Article

Decarbonisation Pathways for the Indian Automobile Sector

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Abstract

The Automotive industry has a central and critical role in achieving India's ambitious commitments to arrest climate change. This paper discusses India's commitments together with the development challenges it faces in its green energy mission in the transportation sector with emphasis on Electric Vehicles (EVs). In this connection, the role and efforts of various stakeholders, including, the Central and State Governments and the industry have been critically analysed. The paper emphasises the need for achieving 'Atmanirbharta' or self-reliance in the manufacturing of Zero Emission Vehicles and their critical components, as well as significantly boosting domestic R&D to successfully achieve the goals.

The Carbon Dioxide (CO_2) level in the atmosphere has steadily risen since the industrial revolution and rapid urbanisation began in the mid-19th century. They also led to the release of other greenhouse gases such as methane, nitrous oxide, and industrial gases, which together have increased the planet's average surface temperature between 1.1 and 1.2 degree centigrade (C). The burning of fossil fuels, as also the conversion of forest land and other natural ecosystems to farmland, brought about a rise in CO_2 level. While carbon dioxide absorbs infrared radiation that helps the surface of the Earth to cool down, excess CO_2 causes warming.

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In 1992 when the CO_2 level climbed to 356 ppm and evidence of anthropogenic warming and its adverse effects became clearly discernible, the world leaders agreed to convene the UN Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro and committed themselves to the "stabilisation of greenhouse-gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[1] This was to be achieved in a "time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and enable economic development to proceed in a sustainable manner."[2] The UNFCCC, in effect, committed its signatories to ending the use of fossil-fuel which has been crucial in the development of the economy for 150 years. However, no specific target could be set to achieve the goal, in view of the challenges the task posed, with the result that concrete action towards the laudable goal was ignored.

In 2015, the same group of countries met in Paris and agreed to translate their aspiration into a set of specific goals. The Paris agreement stated, "Preventing dangerous anthropogenic change" would require in practice "holding the increase in the global average to well below 2^0 C above the pre–industrial levels and pursuing efforts to limit the temperature increase to 1.5^0 C above the pre-industrial levels." As for the time frame, the peak in greenhouse emissions, it stated, should be brought down "as soon as possible" followed by "rapid reduction thereafter." It further called for a balance between anthropogenic emission by sources and removals by sinks, (i.e., zero emissions) to be achieved by "the second half of this century." The 26th global climate summit of COP26 held on November 13, 2021, in Glasgow, agreed to accelerate the action to arrest climate change.[3] Nearly 200 countries agreed, under the Glasgow Climate Pact, to keep the 1.5^0 C goal alive and 130 countries across the globe committed to reverse deforestation along with cutting methane emissions by 30 percent by 2030.[4] India made a bold announcement that it would achieve the target of net-zero carbon emission by 2070 while achieving 500 giga-watt non-fossil energy capacity by 2030, fulfilling the target of meeting 50 percent of its energy requirements from renewable energy sources.

It is in the background of India's commitments together with its development challenges that the country's green initiatives in the transportation segments with emphasis on driving Electric Vehicles (EVs) initiatives, need to be understood.

Vehicular Emissions in India

The Indian automobile market is one of the fastest growing markets globally. India's domestic vehicle sales (2-wheeler, 3-wheeler, passenger vehicle, commercial vehicle) in the last decade have grown exponentially. Today, the Indian Automobile Industry is the fifth largest in the world. India is the world's largest tractor, 2 wheeler (W), 3W and fifth largest passenger vehicle manufacturer. On the other hand, India is hugely dependent on crude oil imports for its fossil fuel needs, with an USD 112 billion oil import bill in the Financial Year 2019 (equivalent to 4 percent of the country's GDP). The demand for fuel in the Transport Sector is primarily met through crude oil import, which significantly drains the exchequer.

In one of its reports, NITI Aayog noted that the transport sector in India is the largest user of oil. India has seen a rapid increase in the number of automobiles in the last ten years. Currently, the Indian transportation sector accounts for one-third of the total crude oil consumed in the country, with 80 percent being consumed by road transportation alone. It also accounts for around 11 percent of total CO_2 emissions from fuel combustion. During 2016, the transport sector contributed 270.6 MT CO_2e of greenhouse gas (GHG) emission, the third highest, after the power sector and industrial combustion. Within transportation, road transport has been the highest contributor to GHG emission. With the rising size of the transport industry, India is also facing intense emission challenges.

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India's transport sector contributes ~10 percent of the country's GHG emissions. Currently, India adds about 2.5 billion metric tons of carbon or ~7 percent of the global emission. The Internal Combustion Engine (ICE) vehicular pollution contributes PM2.5 (having a width of less than 2.5 microns), which amounts to ~40 percent of the total pollution in India. In 2020, an estimated 60 percent of India's final energy use in transport arose from passenger transport and 40 percent from freight transport. At present, 97 percent of Indian vehicles are propelled by petrol and diesel that have an adverse impact on the environment. As per Climate Action Tracker, electrification of passenger and freight transportation in India could reduce emissions from the transport sector by 570 million metric tons of CO_2 equivalent annually. Therefore, in order to achieve the GHG emission targets, it is imperative that India transits to greener

mobility technologies in transport.

'Panchamitra' - India's Commitment at COP26

The COP26 is crucial for developing countries for two reasons – one, framing the rules for carbon markets, and two, climate finance. Prime Minister Narendra Modi's announcement of "Panchamitra", unfolds a five-point agenda for the country to deal with the challenge of climate change during the 26th Conference of Parties (or COP26) of the United Nations Framework Convention on Climate Change on November 1, 2021. These are:

i. Creating 500 GW of non-fossil fuel electricity capacity by 2030;

ii. Fifty percent of India's energy requirements to be met from renewables by 2030;

iii. One billion tonne reduction in cumulative emissions by 2030;

iv. Achieving 45 percent lower emission intensity of GDP by 2030;

v. Attaining Net-Zero emissions by 2070.

On Transport Day at COP26, India, represented by NITI Aayog, participated in the fourth ministerial dialogue of the Zero-Emission Vehicle Transition Council (ZEVTC), a global forum on enhancing political cooperation on the transition to zero-emission vehicles.[5] ZEVTC brings together ministers and representatives of some of the world's largest automobile markets to collectively address key challenges in the transition to ZEVs, to enable a faster, cheaper, and easier transition to EVs for all. The most significant gain was the COP26 declaration on the accelerated transition to zero-emission cars and vans. It set the goal for all new car and van sales to achieve zero-emission by 2040 across the world. For leading markets, the target was set at 2035. The non-binding agreement was signed by governments, automotive manufacturers, financial institutions, and civil society organisations. Thirty-three governments have signed the agreement.[6]

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The NITI Aayog, on behalf of the Government of India, also extended its support to the non binding COP26 declaration focused on accelerated transition to zero-emission

vehicles. As an emerging market, India highlighted the need to transition the country's large fleet of two and three wheelers which, together comprise more than 80 percent of the automobiles in the country—to zero-emission vehicles. India pledged its support to swap its existing two-wheeler and three-wheeler auto-rickshaws for electric or zero-emissions alternatives. Two-wheelers and three-wheelers are the fastest-growing mode of transport in many low and middle-income countries, mostly in Asia, but also in Africa, according to the United Nations Environment Programme (UNEP). Signatories of the pledge called on all developed countries to strengthen international collaboration and support so that a global, equitable and just transition could be realised. Several stakeholders—automotive manufacturers, governments, businesses, fleet owners, etc.,—declared their commitment to actively work towards the proliferation and adoption of zero-emission vehicles.

India launched the website e-AMRIT – https://www.e-amrit.niti.gov.in/ – at the COP26 in Glasgow, which will function as a one-stop destination for all information on electric vehicles. It addresses key concerns about the adoption of EVs and their purchase – such as charging facility locations and EV financing options, information about investment opportunities, government policies, and available subsidies for drivers and manufacturers.[7]

Emission Reduction Measures by the Government

India has been framing policies designed to promote the use of clean fuels, including electric vehicles (EVs), and tightening emission norms to meet its carbon reduction targets. The overall objective is to gradually shift to fuels, which are import substitutes, cost-effective, indigenous and pollution free. The major policies are listed in Table-1. These policies encourage Electric Vehicles, Hydrogen Fuel Cell Vehicles (FCV), flex-fuel vehicles, biodiesel, etc. The Central government's Faster Adoption and Manufacturing of Electric Vehicles (FAME) policy, Production Linked Incentive (PLI) Scheme for Advanced Chemistry Cell and Auto Sector, lower GST rates, income tax rebate, tightening of Corporate Average Fuel Economy (CAFE 2) norms, adoption of BS-VI phase-2, and many State-level (provincial) measures and incentives, have been introduced to help the industry transition to green transportation.

Since 2014, India has introduced passenger vehicle fuel-efficiency standards. Implemented in 2015, these standards mandated efficiency targets for new cars at the

equivalent of 130 g CO_2/km in 2017 and 113 g CO_2/km in 2022. Fuel efficiency labelling for new vehicles has been mandatory since 2011. As part of the National Electric Mobility Mission Plan (NEMMP), India developed the FAME scheme in 2015. FAME was designed to accelerate the uptake of hybrids and electric vehicles by providing subsidies that reduce the upfront purchase price of these vehicles. India's National Mission on Electric Mobility was launched in 2018. Subsequently, the National E-Mobility programme was launched to promote public procurement of electric vehicles and deployment of charging infrastructure. In 2019, the government adopted a scaled-up FAME II scheme, with an outlay of USD 1.4 billion towards upfront incentives and supporting the deployment of charging infrastructure. The scheme, which was scheduled to end in 2022, has now been extended till 2024.

The NITI Aayog in its report titled "India's Electric Mobility Transformation" (April 2019), pegs EV sales penetration in India at 70 percent for commercial cars, 30 percent for private cars, 40 percent for buses, and 80 percent for two-and three-wheelers by 2030. These targets, if achieved, could lead to a net reduction of 14 exa joules of energy and 846 million tons of CO_2 emissions over the vehicles' lifetime. Electric vehicles sold until 2030 can cumulatively save 474 million tons of oil equivalent over their lifetime, worth USD 207.33 billion.[8] Though India hasn't pledged to phase out conventionally fueled vehicles by any target date, it has an ambitious target of 30 percent of all new vehicles to be electric vehicles by 2030. If this target could be achieved, India will save crude oil imports worth over INR 1 lakh crore (USD 14 billion) annually by 2030, according to an independent study by the Council on Energy, Environment and Water (CEEW).[9]

India has an ambitious target of 30 percent of all new vehicles to be electric vehicles by 2030.

The increase in electric vehicles penetration could also increase the combined market for powertrain, battery and public chargers to over INR 2 lakh crore (USD 28 billion), in addition to creating 120,000 new jobs in this sector. In addition, a substantial number of new jobs are likely to be created in emerging areas such as battery recycling, telematics, and allied construction and services. The rapid adoption of electric two and three-wheelers (LEVs- Light Electric Vehicles) would lead the way to this transition. This will help India fulfil its global commitments to lower carbon emissions and increase the use of cleaner sources of energy and transportation as required by the Nationally Determined Contributions (NDCs) under the United Nations Framework Convention on Climate Change (UNFCCC) and EV30@30.

Table 1: Highlights of Government Initiatives: Regulatory, Fiscal and Non-Fiscal Measures

Regulatory	Fiscal	Non-Fiscal
CAFÉ Norms Phase-2 is being implemented from April 2022—to keep emissions less than 113 gm/km	GST rate for EV at 5%	A few Municipality Departments have announced free parking for electric vehicles in certain areas
BS-VI emission norms Phase 2 due in April 2023 will lead to the reduction in NOx, and HC	FAME (Phase-2) scheme with allocation of Rs 10,000 crore	Central and State Governments are investing heavily in building charging infrastructure
20% ethanol blending with petrol has been mandated by 2025 for reduced carbon emissions	PLI scheme for Advanced Chemistry Cell (ACC)	At-home charging has been permitted with existing power connection
Steps to introduce battery swapping policy	PLI Scheme for Auto & Auto Component Sector	Lower electricity charges on charging vehicles
Promotion of Flex fuel engine	Rs 1,50,000 Income tax deduction provided for EVs purchased on loan	Budget 2022 has announced special mobility zones for electric vehicles
	Exemption from Registration charges	Special Green Colour Number plate for EVs
	Lower/Zero Road Tax for EVs in many states	Mandating the creation of charging infrastructure in select residential and commercial buildings
	EV policy introduced in many states with incentives, including allocation of land and power at concessional rates	Mandating a certain percentage of vehicles to be converted into electric by the aggregators
	Depreciation rate for electric vehicles fixed at 40%	Retro fitment of old petrol and diesel vehicles with electric powertrain
	Green Tax introduced for re-registration of vehicles after 15 years	50% domestic value additions under PLI-Auto
	Excise duty on non-blended fuel enhanced by 2%	Phased manufacturing Plan (PMP) for electric vehicle components
		Formation of KABIL to source lithium mineral
		Construction of lithium refinery in Gujarat
		Joining hands with Japan and Australia to source lithium

Source: Compiled from various sources

The government's PLI schemes for the Auto Sector (worth ₹ 2,59,380 million), and the Advanced Chemistry Cell (ACC) (₹ 18,100 crore), have together provided approximately ₹ 4,40,000 million to the automotive sector. This indicates the high commitment of the Government towards Clean Mobility and Atmanirbharta in the Auto Sector. The PLI schemes for the auto sector have been a success and attracted participation from an encouraging number of applicants. The scheme for the Auto Sector has attracted 115 applicants, while the scheme for ACC battery received 2.6 times the bids for the manufacturing capacity awarded.

The PLI Scheme for the auto sector will lead to the indigenisation of components that fall under the advanced auto technology category and would boost manufacturing and demand creation for electric vehicles and fuel cell vehicle technology. The PLI for ACC battery is expected to boost investment in domestic manufacturing, along with facilitating battery storage demand creation. The scheme would focus on battery storage for both electric vehicles and component storage and enable development of a complete domestic supply chain and attract Foreign Direct Investment to the country. Together, the schemes are expected to help overcome the cost disabilities of the industry and enable the industry to leapfrog into becoming a leader in the advanced auto technology components, electric vehicles and fuel cell vehicles. The schemes would also help India emerge as a leader in the automotive space and reduce its import bill by reducing fossil fuel imports and dependence on overseas suppliers for batteries and auto components.

The PLI Scheme for the auto sector will lead to the indigenisation of components.

The government also took action to ensure critical minerals required in EV manufacturing can be made available. National Aluminium Company (Nalco), Mineral Exploration Corporation Ltd (MECL) and Hindustan Copper Ltd (HCL) together forged a Joint Venture (JV) called 'Khanij Bidesh India Ltd' (KABIL) to meet the objective. The JV has already inked a pact with Argentina and is now looking at China and Bolivia for agreements. The Government of India (GOI) is also constructing a lithium refinery to convert lithium ore into battery-grade lithium. India is also collaborating with Japan and Australia to source Lithium.

In short, the Central and State governments have initiated several regulatory, fiscal, and non-fiscal incentives, as shown in Table-1 above, to drive EV initiatives that would

help achieve parity in total cost of internal combustion engine (ICE) vehicles for several segments. Original equipment manufacturers (OEMs) and component manufacturers are investing in indigenous manufacturing and supply chains. EV startups are attracting significant venture funds due to their product and business model innovations, capturing as well as creating the market opportunities presented by EVs.[10]

The Indian Government has created momentum for EVs through its Faster Adoption and Manufacturing of Electric Vehicles Phase I (FAME-1) scheme by providing direct subsidies to customers and providing tax cuts and reducing import duties for manufacturers. Subsequently, in its FAME -II scheme (Table-2), apart from providing direct subsidies to the customers and fleet operators, the Government has shifted towards building a robust indigenous EV ecosystem.[11] The FAME-II scheme has introduced eligibility conditions for subsidies. OEMs now have to ensure at least 40 percent localisation (at ex-factory prices) for buses and 50 percent localisation for other categories. Benefits were discontinued for lead-acid batteries and were limited to Li-ion batteries. The Central and State governments have also initiated several regulatory, fiscal, and non-fiscal incentives to drive their EV initiatives that would help in achieving parity in cost of ownership with internal combustion engine (ICE) vehicles for several segments and uses.

In addition, import duties have been raised as shown in Table-3. For example, import duties on Semi-Knocked Downs (SKDs), and Completely Knocked Downs (CKDs) were increased across vehicle categories. So is the case with import duties on Li-ion cells and battery packs.

Under the Phased Manufacturing Programme (PMP), which falls under FAME-II, the Government has already mandated indigenisation of parts such as HVAC (Heating, Ventilation, and Air Cooling).

Table 2: Initiatives of Stakeholders and Capital Commitment and Deployment for Electric Mobility in India during 2021

Stakeholder(s)	Initiatives
Government of India	● Revision of Faster Adoption and Manufacturing of Electric Vehicles Phase II (FAME II) incentives for electric 2-wheelers (e-2W) from INR 10,000 per kWh to INR 15,000 per kWh. Incentive cap increased from 20 percent to 40 percent of the capital cost of the e-2W. Energy Efficiency Services Limited (EESL) will be responsible for aggregating and leasing 300,000 electric 3-wheelers (e-3W) as well as electric buses (e-buses) available under FAME II.
	● Production-Linked Incentive (PLI) scheme worth INR 18,100 crore (US$2.4 billion) approved for investments in advanced chemistry cell (ACC) battery manufacturing and worth INR 26,058 crore (US$3.5 billion) approved for automotive manufacturing focused on EVs and hydrogen fuel cell vehicles.
State EV policies of Assam, Goa, Gujarat, Himachal Pradesh, Meghalaya, Odisha	● State EV policies of Assam, Goa, Gujarat, Himachal Pradesh, Meghalaya, Odisha, Rajasthan, and West Bengal have been notified. Maharashtra EV policy has been revised to offer additional demand, supply, and charging infrastructure. Karnataka EV policy is undergoing a set of revisions, including the announcement of capital subsidies for manufacturing, and initial proposals for demand incentives and other concessions for EVs.

Source: Banking on Electric Vehicles in India, NITI Aayog & Rocky Mountain Institute (RMI), Jan 2022

Table 3: Import Duty Applicable on EVs and Parts

S. No.	Product Category		Basic Custom Duty(BCD)
	SKD (Semi Knocked Down) - Pre-assembled battery pack, motor, motor controller, charger, power control unit, energy monitor contractor, brake system, electric compressor not mounted on chassis - for **Passenger Cars and 3 Wheelers**		30%
1	SKD (Semi Knocked Down) - **2 Wheelers, Buses & Trucks**		15%
2	CKD (Completely Knocked Down) - Disassembled battery pack, motor, motor controller, charger, power control unit, energy monitor contractor, brake system, and electric compressor not mounted on chassis - for all categories of vehicles		15%
3	Lithium-Ion Cells for use in the manufacturing of Lithium-Ion Accumulator for EVs		10%
4	Battery pack for use in the manufacture of EVs		15%
5	Parts for Use in Manufacture of EVs		
5.1	AC or DC Charger		15%
5.2	AC or DC Motor		
5.3	AC or DC Motor Controller		
5.4	Power Control Unit		
5.5	Energy Monitor		
5.6	Contactor		
5.7	Brake System for Recovering		
5.8	Electric Compressor		

Source : Customs Notifications

Auto Industry Efforts

Not just the Government, the Indian auto industry has also been working on technological advancement and has set a global example by leapfrogging from BS-IV emission norms to BS-VI emission norms in a span of 3 years, even though it was a very challenging task and made little business sense. It, however, helped the industry reduce tailpipe emissions. The Indian automotive industry is committed towards transitioning to low-carbon technologies. The move is driven by two factors: One, government policy and regulatory measures have moved towards cleaner fuels and faster adoptions of Zero-emission vehicles (ZEVs). Two, the industry has awakened to the Original Equipment Manufacturers' (OEMs) increasing commitment to the society's need to reduce carbon emissions. The major industry initiatives are listed in Table-4.

The Indian auto industry has set a global example by leapfrogging from BS-IV emission norms to BS-VI emission norms in a span of 3 years.

Table 4: Industry Initiatives and Capital Commitment and Deployment for Electric Mobility in India during 2021

Stakeholder(s)	Initiatives
E-commerce, fleet operators/ aggregators	• Companies including Amazon, Capgemini, Dalmia Cement, JSW Cement, and Zomato made new commitments on total electrification of their fleets in India between 2030 and 2040.
OEMs, EV component and battery manufacturers, EVSE companies	• Companies, including Ashok Leyland, Mahindra & Mahindra, Omega Seiki Mobility, Simple Energy, and Tata Motors, have announced plans to invest over INR 48,000 crore (US$6.5 billion) in electric vehicles, components, and battery manufacturing; electric vehicle supply equipment (EVSE); research and development (R&D); and deployment in 2021.
EV start-ups	• Start-ups, including Hero Electric, Magenta, and Ola Electric, have raised venture funding of nearly INR 3,307 crore (US$446 million) for EV/component/battery manufacturing and EVSE in 2021.
Financial institutions	• Axis Bank and the United Kingdom's Private Infrastructure Development Group (PIDG) have announced a capital financing guarantee of INR 1,500 crore (US$200 million) towards manufacturing, distribution, and servicing of EVs, batteries, components, and charging infrastructure.

Source : Banking on Electric Vehicles in India, NITI Aayog & RMI, Jan 2022

The Indian Auto sector is not just working on electric vehicles, the manufacturers are also working on vehicles that would meet stringent CAFÉ norms by 2022. This is a move to lower emissions by complying with BS-VI phase-2 by 2023, introducing vehicles that are compliant with 20 percent ethanol blend, orienting R&D and technological adoption towards flex-fuel vehicles, and also working on the nascent hydrogen technology.

The adoption of electric vehicles in the two and three-wheeler segments has been quite remarkable. Many new start-ups have come up and are catering to the market, while the bigger OEMs, such as Hero, Bajaj, TVS and Royal Enfield are forging new partnerships to develop robust electric vehicles. There are nearly 50 companies registered under the FAME scheme of India that are receiving benefits for the production of more than 150 electric vehicle models under different vehicle segments. All the bus manufacturers have introduced Electric buses and are supplying to State Transmission Utility (STUs) to enable the greening of the public transportation system. In the passenger vehicle segment, as well, vehicle manufacturers have introduced electric cars, while other manufacturers are presently developing EV technology.

In the commercial vehicle space, especially small three-wheeler Goods Carrier, low-tonnage vehicles are being converted to Electric, while high-tonnage vehicles are likely to transition to LPG. The Government has a plan to set up 1000 LNG (liquified natural gas) stations across the country by 2024. One of the OEMs has delivered a few buses that operate on LNG. Companies are also working on the recruitment of existing buses to operate on LNG.

Driving Competitiveness through Localisation and R&D

The current Indian EV manufacturing ecosystem largely depends on imports of EV components. The road to large-scale EV manufacturing goes through strong localisation and self-reliance over the next 5 to 10 years. The push towards indigenising EV technology will help bring down the cost and promote quicker adoption of electric vehicles. However, EV manufacturing requires specialised technological expertise.

However, because of several challenges related to technology, raw materials, and the economy of scale, the current scale of localisation is limited. The Indian government has been implementing several schemes and policy initiatives as discussed earlier, to

push scaling up domestic manufacturing and developing local capacity to produce electric battery components. This is beginning to bear fruit -- many Indian and global companies are now looking at setting up Lithium-ion battery and other EV component production units in India. Local companies have also entered the EV space, covering wheel rim integrated with hub motor, from October 2019 and other key components such as electronic throttle, vehicle control unit, electric compressor, etc.

Initially, large-scale localisation of EV components looked like it would take a long time in the face of uncertainty as to the exact scale of EV adoption in India. However, introduction of various incentives and schemes for localisation and indigenisation of batteries and other components has speeded up the process. Several States are also racing to attract investments from OEMs and component players so as to emerge as EV manufacturing hubs. The incentives range from setting up of EV manufacturing parks, providing aid for R&D and IP, partial or full reimbursements on land cost, financial assistance on capital incentives, etc.

Challenges

The Indian automobile and transportation industry is taking significant strides in its efforts to transition to low-carbon electric and alternative energy based new vehicles as the above data and analysis indicate. Yet, many challenges remain on this path. The impediments in the realisation of policy goals and the current state of localisation are indicated in Table-5.

While overall response of the industry in terms of their initiatives to government policy goals is remarkably positive, they confront many challenges. Some of these are:

i. Lack of long-term investment in R&D for new technologies and products for EVs.

ii. Banks and micro-financing organisations are reluctant to fund EVs because of lack of confidence in the technology.

iii. Lack of supply chain for motors, controllers, power electronics, and batteries.

iv. India lacks, as of now, significant competence in basic semiconductor and power electronics manufacturing compared to China, from where these components are currently being imported.

Table 5: EV Components - State of Localisation and Associated Challenges in India

Stakeholder(s)	Initiatives
Battery Cells	• Lack of access to core raw materials like lithium and technology-intensive manufacturing to limit localisation. • India currently imports all its Lithium needs. • Government needs to incentivise companies to acquire overseas Lithium mines.
Battery Production	• Currently evolving at a rapid pace with new chemistries gaining popularity, e.g., magnesium, cobalt, etc. • Associated R&D is technology- intensive. • Indian Space Research Organisation (ISRO) has transferred Li-ion battery technology to 10 firms that have set up plants in the country. • So far, India has not been at the forefront of the innovations in battery technology.
Battery Management System (BMS)	• BMS technology is mostly software system driven and can be mastered by Indian firms.
Motor	• Many Indian companies have started producing motors below 25kW. • Several established and new players have made investments in the production of motors for light vehicles. • High-power motor design and domestic production is still not in place. • Lack of availability of rare earth magnets is a major hurdle. Large motors could take longer to localise.
Power Electronics	• Power electronics like controllers and power IC are technology-intensive; capital investment necessary.
Others	• Indian manufacturers are strongly positioned in this category which includes HVAC, control units, etc.

Source : Compiled from various sources

v. Better and more advanced technologies for motors and controllers are currently available but they are difficult to launch in the market due to their high cost.

vi. There is a lack of mineral resources for manufacturing critical components indigenously. India has limited known reserves of the minerals required for the manufacturing of EV powertrains and batteries. About 58 percent of the world's lithium reserves are in Chile and about 43 percent of rare earth mineral reserves are in China. As per the analysis by The Energy and Resources Institute (TERI), India's lithium imports have increased by about 6.5 times, while rare earth mineral imports increased by about 2.4 times between 2010 and 2017.

vii. There is potential for indigenising motor manufacturing.

Way Forward

It is important that the Indian policy makers balance out the aspirations of its people and economic growth with a clean environment. Sustainability of India's path to a prosperous low-carbon automotive sector rests on two types of measures: job creation in the electric vehicle industry and reducing its automotive emissions in a way that does not disrupt development aspirations. Decarbonising the transport sector is more complicated than other sectors as technology alternatives are not cost-competitive. The current challenge before Indian OEMs is: how they prioritise their fuel strategy given the Government's drive towards green fuel. OEMs are constrained to focus on various alternative fuels, including CNG, ethanol blending and flex-fuel, apart from EVs and Hydrogen Fuel Cell. Clearly, in the short to medium term, this needs huge investments. At another level, forthcoming emission-related regulations will make the vehicles more costly for consumers.

The Indian automotive industry, therefore, needs to be more focused on a standalone and targeted approach towards EVs, rather than seeing them as another addition in their automobile portfolio. Indian OEMs and component manufacturers need to adopt innovative approaches and technologies and invest in long-term R&D in all aspects of EV technologies. The policy framework of the Government of India should be to provide grants and funds for research, and establish centres of excellence for creating a strong manufacturing base. Tax incentives to promote R&D in the EVs ecosystem can also be considered. Overall, the approach should be to make India a manufacturing hub for EVs and components based on local R&D and innovations and

not on imported technologies. Apart from incentives for setting up Li-ion battery-manufacturing and Giga-factories in India, the government should start planning for the development of a robust supply chain for the required raw materials. The cost of cells and the battery pack is largely determined by the price of the raw materials. Start-ups have been playing a pivotal role in the evolving electric mobility space in India. Charging infrastructure and innovation with new technologies in manufacturing are creating new opportunities with the emergence of new business models for start-ups.

Overall, in light of the Government's commitment to achieving the target of net zero carbon emission by 2070, the auto industry has to play a critical role. What is needed is the galvanisation of the industry towards the policy goals set by the government. For achieving 'Atmanirbharta', or self-reliance, the manufacturing of Zero Emission Vehicles and their critical components, and encouraging domestic R&D hold the keys.

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