



# Use of electric vehicles to transform mass transportation in India

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# Preface



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Electric vehicles are the way forward for India and we must move towards self-sufficient electric vehicles that can replace fossil fuel-based ones. With the scale of pollution in India and alarming projections of worsening climatic conditions in the future, the only way to move forward in our quest to achieve environmental sustainability and clean air to breathe is to rapidly move towards electric mobility. Around the world, countries are rapidly adopting electric vehicle-related technologies and gradually phasing out fossil fuel-based vehicles as a part of their concerted plan to combat climate change and rising pollution in cities. For instance, some European countries plan to phase out all fossil fuel-based cars by 2025 and some intend to stop manufacture of such cars. This initiative is expected see more than a million electric cars on road by 2030. In this scenario, India should consider the best interest of health and environment-related considerations in the country. It needs to devise an implementable roadmap and put together the right infrastructure and conducive policy structure required for electric vehicles to meet the needs of the humongous Indian automotive market and public transport system.

While the benefits of electric vehicles is obvious, their adoption rate is minimal in India. Therefore, to push the e-Mobility initiative, the Government needs to provide adequate incentives for adoption of electric vehicles. This will lead to cities seeing a surge in the demand for power. To meet this demand, the Government will need to develop innovative solutions, for instance, by using the rooftops of fuel pump stations to generate solar power across India. These fuel stations could initially double up as solar power-based electric vehicle- charging stations. This will not only augment the earnings of the owners of fuel station, but also facilitate the smooth transition from traditional fuel-based mobility solutions to renewable and clean energy-based ones. Electric vehicles have to be an integral part of an environmentally sustainable future for us, and the sooner we realise this, the faster will be our progress towards mobility of clean and green electricity in the country.

In order to create a conducive environment to aid accelerated implementation of green mobility initiatives, innovators, entrepreneurs and regulators need to work together to evolve new business models for successful adoption of 'green' initiatives. India needs to find ways to implement electric mobility technology systems by

creating a business environment in which equipment manufacturers are provided innovative fiscal incentives to make a concerted effort to produce electric vehicles. Once these elements are in place, the market can move to reduce the cost of electric vehicles by making the technology widely accessible, and thereby bring about a meaningful change in the country.

Public electric vehicles are however only one part of a much broader approach that needs to be taken towards sustainable mobility. What is required is the combination of mutually inclusive elements.

Apart from public transport systems, privately owned cars and other vehicles should also become climate-neutral. Use of such vehicles will play a major role in India meeting its environment and sustainability goals, and drastically reduce pollution levels in the country.

It will not be enough to merely replace internal combustion engines with engines using electricity. Electric vehicles must become an integral part of intermodal transportation systems to ease citizens' transition from traditional modes of transportation to them. This thrust must be a part of a holistic and systemic approach to the establishment of sustainable transport and energy sectors in the country. In addition, demand-side management via smart city and land use planning; promotion of walking, biking (including the use of e-bikes), light rail and trains are other means by which we can reduce our dependence on traditional means of transport, and thereby significantly reduce environmental damage.

There is a need to associate electric vehicles with new patterns of use. Instead of owning one car for years and using it for all transport purposes, people must use several mobility services without owning these, but paying for their short-time use. It is therefore evident that the auto industry needs to shift its business model from selling cars to offering "mobility as a service".

## Electric mobility a paradigm shift

Sustainable mobility is not just about replacing fossil fuel-powered vehicles with modes of transportation propelled by electricity. It requires a drastic reduction in the number of personal vehicles in the country in favour of public transport, even if cars run on renewable electricity.

We also need to keep in mind that today a growing number of young urban professionals do not consider cars a status symbol, but just hire a car when necessary. We would all do well to follow suit. It is all about a shift in cultural thinking, coupled with the global technical revolution around e-Thinking in transport systems.

# A compelling need to create sustainable living – the e-Way.



**‘Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs’.**

– United Nations.

The world’s current population is 7.5 billion<sup>1</sup>. Our earth is going through an appalling period with respect to climate change, an unsustainable population, extinction of flora and fauna, an oil and energy crisis and much more. These conditions can all be attributed to human activities. Therefore, there is an immediate need to focus on sustainable development and life around the world.

Sustainable living is a way of life for humans to reduce or limit their use of the earth’s natural resources, and conduct their lives in a manner that is consistent with and respectful of their interdependent relationship with the earth’s natural ecology and cycles.

The United Nations Summit on Sustainable Development in 2015 had listed Sustainable Development Goals (SDG) to address critical environmental, economic and political challenges faced in the world<sup>2</sup>. Among other issues, climate change is largely attributable to human activities.

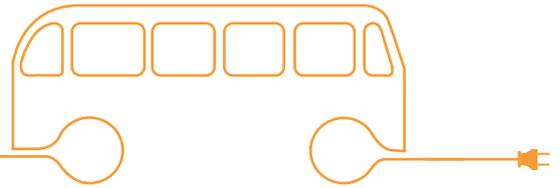
The Intergovernmental Panel on Climate Change (IPCC) has forecast that global temperatures will continue to rise year on year for decades to come, mainly due to greenhouse gases produced by human beings. This translates to a threat to flora, fauna and the entire ecosystem, rising sea levels, the increased risk of new diseases and health-related issues, and finally, the sixth mass extinction of the human race.

Among several factors such as deforestation, changes in land usage and agriculture, decomposition of wastes in landfills, etc., burning of fossil fuels is the key contributor to climate change. Burning of fossil fuels such as gasoline and diesel releases carbon dioxide (CO<sub>2</sub>), a greenhouse gas, into the atmosphere, which causes the earth’s temperature to warm up and result in climate changes. Today, with the world witnessing a dramatic shift in economic, military, technological and cultural strength, countries such as India and China are considered to be the potential superpowers of the future.



1. U.S. Census Bureau, International Data Base, <https://www.census.gov/popclock/world>

2. UN Sustainable Development Goals, <https://www.un.org/sustainabledevelopment/development-agenda/>



India's greenhouse emissions has grown faster than the country's population. The emission of CO<sub>2</sub> equivalent (CO<sub>2</sub>e) in India is 20.54 billion tons with emissions growing annually by 5.57 percent between 2005 and 2013.<sup>3</sup>



#### Analysis of GHG Platform

The transportation sector is one of the major contributors to CO<sub>2</sub> emissions. Moreover, with rapid urbanisation in developing economies such as India and China, CO<sub>2</sub> emission by urban transport is increasing rapidly. Therefore, there is an onus on these economies to act immediately and combat climate change through a constant focus on innovation in industry and infrastructure, and by building sustainable smart cities. The Government of India has been taking concrete steps in addressing climate change by investing heavily on the issues mentioned above. However, taking into consideration the country's ambitions and the pledge taken under the Paris Agreement to reduce carbon intensity to 33-35% by 2030, in comparison to the baseline year 2005<sup>4</sup>, there are still huge gaps that need to be bridged.

Looking from a solution-based approach, the gaps in the system could first be reduced and later bridged. This brings in the quintessential questions: What is causing the change? What needs to be changed and to what? How can the desired change be brought about? This would start

with taking another look at our current fuel-powered mass transportation industry, and ways in which the desired incremental changes can be achieved. With our growing population, a move to mass transportation will reduce the number of privately owned passenger vehicles on the road. To achieve this, the mass transportation industry needs to stay abreast with modern technologies and automobiles that can cut down on CO<sub>2</sub> emissions. The main change will come in the form of e-Vehicles, which can take the industry to new and wider horizons and reimagine our vision of a sustainable future.

This report elaborates on the imperatives for transportation through a sustainable electric vehicle transport system by the adoption of a transformation strategy relating to use of electric vehicles in mass transportation, the penetration of drivers of electric vehicles and the future of e-Mobility in India. These measures will go a long way in fulfilling the nation's promise of reducing carbon intensity and achieving sustainability to improve the quality of life of its inhabitants.

3. GHG Platform's Analysis, <https://www.wri.org/blog/2018/08/numbers-new-emissions-data-quantify-indias-climate-challenge>

4. Climate Goals for India – MoEF, <http://www.moef.gov.in/sites/default/files/revise%20PPT%20Press%20Conference%20INDC%20v5.ppt>



# Understanding the mobility market in India

India is the second most populous country in the world with a population of 1.33 billion, and is growing at the rate of 1.1% year on year<sup>5</sup>. At this rate, it is expected to become the country with the largest population in the world in the next 20 years. Furthermore, the advent of industrialisation and commercialisation has spurred employment opportunities and resulted in spreading urbanisation. With this rapid urbanisation, India is expected to see 500 million people living in its cities by 2030<sup>6</sup>. This, coupled with current and projected economic trends, is likely to lead to rising incomes in Indian households, thereby increase the demand for mobility.

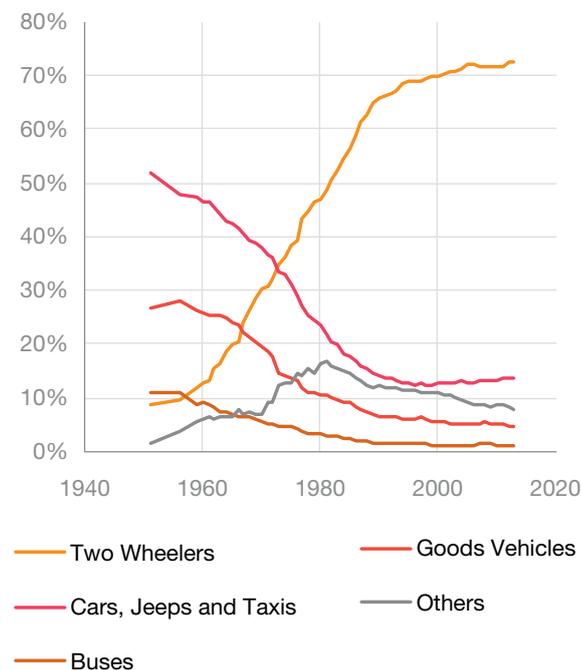
The automobile industry in India is the world's fourth largest and is expected to become the third largest by 2021. The industry accounts for 7.1% of India's Gross Domestic Product (GDP) and the Automotive Mission Plan 2016-2026 of the Government of India aims to raise this to 12%. The Indian automotive industry (including component manufacturing) is expected to grow at a compounded annual growth rate of 5.9% and reach INR16.16-18.18 trillion (US\$251.4-282.8 billion) by 2026, thereby becoming the fastest growing industry in the country<sup>7</sup>.

According to the National Electric Mobility Mission Plan 2020 report, the Indian automobile market is ruled by two wheelers, which account for 75% of the total number of vehicles sold in the country. And the passenger car segment is dominated by the small car segment and there is an increased likelihood for numbers to go up significantly by 2030<sup>8</sup>.

This information has been corroborated by the Society of Indian Automobile Manufacturers' (SIAM) report, 'Overall Auto Industry Growing in Double Digit Marginal Growth in Passenger Vehicles', which indicates that the industry has produced a total of 1.95 crore vehicles, comprising passenger, commercial, three-wheeler and two-wheelers vehicles and quadricycle vehicles in April-October 2018 compared to 1.71 crore in April-October 2017, registering a growth of 14.39%<sup>9</sup>.

With respect to sale of vehicles in the industry, the passenger car segment grew by 5.87%, the commercial vehicle segment by 35.68%, the three-wheeler segment by 31.97% and the two-wheeler segment by 11.14% in April-October 2018 over the same period the previous year<sup>10</sup>.

## Share of vehicle types



Source: <https://data.gov.in/catalog/total-number-registered-motor-vehicles-india>

Although India has been witnessing an increase in its sale of vehicles year on year, automobile ownership in the country still remains low, with only 18 cars per 1,000 citizens, compared to nearly 69 in China and 786 in the US<sup>11</sup>. This indicates that a major section of Indians do not own vehicles and are dependent on shared or public means of mobility.

5. World Bank Data 2017, <https://data.worldbank.org/indicator/SP.POP.GROW>, <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=IN>

6. Urbanization Statistics, <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-mobility-in-indias-passenger-vehicle-market>

7. IBEF, Automobile Industry in India, <https://www.ibef.org/industry/india-automobiles.aspx>

8. NEMMP 2020, <https://dhi.nic.in/writereaddata/Content/NEMMP2020.pdf>

9. SIAM Report, <http://www.siamindia.com/pressrelease-details.aspx?mpgid=48&pgidtrail=50&pid=426%20>

10. SIAM Report, <http://www.siamindia.com/pressrelease-details.aspx?mpgid=48&pgidtrail=50&pid=426%20>

11. <https://www.bloomberg.com/news/articles/2017-10-10/10-000-electric-cars-highlight-steep-path-to-india-s-ambitions>



With the dominance of and Indians' increasing reliance on road and rail transport, public buses and trains have been the primary mode of transport in the country. The report, **The Key Indicators of Household Expenditure on Services and Durable Goods**, published by the Ministry of Statistics and Programme Implementation in 2016, indicated that buses are the most common means of transport both in rural and urban areas. According to the report, the maximum spend of around 66% of households in rural areas and 62% of households in urban areas is on buses. The other modes of transportation include auto-rickshaws, cabs and trains<sup>12</sup>.

However, the supply side has not been able to catch up proportionately with growing demand due to the rising population. Moreover, the share of public transport buses has declined, which has necessitated a revamp of the public transport system in the country. This has resulted in the growth of app-based cab aggregators, and is synonymous with the penetration of smart phones. Today, India's two largest app-based cab aggregators provide close to 3.5 million rides on a day to day basis<sup>13</sup>. This had transformed the industry in terms of mobility and has been a turn-key solution. However, in view of the long-term perspective, what is needed is an efficient public transport system in the country, with vehicles running on electricity or alternative fuels, which make this mode of conveyance efficient, convenient, comfortable and safe, and encourage people to opt for public transport.

In this regard, India's electric vehicle industry is taking huge forward strides. The National Electric Mobility Mission Plan (NEMMP) 2020 was launched by the Central Government in 2013 to boost the manufacture of hybrid and electric vehicles in India and aims to achieve production of seven million electric vehicles by 2020. This initiative has been complemented by the Government providing demand-side incentives through its Faster Adoption & Manufacturing of Hybrid and Electric Vehicles in India (FAME) scheme.

Private automobile players have risen to the challenge and have been investing in R&D facilities and setting up additional manufacturing units for e-Vehicles. And with the Government deciding to fund up to 60% of R&D costs for the development of indigenous low-cost electric technology, global automobile players are investing heavily in R&D in electric vehicle technologies in India<sup>14</sup>.



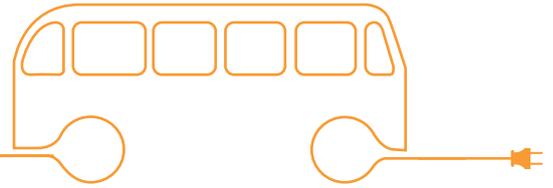
A face lift is definitely anticipated for India's electric vehicle industry with a major thrust from the Government. The differentiating factor will be how automobile manufacturers provide unique tailor-made services to the different segments and at the same time comply with mandated standards, quality and rate of innovation. This will catapult some organisations to the next league and at the same time see the downfall of others.

12. Gol Press Release, [http://www.mospi.gov.in/sites/default/files/press\\_release/press\\_durables\\_29june16.pdf](http://www.mospi.gov.in/sites/default/files/press_release/press_durables_29june16.pdf)

13. Economic Times September 2018, <https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/uber-ola-enter-slow-lane-in-2018/articleshow/65927443.cms>

14. UNEP DTU Partnership, Centre on Energy, Climate and Sustainable Development, [http://www.unepdtu.org/-/media/Sites/Uneprisoe/Publications-\(Pdfs\)/India-Transport/Reports/Study-on-Electric-Mobility-in-India\\_Final.ashx?la=da&hash=7ACFD37E4D155A7E442424A8509064ACE69C8D83](http://www.unepdtu.org/-/media/Sites/Uneprisoe/Publications-(Pdfs)/India-Transport/Reports/Study-on-Electric-Mobility-in-India_Final.ashx?la=da&hash=7ACFD37E4D155A7E442424A8509064ACE69C8D83)

# The end of the road for fuel-powered vehicles?



The answer to whether fuel-powered vehicles will be phased out in India will have to be looked at from different angles, including fuel consumption, and by the transportation industry on its contribution to air pollution, the total cost of ownership of fuel-powered vehicles against e-vehicles, and finally, the Government's focus on improving the sustainability of transport systems in the country.

India's daily consumption of crude oil was around 4.6 million barrels as of December 2017 (1 barrel ~ 159 litres), which is the third highest in the world after the US and China. However, the country's dependence on imports is high at close to 80% of its total oil consumption. This means depletion of its cash reserves, which serve as a cushion during fluctuations in exchange rates. According to 2014 statistics, 70% of diesel and 99.6% of petrol was consumed by the transport sector<sup>15</sup>. Today, the bulk of usage of diesel and petrol is by the transport sector, barring a substantial use of diesel for farm-related services.

Today, the price per litre of petrol is close to 19.5% of India's daily per capita GDP<sup>16</sup>. And the high price volatility of both petrol and diesel increases from the

end consumer's point of view. In addition, if the total cost of ownership, including the depreciation cost, tax, maintenance and insurance of a traditional vehicle, is high, this makes such modes of transport unsustainable.

In 2017, the World Health Organization reported that India has six of the ten cities in the world that are the highest on the air pollution gauge. With the transport sector playing a major role in emission of Particulate Material 2.5 and with the WHO classifying as early as 2012 that diesel exhausts from transportation are Class I carcinogens<sup>17</sup>, it is clear that fuel-powered vehicles have a major role to play in polluting the environment.

The growth story of electric vehicles has been compelling and some technologically advanced economies have developed cutting-edge technologies that have given them the much-needed traction. This is in part a solution to the larger problem in hand, since electric vehicles have zero tailpipe emissions and thereby reduce the carbon footprint. Apart from emissions, electric vehicles have fewer moving parts or components and batteries with a life time of up to 15 years. This drastically reduce their maintenance costs. However, the current stabilisation phase is expected to take longer periods of time in terms of technology, battery support and charging infrastructure that need to be established pan- India.

With government schemes and Smart City projects providing a catalytic base and fostering the growing EV presence, the future looks promising. At the current rate, with the incremental changes introduced and the formulation of policies and standards on emissions, the inflection point is expected to be achieved by 2050, wherein 90% of vehicles will be electric and only 10% traditional<sup>18</sup>.



15. India Crude Oil Consumption and Import Statistics, Crude Oil Consumption of India, <https://www.ceicdata.com/en/indicator/india/oil-consumption>, [https://www.ibef.org/download/Oil\\_and\\_Gas\\_Report\\_Apr\\_2018.pdf](https://www.ibef.org/download/Oil_and_Gas_Report_Apr_2018.pdf), <http://pib.nic.in/newsite/PrintRelease.aspx?relid=102799>

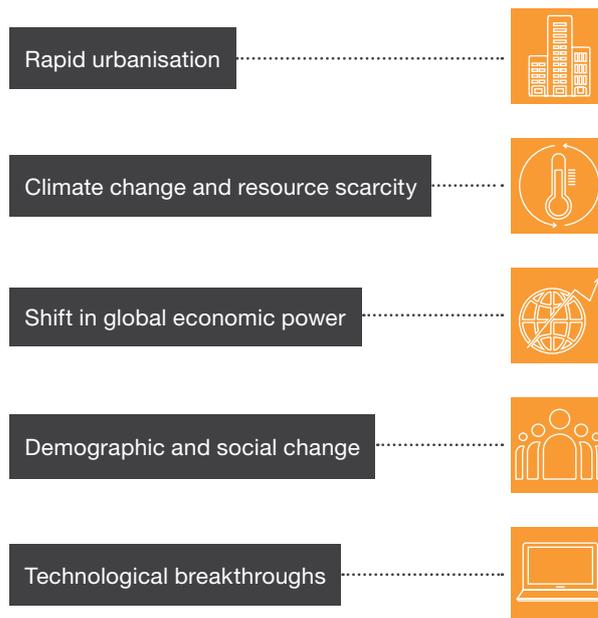
16. Deduced, \$/litre in Chennai, India is 1.06 (approximation based on petrol prices in Chennai during 01st Dec 2018 to 03rd Dec 2018). GDP per capita India is \$5.417 (<https://www.ceicdata.com/en/indicator/india/gdp-per-capita>). Hence price per litre is  $1.06/5.417 = 19.5\%$  of the daily GDP per capita.

17. Top Polluted Cities in the World Data WHO 2017, <https://www.weforum.org/agenda/2018/05/these-are-the-worlds-most-polluted-cities>, [https://www.iarc.fr/wp-content/uploads/2018/07/pr213\\_E.pdf](https://www.iarc.fr/wp-content/uploads/2018/07/pr213_E.pdf)

18. Bank of America Merrill Lynch Forecasts, <http://www.livemint.com/Industry/kDnvPAnuizO1ZSWSGlxTL/How-India-is-paving-the-way-for-an-electric-future.html>

# Megatrends and the public transportation imperative

With India being at the heart of a transformation and with numerous factors contributing to this, it is time for some foresight that will provide India the opportunity to search for innovative solutions, achieve significant growth and build stronger communities. PwC has been helping the Government tackle complex changes inspired by five megatrends, including rapid urbanisation, the shift in global economic power, climate change, scarcity of resources, demographic and social change and technological breakthroughs. These trends are disrupting the economy, business and society as a whole. They are expected to make a major impact on the global economic and commercial landscape, and no society, organisation or individual will be exempt from the effect of these megatrends. Therefore, it is important for us to understand how to respond and adapt to the changes they will bring about.



Electric Mobility is also an example of how these megatrends identified by PwC are interacting with each other while also reshaping the world we live in.

More than a technological breakthrough, electric vehicles need to be seen as a way for society to respond to the changes brought about by the other Megatrends.

Concerns surrounding climate change dictate our need to move to cleaner sources of energy, and all available evidence indicates that such energy will be harnessed in the form of electricity, and therefore it is imperative that vehicles of the future should be built to be driven using electrical energy.

As the forces of demographic transition and continued economic growth run their course, the size of the Indian middle class is expected to surge. Consequently, Indian cities are expected to witness a huge rise in the demand for transportation services. An increase in personal transportation would spell doom for the already overcrowded Indian cities and also be environmentally disastrous. This indicates an urgent need for a rapid ramp up of public transportation infrastructure in Indian cities.



# Increased mobility of electric vehicles in public transportation in India

As the forces unleashed by the five megatrends interact, the twin imperatives of mobility of electric vehicles and public transportation throws up exciting options for a resolution of associated challenges. And while it is not possible to predict how this will evolve, it would be interesting to look at some of the key choices and trends that are emerging.

## Charging infrastructure

Solving this problem is central to driving adoption of electric vehicles. It will also determine the kind of vehicles and the applications for which they will be suitable. While wide availability of charging facilities would take care of range-related anxiety and encourage increasing adoption of electric vehicles, this is expected to take time. This means that early adopters will have to make do with applications with a limited range, which can be serviced by batteries for on-board charging.

## Para-transit

Ensuring first and last mile connectivity is critical for adoption of public transportation, and the intermediate para-transit sector is critical in this. In India, this sector is riddled with problems, with a large number of un-regulated transportation formats. This may be a viable opportunity for governments and policy-makers to rethink their approach to regulation of this critical sector.



## Urban planning

Electric mobility can also be expected to have an impact on how future Indian cities will need to be designed. Space will have to be allocated for the creation of large-scale charging infrastructure, where large fleets of vehicles can be accommodated while they are being charged. This is especially true in the case of India where open urban spaces and proper parking facilities are a rarity. Moreover, increasing adoption of public or shared mobility options will also affect commute distances, travel modes and various other factors necessitating recalibration of how and where urban services are provided. This will have an impact on the design of residential neighbourhoods, workplaces, shopping districts and entertainment facilities.

## Utilisation of vehicles

The high initial cost of their batteries, coupled with the low running cost of electric vehicles, is a clear indication that only high-utilisation vehicle categories will be viable, especially during the early stages of their adoption curve. This points to public transportation vehicles.

## Connected mobility

Shared and connected mobility paradigms are expected to reshape the evolution of this sector. New technology-based solutions, business models and players are expected to revolutionise the sector.

## Form factor innovation

The use of the 'electric drivetrain' component, the need for on-board battery storage, optimisation of vehicles' weight and shape for maximum range and similar engineering considerations, coupled with new ways in which vehicles are likely to be used (e.g., shared mobility), are expected to lead to innovation in the design of future automobiles. This is already evident in the widespread emergence of the motorised e-rickshaws in India. Furthermore, innovations can be expected in the seat and wheel configurations of such vehicles. Regulators will also be required to respond with updated norms, or even new categories of vehicles, e.g., the recently approved 'quadricycle'.

# Driving the future: reshaping India



While India has a clear vision, the path towards being smart and sustainable to achieve this dream will require the coordinated action of all stakeholders across the delivery value chain. Responsibility and accountability will be integral in the creation of a sustainable future for our economies, cities and communities by protecting our environment. And so the change has to come from within, from each of us, with organisations and individuals working together in a world driven by technology and virtue.

The Government should be responsible and draft reforms, policies and programmes to build a favourable ecosystem to promote e-Mobility. It should ensure promotion of demand- and supply- side incentives to boost the Indian electric vehicle industry, and continue with its efforts and initiatives, e.g., proposing to bear up to 60% of the R&D cost of developing indigenous and low-cost electric technology<sup>19</sup>, undertaking pilot studies to provide a structure for electric vehicle-charging infrastructure across the country, supporting setting up of charging stations, promoting electric three-wheelers and battery-powered buses, inviting to India global companies making and selling electric vehicles, seeking investment for setting up charging stations, and subsidising the cost of electric cars, three-wheelers and batteries. Furthermore, the Central and state governments will have to step on the pedal and promote Unified Metropolitan Transport in line with models in countries such as Germany and Singapore. A focus on revamping mass transportation run on electricity or alternative fuels, and integrating bus, train and ferry services in the city (supplemented with Information & Communication Technology-related initiatives) would make the various modes of public transportation efficient, convenient, comfortable and safe, and encourage people to use them.

With the Government investing time, effort and money in the field of e-Mobility, automotive companies will have to do their bit in R&D to tap the full potential of technology from Block Chain to Artificial Intelligence. They will need to set up manufacturing hubs in the country to focus on and invest in building sustainable transport, to contribute to the creation of high performing and sustainable communities.

Lastly, getting closer to a bright future (projected above) will not be possible without the support of Indian citizens. It is the responsibility of every individual to welcome and be a part of this change, to ensure that future generations inherit a beautiful planet!



19. UNEP DTU Partnership, Centre on Energy, Climate and Sustainable Development, [http://www.unepdtu.org/-/media/Sites/Unepdtu/Reports/Publications-\(Pdfs\)/India-Transport/Reports/Study-on-Electric-Mobility-in-India\\_Final.ashx?la=da&hash=7ACFD37E4D155A7E442424A8509064ACE69C8D83](http://www.unepdtu.org/-/media/Sites/Unepdtu/Reports/Publications-(Pdfs)/India-Transport/Reports/Study-on-Electric-Mobility-in-India_Final.ashx?la=da&hash=7ACFD37E4D155A7E442424A8509064ACE69C8D83)







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