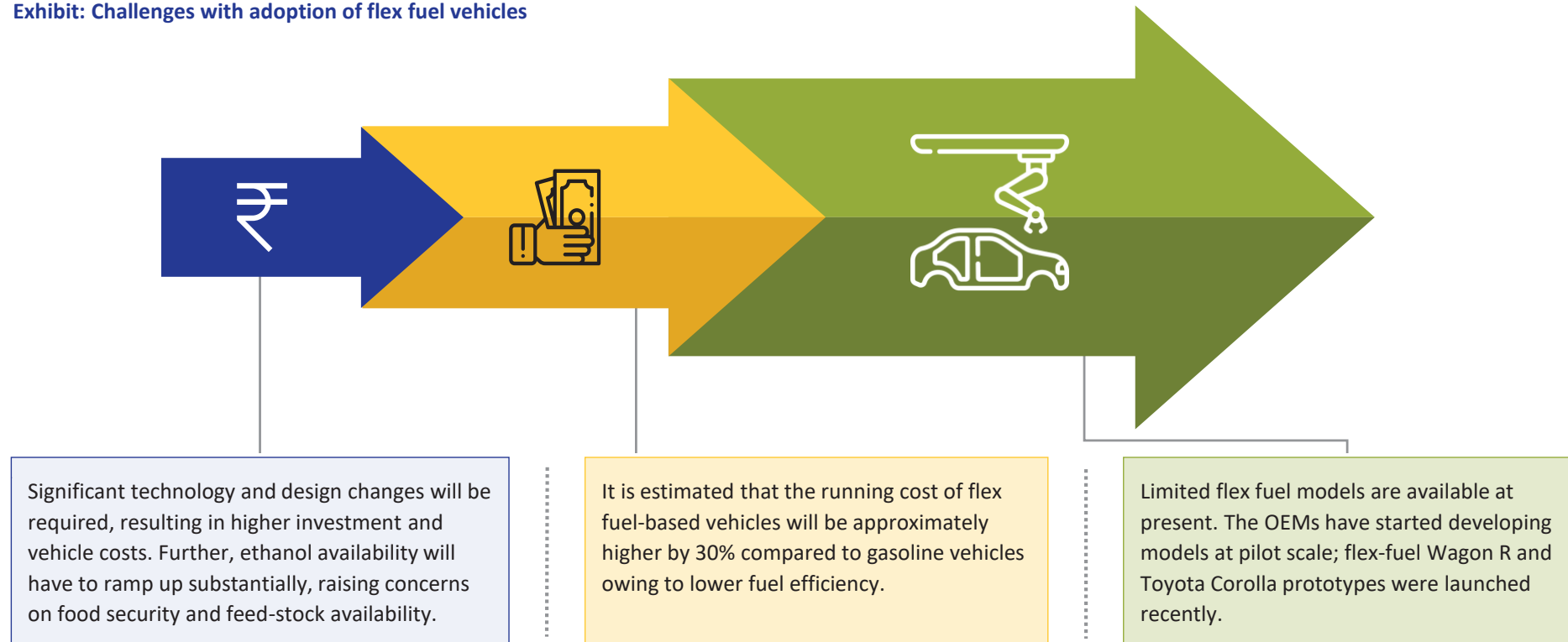
	Strengthens energy security and helps to reduce oil imports and conserve forex reserves
	Economical compared to petrol from a fuel cost perspective
	Currently, the ethanol production is entirely from 1G source. It aids in controlling excess sugar supply in the country as ~65% of total ethanol production comes from molasses-based distilleries.
	Going forward, as 2G ethanol production increases, there would be incremental benefits including end-use of agri-crop waste and lower water requirements.

Cost savings in E100 fuel over E10 petrol (As on January 09, 2024)	Unit	Cost of E10 petrol	Cost of E100 fuel		
			Sugarcane Juice	B heavy molasses	C heavy molasses
Price to Dealers (excluding Excise duty and VAT)	Rs/Lt	57.4	65.6	60.7	49.4
Excise Duty	Rs/Lt	19.9	0.0	0.0	0.0
Dealer Commission	Rs/Lt	3.8	3.8	3.8	3.8
VAT (Including VAT on dealers' commission)	Rs/Lt	15.7	18.7	17.4	14.4
Retail Selling Price in New Delhi	Rs/Lt	96.7	88.1	81.9	67.5

Source: PPAC, NITI Aayog, ICRA Research; E100 is pure ethanol fuel while E10 represents 10% ethanol blended petrol

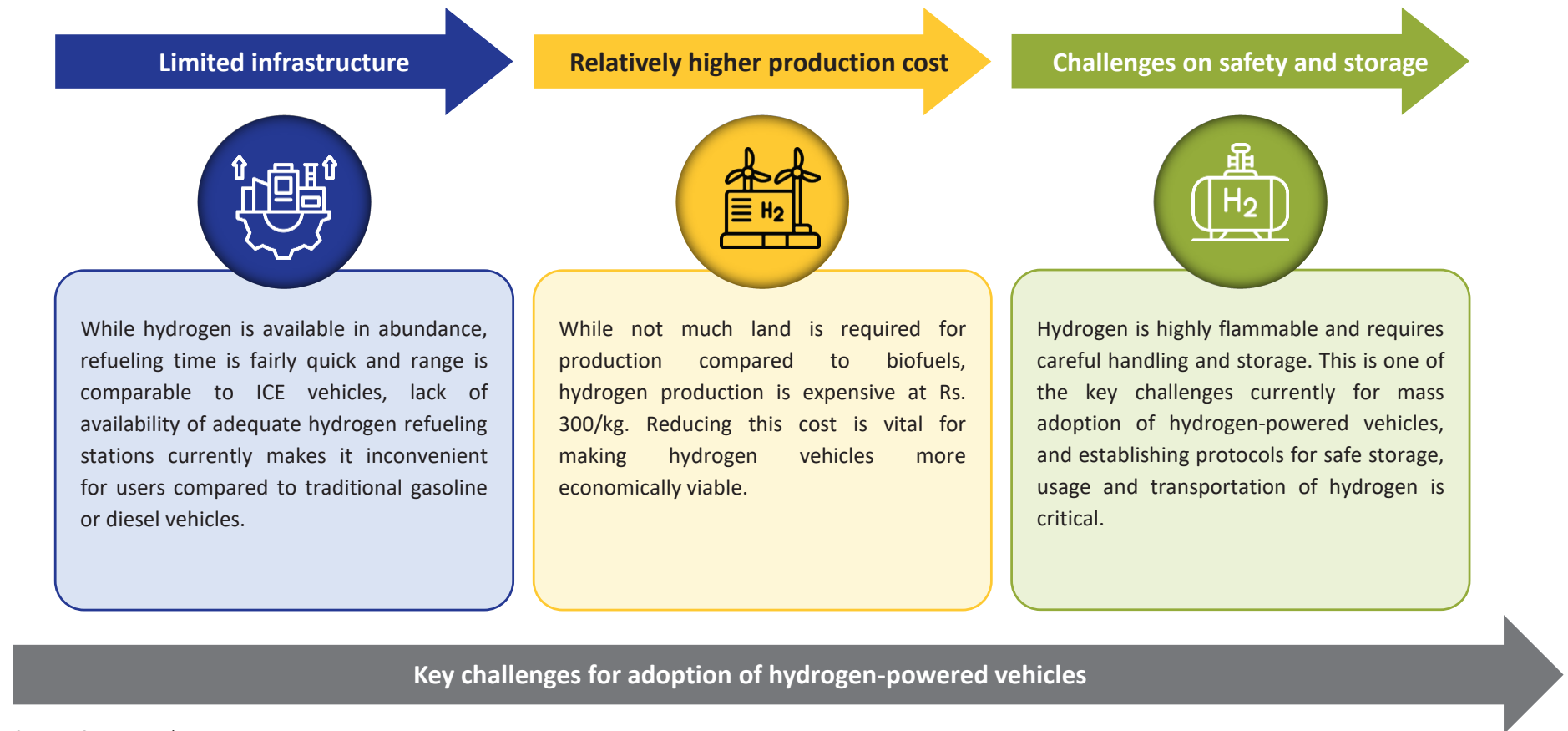
## Meaningful adoption of flex fuel vehicles still some time away

Exhibit: Challenges with adoption of flex fuel vehicles



Source: ICRA Research

## Hydrogen fuel adoption is still at a nascent stage



Source: ICRA Research

## Several incumbent OEMs and ancillaries working on alternate fuel technologies

### Incumbent OEMs



### Component suppliers



Source: ICRA Research; The list is indicative and not exhaustive

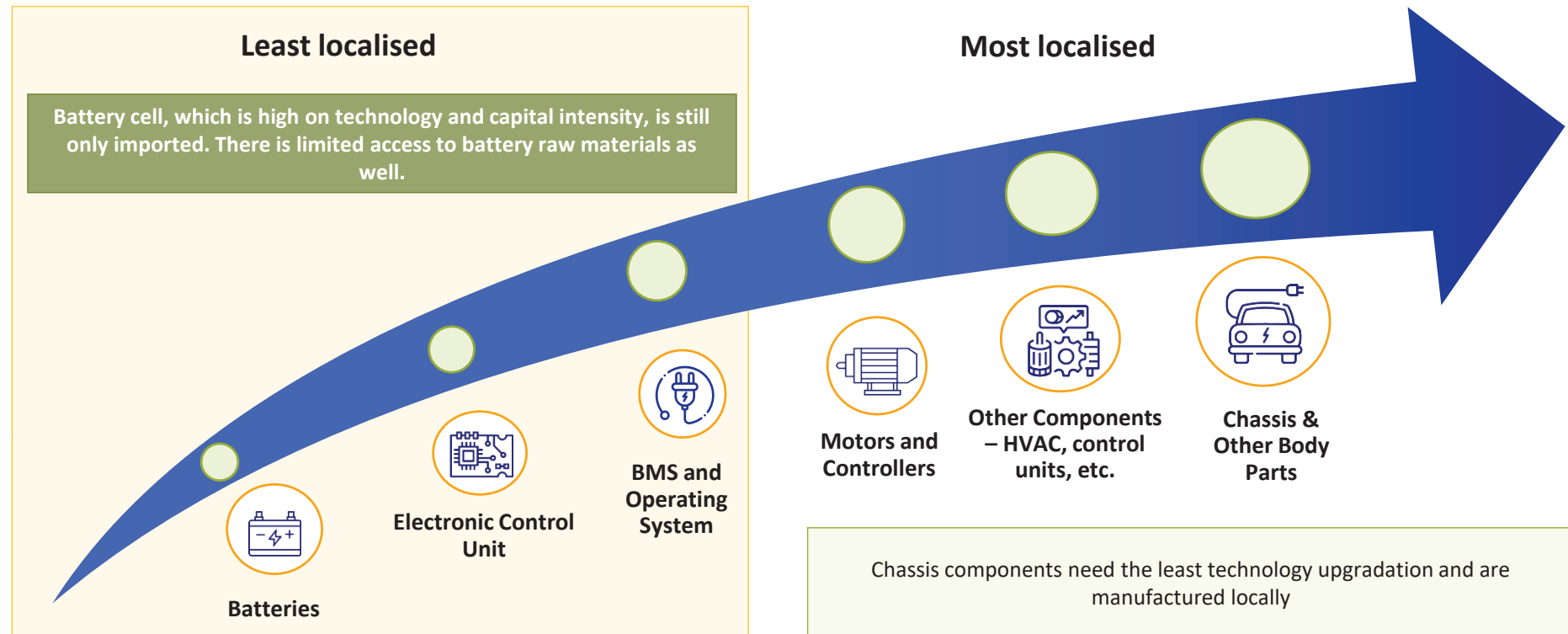
## Opportunities from electrification

*Strong market potential for EV  
components by 2030*



## Only 20-30% of the EV supply chain is currently localised

Exhibit: Extent of localisation of EV components



Source: ICRA Research

## Strong revenue potential from EV components for ancillaries

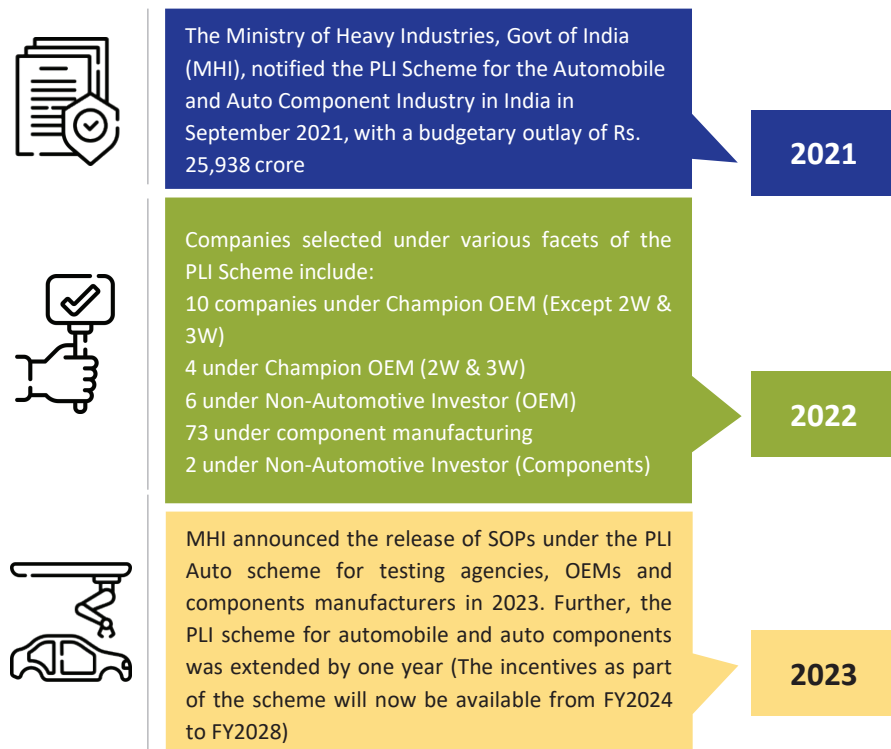
Exhibit: Potential market size of key EV component segments for E-2Ws and E-PVs



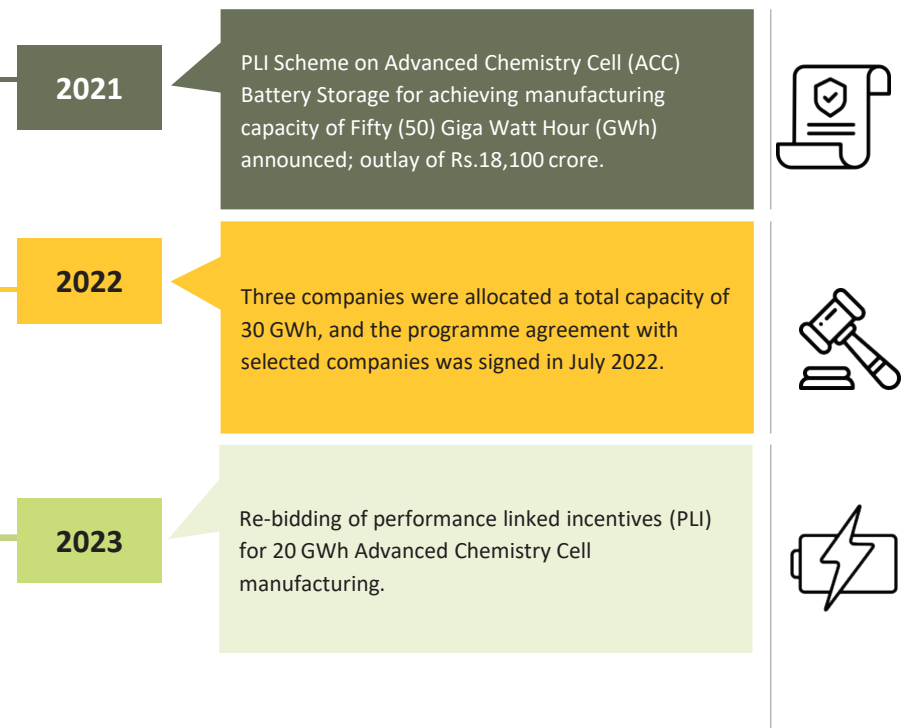
Source: ICRA Research

## PLI scheme has kick-started EV investments; however, implementation remains a monitorable

**Exhibit: Timelines in Auto/Auto Component PLI Scheme**



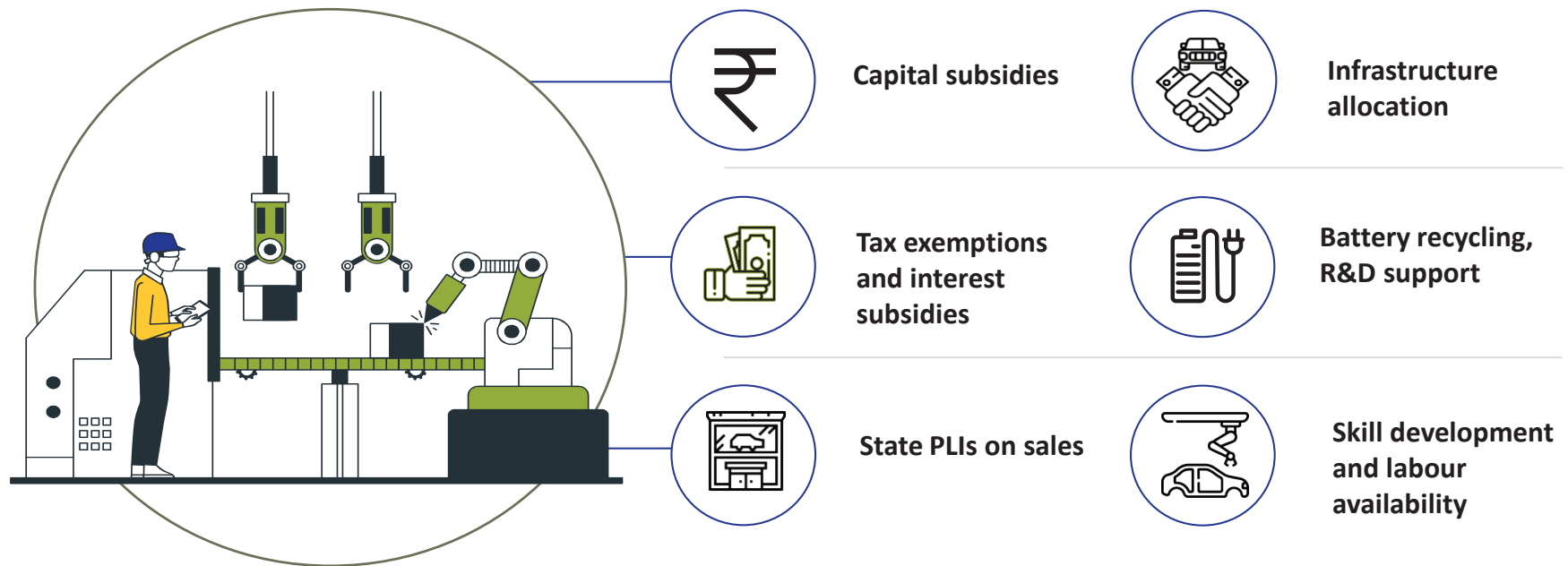
**Exhibit: Timelines in Advanced Chemistry Cell (ACC) PLI Scheme**



Source: Gazette of India, ICRA Research

## State EV policies also provide sops for developing local EV vendor eco-system

**Exhibit: Incentives for Component Suppliers Under State EV Policies**

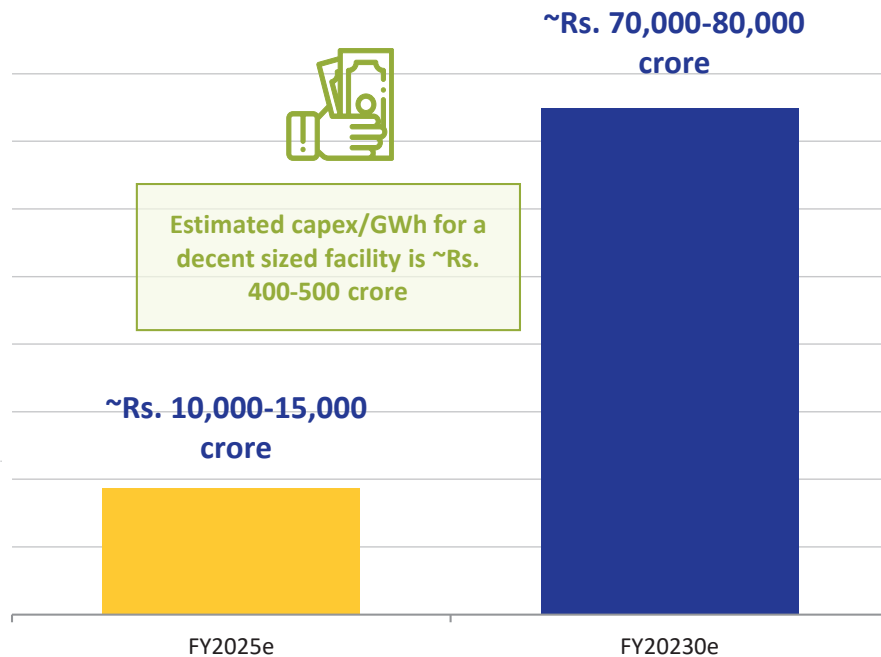


**These are likely to provide additional impetus for investments towards EV components.**

Source: ICRA Research

## Investments in cell manufacturing capabilities estimated to exceed US\$ 9 billion

Exhibit: Capex required to meet EV battery demand (domestic sales)



Source: ICRA Research; \*India Cellular and Electronics Association

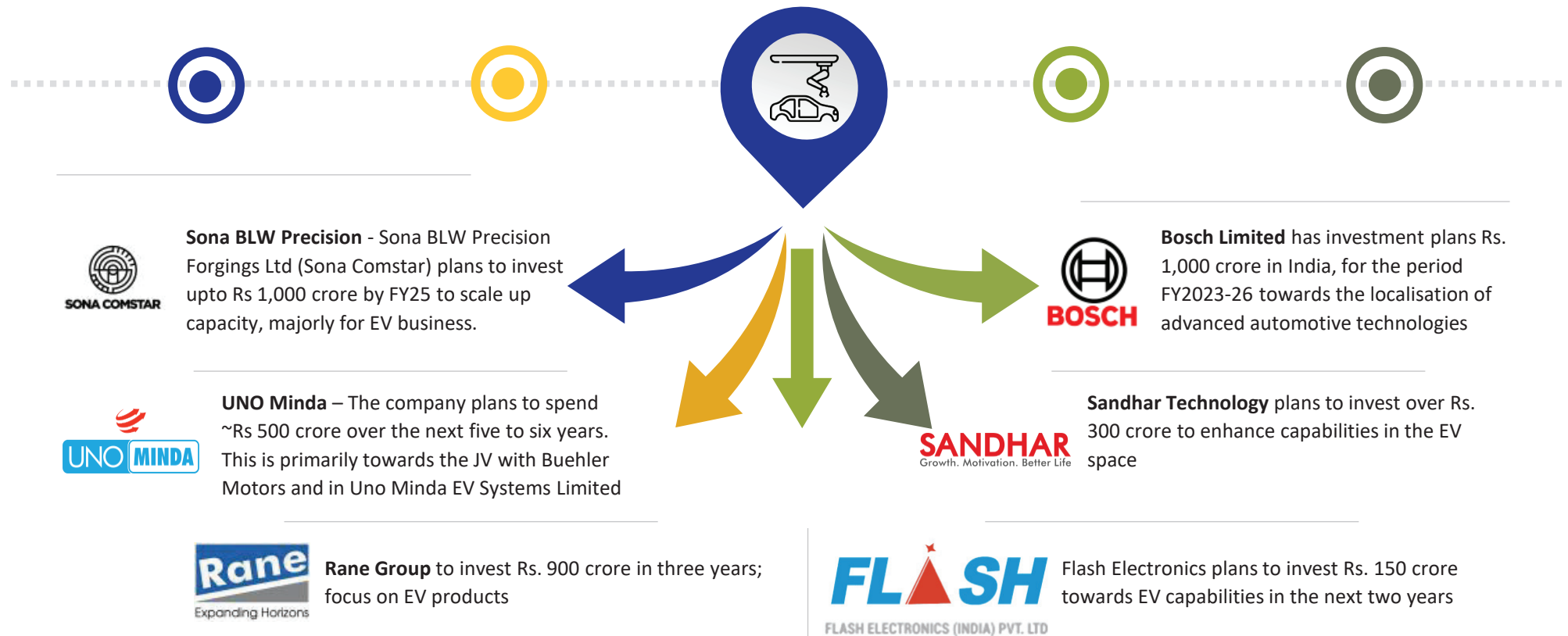


Battery demand for export sales of various OEMs (across segments) also likely to be substantial



Annual battery demand for stationary applications (grid storage, telecom towers etc.) is expected to scale up significantly

## Material investments also announced for other EV components



Source: ICRA Research, Note: Information is not exhaustive; \*Likely/Reported

## Key takeaways

---





Periodic tightening of emission regulations and technology changes adopted by automobile OEMs to improve fuel efficiency and reduce emission have contributed to reduction in particulate matter from ICE vehicles. Also, share of alternate powertrains has also been increasing over the years. All of these are expected to continue going forward as well.

### Three-fold approach



The changes carried out in automobiles to reduce emission have led to increase in content per vehicle and rise in vehicle cost. Prices of PV and 2W have increased by 40-45% since 2019 while that of CV increased by 20-25%.

### Vehicle cost implications



Multiple alternate powertrain options are available for lowering emission, and their share is expected to rise over the years. ICRA expects it to be close to 30% of new vehicle sales by CY2027. However, EVs, hybrids and CNG vehicles are likely to witness significant growth, while meaningful adoption of hydrogen and flex-fuel vehicles is still some time away.

### Alternate powertrains



Multiple factors including favourable policy environment and TCO and increasing number of models are likely to support EV penetration. However, high import dependence, lack of adequate charging infrastructure and cautious financing environment remain challenges.

### Confluence of factors to support EV adoption



Several incumbent OEMs and ancillaries are working on alternate fuel technologies, including EVs. Given that only 20-30% of EV components are localised, there is immense opportunity for the domestic component ecosystem. The Central Govt's PLI scheme and various State Govt policies have accelerated EV component investments.

### Strong localisation potential for EV components

Source: ICRA Research



## About ASSOCHAM

### The Knowledge Architect of Corporate India

The Associated Chambers of Commerce & Industry of India (ASSOCHAM) is the country's oldest apex chamber. It brings in actionable insights to strengthen the Indian ecosystem, leveraging its network of more than 4,50,000 members, of which MSMEs represent a large segment. With a strong presence in states, and key cities globally, ASSOCHAM also has more than 400 associations, federations, and regional chambers in its fold.

Aligned with the vision of creating a New India, ASSOCHAM works as a conduit between the industry and the Government. The Chamber is an agile and forward-looking institution, leading various initiatives to enhance the global competitiveness of the Indian industry, while strengthening the domestic ecosystem.

With more than 100 national and regional sector councils, ASSOCHAM is an impactful representative of the Indian industry. These Councils are led by well-known industry leaders, academicians, economists and independent professionals. The Chamber focuses on aligning critical needs and interests of the industry with the growth aspirations of the nation.

ASSOCHAM is driving four strategic priorities – Sustainability, Empowerment, Entrepreneurship and Digitisation. The Chamber believes that affirmative action in these areas would help drive an inclusive and sustainable socio-economic growth for the country.

ASSOCHAM is working hand in hand with the government, regulators, and national and international think tanks to contribute to the policy making process and share vital feedback on implementation of decisions of far-reaching consequences. In line with its focus on being future-ready, the Chamber is building a strong network of knowledge architects. Thus, ASSOCHAM is all set to redefine the dynamics of growth and development in the technology-driven 'Knowledge-Based Economy'. The Chamber aims to empower stakeholders in the Indian economy by inculcating knowledge that will be the catalyst of growth in the dynamic global environment.

The Chamber also supports civil society through citizenship programmes, to drive inclusive development. ASSOCHAM's member network leads initiatives in various segments such as empowerment, healthcare, education and skilling, hygiene, affirmative action, road safety, livelihood, life skills, sustainability, to name a few.

Contact us:

**Mr. Jaidev Sharma**

Head – Task Force on Alternative Fuels, ASSOCHAM

[jaidev.sharma@assochem.com](mailto:jaidev.sharma@assochem.com)





## **The Associated Chambers of Commerce and Industry of India**

4th Floor, YMCA Cultural Centre and Library Building  
01, Jai Singh Road, New Delhi-110001

Tel: 011-46550500 (Hunting Line) • Fax: 011-23017008, 23017009

Web: [www.assochem.org](http://www.assochem.org)

Follow us on:

