

India Roadmap on Low Carbon and Sustainable Mobility

(Decarbonisation of Indian Transport Sector)

Lead



Knowledge Partners





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MESSAGE FROM THE MINISTER

नितिन गडकरी
NITIN GADKARI



मंत्री
सड़क परिवहन एवं राजमार्ग;
सूक्ष्म, लघु एवं मध्यम उद्यम
भारत सरकार

Minister

Road Transport and Highways;
Micro, Small and Medium Enterprises
Government of India

MESSAGE

I am happy to learn that FICCI embarked on an initiative for developing an India Roadmap on Low Carbon and Sustainable Mobility (Decarbonisation of Indian Transport Sector).

Our Government's focus has always been on developing low-cost and sustainable transport options to be provided to the people of this country. Our focus should be on developing transport options that are cost-effective, pollution free, use the best technology available and help in employment generation also. Our Hon'ble Prime Minister has shared the vision for 7 Cs - common, connected, convenient, congestion-free, charged, clean, and cutting-edge mobility. I am glad that this Roadmap looks at all the Cs and once again commend FICCI for developing this India Roadmap on Low Carbon and Sustainable Mobility.

It is noteworthy that the members from industry as well as think-tanks, non-government organisations and financial institutions contributed to the development of this roadmap and through multi-stakeholder consultations have come around to a comprehensive and holistic set of recommendations.

I congratulate all the members of FICCI for its initiative and extend my best wishes for all the success in its endeavors.


(Nitin Gadkari)

Date: 22nd June, 2020

Place: New Delhi

FOREWORD



The India Roadmap on Low Carbon and Sustainable Mobility is a bottom-up stakeholder driven actionable vision with an operational focus for the Transport sector in the context of Sustainable Development Goals (SDGs) as well as

the objectives of India's Nationally Determined Contributions (NDCs) under the Paris Agreement. It provides a direction for greater policy visibility on low carbon and sustainable mobility ecosystem in India through an integrated approach and actionable recommendations for the short-term (upto 2022), medium-term (2022 to 2030) and long-term (2030 to 2050).

India's commitment to climate goals and ambitious initiatives undertaken by the Government of India through extensive stakeholder and inter-ministerial consultations are already leading the pathways for transforming the mobility landscape. The transport sector being an important contributor to economic growth, the transition to a low carbon pathway will be central to ensuring a sustainable mobility sector as the country moves towards achieving the goal of a 5-trillion dollar economy.

Several companies are taking a lead in technology and business model innovations in the area of transport to deliver low carbon solutions at the local level making the transition to low carbon future. This would certainly help their innovation journeys and act as enablers for a technology innovation ecosystem in the transport system.

The Roadmap recognizes congestion and air pollution as the heart of the problem to decarbonize, and recommends a greater thrust to public transportation, sustainable fuels, shifting the paradigm of building infrastructure for mobility of vehicles to building infrastructure for mobility of people and goods, focusing on transit-oriented development, and developing a strong integrated governance at national, state and city

levels, among many key recommendations. The eight components provide a comprehensive and holistic outlook to solutions and an action agenda encompassing urban transformation, low carbon energy supply, inter-modal and intra-modal efficiencies, reducing freight emissions, reducing vehicle kilometres, making adaptation central to transport and urban planning, sustainable rural mobility, and financial and economic instruments.

This initiative has been unique in its approach, involving diverse organisations from industry, research, think tanks and NGOs, with stakeholder consultations across the country.

I extend my heartfelt gratitude to the Chair and all Working Group Leads and Members whose tireless effort has led to this tremendous body of work, with involvement of 45 experts from 36 organisations. I thank our partners PPMC, Shakti Sustainable Energy Foundation and WWF-India for their support, guidance and feedback towards development of the India Roadmap. The FICCI Environment and Climate Change Secretariat has put in immense hard work with the working groups and partners to complete the journey. I am grateful that this initiative received the blessing of Shri Nitin Gadkari ji at its kick-off and now the final Roadmap launch, a person who is a great visionary and votary of sustainability as the core of his vision for the transport sector.

Our journey does not end here. FICCI is committed to work with the Government for a transition to a low carbon mobility ecosystem. The launch of the India Roadmap is a new beginning for us to work on its actionable recommendations with the Government, in a spirit of partnership and shared vision towards sustainable mobility.

Dr Sangita Reddy, President, FICCI

WORDS FROM SECRETARY GENERAL, CHAIR & PARTNERS



Dilip Chenoy
Secretary General
FICCI

“The Roadmap is an opportunity for stakeholders in government, business, urban and transport planning to integrate low carbon and sustainable options into their strategic decisions. It will inform policymaking towards decarbonisation of the mobility sector through an integrated and interconnected lens and approach and provides actionable recommendations to hit the ground running. FICCI is privileged to have driven this initiative with experts and partners, which will support India’s nationally determined contributions under the Paris Agreement and its sustainable development goals.”



Dr Patrick Oliva
Co-Founder
PPMC

“Transforming mobility requires resolve and realism. Close cooperation between state and non-state actors is of the essence”



Bharat Salhotra
Chair
FICCI Core Group on India Roadmap for
Low Carbon & Sustainable Mobility
MD, Ronmas India

“The Roadmap provides specific recommendations for establishing sustainable mobility, thereby addressing one of the main drivers of climate change. It lays the pathway for a low carbon, high fluidity intermodal transport network by suggesting policy and regulatory changes, institutional and structural reforms, infrastructure development, technology upgradation as well as economic instruments. This Sustainable Mobility Roadmap which has evolved through a collaborative stakeholder approach that included Industry, Government, Civil Society and Urban Planning Professionals provides actionable vision and an operational focus for each mode of Transport (people & freight, Urban & Rural) with the ultimate objective of supporting India’s NDCs under the Paris Agreement as well as for building India’s economy. The work is a culmination of the collective effort of 45 professionals from 36 organisations spread over nearly 24 months.”



Ravi Singh,
Secretary General & CEO
WWF India

“An affordable, congestion-free, and low carbon integrated transport system, with particular focus on public transport and non-motorised modes such as walking and cycling, is essential for meeting the mobility needs of the growing urban population. It would have benefits in terms of improved air quality, reduced health impacts, and reduction of carbon emissions. Further, sustainable mobility solutions that cater to the needs of the rural population can be a strong enabler for social transformation. The steps enumerated in this decarbonisation roadmap would lead to overall better quality of life for the citizens.”



Nicolas Beaumont
Senior Vice President
Sustainable Development and Mobility
Michelin / PPMC

“As Co-Lead of PPMC - Paris Process on Mobility and Climate, I am very impressed by this “Indian Transport Roadmap” developed by FICCI with WWF support in collaboration with the Indian public authorities. Based on PPMC’s approach and methodology, this collective workstream is a major contribution to update India’s NDCs and make them robust in the context of the implementation of the Paris Agreement.”



Ms Vatsala Joseph
Interim CEO
Shakti Sustainable Energy Foundation

“We are happy to be a partner in this venture of FICCI to build a roadmap for Low Carbon & Sustainable Mobility in India through bottom-up consultations with industry and sustainable mobility experts in the country. This roadmap will inform India’s actions on the adoption and implementation of transport decarbonisation strategies. The roadmap has enough recommendations to aid in decision making by Government and climate leaders and identify the roles of various stakeholders in this transition.”

PREFACE

To move down the path of reduced emissions from the Indian transport sector and provide direction to low carbon and sustainable mobility for India, FICCI embarked on the initiative for Developing an **India Roadmap** for Low Carbon and Sustainable Mobility with thrust on decarbonisation of the Indian transport sector. FICCI is supported in this initiative by knowledge partners, WWF-India, Paris Process on Mobility and Climate (PPMC) and Shakti Sustainable Energy Foundation (SSEF). The India Roadmap has eight distinct components outlined below.

1. Urban transformation for healthier, inclusive lifestyles and efficient, resilient, prosperous cities
2. Low-carbon energy supply strategy
3. Improve intermodal and mode-wise system efficiencies
4. Optimise supply chains to manage freight transport emissions
5. Avoid vehicle kilometres for commuting, shopping and accessing services
6. Provide low-carbon solutions for the rural (non-urban) populations
7. Accelerate action on adaptation in the transport sector
8. Large scale deployment of economic instruments and leveraging finance

Each of these components is covered in detail under individual reports, available separately as Theme Reports. The India Roadmap provides summaries of each component and actionable recommendations for short-term (2020-22), medium-term (2022-30) and long-term (2030-50). For detailed narrative of each component, the reader may refer to the individual theme reports of the respective component. For getting an

overview of all components, the India Roadmap provides the complete context for low carbon and sustainable mobility for India.

The work on the India Roadmap has been guided by the FICCI Core Group on Sustainable Mobility, consisting of eight working groups, and each worked on one of the eight components. The components are based on the Global Macro-Roadmap developed by PPMC. This methodological approach developed by PPMC is at the heart of the India Roadmap, with components of the India Roadmap customised to Indian context and circumstances.

The development of this Roadmap is a result of a long journey of detailed deliberations of the working groups Leads and Members who together comprised thirty-six organisations, extensive stakeholder consultations held in New Delhi, Navi Mumbai and Bengaluru, consultation with experts. It was backed by background research, documentation support, and coordination work by FICCI secretariat for the entire initiative and particularly for 6 of the 8 components, and support of WWF-India secretariat for 2 of the 8 components. PPMC and Shakti Sustainable Energy Foundation provided constructive feedback along the way. There was also international showcasing of the roadmap development process and interim work at Movin'On – World Summit on Sustainable Mobility in Montreal in 2018 and 2019 as well as at UNFCCC COP-24 in Katowice, Poland in 2018 and UNFCCC COP-25 in Madrid, Spain in 2019 which garnered international feedback that was dovetailed into the development of the Roadmap.

EXECUTIVE SUMMARY

GLOBAL IMPERATIVE AND GLOBAL ROADMAP

The transport sector as a whole is one of the largest sources of CO₂ emissions globally, accounting for over 23% of global CO₂ emissions in 2016. In the global context, the fact that transport sector emissions are currently very high at 7.7 Gt per year and will continue to increase rapidly with the projection of doubling of transport sector activity by 2050, a transformative change towards decarbonisation of the transport sector has become an imperative. This is even more compelling with several international agreements such as the Paris Agreement (UN Framework Convention on Climate Change) as well as the UN 2030 Agenda for Sustainable Development (the SDGs) both of which were adopted in 2015 (India being a signatory to both).

The Paris Process on Mobility and Climate, born in 2015, is setting a direction towards a global transformation for transport sector decarbonisation, through a global macro roadmap. The global roadmap spells out actions for governments to effect deep changes towards de-carbonisation of the transport sector through strategic coordination between public and private actors and targeted measures that will propel innovation and investments in a new sustainable mobility paradigm.

Mobility solutions across the world are being created on the principles of shared, connected and clean mobility.

INDIA EMISSIONS AND IMPERATIVE

The Indian transport sector comprises distinct modes such as railways, road, inland waterways, air, and marine transport systems. Overall, 18% of India's CO₂ emissions come from road transport. While rail is typically more expensive to build, operate and maintain than road, those investments are more efficient in terms of emissions per rupee spent. On average, road activities generate annually 3 to 14 times more CO₂ per rupee spent on infrastructure than rail activities.

India has initiated a slew of measures through regulations, policies, programmes and missions to control carbon emissions emanating from mobility. The Motor Vehicles Act 2019, the National Mission on Transformative Mobility and Battery Storage (2019), the Transformative Mobility Solutions for All, the Urban Green Mobility Programme, the Long-Term National Transport Policy, the Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India (FAME India scheme), the National Electric Mobility Mission Plan (NEMMP). In addition to these, India's first light vehicle fuel efficiency standards came into force in 2017. While all of these provide impetus to sustainable mobility, the challenge lies in the fact that they have overlapping timelines, some short term and some long term (ranging from 2015 to 2032) and have different government ministries implementing each. There are different government institutions that address transportation in India: Niti Aayog, Ministry of Road Transport and Highways, Ministry of Shipping and Civil Aviation, Ministry of Railways, Ministry of Housing and Urban Affairs, and Department of Heavy Industry. Further, the Indian Constitution lists road transport in the concurrent list, but passenger transport is a state monopoly in most states. As a result, a coordinated action across all Central Government Ministries and Central Authority and the States becomes imperative.

The current challenge before India is to evolve a strategy, which ensures rapid economic growth in line with the aspirations of the people and at the same having a growth trajectory which is sustainable from an environmental and climate change perspective. As India moves towards achieving a sustainable middle-income status over the next two decades, it will have to initiate several structural as well as regulatory reforms. To achieve the same, the economic growth over the next 20 years will have to be at a sustained rate that at least matches the growth rates achieved in the preceding two decades.

For this to happen, adequate transport provision in terms of quality, quantity and resource-efficiency is essential. If the required transport investment is not made, and in time, to satisfy the burgeoning transport demands driven by urban transformation, the aspirational growth envisaged will not be achieved. Much of the thinking in India so far has been project centric, done within single mode silos. A key requirement, therefore, is to evolve a transport strategy, which is system based. While this strategy should address sectoral issues, it must keep the focus on crosscutting themes both for assessing the transport capacity requirements as well as on working out the investment strategies to achieve the same.

To secure a significant improvement in overall productivity and efficiency of the system, it would be imperative that future development of the transportation network should aim to secure a better integration of the various modes of transport in order to facilitate the development of multimodal transport within the country for both domestic as well as external trade. The focus, ultimately, has to be on providing systemic sustainable solutions and outcomes to citizens rather than on addressing the inputs side of the equation – e.g. infrastructure alone or physical inputs alone. The objective must be to create an efficient and cost-effective system while minimising the adverse impact on the environment.

During the Global Mobility Summit in September 2018 in New Delhi, the Prime Minister of India outlined the vision for the future of mobility in India based on **7 Cs – common, connected, convenient, congestion-free, charged, clean, and cutting-edge mobility**. PM's vision espouses mobility as a key element of 'ease of living' and speaks of the need to create a mobility ecosystem that is in sync with nature. Affordable, accessible, inclusive and safe mobility solutions are primary strategic levers for rapid economic development and improving the ease of living. Further, India's efforts towards addressing mobility through a climate lens will also be aligned to India's pledges under the Paris Agreement (India's Nationally Determined

Contributions or the NDCs) that aims to reduce the emissions intensity of GDP from 33% to 35% below 2005 levels by 2030, and increase the share of non-fossil based power generation to 40% by 2030.

INDIA ROADMAP

The India roadmap will lay out a long term direction for policy interventions towards a low carbon and sustainable mobility ecosystem for India and will provide the vision for an integrated approach to decarbonisation of the transport sector in the short term (2022), medium term (2030) and long term (2050). While the global roadmap provides the direction towards decarbonisation of the transport sector by 2050, the India roadmap sets itself apart through a phased approach to decarbonisation.

The process of building the India roadmap involves a mapping of the landscape of sustainable mobility policy framework in the country, bottom-up industry-led consultation and inputs, and interface with government and other stakeholders in the mobility space in India. The India roadmap has 8 components –

- **Urban transformation for healthier, inclusive lifestyles and efficient, resilient, prosperous cities**
- **Low-carbon energy supply strategy**
- **Improve intermodal and mode-wise system efficiencies**
- **Optimise supply chains to manage freight transport emissions**
- **Avoid vehicle kilometres for commuting, shopping and accessing services**
- **Provide low-carbon solutions for the rural (non-urban) populations**
- **Accelerate action on adaptation in the transport sector**
- **Large scale deployment of economic instruments and leveraging finance**

Each component is introduced below and detailed in subsequent chapters.

Component 1: Urban transformation for healthier, inclusive lifestyles and efficient, resilient, prosperous cities

The first component of the roadmap addresses key aspects related to urban transportation such

as common governance structures, policies to incentivise public, shared and sustainable transport, improving infrastructure for public, shared, and non-motorised transport, creation of low and zero emission zones in peak hours, enhancing last mile connectivity, and ensuring smooth Interoperability for payments/technology solutions.

Component 2: Low-carbon energy supply strategy

The second component focuses on aims to analyse the present gaps and challenges that prevent the transition to a renewable based energy supply for sustainable low carbon transport in India and propose practical recommendations, including short term, medium-term and long term, including building awareness and campaigns about low carbon transportation, encouraging closer alignment of energy and transport sector to develop joint pathway, developing ecosystem for low carbon transport, need of standardisation and laying standards that could aid the development of renewable sources of energy and their deployment in the Indian transport sector, and developing hydrogen as a transportation fuel.

Component 3: Improve intermodal and mode-wise system efficiencies

Component 3 discusses the existing gaps and challenges related to multi-modal transport. In the Indian context, the future planning of Indian transport is aimed at the development of Multi-modal transport within the country as well for import export trade. Although the existing imperatives as well as transport infrastructure favours multi-modal transport, there remains little intermodal coordination, and a system with unclear responsibilities and weak accountability resulting in inefficiencies. The third component of the Roadmap aims to present the current status, gaps and challenges with respect to improving different aspects of multi-modality including Institutional and fiscal reforms, changes needed in regulations, multi-modal infrastructure, and integrating intelligent transport systems. Transport networks cannot exist in silos.

Sustainable urban mobility calls for intermodal integration, i.e., integration of various modes of transport to provide seamless connectivity for commuters and ensuring last mile connectivity will be a key factor for determining the success of a public transport system in a city.

Component 4: Optimise supply chains to manage freight transport emissions

Freight transport is a large contributor to emissions of CO₂ and to mitigate its environmental impact, it is essential to strive for a sustainable future. Of the total transport sector, road transport accounts for more than two thirds of the CO₂ emissions, shipping accounts for 14% and aviation 11%. The development of Dedicated Freight Corridors and emergence of multi-modal logistics parks are at the forefront of reducing emission due to freight transportation. Activities such as reducing packaging, increasing rail based and more fuel-efficient transportation or adopting multi-modalism involving the hub and spoke approach to freight transportation are some of the key steps required to be initiated. Building framework for ensuring that negative externalities are internalised for each mode of transport and ensuring allocation of resources for strengthening of the basic infrastructure between the different modes are also some of the key policy imperatives. Component 4 of the Roadmap therefore aims towards reduction of GHG emissions by addressing the existing gaps and challenges related to supply chain to manage freight transport emissions.

Component 5: Avoid vehicle kilometres for commuting, shopping and accessing services

The need for travel can be for both work and leisure. With increasing population and rapid urbanisation, the travel demand is also increasing. The National Transport Development Policy development committee has estimated the travel demand to grow almost 16 times by 2032. According to the report, the total passenger traffic in the country is expected to grow at about 15% per annum to reach 168,875 billion passenger kilometre (bpkm) in 2031-32 from 10,375 bpkm in 2011-12. The growth demands a multi-fold

increase in investments for smart and integrated transport infrastructure, mandate to adopt sustainable transport models with focus on usage of public transport, shared mobility to reduce the numbers of private vehicles on road, Transit-oriented development plans including mixed land use, non-motorised infrastructure and adopting sustainable designs, policies, systems to promote compact city approach. Component 5 focuses on vehicle kilometres travelled (VKT) and looks at three different pillars – system efficiency, trip efficiency and vehicle efficiency – separately, but will go hand in hand in providing an integrated solution for reducing VKT.

Component 6: Provide low-carbon solutions for the rural (non-urban) populations

The Component 6 of the Roadmap aims to provide insights on the need for rural mobility and access to rural areas to be in line with a number of Sustainable Development Goals (SDGs), discuss the challenges to be addressed on providing sustainable mobility solutions for rural populations in India. It gives thrust to suggesting ways to build and strengthen rural infrastructure, creating local employment through building sustainable business solutions (such as low-cost biofuel distilleries and battery recycling units), creating awareness campaigns for low carbon mobility while also deliberating upon the policy, regulations and incentives required. Avenues for funding in rural areas in India have also been considered.

Component 7: Accelerate action on adaptation in the transport sector

Transport systems and services are already being severely disrupted by climate-related events, with an increasing number of such events in the recent past in India as well. A transport system that cannot withstand the emerging impacts of climate change, will impose high costs for maintenance and repair, limit transportability and access, and result into significant economic losses. Ensuring climate resilience of transport investments is also critical as it will reduce the impacts of climatic events on transportation systems as well as allow faster rebound. Sustainable and resilient transport

is a cross-cutting issue under the 17 Sustainable Development Goals set by the international community in 2015. The increasing climate change impact requires countries to develop strategies for resilient transport infrastructure and systems, but much international debate and action in relation to climate change and international transport has focused on addressing the causes (mitigation) rather than coping with the impacts (adaptation). This component reflects on how India could develop a proactive approach to climate change adaptation strategies for the transportation infrastructure, public transport vehicles and mobility behaviour.

Component 8: Large scale deployment of economic instruments and leveraging Finance

The transport sector has been one of the major contributors to this growing GHGs. Increase in economic activity and consequently increase in per capita incomes is expected to drive the demand for transport further. This trend is expected to result in increased share of energy demand and CO₂ emissions from the transport sector. Going by the current trends, the high dependence on fossil fuels, now and in future, is poised to pose challenges for energy security, air pollution in cities and climate.

To improve the mobility scenario, there is a need to innovate and embrace some of the many secondary funding tools successfully used in cities, states and countries around the world. Alternative revenue raising tools such as value capture, transit-oriented developments, congestion charging, payroll, sales and fuel taxes and superannuation funds have been providing dedicated funding sources for transport operations and expansions around the globe for years. To capitalise on the broad benefits that sustainable transport system provides and to continue improving India's transport scenario, it is vital that sustainable, long term funding for improving service offerings and the transport infrastructure expansion is vital. Under this scenario, component 8 highlights existing gaps and challenges in financing and deployment of various fiscal and economic instruments, potential solutions to channel financing and

Institutional & Capacity building for developing a sustainable mobility ecosystem in the country.

OVERALL GAPS AND CHALLENGES IN MOBILITY AND TRANSPORT

The components of the roadmap provide insights into the gaps, issues and challenges facing the Indian transport sector and the adverse impacts they are producing. The components raise pertinent issues on rising private vehicle ownership resulting in declining air quality, increased pollution, increased congestion in the cities, decreasing share of public transportation and the resultant externalities such as deteriorating health, and increasing health costs. On the one hand, the key challenges are to increase production of clean fuels such as biofuels and hydrogen, increase usage of electric vehicles and build the requisite infrastructure, on the other hand, there are issues in permit and licensing of public bus transport and challenges to streamline procedures and regulations for increasing usage of public transport. Similarly, there are challenges for improving system efficiency, trip efficiency and vehicle efficiency, improving interoperability across the passenger transport systems such as buses and railways and improving inter-modal integration and co-ordination across freight transportation.

Majority of the Indian population lives in rural areas, hence sustainable mobility of the rural population becomes crucial. However, lack of data on rural mobility as well as their fuel consumption patterns, as well as willingness to pay, and shortfall in rural infrastructure are key barriers.

The major challenge for climate change adaptation on the transport sector is a non-integrated approach amongst various ministries of the Central Government and the States. Other challenges include identifying areas of extreme climate events which can impact the transport infrastructure, lack of use of screening tools for mitigating climate related risks and non-adhering to urban planning standards and regulations when building the transport infrastructure.

Financing the sustainable mobility ecosystem at a large scale in India would be a challenge. Lack of financing options such as low penetration of green bonds, high cost of capital, no priority sector lending for sustainable mobility and fiscal disincentives on public transport are some of the barriers to a low-carbon transport system.

POTENTIAL SOLUTIONS

Policy, regulation and standards

The components of the India roadmap highlight policy measures needed to drive changes in the overarching regulations for improving empowerment, ensure closer alignment of energy and transport sector, build framework for capturing all externalities for each mode of transport, setting standards, and providing incentives. Better enforcement and compliance of existing regulations, doing away with multiple taxation, better integration through interoperability, technology, infrastructure, and setting standards for charging infrastructure, climate resilient mobility infrastructure, and clear policy signal for low carbon energy supply to transportation will facilitate the transformation towards sustainable mobility in India. A framework for dynamic pricing for public transport has also been emphasised. Finally, the bedrock of India roadmap is the shift from the focus on movement of vehicles to movement of people and goods and incentivising appropriate usage of transportation rather than private ownership alone.

Governance and Institutional

In the current scenario, the absence of a unifying approach supported by an overarching legislative framework results in distortions in service provision, financing, infrastructure, implementation and operation of sustainable mobility solutions. It further limits the deployment of infrastructure, technology, and mobility services in a manner that optimises quality of mobility services for the urban citizen. The same can be addressed through establishing a unified authority to overcome institutional gaps as well as rationalise functions related to mobility to serve the citizens taking a holistic and integrated approach.

Since there is no integration at the government level, with several ministries focusing on transport and mobility, an integrated and interconnected approach at the national level as well as the city level for better governance is the absolute need for enabling an efficient, effective and sustainable ecosystem for mobility in India. A single urban mass transit authority for transport planning and operation at city level, and interconnectedness of various transport departments at the state level will be required alongside the integration and interconnectedness at the national level to bring the desired effect. Institutional capacity building of agencies and authorities across various levels of government for building a collaborative approach among local and state authorities will be needed. Awareness building and behavioural change campaigns through information, education, and communication will create a behavioural shift towards sustainable mobility choices in India among citizens.

Infrastructure

On the infrastructure front, India needs an integrated approach to build integrated transport systems with first and last mile connectivity for public transport, infrastructure for non-motorised transport (NMT) and shared mobility, and advancements in data infrastructure to bring efficiency in different modes and building multi-modal terminals. Establishing an optimised transport infrastructure for the cities which is well maintained and fully operational, applying transit-oriented development for urban areas, and providing sustainable transport solutions in rural areas is the need of the hour. The roadmap emphasises the need to build climate-resilient infrastructure by integrating transport into urban planning, developing tools and strategies for climate risk evaluation and weather and disaster forecasting.

Fiscal and Financial measures

The components of the roadmap discuss and provide insights on the fiscal disincentives and incentives and provide measures to finance the sustainable mobility ecosystem. The components discuss current disincentives on public transportation compared to private vehicles in India and provide financial frameworks and

incentives required to overcome the barriers.

There is a need to devise specific funds and economic instruments to facilitate transition to low carbon and sustainable mobility transport options. Ways for reducing the usage of fossil fuel powered private vehicles, suggestions for financial support for increasing usage of biofuels as well as increasing usage of electric vehicles in rural areas, building public-private partnerships for increasing investments in the freight sector, especially the energy efficient railways and coastal and inland waterways have been deliberated upon.

Large-scale investments will be required for building sustainable mobility infrastructure in India. Therefore, establishing a Nodal Development Finance Institution for Sustainable Mobility, establishing a green taxonomy, formulating green investment strategies, priority sector lending for sustainable mobility, and funding from multilateral banks, development finance institutions (DFIs) should be made available indirectly through the Indian banks and non-banking financial companies (NBFC). Patient capital from pension and sovereign wealth funds into green bonds will also help to mobilise required investments. Various financial instruments such as asset-backed securities (ABS) for increasing penetration of green bonds, credit enhancement schemes for reducing the cost of debt, viability gap funding, partial risk sharing facility could be used for minimising financial risks.

Technology

Technological changes will play a key role in integration of modes of transport, in delivering intra-modal, inter-modal, multi-modal efficiencies and last mile connectivity. Investments in advanced technologies and making concerted efforts in R&D will ensure progressive technological solutions for sustainable mobility. Advancements in technology-agnostic battery storage solutions will drive the shift to electrification of transport, implementation of the policies and investments in new technological developments in sustainable fuels will usher in mobility options based on different energy choices. Using technology for creating better

climate risk evaluation tools and weather forecasting tools to assess risks and build mitigation strategies have to be considered and facilitated.

FINAL INSIGHTS

The India roadmap recognises the need for government, private sector and other stakeholders to work together in a concerted manner for building a sustainable mobility ecosystem in India. The findings and consultations of the India roadmap development process have thrown up interesting insights which point towards the scope for interventions in governance structures, policy and regulations, strategies for low carbon energy supply, policy imperatives required for optimising freight supply chains, sustainable transport models to reduce vehicle kilometres.

The roadmap gives clear actionable recommendations for each of these, many of which need to be implemented within the next two years (by 2022) and others that would ensure further implementation of policies and programmes in the medium term (between 2022 and 2030). The roadmap provides directional recommendations for the long-term (between 2030 and 2050) that focus more on R&D on advanced technologies.

The detailed insights also imply the scope for new and innovative business models as well as public-private partnership models that could

be explored with the impetus on sustainable mobility in India. There is potential opportunity for collaboration in terms of multi-modality, interoperability, development of standards, implementation of transit-oriented development and low-emission and zero-emission zones. The need to improve interconnectedness among various ministries through implementation of a common governance structure, and the need for greater technology interface to enhance smart and connected mobility is a critical requirement.

The roadmap indicates the clear thrust needed on public transportation, shifting paradigm to movement of people more than the paradigm of movement of vehicles as the effective means to reduce congestion, air pollution, and vehicle kilometres. An integrated approach that integrates governance and institutions, infrastructure and technology for different modes is a strong imperative for sustainability.

It also points out the gap in data and information, and therefore highlights the urgent need to develop data repository on mobility, especially for rural mobility, which would help extrapolate demand for rural mobility solutions. The roadmap provides recommendations on financial and economic instruments for sustainable mobility. Overall, it emphasises the need to deliver a concerted and holistic pathway towards decarbonisation by setting a strategic direction towards policy formulation and effective implementation.

URBAN TRANSFORMATION FOR HEALTHIER, INCLUSIVE LIFESTYLES AND EFFICIENT, RESILIENT, PROSPEROUS CITIES

The intent to change is the very seed of transformation.

The first component of the roadmap addresses key aspects related to urban transportation such as common governance structures, policies to incentivise public, shared and sustainable transport, improving infrastructure for public, shared, and NMT (non-motorised transport), creation of low and zero emission zones in peak hours, enhancing last mile connectivity, and ensuring smooth Interoperability for payments/technology solutions.

Heart of the Problem

With 377 million people forming a third of India's population living in urban centres, India is at the cusp of urban transformation. In fact, the 2011 Census identified 50 metropolitan cities (with population over one million) across the country which are likely to witness significant growth in their size and population in the coming decades. According to NITI (National Institution for Transforming India) Aayog in 2011-12, these urban centres contributed 53% of the national income.

Given the pace of urban transformation, it is imperative that urban India rises to the challenge of managing the twin problems of congestion and air quality, since both adversely impact quality of life and health of the citizens. The economic cost of traffic congestion just in Delhi, Mumbai, Kolkata and Bengaluru has been estimated at approximately USD 22 billion annually.¹ With India expected to have nearly 14 times growth in passenger kilometre travelled (PKT) from 1,400 billion passenger kilometre (BPKM) to 18,750 BPKM between now and 2030,² immediate steps are needed to improve mobility. A BAU (business-as-usual) scenario is not really an alternative for a country that is relying on urban India to contribute the major part of the GDP (gross domestic product) growth. Left unresolved, it will push our cities

into a gridlock and make our cities unliveable. Clearly, given the expected contribution to the country's GDP from urban India, the manner in which India responds to the challenge of rapid urbanisation and the manner in which it plans and implements mobility solutions in its cities will determine to a large extent, how India performs at an economic level.

The accelerating urbanisation has several social implications as well. In the last few decades, there has been an exponential increase in demand for travel. This combined with an aspirational India wanting to move up the social ladder and get behind the wheel has been a major contributor to the rising vehicle ownership (Figure 1). While rising car ownership meets ambitions of the burgeoning middle class, it has been accompanied by increased congestion in the cities, gradual conversion of community spaces to parking spaces, rising vehicular pollution levels and high stress levels. Use of public transportation has been relegated to the bottom of pyramid as, socially, it is seen as an inferior mode of travel and below one's status. All these social changes have had an adverse impact on quality of life as well as wellness of urban citizens. As an example, with the average speed to travel in several of India's busiest cities reducing to below 10 kilometres per hour, the unintended side effect of rising vehicle ownership has led to a loss of several million man-hours in congestion.

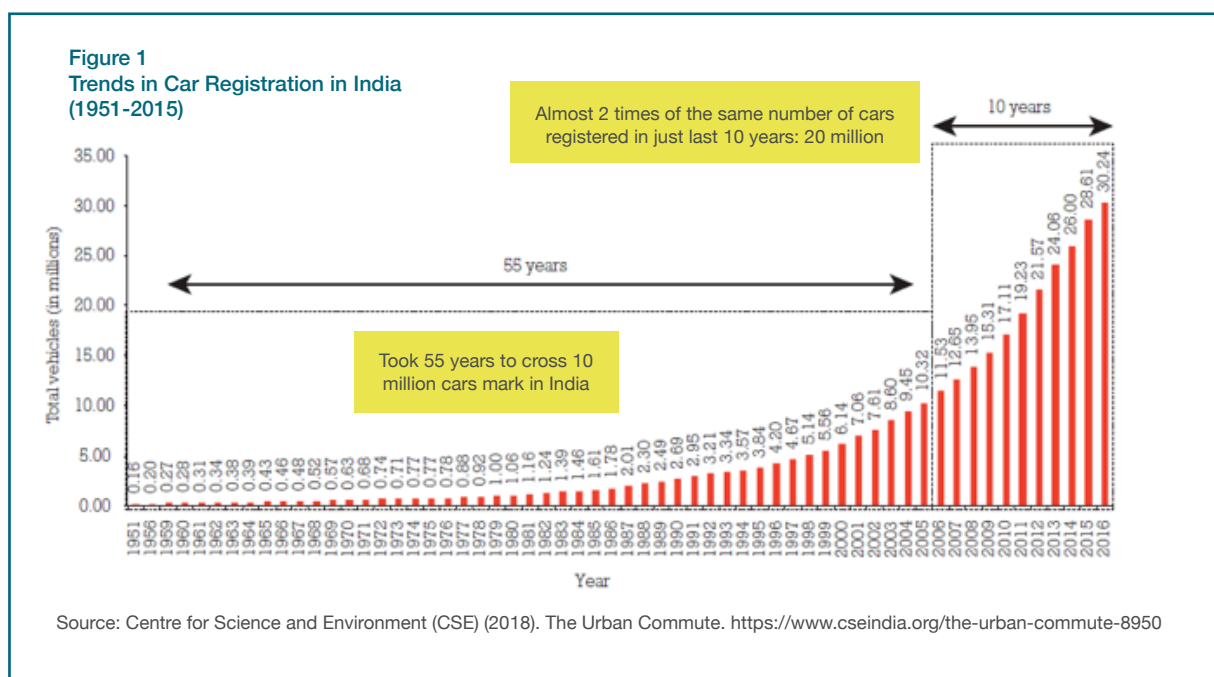
Apart from congestion, the adverse impact of higher private vehicle ownership is evident in the declining air quality, increased pollution, and rising vehicle fatalities.

¹ NITI Aayog and The Boston Consulting Group (2018). Transforming India's Mobility: A Perspective.

² NITI Aayog, Rocky Mountain Institute and Observer Research Foundation (2018). Moving Forward Together: Enabling Shared Mobility in India.

- A global report on air pollution by the World Health Organization (WHO) shows that 14 of the 15 cities with the highest levels of PM 2.5 pollutants in 2016 were in India.
- There were 6,73,100 deaths due to exposure to outdoor PM 2.5. Exposure to outdoor PM also accounted for a loss of nearly 1 year and 6 months in life expectancy.³
- In 2017, a total of 82,286 road accidents were recorded in the 50 one million-plus cities out of which 15,996 were fatal accidents, resulting in loss of 16,971 lives and causing injuries to 73,945 persons.⁴
- Overall, the transportation sector contributes to 10.8% of the total GHG (greenhouse gas) emissions in India (with LULUCF) for the year 2014.⁵
- Health cost because of poor air quality is assessed to be around 3% of India's GDP.⁶

All these adverse outcomes call for immediate correction through a well thought out and an integrated policy response towards urban mobility, which, sadly, has been missing so far. As an example, till recently, most of the development efforts in cities have been reactive in terms of planning transport infrastructure and focused on moving vehicles rather than people. More flyovers, under passes and parking lots for cars have often meant less space for NMT, less green cover and narrower pavements. This is a compromise that needs to be evaluated comprehensively and keeping a long term and an integrated perspective in mind. The linkage between transportation and land development in the city is another missing link since land development has been arbitrarily and mainly driven by organic growth.



Existing Policy Response

Recent years have seen some positive developments in terms of policy initiatives, emphasis on building transport infrastructure such as metros and BRTs, innovations in business models for promoting shared mobility solutions, emerging solutions in the domain of IT (information technology), EVs (electric vehicles), etc. The government is also laying out the roadmap for sustainable urban transport with encouraging policies. Some of the policy initiatives taken in the recent past are summarised below:

- **NUTP:** The Ministry of Urban Development devised a comprehensive National Urban Transport Policy (NUTP) in 2006 to ensure safe, affordable, quick, comfortable, reliable and sustainable access for more city residents to jobs, education, recreation, and such other needs within our cities
- **AMRUT:** Atal Mission for Rejuvenation and Urban Transformation and Smart Cities Mission to drive economic growth and foster inclusive urban development.

³ Health Effects Institute (2019). https://www.stateofglobalair.org/sites/default/files/soga_2019_india.pdf

⁴ ROAD ACCIDENTS IN INDIA – 2017, MoRTH

⁵ MoEFCC (2018). India: Second Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment, Forest and Climate Change, Govt.

⁶ World Bank (2013). India Diagnostic Assessment of Select Environmental Challenges.

Existing Policy Response

- **NUPF 2018:** National Urban Policy Framework (NUPF) is an in-process framework currently open for public comments. It outlines an integrated and coherent approach towards the future of urban planning in India. Transportation and mobility is one of the key 10 functional areas.
- **NEMMP:** Launched in 2013, The National Electric Mobility Mission Plan (NEMMP) 2020 has the potential to bring about a transformational paradigm shift in the automotive and transportation industry. It aims at gradually ensuring a vehicle population of about 6-7 million electric/hybrid vehicles in India by the year 2020 along with a certain level of indigenisation of technology ensuring India's global leadership.
- **FAME India Phase 2:** Faster Adoption and Manufacturing of EVs in India Phase 2 - The scheme with total outlay of INR 10,000 crores over the period of three years was implemented on 1 April 2019. Through the scheme, it is planned to support 10Lakh e-2W, 5 lakh e-3W, 55,000 4Ws and 7,000 buses. The scheme also proposes for establishment of charging infrastructure. As per NITI Aayog recommendations, the FAME II Subsidy will be provided to State Transport Undertakings (STUs) only when the procurement of all electric public buses is done under Operational Expenditure Model – wherein STUs buy mobility as a service on per km basis from private operators. Earlier, most STUs were procuring buses rather than procuring mobility services. This shift focusing on the quality of service, on outcomes rather than on asset creation is a welcome step towards improving quality of service. The draft guidelines framed by NITI Aayog are likely to facilitate a smooth transition towards electric mobility. This change in procurement practice needs to be institutionalised for CNG buses as well, in order to improve not only the quality of service, but also to improve the financial health of STUs which are mostly in the red.
- **Metro Rail Policy 2017:** The policy seeks to enable realisation of growing metro rail aspirations of a large number of cities. It focuses on compact urban development, cost reduction and MMI (multi-modal integration). The policy opens a big window for private investments across a range of metro operations making PPP (public private partnership) component mandatory for availing central assistance for new metro projects.
- **National Transit Oriented Development Policy (2017):** National Transit Oriented Development Policy integrates land use and transport planning to develop

compact growth centres within the influence zone of 500-800 m on either side of the transit stations i.e. areas within walking distance. States and UTs are required to incorporate TOD in the Master Plans and Development Plans of cities.

- **NCAP:** It is a time bound national level strategy for pan India implementation to tackle the increasing air pollution problem across the country. The tentative national level target of 20–30% reduction of PM 2.5 and PM 10 concentration by 2024 is proposed under the National Clean Air Programme (NCAP) taking 2017 as the base year for the comparison of concentration.
- **National Mission on Transformative Mobility and Battery Storage:** This mission aims to drive clean, connected, shared, sustainable and holistic mobility initiatives. It will recommend and drive the strategies for transformative mobility and phased manufacturing programmes for EVs, EV components and batteries.
- **NHREM:** The National Hydrogen Road Map (NHERM) is a programme initiated by the National Hydrogen Energy Board (NHEB) in 2003. It was approved in 2006 for bridging the technological gaps in different areas of hydrogen energy, including its production, storage, transportation and delivery, applications, safety, codes and standards and capacity building up to the year 2020.
- **Biofuels initiatives:** In order to promote biofuels in the country, a National Policy on Biofuels was made by the Ministry of New and Renewable Energy in 2009.

While these initiatives have consistently focused on improving sustainable mobility, the policy response is still inadequate and reactive, rather than proactive, when one looks at the quantum of challenge facing urban transportation. This “catch up” approach is demonstrated by all round degradation in the average speed of traffic, increasing congestion levels as well as deterioration in the quality of air despite these policy initiatives. Several of these schemes may have achieved some success; however, fundamental structural changes are needed to overcome roadblocks that exist. The entire ecosystem of mobility requires a relook and a reboot so that the urban India transformation is accompanied by healthier, inclusive lifestyles, and efficient, resilient, prosperous cities.

We discuss the challenges and thereafter some potential solutions to these challenges.

Challenges Along the Way

A number of challenges need to be overcome in order to move towards a sustainable mobility future.

The challenges are multi-dimensional in nature covering aspects such as governance, regulatory and institutional framework; lack of infrastructure, hindrances in adoption of newer technologies and business models, and issues related to capacity building and awareness.

The major challenges which hinder the present and future shift towards sustainable mobility are discussed below:

- **Governance:** There is at present, no unified organisation at the city level that is responsible for delivering mobility solution to urban citizens.

Presently, different public transport agencies/ authorities (bus, metro, ferry etc.) have built their infrastructure as well as service offerings without taking an integrated approach to mobility. These agencies build infrastructure in silos and also provide services on their network without taking into account the end-to-end mobility needs of the citizens. As a result, there has been an absence of a common and well-defined approach to building transport infrastructure or delivering quality customer experience. Often the agencies are seen to be competing for land, finances, and resources, and are perceived as working at cross-purposes. The absence of a unifying approach at the city level through a common organisation supported by an overarching legislative framework results in distortions in service provision, financing, implementation and operation of sustainable mobility solutions. It also limits the deployment of infrastructure, technology, and mobility services in a manner that optimises quality of mobility services for the urban citizen.

Figure 2
Need for UMTA

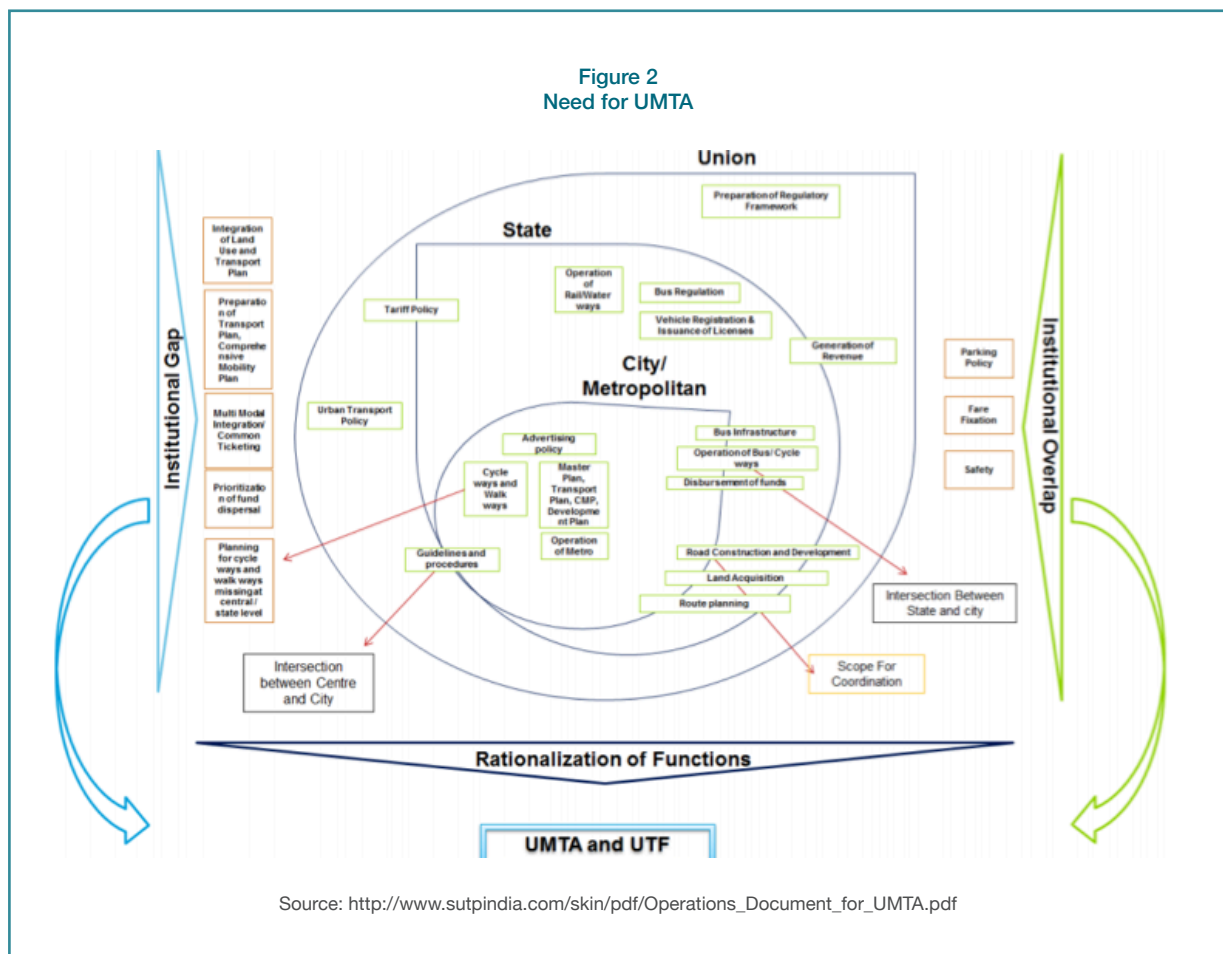


Figure 2 above in an extract from the Unified Metropolitan Transport Authority (UMTA) Operations Document prepared by Ministry of Urban Development. It underscores the acknowledgement of need to establish a unified authority at the city level to address the institutional gaps as well as to rationalise functions related to mobility, as a professional body working under the city council with representation from city agencies and stakeholders including those from the surrounding region. The referenced document clearly describes the need for having a well empowered Authority at each city level which can take a holistic and integrated view of Mobility as a Service to its citizens. Needless to say, the Authority must be well empowered and have the single unified mandate to improve mobility and quality of service.

In line with this approach, the Government of India through the Ministry of Urban Development decided to establish an Urban Metropolitan Transport Authority (UMTA) in all cities with population exceeding 1 million. Several cities in India like Hyderabad, Chennai, Indore, Pune, Kochi, and Jaipur have started to implement this approach and have established UMTA which has jurisdictional control over the city within the municipal limits. However, in most cases, the role of UMTA has generally been restricted to infrastructure planning and financing decisions. The regulatory aspects have not been a priority area and this is the second challenge being faced by urban mobility.

CROSSROADS OF CHANGE



HYDERABAD URBAN METROPOLITAN TRANSPORT AUTHORITY⁷

Various agencies like HMC, Hyderabad Metropolitan Development Authority (HMDA), National Highway Authority of India (NHAI), Andhra Pradesh State Road Transport Corporation (APSRTC), Society for Employment and Training in the twin cities of Hyderabad and Secunderabad (SETWIN), Multi-Modal Transport System (MMTS), Railways are involved in supporting and facilitating the traffic and transportation mechanism in Hyderabad.

UMTA for Hyderabad was constituted by an Act of the Andhra Pradesh Government legislature (GO Ms No. 624). It was formed in order to deal with issues related to traffic and transportation in the Hyderabad Metropolitan Region (HMR). Under subsection (1) of section 16 of HMDA Act No. 8, 2008, the Governor of Andhra Pradesh constituted Hyderabad UMTA with the following members:

Designation	Post in Hyderabad UMTA
Chief Secretary	Chairman
Commissioner, Greater Hyderabad Municipal Corporation	Member
Principal Secretary/ Secretary to the Government, Municipal Administration and Urban Development (MA&UD) Department	"
Principal Secretary/ Secretary to Government, Transport, Roads and Buildings	"
Transport Corporation	"
Commissioner of Police, Hyderabad	"
Commissioner of Police, Cyberabad	"
Member Secretary, Andhra Pradesh Pollution Control Board	"
General Manager, South Central Railway	"
Transport Commissioner	"
Two Experts in the field of Urban Transport (nominated by the Government)	"
Metropolitan Commissioner, HMDA	Member Convenor
Any other person nominated by the Government	Member

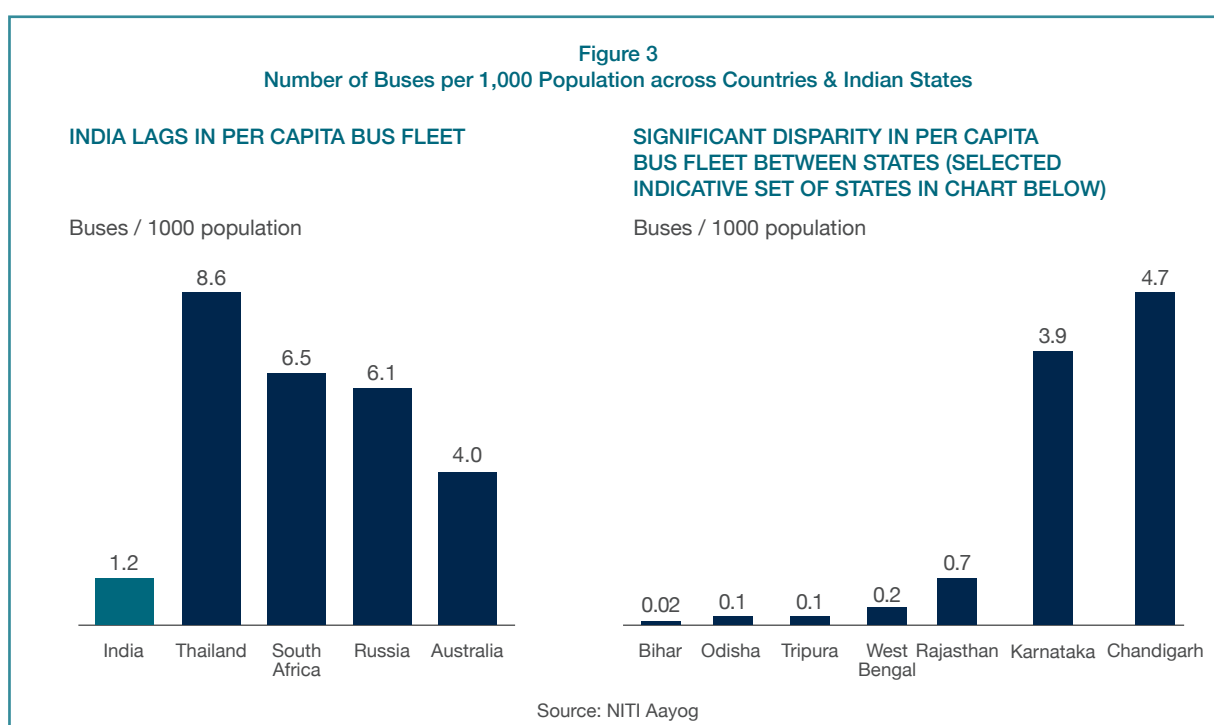
• Regulations

The **permits and licensing** for operating public transport are strict and create hindrance in flexible operations as well as present a major barrier to entry for new bus operators. Presently, under the Central Motor Vehicles Rules (CMVR), a bus operator can be provided the following two types of permits:

- **Contract Carriage:** The permit holder can operate a vehicle under a contract with his client for a fixed destination within or outside the State. This agreement should be executed between the clients and the operators and the list of passengers are also to be made available with the driver of the bus.
- **Stage Carriage:** A motor vehicle constructed or adapted to carry more than six passengers excluding

the driver for hire or reward at separate fares paid by or for individual passengers, either for the whole journey or for stages of the journey.

Indirectly, the licensing system dissuades expansion of public transport by restricting the number of urban buses deployed. There is an artificial scarcity created in issuing stage carriage licenses to private operators and this gets reflected in the abysmally low number of buses plying in urban India. As an example, the per capita index for urban India is 1.2 buses/1000 people versus 6 buses /1000 people in China and similar gap is visible when one compares with other countries. Figure 3 presents the significant shortage of buses in urban India in comparison to other economies.



Not only are there an inadequate number of buses, the current format of regulation also leads to underutilisation of assets.

Thus, a bus which is used for transporting office workers on a fixed route or for ferrying school children under a Contract Carriage cannot be utilised for any other activity during the day such as functioning as a local bus for all public in certain region.

- **Inadequate public transport is a key challenge facing urban India.** A major contributor to urban India's increased traffic congestion has been the

greater primacy given to private vehicles, often at the cost of public transport. Widening roads and increasing parking spaces at the expense of walkways and green cover is a perpetual activity going on in Indian cities. On the one hand, there is absence of a credible, acceptable, and attractive public transport offering; on the other, there is an aspirational aspect in a developing country to own private vehicles. Both these, working in tandem, have created a toxic combination that has a demonstrated adverse impact on citizen's health. The focus needs to shift towards making people movement fluid by encouraging walking, cycling, and the use of public transport rather than accommodating more private vehicles and private parking lots. The current approach towards transportation has resulted in the following:

• Poor Road Infrastructure Development and Management

- Encroachments like parked vehicles, hawkers, pavement dwellers and stray animals on the roads. Lack of proper drainage system and its maintenance.
- Old and ill maintained vehicles which comply with obsolete emission standards, still run on the road. PUC mandates are not implemented strictly.
- Manual toll collection leading to prolonged waiting time.

• Shortage of Public Transport:

- Inadequate/old transport infrastructure leading to limited use.
- Lack of inter-modal synchronisation of various public transport modes.
- Limited urban rail services in multi-million populated cities.
- Lack of innovations and different business models in public transport system.

- **Poor Quality of Public Transport:** Public transport ridership can only improve if the quality and reliability of service is aligned with the aspirations

and expectations of the public. The thrust so far has been on addressing the segment at the bottom of the pyramid which is very sensitive to fares. However, there is another segment of users who can afford higher fares provided they get the optimum reliability and quality of service. This segment which indirectly contributes to high congestion by using fossil based private transport and air pollution has been ignored by public transport cost.

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Figure 4 indicates the disparate situation about passenger road transport sector in select states:

Figure 4
Competition, Efficiency and Composite Consumer Satisfaction

Competition, Efficiency and Composite Consumer Satisfaction (Indices and Ranking)

States	Competition Index	Efficiency Index	Composite Customer Satisfaction Index	Rank of Competition Index	Rank of Efficiency Index	Rank of Composite Consumer Satisfaction Index
Rajasthan	0.838	0.893	0.622	1	1	1
Orissa	0.764	0.636	0.462	2	3	6
Kerala	0.721	0.438	0.470	3	6	5
Tamil Nadu	0.622	0.517	0.597	4	5	3
West Bengal	0.602	0.052	0.509	5	7	4
Himachal Pradesh	0.595	0.631	0.409	6	4	7
Maharashtra	0.569	0.688	0.607	7	2	2

Source: National Council of Applied Economic Research (NCAER)

- **Interoperability:** There is absence of interoperability between transport modes in terms of quality, schedule alignment, and integrated ticketing. Seamless intermodal travel and feeder system for first and last mile connectivity is missing in the present system. Also, in the absence of one Land Transport Authority in cities, it is impossible to optimise the transport infrastructure as well as transport operations.

All these challenges underscore the need for an immediate policy response supported by the right planning and infrastructure creation as well as the most appropriate structures for governance and operations.

- **Roadblock to Shared Mobility:** The world is moving towards shared modes so as to reduce the ownership and usage of private transport models. All modes including cycles, bikes and cars are being offered as a service. Digitisation of Intermediate Public Transport (IPT) has strengthened the uptake of shared mobility. Cab aggregator businesses are a striking example of the aforesaid. The ridership for aggregator businesses has risen from 1 Million in 2015 to 3.5 Million in 2018. In tier I and II cities, Intermediate Public Transport (IPT) ends up serving as public transport itself. Digitisation has enabled people to raise demand and avail door-to-door service. The original regulations and policies did not envision this rapid development, thus requires new changes:
- **State government policies on IPT and NMT** are arbitrary, not sustainable / forward-looking, and are not consistent across states. Until 2015, Goa was the only State in India to allow Bike Taxis. However, the following 11 states have now made policies to allow bike taxis to operate in their cities: Haryana, Goa, Gujarat, Telangana, Andhra Pradesh, Rajasthan, Punjab, Uttar Pradesh, Bihar, West Bengal, and Mizoram.

Transport is a concurrent subject, thus Ministry of Road Transport and Highways (MoRTH)'s policies only act as guidelines for states and are not binding. Policies can be made catering to the specific needs of different users by improving service levels.

- **Restriction on usage of All India Tourist Permit (AITP) Vehicles:** Limiting the use of AITP cars for tourist purposes alone, creates a vacuum in the contract carriage sector leading to increased personalised car ownership. Cap on city taxi permits and not allowing AITP taxis to ply has led to artificial scarcity and underutilisation of supply.
- **Carpooling:** At present, Central Motor Vehicles Act does not legalise carpooling. Regulated by the act, contract carriages and public service vehicles can carry passengers for 'hire and reward'. The definition of the two, however, excludes 'a private car which is only used occasionally for giving the lift against some payment'. Although MoRTH taxi guidelines and Moving Together Forward, a report by NITI Aayog, launched at the MOVE summit, revealed a political will to implement carpooling in India, due to lack of clarity around nature and probabilities of outcomes of the new intervention, it is associated with various risks.

- **Limited NMT and Last Mile Connectivity:** Cities lack infrastructure for NMT, which tends to limit adoption of bike/cycle sharing schemes. Inadequate NMT ecosystem leads to increased risk exposure to accidents due to common road space, in turn decreasing the acceptability of NMT. Also, lack of other infrastructure like vehicle pick-up and drop-off points, auto-rickshaw stands, parking spaces, etc., could also be a bottleneck to proliferation of new shared mobility solutions. At the same, new technologies such as dock less bicycle sharing, E-bikes, Segways, Urban Ropeways, etc., need to be evaluated for last mile connectivity. Several cities in the world – Medellin, Caracas, Constantine etc., have adopted urban ropeways for catering to the last mile connectivity. Urban ropeways are low capex intensive, and easy to insert in congested cities. They serve as good feeders to BRTs and Metro Stations, particularly in cities which have urban sprawl and contour terrain.

- **Roadblocks in Adopting Innovative Solutions:** As the world is going through a technological revolution, there are innovative solutions to a wide range of problems. However, the pace of technological development has outrun the policy development in most cases. Urban transport is one such example. While there are innovative solutions available for the new era, they are being hindered by rules of the times past. This diminishes the adoption of much needed innovative interventions.

- **Inconsistencies in data standards and guidelines** for best practices between public and private transportation providers become a barrier for promoting shared mobility. Operators face problem due to lack of any publicly available data regarding transport sector. In most developed countries, government creates infrastructure to collect, analyse and disseminate important business-related information. There has to be an independent agency who maintain and collect this information on regular basis. For example, the following are some areas:

1. Origin and Destination Survey, Occupancy.
2. National as well as regional freight volume and person movement data (billion ton kilometres).
3. Emerging routes.
4. Business benchmarks like fuel cost per ton kilometre/1000 person-kilometre etc.
5. Carbon footprint of various operators etc.

Also, there are limitations with regard to collection and processing of mobility data. The commuters as well as service providers are unable to fully utilise the potential of data and connectivity in transport space.

- **Interoperability:** No interoperability between transport modes in terms of quality, schedule alignment, and integrated ticketing means that intermodal travel and feeder system for first and last-mile connectivity are not seamless.
- **Lack of Standards:** Lack of standards in EV charging, connectors, and power quality and a plethora of options available today prevents EVs from scaling up. Presently, there is a lack of common standards for fleet operations. This needs to be designed in a manner that optimises the space for charging and looks at options such as swapping station which occupy less space.
- **Human Capital:** The capability for undertaking a coordinated approach and a complete understanding of issues involved is limited at the State Government and city level. There is gap between capacity and understanding of innovators, planners, policy makers and regulators which leads to friction in uptake of sustainable solutions.
- Most of the relevant **workforce needs skill upgradation** in consistency with new technologies like in manufacturing and maintenance of EVs, operation and troubleshooting of smart vehicles etc.

Routes to Change: Proposed Solutions

A paradigm shift has been observed in the stakeholder's approach towards urban transport with three key strategies, namely, Avoid, Shift and Improve.

It is widely understood that to undertake the huge challenge and to manage the massive investments needed in urban transport, two vital steps are needed: creating a strong institutional framework in cities,

states and the centre, and upgrade of skills. The working group recommends that the strategy for shifting towards a sustainable urban transport should include the following components:

- Remove the inefficiencies of the present system.
- Address the hurdles in adopting new solutions.
- Incentivising and promoting new solutions.

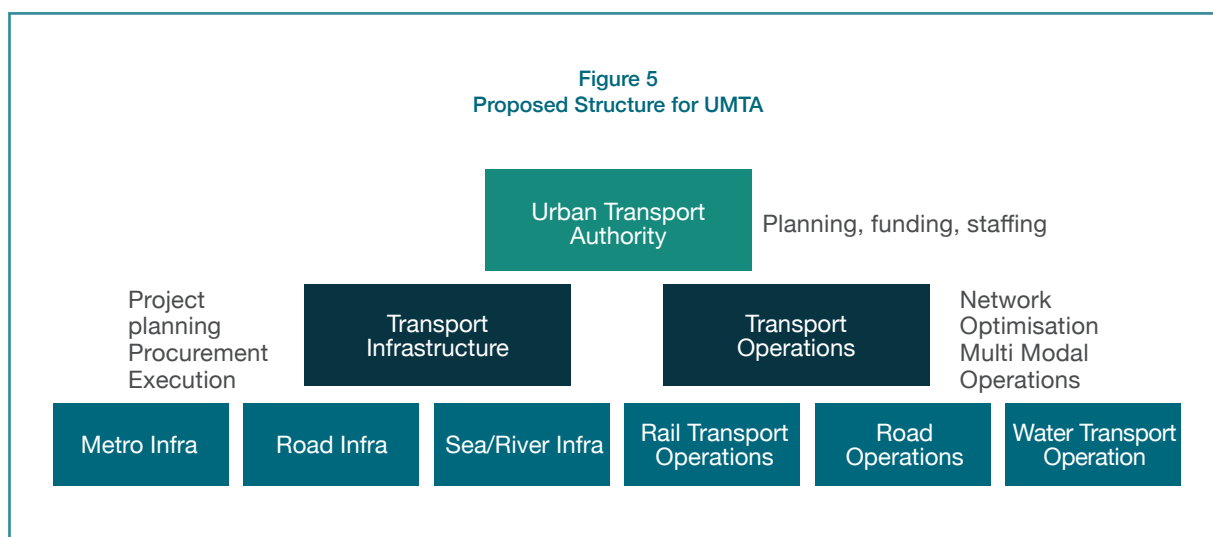
Changes have been proposed keeping the above-mentioned steps in consideration:

- **Changes in Governance:** Institutional mechanisms need to be modified for enhanced coordination in planning and management of transport services.
- **Unified Metropolitan Transportation Authority:** UMTA will be responsible for integration and approval of proposals by city agencies such as the municipality, development authority, Regional Development Authority and traffic police; handling NMT and shared mobility; strategy and policy functions; transport demand management; organising urban transport services; providing common services; resolution of day to day matters and monitoring the work assigned to implementing agencies both for the city and the surrounding region. The regulatory aspects have not been a priority area. Therefore, for smooth operations and interconnectivity of urban transport, role of a local regulator is also proposed for UMTA.

The UMTA should be backed by UTF that can be used to supplement capital and operational financing of public transport agencies. Such a fund will also incentivise various agencies in charge of shared mobility to be part of the integrated decision-making process. The likely revenue streams of the UTF can be through grants from the Government, levying a 'Green tax' on high polluting vehicles, surcharge on property tax and stamp duty etc.⁸ Additional responsibility of UMTA is to be the authority for collecting and dispersing of UTF to various agencies in the city to undertake various urban transport related activities.

⁸ <https://india.uitp.org/articles/regulatory-and-financial-frameworks-for-shared-mobility-in-india>

Figure 5
Proposed Structure for UMTA



- Transit oriented development (TOD):** Urban transport needs to be incorporated as an important element of urban planning. Estimates from IIT Delhi⁹ show that more than half of all travel trips in most cities are below 5 km average due to compactness of the cities. But this advantage is rapidly eroding as cities are sprawling and adopting the gated community approach. Sprawl is increasing distances and overall vehicle miles travelled. In the growing cities, TOD should be made an integral part of any mass transit system and urban planning system which is funded by the Central government. At the same time, road networks are being expanded to allow vehicles to move at high speed, often at the expense of pedestrian movement and public transport access. A disproportionate share of the right-of-way is taken up by the carriageway and its continuous widening.
 - Changes in regulation:**
 - Permits and Ease of Business:
 - Chapter 6 of Motor Vehicles Act (MVA), 1988 should be suspended as it overrides Chapter 5 of the MVA which gives excessive and overarching powers to STUs to exclude private operators. However, on ground in many states the state bureaucracy is oblivious of this fact. This thwarts a healthy growth of private operators as they are at the mercy of STUs. Regulations for permits need to be eased to adopt new and shared mobility solutions. As the private transport is responsible for major bottlenecks in urban mobility, permits for private vehicles needs to be made difficult with a certain cap on the licenses distributed for private car ownership. At the same time, it may be a judicious idea to open up the market for private players interested in operating as public transport. There shall be no need for any permit for public transport providers as long as it satisfies minimum criterion for passenger safety, comfort, and experience. A mechanism needs to be set up in place to set and maintain a benchmark for these services. Also, for buses a limited number of licenses can be provided for aggregators so as to have competition based on quality and reliability of services. The need for GPS-enabled buses with real time location updates on a common platform is paramount.
 - As the merit of buses in providing mobility is already proven and government aims to promote electric mobility thus, private electric buses should also be included in FAME II subsidies. Also, electric bus operator's revenue should not be taxed to make them viable business case.
 - For a large country like India, a point to point route network (for cargo as well as passenger), that attempts to connect each node to every other node result in large number of routes in the network which makes it practically very complex to operate and also leads to considerable underutilisation of assets.
- A combination of traditional destination-oriented routes along with direction-oriented routes, which is called as Hub and Spoke network should be adopted for operating trucks and buses transiting in a large network – in a way similar to how the airline network operates.

⁹ OECD (2018). Climate-resilient Infrastructure, Policy Perspectives.

Bus port concept needs to be introduced so that the existing bus depots and bus stands which are monopolised by STUs are modernised as separate entities. Like the Railway Stations Modernisation Projects wherein stations are being modernised and air space above railway stations will be opened up for commercial exploitation, in the same manner bus ports should be developed potentially under PPP arrangement. This can also be a good revenue source for STUs.

• **Compliance and Enforcement:**

- Government of India has passed the MVA (Amendment) Bill 2017. The bill tries to strengthen the compliance by increasing the fines, offering safety to first responders, holding builders accountable for poor quality infrastructure, etc. The success of the new bill will depend on how effectively it is enforced.
- Role of RTO – With increasing sophistication in automotive technology, vehicles have become more complex, integrated and computerised. Today no vehicle diagnostics can be done without help of computerised check-up at company owned garages. Under such circumstance, vehicle passing both initial as well as periodic check by RTO has become redundant. However, the system continues as an arrangement for assured extortion. Under changed circumstances, RTO function must be reviewed and made more appropriate to emerging realities. There is a need to have a check on the RTO by shifting registration/certification of vehicles and issuing of license services online with minimal face to face contact to increase efficiency and efficacy. Also, RTOs should qualify bus operators instead of buses based on procedure set up by UMTA valuing service quality.
- On demand bus services should be encouraged with virtual bus stands/stops (UBER model for buses).
- Market determination of fares for app based public transport should be allowed.
- Role of STU should be limited to running scheduled services so as to cater to the basic connectivity need of cities. STUs must encourage more Stage Carriage licenses to be offered so as to supplement their own efforts in improving mobility services in cities.
 - As India develops and adopts more digitalisation, compliance can be made effective by leveraging technology. As most vehicles are already being delivered using Radio Frequency Identification Device (RFID), intelligent poles at intersections

can be used for checking compliance and enforcing fines on violators. An alternative approach is using license plate reading cameras.

– **AITP vehicles should be allowed to operate on aggregator platforms across states:**

Distinction between city cab permit and AITP is artificial, and AITP permits may be allowed to be converted to city taxi permits or convert city taxi permits to AITP as recommended by NITI Aayog to reduce the risk of regulatory burden. This may be permitted subject to compliance to fuel and safety norms prescribed by respective State Governments. Premium Public Transport services to be run by Operators who have been qualified by RTOs. Norms for qualification of Operators to be set up by State Transport Authority. For these services, the price discovery mechanism needs to be implemented for fares.

– **Carpooling:** Government should enable private vehicle owners to share ride with passengers along the same route, by qualifying 'private vehicles' for contract carriage, as long as the practice isn't done for profit (or is done for "cost-sharing" purposes) and requisite safety measures are taken.

– **Fares:** A 2 tier approach should be taken for deciding the fares. Premium Public Transport services can be provided at fares decided by market and services delivered by private operators. While for the low cost scheduled public transport services being provided by STUs supplemented with private operators, fares can be set up by authorities.

– **Improving Public Road Transport:** Multimodality as a concept does not have to be restricted to creating feeder services to metro rail systems alone; rather, the focus should be on providing end-to-end connectivity through public transport as well as NMT. To kickstart, urban India needs two types of bus services:

- **Scheduled Services:** These buses will ply at high frequency – depending on traffic demand – with a basic focus on reliability and adherence to the timetable. This service can be offered by STUs or private operators or a combination of the two. Their performance must be evaluated by UMTA in terms of their adherence to the timetable. The private operators can be issued permits so as to regulate the number of buses and

also ensure that there is no 'competition' between competing bus operators to pick up passengers at bus stops. These private operators need to be evaluated based on the passenger feedback collected by UMTA from time to time.

- **Metered or App-Based Services:** These services would require the users to 'book' their seats on the bus. They could be covered by a separate permit that qualifies operators based on the quality of services and the customer experience that they offer. This would be a self-regulating segment that is regulated by market forces.
- **Performance Monitoring of Public transport:**
 - KPIs (key performance indicators) should be developed to measure performance of public transport. The RTO should monitor the performance of different operators and decide on whether to extend the license or not.
 - Improving public transit efficiency and convenience with route rationalisation and better vehicles will support public transit.
- **Phasing out the old internal combustion-based vehicles:** A strict deadline for phasing out old internal combustion vehicles and long-term shift to zero emission vehicles should be announced.
- **Low and zero-emission zones in peak hours:** Low-emission and zero-emission zones lead to decongestion of traffic and reduction in the number of private cars on the roads. Commuters are incentivised to seek public transport. Clearly, these zones need to be defined in accordance with local/city concerns. Extra charges can be levied on private vehicles if they enter the congestion zones in peak hours. Congestion charges can also be levied on certain routes based on the timing of travel.
- **Dis-incentivising Vehicle Ownership:** The major cost in the vehicle ownership are externalised, thus actual cost of private vehicle ownership should be internalised for highlighting the negative impacts.
 - Creation of low and zero emission zones in peak hours
 - Raising parking prices
 - Congestion based pricing: Extra charges can be levied on private vehicles if they enter the congestion zones
- **Introduction of Vehicle Scrapping Policy:** Many old vehicles with outdated pollution certificates continue to ply on the road even after their fitness expires. These vehicles cause pollution as well as congestion, occupying parking spaces in the cities or add to the congestion by parked in the wrong area. Thus, a strict vehicle scrapping policy is required.
- **Accessibility:** The accessibility of public transport and related infrastructure should be increased for specially-abled and older citizens. Design changes need to be made for easy and safe transfer of people using public transport to increase equity. For e.g. Delhi metro has made efforts to increase accessibility for specially-abled by providing foot markings, tactile paving wheelchairs etc.
- **Safety:** Designating road space for pedestrians and cyclists in proportion to the demand for NMT is crucial. Physical measures such as wide, well-lit, and well-drained sidewalks, are important for reducing conflicts between people and vehicles on higher-speed roads.
- **Changes for adopting new solutions:**
 - Mechanism should be developed for assessment and approval of new propositions.
 - Local pilot projects proposing innovative solutions should be tested. The successful pilot projects need to be scaled up with conducive government policies after standardisation for all over India deployment.
 - **Data and information technology:** Data will be a key enabler for transitioning to shared mobility and MMI. Standards are required for data sharing. Intelligent systems are to be used in public transport for optimising the resources. A platform should be developed to connect various forms of mobility to provide seamless multimodal transport across services. Knowledge-sharing platforms should be created so that early adopters of intelligent transportation system (ITS) and other new technology can share their learning with newer adopters. Demonstrated early wins include cashless ticketing using mobile phones as a way to improve passenger security and reduce transfer costs, and ride-matching and e-hailing services to improve the first/last mile connectivity of formal transit.

- **Infrastructure:** There is a need to first allocate space to pedestrians, bicyclists and public transport, and then to personal motor vehicle users, in order to promote and encourage the use of a sustainable transport system in cities. Cities should focus on developing infrastructure for shared mobility, NMT and public transport to avoid bottlenecks in future development.
- **Interoperability and Integration of different modes:** Integration requires a paradigm shift in city governments' thinking and organisation. Governments must take responsibility for developing and nurturing their entire multimodal transport network, including both formal and informal transit and private operators.
- **Incubation centres:** Incubation centres at city or state level to give backing to promising solutions in urban areas and particularly to urban mobility. Entrepreneurship will enable faster transition.
- **Reducing the travel demand:** The need for travel, especially during peak hours can be reduced by using new solution like remote working. Government authorities responsible for traffic management may engage with businesses to encourage a tele/e-work culture and flexi-work hours as well as encourage them to develop sustainable mobility plans for their staff.
- **Training and skilling of workforce in mobility solutions** will be required for bridging the gap between present and future mobility. Workforces need to train in handling EVs both in manufacturing and maintenance as well as in developing infrastructure for same. Gap assessment and plan for bridging the gap need to be developed.
- **Government officials' capacity building is required on:**
 - Linkages between climate change, urban development, and planning for climate resilience.
 - Knowledge and Data handling: Central data repositories will need to be handled by government for success of intelligent transport. Thus, knowledge about data management, security, access etc., is to be delivered.
 - Involvement of designers, planners and all stakeholders on climate resilient mobility planning for urban areas.
- **Research and Development Institutions in the field of urban mobility:** Presently, the country has institutions but research is lagging behind the industry. Thus an active interaction between industry and these institutions should be enhanced.

Closer to the Destination: Actionable Recommendations

SHORT TERM (2020-2022)	
HIGH PRIORITY ACTION What: Form UMTA and set up a task force. Citizen Charter for Urban Mobility (CCUM) at Strategic, Tactical and Operational Level Who: State Government (Legislation)	IMPACT A transformational impact will be created on integrated urban mobility. There will be market access for public bus operators for providing app-based public transport, backed by the availability of bus-ports. Bus Ports should be made available to the private bus operators from the government.
What: Change in the permit system. One Country One Permit to incentivise interstate shared mobility and public Transport Redefine RTO's role in qualifying bus operators for providing MAAS under direction of the Urban Mass Transit Authority Who: State Transport Department and UMTA	This will provide improved access to quality public and shared transport. There will be a sustained improvement in the quality of service and increased supply of quality private operators. Here, the role of the RTO will be redefined by digitisation and automation of licensing, fitness certification with minimal F2F contact.
What: Establish state-level innovation parks with specific funds for mobility Who: State Government and UMTA	This will lead to reduced congestion and emissions.

MEDIUM TERM (2020-2030)

- Extend incentives for public transport, limit registration of private vehicles in large metros, enforce congestion charging and implement Scrap Policy rigorously
- Set up Scheduled Services and app-based Services for Public Transport
- Implement new technologies for last-mile connectivity, such as urban ropeways, shared mobility, and infrastructure and technologies for

non-motorised transport

- Increase utility of Bus Ports through allowing their use by private operators under PPP model.
- Implement TOD rigorously
- Develop and implement Integrated Transport Mobility Plan

LONG TERM (2030-2050)

Invest in advanced technologies for electric mobility and intelligent transport systems.

LOW-CARBON ENERGY SUPPLY STRATEGY

Change is a revolution that lies low, but leaves a deep impact.

In 2013, 97% authors of 4014 research papers were unanimous that humans are the cause of global warming. The largest human influence has been the emission of greenhouse gases such as carbon dioxide, methane, and nitrous oxide. The main human activity that emits CO₂, is the combustion of fossil fuel such as coal, natural gas and oil, for energy and transportation. Most of the GHG emission from transportation is CO₂ resulting from the combustion of petroleum-based products. Relatively small amounts of methane (CH₄) and nitrogen oxide (N₂O) are emitted during fuel consumption. A small amount of hydrofluorocarbon (HFC) emissions is also attributed to transportation. The breakup of CO₂ emissions in India is as under:

1. Energy sector (including transportation sector) 68.7%
2. Agriculture 19.6%
3. Industrial processes 6%
4. Land-use change and forestry 3.8%
5. Waste 1.9%

CO₂ is continuously being exchanged in the atmosphere, ocean and land surface as it is produced and absorbed by many microorganisms, plants and animals. Emission and removal of CO₂ by these natural processes tend to balance out absent anthropogenic impacts.

Countries work together on climate change under the umbrella of the United Nations Framework Convention on Climate Change (UNFCCC), which has near-universal membership. The ultimate goal of the convention is to “prevent dangerous anthropogenic interference with the climate system”. Parties to the UNFCCC have agreed that deep cuts in emissions are required and global warming should be limited to well below 2 °C (3.6 °F) in the Paris Agreement. Yet the Earth’s average surface temperature has already increased by about half this threshold, and current pledges by countries to cut emissions are inadequate to limit future warming.

SECTION 1: ENERGY FOR TRANSPORT

The transport sector at the global level continues to grow unabated, with several experts forecasting a potential doubling of transport activity by 2050 which gives a Business as Usual (BAU) emission scenario of 12-13 GtCO₂e per year by 2050 (as per GMR).

Heart of the Problem

The transport sector accounts for nearly 18% of the total energy consumed in India. Nearly 98% of the energy needs of transportation are met through petroleum products and almost half of the total consumption of petroleum products in India occurs on account of transport activities.

India’s total GHG emissions in 2014 were 32.02 billion metric tons of CO₂ (BtCO₂e) totalling 6.55 % of Global GHG emission. In 2018 India contributed 7% of CO₂ emission out of 37.1 Bt CO₂ in the world. However, India is the 3rd largest producer of CO₂ in the world. In 2018, the GHG emissions increased by 4.8 % from the preceding year, though the per capita CO₂ in India is only 40% of the global average.

As per a study by the Ministry of Environment, Forest and Climate Change (MoEFCC), the energy sector is the largest CO₂ emitter, as most of the electricity is generated from coal in India. The transport sector is the second largest contributor to CO₂ of which road transport contributes 87% of total CO₂ equivalent. By 2030, road transport is expected to contribute 850-900 MT of CO₂ if BAU continues^{ab}. These huge numbers add up to a large impending problem in the energy utilised for transport. And the future of this sector depends on how we respond to it today

Existing Policy Response

In Nov-2017, the Paris Process on Mobility and Climate (PPMC) issued a GLOBAL MACRO ROADMAP (GMR) outlining an actionable vision towards decarbonised, resilient transport, implementing the Paris Agreement on climate change in the transport sector. This was in support of a net zero-emission, climate-resilient economy by 2050 or shortly thereafter.

According to the GMR, at present, the sector as a whole (mobility of people and transportation of goods) accounts for about 7.7 Gt of CO₂ emissions, with 23%

CO₂ emissions from the burning of fossil fuels and 14% from anthropogenic GHG emissions making it one of the largest sources of CO₂ emissions. Road and rail transport represent the bulk of transport emissions. The GMR envisaged both short as well as mid to long term actions, and stipulated a three-pronged low carbon energy for transport strategy including:

- Decarbonising power generation
- Developing a clean hydrogen industry
- Ensuring a sustainable bio or synthetic fuel supply with improved energy efficiency as a key part of transport sector transportation

CROSSROADS OF CHANGE



A total of 195 Countries negotiated on and adopted the Paris Agreement (PA), which includes the objectives to peak greenhouse gas emissions as soon as possible. This is with an aim to limit the global average temperature increase above pre-industrial level to well below 20°C and pursue to limit the increase to 1.50°C.

The PA, which entered into force on November 4, 2016 requires Parties to put forward their best efforts through “Nationally determined Contributions (NDCs)”. India’s first NDC inter-alia includes:

- Reduce the emissions intensity of GDP by 30-35% from 2005 levels by 2030.
- Achieve about 40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, with the help of the transfer of technology and low-cost international finance including from Green Climate Fund (GCF)
- Better adaptation to climate change by enhancing investment in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, health and disaster management and regions such as Himalayan region and coastal regions.

India has already been progressing steadily on the path of reducing the emission of CO₂ and greenhouse gases. There has always been a considerable amount of emphasis on renewable energy. The current installed power generation and energy capacities and the way forward are:

Table 1: Cumulative installed capacity as on 31-01-2019^o

Sector	Figures in MW	Proportion in %
Hydro*	45399	13.0
Coal+ Lignite	197452	56.5
Gas	25575	7.3
Nuclear	6780	1.9
RES	74081	21.2
Total	349287	

Table 2: Installed generation for 2018-19 as on 31-12-2018

Sector	Figures in MWh	Proportion in %
Thermal (Coal+ Lignite+Gas)	805433	76.9
Nuclear	28457	2.7
Hydro	111719	10.7
Bhutan Import	4322	0.4
RES	97923	9.3
Total	1047854	

Though the installed capacity of thermal (coal + lignite + gas) sources is about 64% of the total installed capacity, the generation from these sources is around 77% of the total. The share of RES is 21% of the total installed capacity, but its share in the total energy generation mix is only 20% (including share of hydro). This is due to the intermittency of renewable energy resources and lack of storage options, which limits the plant utilisation.

In the Union Budget of 2015, the Government of India set the target of achieving 175 GW through RES by 2022, comprising:

- 60 GW from wind
- 100 GW from solar
- 10 GW from biomass

- 5 GW from small hydro.
- Of 100 GW solar, 40 GW is estimated to be from roof top solar while the remaining 60 GW to be from ground-mounted, grid-connected medium and large solar projects.

The estimated RE potential versus RE target is depicted:

Table 3: RE capacity: Potential Versus Target 2022

Sector	Potential (GW)	Target by 2022 (GW)	Apportionment (%)
Solar	750	100	13
Roof Top		40	
Ground-mounted		60	
Wind	750	60	8
Small/ Mini Hydro	21	5	24
Biomass Energy	25	10	40
Total	1546	175	11

Table 4: Progressive Installed RE Capacity Targets (GW) Sector-wise^d

Year	Roof Top Solar	Ground-Mounted Solar	Total Solar	Wind	Small Hydro	Biomass	Total
2014-15 Cumulative capacities		3	3	24	4.1	4.4	35.5
2015-16	0.2	1.8	2	3.2	0.14	0	5.3
2016-17	4.8	7.2	12	3.6	0.14	0.9	16.6
2017-18	5	10	15	4.1	0.14	0.9	20.1
2018-19	6	10	16	4.7	0.14	0.9	21.7
2019-20	7	10	17	5.4	0.14	0.9	23.4
2020-21	8	9.5	17.5	6.1	0.14	0.9	24.6
2021-22	9	8.5	17.5	8.9	0.14	0.9	27.4
Total (GW)	40	60	100	60	5.08	9.8	174.9

If the target of 175 GW by 2022 is achieved, it would contribute to 11 % of total RE potential of 1546 GW. The grid-scale battery energy storage technologies have started gaining popularity globally as their cost of installation is falling over the years. Since roof top space is limited it is imperative that this space is occupied only by the high efficiency (KW/sqm) solar panels.

The estimated installed capacity and generation mix of fossil & non-fossil fuel by 2029-30 is:

Table 5: Estimated installed capacity mix of fossil & non-fossil fuel by 2029-30

Fuel Type	Capacity (MW) in 2029-30	Percentage Mix (%)
Coal + Lignite	266827	32.1%
Gas	24350	2.9%
Sub Total Fossil Fuel	291177	35.0%
Hydro*	73445	8.8%
Nuclear	16880	2.0%
Solar	300000	36.1%
Wind	140000	16.8%
Biomass	10000	1.2%
Sub Total Non-Fossil Fuel	540325	65.0%
Total (MW)	831502	

Table 6: Estimated Gross Generation (BU) in 2029-30^e

Fuel type	BU	% Proportion
Hydro*	197	8
Coal+ Lignite + Gas	1297	52
Nuclear	101	4
Solar and Wind	887	35
Biomass	26	1
Total	2508	

Thus by 2029-30, non-fossil fuel-based installed capacity is likely to be about 65% of the total installed capacity. Non-fossil fuel would contribute around 48% (including hydro) of the gross electricity generation in the year 2029-30.

^e It was observed that the RE generation falls in the range of 0% (on minimum RE generation day) to 17 % (max. RE generation day)

Challenges Along the Way

Compared to 2018-19, the installed capacity and energy will increase from 349 GW to 841 GW and 1048 BU to 2508 BU respectively by 2030. Wheeling of this energy will necessitate significant upgradation of transmission and distribution network.

The percentage of non-fossil fuel in installed capacity will increase from 36.15 % in January 2019 to 65 % by March 2030. As per INDC target, the percentage of non-fossil fuel in installed capacity is 40%. Thus, INDC targets are likely to be exceeded by a significant margin.

Table 7: Likely Annual CO₂ emission

	Year 2022 (as per NEP ¹)	Year 2029-30
CO ₂ Emission in Million Tonnes	1026	1154

The International Energy Agency (IEA) predicts that decarbonised power production (20g CO₂/kWh) will be possible by 2050 in the OECD countries. Developing countries are likely to take longer (2070).

To get the impetus, countries that are currently above 400-600 g CO₂/kWh (India- 800-1000g CO₂/kWh) will need to embrace a shift in the primary energy mix without delay and prioritise renewable sources (solar & wind) of energy.

Decarbonising power production would need:

- Supporting renewable energy through better storage (batteries, supercapacitors and H₂) and by SMART grids to optimise energy needs and flows. Development of e-mobility with matching interoperable charging infrastructure.
- Closer alignment of energy and transport sector for developing a joint pathway for the production of renewable sources of energy and their deployment in transport.

Routes to Change

As is evident, climate change related to the transport sector requires short, medium-term and long-term solutions. Renewable energy will play a significant role in implementing this change. The energy, transport and infrastructure sectors will need to work in tandem to develop a sustainable pathway for the production of renewable sources of energy, which will give a facelift to the transport sector as we know it today.

SECTION 2 – OIL & GAS

To reduce dependence on oil and make meaningful efforts to decarbonise the transport sector, renewable fuels provide a plausible solution with minimal changes to vehicle stocks and distribution infrastructure. The Government of India has prepared a road map that envisages a strategic role for biofuels in the Indian energy basket to reduce the import dependency in the oil & gas sector. The Government envisions the scope for the higher production of biofuels. It believes that higher production of biofuels will increasingly substitute fossil fuels while making a significant contribution towards the national energy security, climate change mitigation, besides creating new employment opportunities in a sustainable way.

Prioritisation of renewable energy is key to low carbon supply strategy

Heart of the Problem

The total energy consumption of India during 2017, as per British Petroleum (BP) and using conventional sources such as oil, coal & natural gas has been 692 MMtOE. As per the India Energy Outlook of IEA, this is expected to rise to 1018 MMtOE by 2020 and 1440 MMtOE by 2030.

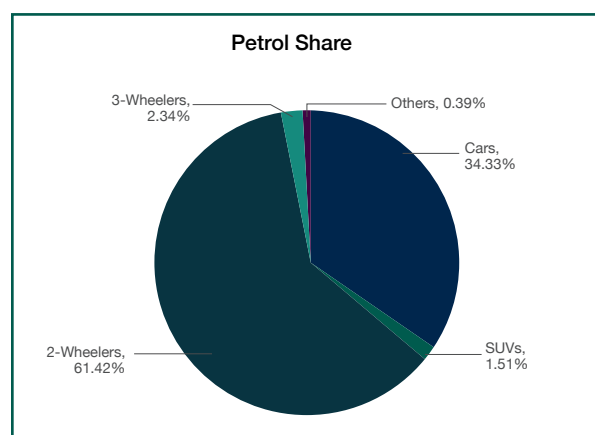
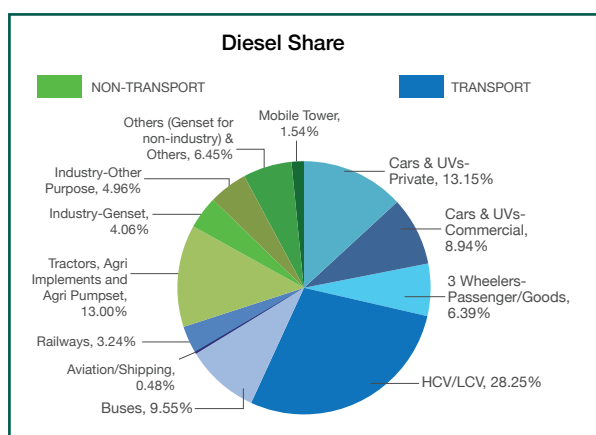
India's dependency on fossil fuels for its energy needs has two major concerns: a growing import bill (India imports 80% of crude oil for 40% of its energy requirements) and carbon emissions.

India's transport sector is a major energy consumer, accounting for more than half of the country's total petroleum consumption and 18% of its total energy. It also accounts for about 13% of the carbon emissions from the energy sector.

The road transport sector accounts for 6.7% of India's GDP (gross domestic product). Currently, diesel

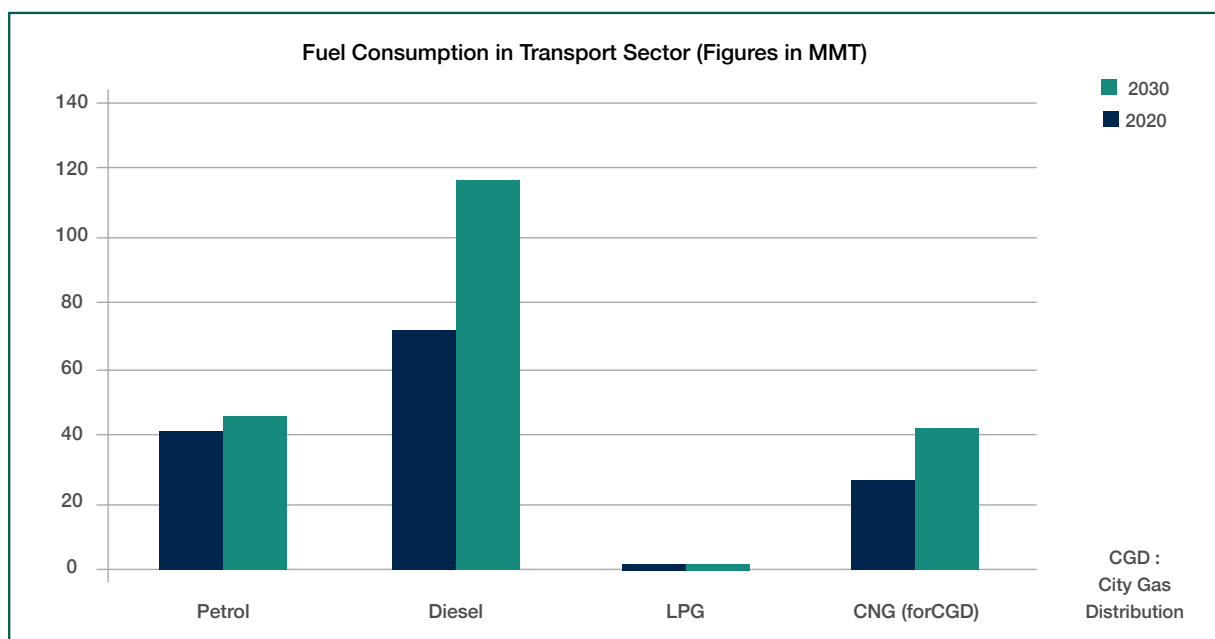
alone meets an estimated 72 % of transportation fuel demand followed by 23% petrol and balance by other fuels such as CNG, LPG and others. Country imports 80% of crude for 40% of energy. Crude oil required for internal consumption of petroleum products in FY 2017-18 was about 210 MMT.

All India end-use share of diesel and petrol in retail across various sectors according to Petroleum Planning & Analytical Cell (PPAC) is provided in the charts below:



In 2018-19, the total diesel consumption was 83.5 MMT and petrol consumption was 28.3 MMT. Out of this, 99.61 % of petrol and 70% of diesel had been consumed in transport. This translates to about 262 MMT of CO₂ emissions by diesel and about 87.5 MMT of CO₂ emissions by petrol consumption.

As per the BAU (business as usual) scenario, the energy from conventional sources (Coal, Oil, and Gas) will attribute 78% (48% Coal, 23% Oil, 7% Gas) by 2030, with an increase of 41% from 2017 to 2030. The transport fuel demand growth, combining PPAC The Petroleum and Natural Gas Regulatory Board (PNGRB) and internal projections with a CAGR in passenger transport is estimated at 4.4% and freight transport at 6.8% from 2015 to 2040. The contribution of natural gas in the transport sector has been considered as 20%.



MoP&NG forecast for Petroleum Products demand, for planning Refinery capacity, by 2030 & 2040 is as under:

S.No.	Item	Requirement in MT	
		2040	2030
1	Diesel	240	163
2	Petrol	83	49
3	LPG	41	34

Existing Policy Response

Various notifications specifying mass emission standards for Compressed Natural Gas, Biodiesel (B-100), Flex fuel (E 85) or (E100) and Ethanol (ED 95), LNG and Flex fuel Methanol M15 or M100, Methanol MD 95, A20 (blend of 15% methanol and 5% ethanol) and dual fuel vehicles have been issued by the Government of India.

The Government of India has also prepared a roadmap that envisages a strategic role for biofuels in the Indian energy basket to reduce import dependence on oil & gas sector by adopting a four-pronged strategy:

- (i) Increasing Domestic Production,
- (ii) Adopting Biofuels & Renewables,
- (iii) Implementing Energy Efficiency Norms, and

- (iv) Improving Refinery Processes and Demand Substitution.

The roadmap envisages a strategic role for biofuels in the Indian energy basket. The Government has already announced policies that have set the broader framework and provided the initial thrust required for the development of the sector.

National Policy on Biofuels 2018

Thrust Areas: Increase in domestic production, setting up Second Generation (2G) biorefineries, development of new feedstock & technologies

New Feedstock: B-Molasses, Sugarcane Juice, Agriculture Residues, Sugar & Starch Crops, Damaged Food Grains etc. for Ethanol

Non-edible Oilseeds, Used Cooking Oil (UCO), Animal Tallow, Acid Oil, Algal Feedstock etc. for Biodiesel

Biomass, MSW, Industrial Waste, Plastic Waste etc. for Advanced Biofuels

Biomass Potential: Biomass surplus availability: 120-160 MMT

Bioethanol potential: 30,000 Million Litre

Indicative blending target by 2030: Ethanol in Petrol : 20%, Biodiesel in Diesel : 5%

Ethanol Blending Programme (EBP): The Ethanol Blending Programme (EBP) was announced by the Government of India on 4 September 2002. Initially, the blending was permitted up to 5% of Ethanol in petrol, which was later revised to up to 10% blending on 2 February 2013.

Biodiesel: Policy initiatives have been undertaken by Government of India to increase biodiesel blending. In 2003, a National Biodiesel Mission (NBM) was formulated with a goal of 20% biodiesel blends by 2011-2012. In December 2009, in order to strengthen and formalise the country's commitment to promoting a sustainable biofuels industry, India adopted the National Policy on Biofuels. The policy encouraged the use of renewable fuels and proposed a 20% biofuel (ethanol and biodiesel) mandate by the end of 2017.

Compressed Biogas under SATAT scheme: Ministry of Petroleum & Natural Gas has launched the 'SATAT' (Sustainable Alternative Towards Affordable Transportation) scheme for CBG (Bio-CNG) on 1.10.2018. It envisages targetting production of 25% of available CBG potential in the country i.e. 15 MMT by 2023, from 5000 plants. 15 MT of CBG corresponds to over 1/3rd of present natural gas consumption of 44 MMT. Thus, production of CBG from biomass/waste resources can substitute the import of LNG in the country.

Pradhan Mantri JI-VAN (Jaiv Indhan-Vatavaran Anukool Fasal Awashesh Nivaran) Yojana' provides financial support to integrated bioethanol projects using lignocellulosic biomass and other renewable feedstock. The JI-VAN Yojana will be supported with total financial outlay of INR 19.695 billion from 2018-19 to 2023-24. Out of the scheme fund of INR 19.695 billion, INR 18 billion has been allocated for supporting 12 commercial projects, INR 1.5 billion has been allocated for supporting 10 demonstration projects and remaining INR 0.95 billion will be provided to Centre for High Technology (CHT) as administrative charges.

The Government is extending soft loans of INR61.39 billion through banks to the sugar mills for setting up new distilleries and installation of incineration boilers to augment ethanol production capacity. The government will bear interest subvention of INR 13.32 billion for this. Further, government has planned to create a buffer stock of 3 million MT to be maintained by sugar mills for which the government would reimburse carrying cost in terms of interest, insurance & storage charges towards the maintenance of buffer stock.

'Galvanising Organic Bio-Agro Resources Dhan (GOBAR-DHAN)' scheme: To convert cattle dung and solid waste in farms to CBG and compost. GOBAR-DHAN scheme proposes to cover 700 projects across the country in 2018-19. The programme will be funded under Solid and Liquid Waste Management (SLWM) component of Swachh Bharat Mission-Gramin (SBM-G) following the suggested guidelines of SBM-G.

The total assistance under SBM-G for SLWM projects is on the basis of total households in each Gram Panchayat (GP), subject to a maximum of INR 0.7 million for a GP having up to 150 households, INR 1.2 million up to 300 households, INR 1.5 million up to 500 households and INR 2 million for GPs with more than 500 households. Only those Gram Panchayats that have not availed SLWM funds under SBM-G are eligible to receive the financial assistance under GOBAR-DHAN scheme.

Ministry of New and Renewable Energy has notified Central Financial Assistance (CFA) of INR 0.04 billion per 4800 kg of CBG per day generated from 12000 m3 of biogas per day, with a maximum of INR 0.1 billion per project. The CBG generation shall be based on biogas generated from urban waste/agricultural waste/industrial wastes/effluents or a mix of these wastes. In case the developer wants to set up CBG generating unit at already existing biogas generation unit, applicable CFA will be INR 0.03 billion. As per the policy, INR 0.01 billion CFA has also been provided per 12000 m3 biogas/day for biogas generation from urban waste/agricultural waste/industrial wastes/effluents or a mix of these wastes (distillery effluent is excluded).

Blending of various fuels by Indian Oil:

Year (April-March)	Percentage of ethanol blended in Petrol	Percentage of biodiesel blended in Diesel
2015-16	3.46%	0.01%
2016-17	3.54%	0.04%
2017-18	2.80%	0.05%
2018-19	5.25%	0.08%

Challenges Along the Way

1. Renewable Fuel: There is a pressing need for renewable fuels in India, and a range of critical factors affect the Renewable Fuel Supply Chain. It is crucial to understand them before they can be addressed.

a. **Bioethanol:** 1G and 2G: As per the current production, even after using additional sugarcane juice or the B-molasses pathway, it will not be possible to achieve the targeted 20% ethanol blending envisaged under National Biofuels Policy-2018. Even in countries such as USA and Canada, the ethanol blending is 10%. There is a pressing need for alternate feedstock. Additionally, import of biofuels is not allowed under National Policy on Biofuels 2018. Blending of 10% Ethanol would require Bio-Ethanol of 6,533 million liters by (2030).

b. **Biodiesel:** According to the Biodiesel Association of India, the installed production capacity of biodiesel in the country is ~1.2 MMT. Currently, at around 0.3 MMT, Indian domestic production is insufficient to meet

the palm oil demand in the country, leading to India's dependence on imports of palm oil from Indonesia and Malaysia. The biodiesel blending percentage achieved so far has been extremely insignificant (<0.03%).

To achieve the target of 10% blending of Biodiesel, 6.3 million tons of Biodiesel would be required by 2030.

c. The figures are likely to be lower with

(a) Bio-CNG displacing MS

(b) EVs with Batteries and Direct Alcohol Fuel Cells displacing ICEs, (c) Public Transport & Shared Mobility reducing Personal Vehicles use.

(c) **Used Cooking Oil:** Used Cooking Oil (UCO) which is waste or spent cooking oil collected from commercial food factories, restaurants, schools' canteens, bakeries, etc. is a potent feedstock for increasing biodiesel production due to its triglyceride and free fatty acid content. The potential of Biodiesel from UCO in India is estimated as 3 MMTPA. However, the collection and supply of UCO remain a big challenge.

2. Framing of Standards will Set the Right Precedent

a. **Compressed Biogas (CBG):** Automotive grade CBG shall meet IS 16087:2016 specifications of BIS and further revisions in the said specifications.

IS 16087 : 2016 Standard		
S No.	Characteristic	Requirement
1	Methane percentage (CH ₄), minimum	90.0 %
2	Only Carbon Dioxide percentage (CO ₂), maximum	4%
3	Carbon Dioxide (CO ₂)+ Nitrogen (N ₂)+ Oxygen (O ₂) percentage maximum	10%
4	Oxygen (O ₂) percentage maximum	0.5%
5	Total sulphur (including H ₂ S) mg/m ³ , maximum	20 mg/m ³
6	Moisture mg/m ³ , maximum	5 mg/m ³

b. **Ethanol:** IS 15464: Anhydrous Ethanol for Use in Automotive Fuel

c. **Biodiesel:** For Biodiesel, Biodiesel (B100) - Fatty Acid Methyl Esters (Fame) Specifications are used. While pure (100%) Biodiesel is referred as B100, a 20% blend of Biodiesel with regular diesel is referred as B20, and so on. The Bureau of Indian Standards (BIS) has developed standards for standalone Biodiesel (B100), B5 and biodiesel blends from B6 to B 20.

3. Government support will be vital

- a. **Compressed Biogas:** There will be a need for assured supply of segregated waste and biomass at a long term steady price to ensure plant viability and bankability. CBG will need to be included in the priority sector lending with interest subvention scheme and in the 'White Category' for Pollution Clearance.
- b. **Bio-manure from CBG Plants:** To ease production and propagation of bio-manure, specifications in The Fertiliser Control Order 1985 (as amended up to January 2018), may be introduced for Bio-Manure from CBG plants in line with specifications for Bio-enriched organic manure and City Compost (where moisture content maximum 40% and NPK Nutrients - total N, P_2O_5 and K_2O nutrient should not be less than 1.2%). A mandate of 20% blending of bio-manure with chemical fertilizers will be needed
- c. **Financing of CBG Plants:** The CBG Plants will require assistance from banking sector for financing. The All India Financial Institutions such as National Bank for Agriculture and Rural Development (NABARD), Small Industries Development Bank of India (SIDBI), PSEBs have to extend assistance to ensure success of the projects. CBG plants under the SATAT scheme may be included in Priority Sector Lending under Renewable Energy for ease of soft financing for such projects. State wise Nodal Officers may be nominated by lead Banks for facilitating loans on CBG Plants.
- d. **Waste to Fuel:** Segregated waste will need to be delivered free of cost, land given on nominal lease, and Municipal Corporation will need to participate in the waste supply chain.

Routes to Change

In Oil and Gas, a line-up of solutions is proposed to bring about impending change:

1. Renewable Fuels will be at the Centre of Change

In order to reduce dependence on oil and contribute to the growing efforts to decarbonise the transport sector, renewable fuels provide a way of shifting to low-carbon, non-petroleum fuels, often with minimal changes to vehicle stocks and distribution infrastructure.

Renewable fuels are fuels produced from renewable resources. Examples include: Biofuels (e.g. Bioethanol, Biodiesel, Biogas, Biomethanol etc.) and Biohydrogen. Renewable fuels can also include fuels that are synthesised from renewable energy sources, such as wind and solar.

Classification of Biofuels			
Generation	Feedstock	Technology	Example
First Generation (1G) Biofuel	Sugar, starch, vegetable oils, or animal fat	<ul style="list-style-type: none"> Cold / hot pressing, extraction & Transesterification Cold / hot pressing, extraction, and purification Hydrolysis and fermentation 	Bioethanol, vegetable oil, bio-diesel, biogas
Second Generation (2G) Biofuel	Non-food crops, rice/ wheat straw, corn, wood, solid waste, energy crop	<ul style="list-style-type: none"> Hydrolysis & fermentation Pyrolysis, gasification, methanation Pyrolysis, gasification, water gas shift reaction (WGSR) 	Cellulosic bioethanol, bio SNG, synthetic biofuels and bio-hydrogen
Third Generation (3G) Biofuel	Algae	<ul style="list-style-type: none"> Transesterification Fermentation 	Vegetable oil, biodiesel

The vision for renewable or alternative fuels in the country is to utilise, develop and promote domestic feedstock, and its utilisation for producing biofuels. This will help in increasingly substituting fossil fuels while contributing to national energy security, climate change mitigation, besides creating new employment opportunities in a sustainable way.

a. Bioethanol: 1G and 2G

Bioethanol is an alcohol ($\text{CH}_3\text{CH}_2\text{OH}$) made by fermentation, mostly from carbohydrates produced in sugar or starch crops, such as corn or sugarcane (1st generation) or from cellulosic biomass, derived from non-food sources, such as crops, plants and grasses (2nd generation).

Ethanol can be combined with petrol in any concentration up to pure ethanol (E100). Anhydrous ethanol, that is, ethanol without water, can be blended with petrol in varying quantities to reduce the consumption of petroleum fuels, as well as to reduce air pollution.

2G ethanol, one of the potential alternative solutions, refers to the ethanol produced from lignocellulosic material. The feedstock includes agri-residues like rice & wheat straw, sugarcane bagasse, corn cobs and stover, cotton stalk etc. which are inedible.

As per an estimate, surplus biomass availability in the country is in the range of 180 MMT per annum, which, if converted, has the potential to yield 50 million litres of ethanol annually.

b. Bio-methanol & Bio-dimethyl Ether (Bio-DME)

Methanol (CH_3OH) is the simplest member of a group of organic chemicals called alcohols. Also known as wood alcohol, it is generally produced by steam-reforming natural gas to create syngas (a mixture of H_2 and CO).

Dimethyl ether (DME) is the simplest ether, consisting of two methyl groups bonded to a central oxygen atom (CH_3OCH_3); also known as wood ether. The energy efficiency and power ratings of DME and diesel engines

are virtually the same. DME does not have any carbon-to-carbon bonds – thus using it as an alternative to diesel can virtually eliminate particulate emissions and potentially negate the need for costly diesel particulate filters. However, DME has half the energy density of diesel fuel, requiring a fuel tank twice as large as that needed for diesel.

c. Plasma Gasification

Plasma gasification is an emerging technology that can process Municipal Solid Waste (MSW) and other wastes including hazardous ones to convert carbon-based materials into fuels.

Plasma gasification gets its name from the use of plasma torches to enhance gasification in addition to conventional furnace, as opposed to conventional fires and furnaces.

As per the report of the Task Force on Waste to Energy, constituted by erstwhile Planning Commission, **62 million tonne of MSW is annually generated in urban India.**

This may be utilised to produce about 9 billion litres of bioethanol, based on plasma gasification technology. As per PPAC, the total consumption of petrol in 2017-18 was 33 billion litres. Thus, bioethanol from MSW route can achieve 27% ethanol blending.

d. Compressed Biogas

Producing CBG from biomass/waste resources can substitute the import of crude and LNG in the country. Waste/biomass sources, agriculture residue, cattle dung, sugarcane press mud, municipal solid waste and sewage treatment plant waste, etc. produce biogas through anaerobic decomposition. This biogas can be purified to remove hydrogen sulphide (H_2S), carbon dioxide (CO_2), water vapour. Biogas can be used as a fuel for the production of electricity, cooking and transportation fuel and to produce CBG.

e. Biodiesel

Biodiesel is a renewable alternative fuel created from new and used vegetable oils, animal fats and greases through a chemical process called transesterification.

Biodiesel can be blended with petroleum diesel in any percentage, including B100 (pure biodiesel) and, the most common blend, B20 (a blend containing 20% biodiesel and 80% petroleum diesel). The blended diesel significantly reduces emissions and gases that contribute to global warming.

f. Biofuels from Algae

Algae are single-celled organisms having a photosynthetic ability to convert sunshine into chemical energy. For some species of algae, this chemical energy exists in the form of oils very similar to common vegetable oil. These oils can be processed and used to produce biodiesel.

g. Drop-in Fuels & Bio-crude

According to IEA, drop-in biofuels are defined as “liquid bio-hydrocarbons that are functionally and chemically similar to petroleum fuels and are fully compatible with existing petroleum infrastructure”.

Drop-in biofuels are liquid hydrocarbons that are functionally equivalent and as oxygen-free as petroleum derived transportation blend stocks (fuels).

2. Feedstock for Renewable Fuels will be Crucial

Feedstock and potential of ethanol and CBG production is available from a range of sources:

Source	Availability	Ethanol Potential	CBG Potential
		Mill. Its	MMT
Agriculture Residue	180 MMT	52	18
Press Mud	15 MMT		
Spent Wash	30 billion lt.		14
Bagasse	115 MMT		
Collectible Cattle Dung	700 MMT		41
Chicken Litter	25 MMT		
Forest Residue	220 MMT		22
Municipal Solid Waste	72 MMT		3
Total		52	98

Potential sources for the future could be specific energy crops grown in barren, waste and single cropland.

3. Government Support and Financing will give the Right Impetus

Government policies would be the major drivers for the growth of the biofuel industry. The variability in petroleum prices that impact the short-term demand and investment in biofuel projects, need for rural development, energy security, reduction in import dependence, environmental concerns would be major contours of the policy framework for biofuels.

THE CASE OF HYDROGEN

Hydrogen is considered an alternative fuel due to its ability to power fuel cells in zero-emission electric vehicles, its potential for domestic production, and the fuel cell's potential for high efficiency.

It is an energy carrier that can be used as a possible substitute for liquid and fossil fuels. Unlike conventional biofuels (bio-ethanol, biodiesel, biogas, etc.) and fossil fuels, hydrogen produces only water as the by-product of its combustion; and hence, is considered as one of the cleanest renewable energy carriers for future.

- Hydrogen fuelled automobiles use hydrogen on-board to generate motive power, either directly through internal combustion engine or indirectly, i.e. first to electrical energy through fuel cell then to motive power. Hydrogen can be used in different configurations of Internal Combustion (IC) engine, such as spark ignition (SI) engine, compression ignition (CI) engine / dual-fuel engine and CNG dual-fuel engine. Hydrogen can also be blended with CNG to make HCNG (**HCNG = CNG + H₂**), which can be used as a fuel of the Internal Combustion Engine. HCNG is a cleaner source of fuel, more powerful and offers more mileage than CNG.

Presently, most of the hydrogen is produced from fossil fuels, which accounts for about 98% of its total production. Conventional physiochemical methods for H₂ production are based on steam reforming of natural gas (40 %); coal gasification (18%) and pyrolysis or gasification of biomass, which produces a mixture of gases (H₂, CH₄, CO₂, CO, and N₂). All these methods require high temperature (>850°C) and, therefore, are energy-intensive and expensive. In addition to the above, hydrogen is produced for non-energy application, e.g. in fertiliser industries and petroleum refineries.

In India, there are abundant sources of hydrogen in industries, which produce around 6600 tonnes of hydrogen (unutilised) from the Chlor-alkali industry alone, in 2016. Biological production of hydrogen is carried out using microorganisms in an aqueous environment at a particular temperature and pH. However, the yield of hydrogen production is low as compared to other conventional methods but there is reduced emission of GHGs by 50-70% using biological methods.

Hydrogen can also be produced by electrolysis of water. The most environment-friendly way to generate hydrogen would be via electrolysis with excess renewable energy. The current best processes, which have an efficiency of 50 - 80%, require 50 – 79 kWh electricity to produce 1 kg of hydrogen with a specific energy of 143 MJ/kg (Ministry of New and Renewable Energy 2016). At the cost of electricity as \$0.08/kWh, hydrogen from electrolysis would cost \$4.00/kg hydrogen, which is 3 to 10 times the price of hydrogen obtained from steam reforming of natural gas.

A variety of solid-state hydrogen storage materials like hydrides (MgH₂, Mg₂NiH₄, NaAlH₄, etc) can be used for hydrogenation and dehydrogenation reaction and storage of hydrogen. Hydrogen has the potential to replace LPG and CNG for cooking because it has superior characteristics to LPG and CNG fuel in terms of ignitability, it has a low ignition.

However, the biggest challenge in the hydrogen economy is the infrastructure.

Hydrogen storage needs special attention as hydrogen is the smallest molecule, lightest by density, has the lowest ignition energy and a wide range of explosion limits with air, leading to the embrittlement of materials of construction of hydrogen storage vessels and safety hazards. Currently, hydrogen is being stored in a compressed form, at 350 bars (5,000 psi) in onboard in demonstration vehicles and 700 bars (10,000 psi) in Type IV carbon composite cylinders. The cryogenic hydrogen can be stored in specially insulated vessels at (-) 252.88°C. The high pressures and special pipes needed to store hydrogen at ambient conditions make it difficult to transport and store. The cost of production of hydrogen is at the same level as that of its cost for distribution and storage (Dou, Sun, Ren, & Dong 2017)

The distribution cost is highest because special nickel pipelines are required to keep away from hydrogen embrittlement along with high-pressure compression costs.

The supply chain is not yet well established, especially in India where most of the material is sourced from abroad. Owing to this ecosystem, there is no commercially available fuel cell car in India yet. However, such cars by Toyota, Honda and Hyundai are available in countries like Japan, Germany and Korea.

Hydrogen unlocks many benefits and exciting future prospects

Hydrogen fuel cell-powered vehicles have a longer range and shorter refilling time. The fuel cells and hydrogen storage requires less space and weight (Thomas 2009). This is linked to the weight of the batteries and lifecycle greenhouse gas emissions needed to cover this extra range. At the same time, fuel cells can be combined with battery-powered EVs to extend their range.

CROSSROADS OF CHANGE



Today several EU nations and the USA are working towards Hydrogen Injection in the Gas Grid (HIGG), wherein Hydrogen up to 20% volume can be injected into the natural gas or CNG grid without any major changes (based on the country regulations). Hydrogen can be further removed using separation techniques eventually fueling fuel cell vehicles (Quarton & Samsatli 2018).

This would have significant cost reductions as compared to building a separate pipeline infrastructure for distributing hydrogen. Considering the fact that fossil fuels are not going to be removed as an energy source very soon, generating hydrogen via coal or natural gas and using Carbon Capture Utilization and Storage (CCUS) is another path being explored in various countries (NREL 2013).

Lastly, generating on-site hydrogen via electrolysis at locations that have lower electricity prices and excess renewable energy could be synergised with the hydrogen mix in natural gas grids. By 2030, solar and wind energy prices will drop down to 0.027-0.035 \$/kWh in India, which indicates a strong possibility of using excess renewable energy to generate hydrogen at a competitive price (Pachauri, Spencer, & G. Renjith).

Stranded power generation from renewable energy is yet another source of generating hydrogen that would otherwise be wasted.

Sourcing hydrogen from renewable energy via electrolysis is not only a sustainable method but has two-fold benefits.

- It reduces the oil and gas imports of India.
- Hydrogen purity is the highest when electrolysis is used while methods involving fossil fuels need downstream treatments to reach the required purity levels of fuel cells (Kalamaras & Efstathiou 2013).

Now, there are several lessons to be learnt on the way to building a hydrogen economy.

CROSSROADS OF CHANGE



Japan's Hydrogen Economy: Japan's hydrogen economy has been resting solely on a focussed approach and a wide cooperation system among the government, industry, and research sectors for developing technology and promoting the popularisation of hydrogen technologies. They are on track to having 200,000 fuel cell vehicles by 2025.

Their roadmap to a hydrogen economy is divided into three phases:

Phase 1 (2015): Focus on the rapid popularisation of the hydrogen economy, while investing heavily in research and development while introducing commercially available fuel cell products in mobility and power generation.

Phase 2 (2025): Fully introduce hydrogen power generation, establish large-scale infrastructure for hydrogen supply (Dou, Sun, Ren, & Dong 2017). With the increment of hydrogen demand, promote the utilisation of hydrogen technology to the field of unused energy so that hydrogen with electricity and heat would become three main forms of secondary energy.

Phase 3 (2040): Establish totally CO₂-free hydrogen supply systems. Combination of Carbon Capture and Storage in hydrogen production and utilisation of renewable fuel, a CO₂-free hydrogen supply system can be realised in totality. Similar strategies can be applied in the Indian context.

In 2004, the Ministry of New and Renewable Energy in the National Power Energy Roadmap projected that one million hydrogen-fuelled vehicles on road and 1000 MW aggregate hydrogen-based power generating capacity be set up in the country by 2020 through PPP. Though there has been an effort to encourage a hydrogen economy, the focus has probably been lost. However, recently, Tata Motors in association with Indian Oil Corporation has flagged off the trials of the first-ever hydrogen fuel cell power bus in 2018.

SECTION 3 - Energy for Electric Vehicles

Electric vehicles or EVs are thrice as energy efficient as compared to the ICE vehicles. Introducing 30% EVs by 2030 itself will reduce the petrol and diesel requirement and hence, reduce the carbon emissions as well as the import bill. Therefore, irrespective of the fact whether the EV power is drawn from the RES or not, the introduction of EV is desirable. However, many challenges presently exist in the path to mass-scale adoption of EVs.

Heart of the Problem

Charging infrastructure is a critical component of the emerging EV ecosystem. Internal combustion engine (ICE) vehicles are equipped with fuel storage tanks which accommodate sufficient fuel for long journeys. EVs store electrical energy in the form of chemical energy through on-board batteries, which is then converted to electrical energy for use in vehicle. Since battery accounts for almost half the vehicle cost, large capacity battery EVs will require a huge upfront capital cost. It is important to develop an appropriate charging network to enable the deployment of all types of EVs. It is vital to discuss the EV population under various timelines and penetration scenarios along with various challenges and potential solutions. This includes details of different types of electric vehicle supply equipment (EVSE) including slow charging, fast charging and battery swapping. Linear projections based on vehicle registration data from the Ministry of Road Transport and Highways (MoRTH), Government of India combined with EV penetration targets from NITI Aayog have yielded critical numbers. Considering only passenger road transport vehicles, the figures are:

In India's Nationally Determined Contributions (NDCs), India aimed to reduce emission intensity of GDP by 30-33% from 2005 to 2030.

The Government policies would provide a prime impetus for growing the biofuel industry. Shifting petroleum prices impact the short-term demand and investment in biofuel projects, need for rural development, energy security, reduction in import dependence, environmental concerns would be major contours of the policy framework for biofuels.

The production of biofuels will substitute fossil fuels increasingly, while creating new vistas for national employment while catalysing climate change.

EV penetration estimation by 2030 and 2050

Category used by MoRTH (VAHAN Dashboard)	Vehicle registration penetration by 2030 (NITI Aayog-RMI)	On-road EVs at 2030 (in millions) ^a	Vehicle registration penetration by 2050 (estimated)	On-road EVs at 2050 (in millions) ^b
Motor Car	30%	7	100%	66
Motor Cab	70%	1.1	100%	5.8
Bus	40%	0.17	100%	1.21
M-Cycle/Scooter	80%	110	100%	516
Three Wheeler (Passenger)	80%	2.6	100%	11.9

^a Includes all vehicles registered between 2020 to 2030 (11 years)

^b Includes all vehicles registered between 2036 to 2050 (15 years)

As per the Motor Vehicles Act, 1988, these categories are defined as:

- “Motor car” means any motor vehicle other than a transport vehicle, omnibus, road-roller, tractor, motorcycle or an invalid carriage
- “Motor cab” means any motor vehicle constructed or adapted to carry not more than six passengers, excluding the driver for hire or reward
- “Motorcycle” means a two-wheeled motor vehicle, inclusive of any detachable side-car having an extra wheel, attached to the motor vehicle. It does not include mopeds/other low powered 2W categories
- “Bus” does not include the omnibus category, and does not distinguish between public (held by SRTU/STUs) and private buses
- “Three Wheeler (Passenger)” class is not defined in the MVA 1988.

The corresponding energy requirements for the projected electric vehicles are:

Estimated energy requirements for the projected vehicles

Category used by NITI	2030 (vehicle numbers)	2050 (vehicle numbers)	Annual km driven	Mileage (kWhr / km)	GW hr (2030)	% Proportion	GW hr (2050)	% Proportion
Motor cars	7000000	66000000	9498	0.225	14959	21%	141038	32%
Motor Cab	1100000	5800000	75000	0.225	18563	26%	97875	22%
Buses	170000	1210000	48589	1.100	9086	13%	64672	15%
2W	110000000	516000000	7281	0.030	24028	34%	112714	26%
3W	2600000	11900000	34400	0.050	4472	6%	20468	5%
TOTAL					71107		436766	

The estimated energy requirement of EVs (71.11 BU) by 2030 would be 6% of the total energy estimated to be produced by 2030.

Barring a few exceptions at any place or time, due to intermittency associated with RE, 6% of energy requirement is not likely to pose any major problems. The local aberrations, like local distribution grid congestion, are to be dealt on a case-by-case basis. Even 6% demand is unlikely to be there as by then, technology may leapfrog and more energy efficient vehicles may be developed. Hydrogen and fuel cell-based vehicles may be introduced, while the travel requirement may come down, if public transport and Time of Day (ToD) tariff are introduced. EVs are thrice as energy efficient as compared to ICE vehicles. Introducing 30% EVs by 2030 itself will reduce the petrol and diesel requirement and consequently,

carbon emissions as well as the import bill. Therefore, irrespective of the fact whether the EV energy is drawn from the RES or not, the introduction of EV is desirable.

It is important to assess the overall impact of transitioning to EV based transportation from an oil based system. This includes developing a systematic approach for phasing out of internal combustion based vehicles (ICV) and components exclusively related to the ICV, along with creating a new supply chain for EV components like battery, battery management systems (BMS), electric motor, and controller etc. As an intermediate step, retrofitting existing ICE vehicles into EV for some segments can be considered after evaluating the retrofitted vehicle performance and economics involved therein. All these aspects need to be carefully examined to ensure a smooth transition to cleaner transport fleets across various vehicular segments through detailed guidelines and policy framework for phasing out petrol and diesel vehicles.

Existing Policy Response

The Ministry of Power has introduced recent policy and regulatory changes:

- Permitted different standards for public charging Infrastructure
- Electricity tariff shall not be more than the average cost of supply plus 15%
- Electricity tariff applicable for domestic consumption shall be applicable for domestic charging

Recently, necessary regulatory provisions for the third-party sale of electricity have been notified by the Central Government.

Challenges Along the Way

Charging infrastructure-related challenges:

Firstly, EV charging is estimated to be 6% of total energy consumption of India by 2030, whereas installed capacity and energy generation is likely to increase by 140%. To wheel this additional 140% power, huge investments are needed for strengthening the transmission and distribution network. This would cover the energy requirement of EVs.

However, some local aberrations due to pulsating loads during the peak loads and other such factors can be dealt with dynamic tariff for EV (private and public). This will help manage the overall grid load better.

The difference between peak and off-peak cost of power should also be kept sufficiently high so as to influence consumer behaviour. To find the proper balance, detailed studies and pilots must be conducted on a place-to-place basis. There would be a provision to change the rates from time to time as EV charging load and pattern evolves over time.

Charging Standards: MoP guidelines specify 5 types of chargers that can be installed at a public charging station. This may change in the future, as the market evolves. **Official standards are yet to be released by Bureau of Indian Standards (BIS), and therefore currently OEMs are following standards listed:**

Table 10: Current AC charging standards in India

	Standards	kW range	Application	Communication	Remarks
1	Bharat AC0001	3.5 kW max.	2W, 3W, small 4W	No communication between EV and EVSE	IEC 60309 connector (blue)
2	Type 2 (1 ph and 3 ph)	Up to 43 kW	(2W, 3W) 4W	PLC based	Provides increased safety due to communication

Current DC charging standards in India

	Standard	kW range	Application	Communication	Remarks
1	Bharat DC001 (with GB/T DC connector)	Up to 15 kW	2W, 3W, small 4W	CAN	Based on Chinese GB/T DC connector. DC only.
2	CHAdemo	Usually 50 kW (up to 150 kW)	(2W, 3W) 4W, trucks	CAN	Many DC chargers come with CHAdemo and CCS outlets. DC only.
3	CCS (Combo 2)	Up to 350 kW	(2W, 3W) 4W, trucks	PLC	Vehicle inlet supports DC and AC (type2)

However, there are several factors creating uncertainties in the minds of prospective buyers:

high upfront costs of EVs, range anxiety, lack of EV models, and the absence of adequate charging infrastructure. There are many hurdles in the way of charging station proliferation, such as varying standards in connectors and land acquisition for charging stations. A major challenge for deploying slow chargers in India is a lack of dedicated parking spaces for vehicle owners. Making smart chargers for the purpose of tracking, billing and availing the ToU tariff and demand response system is a major impediment.

Technical Challenges

There are many technical challenges to be addressed such as:

- **Technology that allows one charger for charging several EVs simultaneously** is crucial in terms of increasing the charging infrastructure usage. It is still in a nascent stage of development.
- **High voltage charging:** Pantograph charging is at high voltage and power eg. 600 kW- at 400V to 1200 V. Hence, limited use is needed in enclosed premises like depot, etc.
- **Battery swapping needs standardisation of battery modules and additional land area.** Since the weight of swappable batteries is a limitation, it is mostly suitable for 2 or 3 wheelers only. Further, unclear standards and legality are creating an atmosphere of uncertainty. So the market is developing on its own to meet the demand, resulting in non-standard products (like e-rickshaws). These rampant products may become a bottleneck in the

future during standardisation.

- **Common protocol and regulation/procedure need to be in place at the central level** towards communication between all public EVSEs and respective DISCOM for real-time transmission and display of ToU tariff for consumers. Consumers should be able to look at prices on EVSE on-screen display and then decide time and amount of charging. Sending emergency control signals (shutdown or reduce the rate of kWh charge) from the DISCOM side should be able to manage excessive loading and prevent grid outages.

Manufacturing challenges: EV manufacturing is also ridden with challenges:

To understand the challenges, it is important to know that EVs have 3 crucial components: Battery, Permanent magnet-based motor and Controller. LIBs or Lithium-Ion Batteries are considered to be the most suitable storage option as they are fast charging, possess higher power density, are smaller in size 6-12 kg/kWh and have a longer life. Presently, EVs are expensive due to high cost of LIB that accounts for 40-46% of vehicle cost. Depending upon the LIB variant, capital expenditure can be lined up for battery replacement after 3-5 years. Moreover, at present, there is no ecosystem for a secondary market of LIB. Almost all the components and raw material for LIBs (and also motors and controllers) are currently imported and hence, require supply chain security. At the end of life, LIB has a significant amount of waste, composed of precious materials that can be recovered. But India currently lacks the LIB recycling ecosystem. While the introduction of EVs is imperative to implement climate change at the earliest, there are plenty of challenges to be addressed to make mass adoption of EVs a reality in about a decade.

Routes to Change

The growth of the EV ecosystem is possible by implanting a range of solutions with regards to charging and storage. Some class-wise recommendations are as follows:

- **By 2030, 40% of energy dispensed to electric vehicles is estimated to be consumed by 2 or 3 wheelers only:** This sector can predominantly be supplied with battery swapping, to control the logistics and reduce the cost of the vehicle for the lower income groups.
- **Buses are estimated to consume 13% of total energy required for charging:** These can be charged at depots at night and boost charging may be given en-route once a day. Considering the large power requirement at a few places (EV-heavy routes), the substations, tariffs and other factors will be planned accordingly.
- **26% energy is estimated to be consumed by motor cabs:** Cabs can well be charged at night at stands, parking, and so on. However, some cabs may also require daytime top-up charging due to long daily trip lengths.
- **21% energy is estimated to be consumed by motor cars:** These can be charged at home at night and the slow charging can be done at the parking of workplaces. For this segment, charging at commercial parking, metro stations, and railway stations may be earmarked. Once again, this is a concentrated requirement at a few places and substation, etc. can be planned accordingly.

There can be other storage options too in future beyond LIB:

Beside lithium batteries, other cell chemistries and storage technologies will have to be taken into consideration for future energy storage solutions for the transport sector. Several driving forces or optimisation strategies account for this trade-off:

- Fuel price trends for coming years
- Costs for alternate energy storage technology and raw materials
- Refuelling, recharging time of the energy storage
- Energy density of the storage
- Energy efficiency of the conversion, especially in automotive drivetrain solutions
- Technology know-how and experience in alternate storage technology deployment
- Environmental aspects, carbon footprint, well-to-wheel efficiency and sustainability.

Few other emerging technologies are being pursued globally at prototype or lab and pilot stage, such as supercapacitors, Lithium-Air batteries and Graphene batteries. Several aspects of future energy storage solutions are currently under research on a global scale for the mass adoption of electric vehicles that can be a gamechanger in the pursuits of low carbon energy utilisation.

Closer to the Destination: Actionable Recommendations

Meaningful climate change mitigation efforts can be implemented through constant efforts in the short, medium and long term. Here is a quick look at recommendations and plausible solutions:

1. Environment and Pollution:

Short-term (2022)

Public participation begins with informed citizens and raised awareness levels. Similarly, public awareness is a key aspect of participative vigilance over emitting sources. Thus, the concern about environment protection, global warming and its effect, and CO₂ emissions due to different activities needs to be made public. Awareness should be enhanced through a display of Air Quality Indices and spatial air quality maps using print and electronic media.

The clean air mission should include sensitisation and capacity building initiatives with academic institutions and local communities. The main objectives would be to empower and educate young minds on aspects of air pollution, sources, emission factors, indoor air quality, reduction and controlling measures.

Effective pedagogy and incorporating an array of teaching strategies will need to be adopted for triggering behavioural change. This will pave the way for vigorous implementation and adoption of mitigation strategies.

- Raise awareness for low carbon energy mobility
- Build public awareness campaigns and participation, with awareness about low carbon transportation
- Adopt effective pedagogy for triggering behavioural change towards sustainable, low carbon mobility options

2. Renewable Energy

Short-term (2022)	Medium-term (2030)	Long-term (2050)
<ul style="list-style-type: none"> - Encourage optimum efficiency power/square meter solar technology for rooftop solar charging stations - Bundle EVSE as mandatory in new buildings through Building Codes - Ensure closer alignment of Energy and Transport Sector to develop joint pathway 	<ul style="list-style-type: none"> • Develop framework for recycling and disposal of solar panel to EVs 	<p>100% EV stations powered from renewable energy would become imperative: either through decentralised renewable energy applications or by having PPAs on open access basis with renewable energy developers</p>

3. Petroleum and Biofuels:

3.1

Short-term (2022)	Medium-term (2030)
<p>a) Create enabling ecosystem, off-take agreement and financing instruments for achieving the goals of National Policy on Biofuels 2018, Pradhan Mantri Ji-VAN Yojna, GOBAR-DHAN and SATAT schemes</p> <p>b) Advanced Biofuels would need the following measures:</p> <ul style="list-style-type: none"> - Assured supply of segregated waste - Inclusion in priority sector lending with interest subvention scheme - Inclusion in 'White Category' for Pollution Clearance <p>c) Improve fuel efficiency of vehicle fleet by introducing labelling/ratings systems, minimum efficiency standard and corporate fleet efficiency standards</p>	<p>Monitor Implementation of goals of National Policy on Biofuels, 2018</p>

3.2 As per the present Policy, only 30% of the newly registered vehicles will be EVs and the remaining 70% will remain petroleum vehicles. Existing vehicles will also continue - consequently, the petroleum fuels will continue and the following steps will need to be taken urgently:

Short-term (2022)	Medium-term (2030)
<p>Shift: Develop and focus on the use of more carbon-efficient modes of transport (Priority to Rail, Metro, LRT, Buses taxis etc)</p>	<p>Avoid: There would be a need to adopt a systems approach and reduce the need of transport through appropriate choices for locating industries and other businesses, and through better planning to minimise commuting needs. The concept would need to be built around growing vertically and provide residential-cum-commercial complexes so that all the needs are fulfilled in one building only, cutting the need to travel. TOD Policy of the Ministry of Urban Development will need to be issued.</p> <p>Improve: There will need to be increasing emphasis on the use of the most carbon-efficient technologies for any mode of transport. (Hydro fuel and EVs). For improving fuel efficiency of the vehicle fleet, it is recommended to introduce vehicle labelling/ratings systems, minimum efficiency standard and corporate fleet efficiency standards. A combined land and transport authority is a preferred solution to help achieve the above.</p>

4. Hydrogen Fuels: There are sufficient sources of hydrogen available, but the infrastructure needs to be built to proliferate the hydrogen economy:

Medium-term (2030)	Long-term (2050)
<ul style="list-style-type: none"> - Develop time-bound National Hydrogen Energy Roadmap to make hydrogen commercially available as a transportation fuel - Enhance injection of Hydrogen into the CNG grid to enable transportation of hydrogen without the need of building separate nickel-coated pipelines, to help save costs - Invest in research to bring down electrolysis costs - Cost-effective plan to develop multiple Fuel Cell technologies on a large scale - Utilisation of excess and stranded RE to generate hydrogen via electrolysis process at location - Invest in establishing Infrastructure of hydrogen storage, delivery and transport system - Development of proper pipelines dedicated solely for hydrogen needs to be built. At the same time, costs of doing so need to be brought down by economies of scale and investment in research. 	<p>There needs to be a focus on developing on-site generation of hydrogen via electrolysis powered by renewable sources of energy.</p>

This could not only help India reduce greenhouse emissions but also bring down oil and gas imports by using hydrogen as the energy carrier.

Challenges and Conclusion on Hydrogen Fuels

The production of hydrogen and dispensing it through a compatible storage and transport network is a capital-intensive affair. Although research and development on hydrogen in India is underway, importance should also be given to making hydrogen economically viable. This will enable it to compete with the conventional fuels and electric vehicles, which have attained more market-maturity than hydrogen. Hydrogen is largely produced from fossil fuels, and hence it is essential that producing hydrogen from renewable resources is prioritised by the government. At present, the use of hydrogen in vehicles in India has been limited to research, demonstrations, and test runs. The fuel cell technology is still expensive in India and the government, therefore, must come up with a cost-effective plan to develop the same on a large scale. It will also need to invest heavily towards establishing the required infrastructure consisting of hydrogen delivery network, storage and transport systems, and refueling stations. An active and time-bound policy is thus required in order to make hydrogen commercially available as a transportation fuel in India.

Deployment of EVs

Short-term (2022)	Medium-term (2030)	Long-term (2050)
a) Develop ecosystem to convert existing ICE vehicles to EVs and encourage large volume manufacturing of EVs to control prices b) Develop charging standards c) Due to the inadequacy of natural sources of lithium, cobalt, nickel and other key elements required for manufacturing lithium cells in India, it is imperative that the country secures the import of these metals by establishing trade agreements with international partners. This will ensure a regular supply of raw materials and provide the foundation for indigenous manufacturing of lithium-ion cells, controllers and chargers in the country d) Integration of efforts across different regulatory and governance entities relevant to the EV space is also called for. This includes developing a detailed guideline and policy framework for phasing out ICE vehicles e) Minimum renewable energy purchase obligations by EV charger installations f) Tax incentives for EV charging from renewable energy sources	a) Optimise lifecycle of lithium-ion batteries for usage in energy storage applications post use in mobility. b) Establish a clear national framework for both secondary use as well as recycling of lithium batteries should be lined up to ensure optimal utilisation of scarce resources. c) Standard practices and guidelines for the secondary usage of EV batteries for energy storage applications must also be prepared to ensure a smooth transition between the two sectors. This will provide quality assurance and reliability to potential consumers. d) Mandate for infrastructure development by City governments/ municipalities and Highway Authorities to allot space for EVSE networks on lease at concessional rates under OPEX model	To ensure as little dependence on the import of metals, such as nickel and cobalt as possible, cell chemistries, such as Lithium Iron Phosphate (LFP) that do not require these metals should be promoted for use in EVs. It is important to consider alternatives to lithium-ion batteries, such as sodium ion batteries, hydrogen fuel cells, supercapacitors, thermal batteries, and so on. Concerted efforts and Government investment in research and development will ensure that the country is not locked into one technological solution for the long-term and possesses the capability to migrate to a better solution in the future, if required.

Despite promising growth, the government's targets for 2030 seem ambitious and may be a challenge to achieve as the industry and consumers are not ready to adapt and adopt rapidly, given the relative economics. Recycling and alternate use of batteries is a relatively new process as well. The Government has already taken a lot of initiatives to control CO₂ emissions such as ambitious RE and EV deployment targets, National Policy on Biofuels-2018 etc. Some agencies and ministries involved already in the process of implementing the same are:

- a) Ministry of Environment, Forest & Climate Change
- b) Ministry of Power
- c) Ministry of Road Transport and Highways

- d) Ministry of New and Renewable Energy
- e) Ministry of Heavy Industries and Public Enterprises
- f) Ministry of Petroleum and Natural Gas
- g) NITI Aayog
- h) State Governments and Utilities for implementation

However, since many issues and government departments are involved, the approach needs to be holistic and focused. A roadmap with definite policy and guidelines is an imperative.

A mission mode, integrated, time-bound approach needs to be adopted under one agency.

IMPROVE INTERMODAL AND MODE-WISE SYSTEM EFFICIENCIES

Every new idea is an opportunity to improve.

The environmental impact of different modes of transport such as road, rail, and air is that they are the largest contribution to GHG (greenhouse gas) emissions globally. Component 3 aims to discuss the existing gaps and challenges related to multi-modal transport. In the Indian context, the future planning of Indian transport is aimed at the development of multi-modal transport within the country as well for import export trade. Although the existing transport infrastructure favours multi-modal transport, there remains little intermodal coordination, and a system with unclear responsibilities and weak accountability resulting in inefficiencies. The third component of the Roadmap aims to present the current status, gaps and challenges with respect to improving different aspects of multi-modality. Transport networks cannot exist in silos.

Sustainable urban mobility calls for intermodal integration, i.e., integration of various modes of transport to provide seamless connectivity for commuters and ensuring last mile connectivity which is a key factor for determining the success of a public transport system in a city.

Heart of the Problem

Poor public transport system is forcing people to use their own vehicles for daily commuting creating traffic congestion and resulting in heavy automobile pollution. Partial or complete nationalisation of public transport systems has made it highly inefficient. Integration within and between various modes of travel is completely missing, resulting in lot of inconvenience to travellers. Add to it, there are separate ministries for each mode of transport and each state has its own rules.

Some Critical Issues include

- i. Absence of a National Level Transport Authority which will facilitate the process of integration between multiple modes to effectively plan and monitor passenger mobility across India.
- ii. Indian railways, road transport and waterways majorly work in isolation
- iii. The Motor Vehicles Act (MVA), 1988 governing road transport has several outdated provisions e.g., it does not allow corporatisation of the passenger transport sector. The transporter is recognised as the 'owner' of the vehicle and not as an organisation authorised to work as a 'transporter'. This hinders the focus on introducing mobility as a service and suggests an input-based, asset-oriented approach, rather than an outcome-driven approach.
- iv. Transport being a subject from the concurrent list, each state has its own rules to issue permits and give monopoly to State Transport Undertaking (STU).
- v. Seamless movement of vehicles is the main purpose of the MVA, 1988. Transport being a state subject, State governments can restrict entry of vehicles from other states. Only in case of an All India Permit (AIP), individual states cannot restrict entry of the vehicles which are covered under this permit. However, to overcome this issue, the State governments have started levying heavy taxes on such vehicles.
- vi. Urban transport is ignored by the State governments, STUs and Urban Local Bodies (ULBs), which do not take responsibility to ensure city transport services are provided to all of its citizens. There is a lack of coordination between various agencies which are involved in the process of transportation. Laws are made by the Ministry of Road Transport and Highways (MoRTH), Government of India (GoI). Some of the rules are made by the State governments. Permits and ticket rates are issued and defined by Regional Transport Authority/Office (RTA/ RTO), traffic is monitored by Traffic Police, and ULB is expected to provide city transport services.

vii. Firstly, it is not mandatory on ULBs to provide public transport services to its citizens. Secondly, in order to keep the public transport services economical, RTO keeps minimal ticket rates which lead to monetary loss on such services. ULBs do not have enough funds to support the loss-making services, hence, they either do not take initiatives to start such services or when they do start, they do not provide the required quality and adequate services. The result is that the RTO allows unorganised private players to operate such services without any planning and completely ignoring ULBs' future plans. This results in a penny war on some of the routes, while some of the routes are not serviced at all.

viii. People from rural areas near urban or semi-urban areas commute to the city for various purposes and require frequent services from their town to the city. STUs serve these towns only once or twice in a day, whereas people want services throughout the day. As these routes are STUs' monopoly, the RTO cannot issue permits to serve this requirement. Under these circumstances, private vehicles ply on these routes without having any permit or using permit given for other purpose, violating the norms.

ix. For long distances, people require more comfortable buses. STUs do not have enough of such vehicles and are not tuned to serve this class of travellers. This void is being filled by buses having AIP in the states where there is no other permit available to serve this purpose.

Challenges Along the Way

- ✓ Planning of services and coordination between and within different modes of travel such as road transport, Indian railways and inland waterways.
- ✓ Availability of infrastructure and land to develop depots, parking lots, pick up and drop points, and bus and multimodal terminals at strategic locations. Presently, bus terminals are exclusively owned by STUs and railway stations are exclusively owned by Indian railways and they do not allow other operators' vehicles to use such facilities.
- ✓ Availability of stage carriage permits and stringent conditions for contract carriage permits do not allow passenger mobility sector and tourism sector to grow.
- ✓ Low ticket rates which do not change with rise in input costs and heavy taxation on buses.
- ✓ Lack of integration in technology within and across multiple modes of transport.
- ✓ Non-availability of funds to strengthen the public transport sector.

Routes to Change: Proposed Solutions

- ✓ **Paradigm shift from moving vehicles to moving people** - Majority of people in India do not own a vehicle. Such people prefer a system that will take them from one place to the other on pay per use/ sharing per seat basis. This means there has to be a paradigm shift in the way we develop transportation infrastructure in India.

We need to shift from the paradigm of building infrastructure to move vehicles to a new paradigm of building infrastructure to move people.

- ✓ **Institutional reforms** – In India, there is an urgent need for a unified transport ministry for integration of planning, development and services. Though there are a plethora of ministries, there is a complete lack of coordination among various ministries such as MoRTH, Ministry of Railways, Ministry of Housing and Urban Affairs, Ministry of Shipping, and Ministry of Civil Aviation. In addition, there is no regulatory institution that is responsible for ensuring the development of passenger mobility in the country. All major sectors have regulatory bodies, which not only regulate but also facilitate the growth of that sector. Some of the examples include Telecom Regulatory Authority of India (TRAI), Insurance Regulatory Development Authority (IRDA), Airports Authority of India (AAI), Central Electricity Authority (CEA), etc.

- ✓ **Changes in Development Control (DC) Rules** – Urbanisation in India is growing. By 2030, it is estimated that more than 50% of Indians will stay in urban areas because of which, urban sprawl is becoming larger and distances from home to office or home to school and markets are becoming longer. This is creating a major challenge for people to commute from one place to another. The result is that city roads are getting congested and polluted, while also creating safety, health, and environmental challenges. The Ministry of Housing and Urban Affairs, GoI defined a substantive policy, National Urban Transport Policy in 2006, but have not yet ensured that the issues addressed in policy are resolved even after 13 years of its coming into existence. It is high time changes in the DC Rules

are made to facilitate the changes as defined in the policy, so that the movement of people gets priority over the movement of vehicles. It is important that the movement of personal vehicles is restricted and simultaneously the quality of public transport services is improved. This will motivate people to use public transport. In the absence of a quality public transport system, restricting movement of personal vehicles will only add to people's inconvenience. One of the other major challenges for public transport is the availability of land for the development of required infrastructure and shortage of funds that need to be addressed on priority. By making changes in development rules, private lands can be made available for use by public transport. For example, an underground bus station or an interchange below a shopping mall or commercial buildings having built-up facility beyond certain square feet area, can be an innovative approach. To address these issues effectively, the following suggestions have been made:

- To adopt rules in line with the National Urban Transport Policy of GoI (NUTP 2006)
 - To make it mandatory for cities having a population of more than one lakh to provide public transport services to all its citizens at an affordable price
 - Public transport services should become an integral part of development plan of the city
 - To plan and effectively operate minimum 50 buses per lakh of population
 - To keep the target for next 10 years to increase share of public transport in total passenger trips in cities to more than 60%
 - To develop Infrastructure and systems which will promote movement of people and not vehicles
 - To ensure multimodal integrated passenger transport services having last mile connectivity is provided
 - Maximum and not minimum allowable parking norm to be introduced in DC Rules for personal vehicles
 - To make it mandatory for all township projects to develop multimodal/bus terminals within their premises and to have shuttle services integrate with city bus service at regular frequency. In addition, it can have special services at fixed timings from the township to the main bus terminals, railway stations, airport and important shopping areas
 - Usage of personal vehicles should be restricted by introducing heavy taxation, congestion tax and parking charges
 - Mandate to provide a certain percentage of parking space or amenity space which are within privately developed premises having built up area of more than 1 lakh square feet such as malls, government establishments, hospitals, commercial, educational and large residential complexes to be available for public transport vehicles such as buses, taxis and autos.
- ✓ **Changes in the MVA, 1988** – Amendments to the MVA, 1988 bill have been passed and it is hoped that it will prove to be the beginning of a new era for the passenger transport industry. However, some suggestions on the MVA are as follows.
- To redefine public transport as a system that works on sharing of vehicles on per seat basis. It should not be limited to only urban buses, trains, stage carriage buses or Government operated services
 - Encourage private participation in the development of passenger mobility by liberalising permits and conditions attached to it. One Nation, One Permit, One Tax scheme should be introduced
 - Definition of stage carriage and contract carriage should be replaced by schedule and rental services
 - Each permit should have a list of Standard Operating Procedures (SOP) with a do's and don'ts list
 - To ensure seamless travel of buses throughout India by defining strict norms against stoppages of commercial passenger and goods vehicles under the pretext of checking en-route
 - Amendments must be made to ensure vehicle owners are not harassed unnecessarily en-route or while in operations
 - To utilise "Vahan" data for checking of documents rather than stopping the vehicles on the pretext of checking of documents
 - All fines should have electronic proof to avoid their misuse by the authorities
 - To computerise all RTO offices and processes and to provide online transactions for transfer of vehicles, payment of tax, and issuance of permit etc.
 - Rural connectivity should be promoted by using smaller vehicles with higher frequency. STU or SPV (special purpose vehicle) can act as an aggregator through a private technology partner or entire scheme can be managed under PPP (public private partnership) by establishing state level or local level SPV.
 - City services should be extended from a minimum of 10 to 20 kilometres from the periphery of city limits
 - App-based city services should be allowed to run as per the operator's defined schedule.

- Uniform technology platform for all modes of transport to facilitate integration of services in information and payment.
- Long distance services by luxury coaches should be denationalised to encourage private operators' participation.
- A permit system should be introduced for personal vehicles to limit number of cars per city/owner/ household, etc.
- OEM (original equipment manufacturer) should define life of a vehicle; it should replace the vehicle after its life is over.
- Speed limit of the vehicles should be defined on the basis of safety features provided by OEM and not by discriminating between private/personal and commercial vehicle.
- Validity of the permit (in terms of number of years) should be dependent on the quality of the vehicle. High-end vehicles should be allowed to operate under the same permit for more number of years.

✓ **Infrastructure** - Availability of required quality infrastructure is a major impediment in the development of better passenger mobility systems. Physical infrastructure, such as terminals or IT infrastructure that will provide a single platform for information, planning of journey to money transactions for all types of transport is completely missing. Unless the integration of multiple services happens, last-mile connectivity is going to remain a challenge and will remain the biggest barrier in getting more people on public transport. In absence of any nodal agency, such development would not take place. Hence, after development of such an agency, we propose the following.

- To build bus and multimodal terminals in all cities having a population of more than five lakh. In bigger cities, it can be in proportion of one terminal per million of population and can be operated on the lines of an airport where all companies, public or private, operate under the same rules and regulations.
- To develop ring road around all cities so that vehicles unnecessarily do not enter city for passing through it.
- To develop rest area/passenger amenity centres every 50 km on all highways.
- To make India barrier free by removing toll plazas on main highway. Instead, it can be put up only at entry and exit roads approaching national highways.
- To develop a network of common charging infrastructure to promote usage of EVs (electric vehicles).

✓ **Skill Development** – The transport sector has a huge potential to create jobs. However, there is a tremendous shortage of skilled manpower in this sector. One bus gives direct jobs to 5 people and indirect jobs to 15 people. India needs 3 million more buses to reach near the global standard. If changes as defined above are made, this sector has the potential to create jobs for at least 5 to 6 crore people. Every year, around 1.5 lakh people die on Indian roads. One of the major reasons is that vehicles are driven by unskilled drivers. To improve safety on roads, it is also important that drivers are trained. Similarly, there is a dearth of mechanics, electricians, cleaners, traffic planners, traffic managers, supervisors, etc. Therefore, driver training institutes should be established at a district-level, particularly, in areas where unemployment is more, such as backward or Adivasi areas. Motor mechanic courses should be included in educational institutes, and also transport management at all major universities.

✓ **Public Private Partnership** - Private participation should be encouraged in developing better public transport facilities, development of infrastructures, such as bus and multimodal terminals on the lines of PPP models for developing airports in India, which can be used successfully, and define a pragmatic concession agreement to ensure the sustainability of the partnership.

✓ **Goods Transport** - More proposed solutions can lay a strong foundation for change. These include forming policies to encourage investments in the development of cold-chain infrastructure in India, bringing policy reforms to encourage investments and building capacity for the movement of cargo through inland waterways. There is also a pressing need to provide a simple, transparent and efficient regulatory environment, along with standardising a single multimodal transport document. This will go a long way in reducing the burden of documentation and enabling faster movement of cargo.

✓ **Decongesting traffic through inter-related steps-** Sustainable solutions to traffic problems can be secured by combining public policy and private sector innovation. For one, congested roads are not only a strain on the environment, but have a negative impact on the economy and the overall quality of life. Some possible solutions are improving public transport and discouraging private vehicles from using parking pricing and management,

multimodal integration and IPT (intermediate public transport); enhancing walkability and use of NMT (non-motorised transport; developing transport hubs (multimodal and bus terminus); making reforms in the issuance of permits and encouraging private operators' participation.

- ✓ Road safety and better traffic management can be done by integrating ITS (intelligent transport systems), optimising road networks, improving junction and roadway design, strengthening traffic management measures, segregating traffic and building ring roads and logistics parks around cities. For a large country like India, a point-to-point route network (for cargo as well as passengers) i.e., attempting to connect each node to every other node, results in a large number of routes in the network. This makes it practically complex to operate and results in considerable underutilisation of assets, empty return trips, localised imperfect freight market, as well as reduced consumer welfare. To overcome these limitations, a different transit network design approach is required. A combination of traditional destination-oriented routes along with direction-oriented routes, called 'Hub and Spoke' network could be better for operating trucks and buses' transit in a large network. This is similar to the way that an airline network operates. It is also important to make it mandatory for cities to provide mobility solutions to all its citizens and to expand cities by using TOD (transit-oriented development) to reduce passenger trips. Promoting shared mobility and limiting usage of shared vehicles are important next steps as well.
- ✓ Capacity and Institution Building - Building capacities of existing authorities/departments and building new agencies at National, State and local level (Unified Metropolitan Transportation Authority—UMTA) is imperative.

Closer to the Destination: Actionable Recommendations

✓ Short Term Plan (2020-2022)

Institutional Reforms

- To establish a transport regulatory authority like TRAI that will facilitate the growth of this sector—National Transport Authority at the National level, State Transport Authority at the state level and UMTA at the metropolitan region level.
 - To establish Surface Port Development Authority of India (as a step-down entity to the National Transport Authority of India) to develop multimodal terminals. Initially, these terminals can be developed in all the smart cities and the 10 biggest cities in India on the lines of airports and should be accessible to all operators
 - To make it obligatory for ULBs to provide safe, smart, and sustainable public transport services, for example, providing 50 buses per lakh of population
- Multimodal Integration:** To provide departure and arrival bus bays at the railway stations, air and seaports having enough parking space, connectivity of feeder buses with metro systems (following an integrated systems approach).
- Fiscal Reforms:** Earmark substantial part of the road budget towards the development of public transport infrastructure, such as multi-modal terminals, surface ports, bus stations, highway amenity centres, rest areas, viewpoints, parking lots, multi-modal logistics parks, etc.

Revision in Acts

Motor Vehicles Act:

- To liberalise the issuance of permits and to operate regular services by private operators, start with a 50/50 formula, wherein minimum 50% of the permits are given to private operators. For the luxury segment, notify the '**One Nation One Tax One Permit Scheme**' to liberalise this segment of passenger road transport and allow such buses to operate regular services. Similar to GST (goods and services tax), Motor Vehicle Tax also needs to be standardised to bring in seamless vehicle movement.
- To improve quality of public transport operations, it is important to introduce '**Authorised Operator system**', wherein organisations will be authorised to manage public transport services as an operator on the basis of its capability to manage quality services.
- Permits should be clearly defined for the relevant type of services to bring in clarity in the type of services it is expected to provide. Permits can be of three types:
 - i) Scheduled—Vehicle that operates on a fixed route,
 - ii) Schedule Metered—Vehicles that runs on time and km basis for the general public as per government approved rates, and
 - iii) Chartered – Vehicle that is available for hire or reward for the general public.

Goods Transport:

Amend Multimodal Transportation of Goods Act, 1993 and Carriage of Goods by Sea Act, 1925 as per the current needs and environment.

Infrastructure

- To plan and develop bus, truck and multimodal terminals, parking lots for public vehicles across the country
- To reserve lands for the development of depots for bus depots
- To facilitate the addition of a minimum of 0.3 million buses on road till 2022
- To develop electric charging infrastructure throughout India for all type of vehicles
- Warehousing zones/logistics parks to be present on ring roads
- Design of toll plazas should be barrier-free, without any manual intervention and have gantries. Toll plazas should be located at all entry and exit points of highways and collection systems should be based on kilometres travelled and should be collected at the time of exit on the basis of kilometres travelled

✓ Mid-Term (2030)

Revision in Acts

Development Control Rules: By making appropriate changes in laws, make it mandatory for ULBs to provide People Mobility Solutions (Public Transport Services) to all its citizens

Motor Vehicles Act: Open up road transport segment completely for private buses. In public transport, promote PPP models for ordinary services and allow private operators to operate freely in long distance luxury services.

Institutional Reforms: A permanent institution (in line with advanced countries, such as the Korea Transport Institute) should be established that will not only help in operating and coordinating the National Logistics Network, but also become an epicentre for research, analysis and knowledge for the entire Integrated National Logistics System. It will provide recommendations and alternatives for the nation's transport policy and create the optimal transport system through specialised research and technical innovations.

Fiscal

- Either keep minimal taxes or do away with taxes on buses
- Spend 50% of the road budget on development of bus-based quality public transport system

ITS

- Set up a national ITS clearing house that documents all ITS projects with details on the design, implementation, lessons learned/best practices, and cost-benefit analysis
- Set up fully functional Traffic Management Centres for coordinating the urban and regional ITS activities
- Create a National Single Window for all logistics modes, which enables a seamless data flow between the various stakeholders through a common interface, and enables them to determine the combination of modes and routes that make the most cost-effective and efficient transportation path for their goods.

Multi-modal Integration: Promote greater use of our coastline and inland waterways for passenger and freight movement, there is a need to address the concerns of all stakeholders, including ship and barge owners, without whom there can be no growth, no matter how much we develop infrastructure or amend policies.

PPP: Encourage private partnership through the PPP mode in multimodal logistics to harness the power of cutting-edge technologies, such as automation, IoT, Blockchain, Big Data, etc., for making overall network highly-efficient and seamless.

Infrastructure

- Create a national grid of common battery charging infrastructure.
- Develop bus and multimodal terminals across India on the lines of airports.
- Build multimodal logistics parks (MMLPs) around major manufacturing and production centres with seamless rail and road connectivity to nearby ports, inland waterways terminals, and distribution centres.

The transport sector in India accounts for 6.4% share of India's GDP (gross domestic product).

With enhanced system and modal efficiencies, transportation can truly come alive in its role as the foundation of economic infrastructure, facilitating the movement of people and goods, and even helping in removing regional inequalities.

OPTIMISE SUPPLY CHAINS TO MANAGE FREIGHT TRANSPORT EMISSIONS

With a balanced eye on the way forward, one can go farther.

Heart of the Problem and Existing Policy Response

The overall cost of logistics and transport are significantly higher based on international benchmarks and does affect the competitiveness of Indian goods and services in the global marketplace. There are areas of inefficiency and low productivity of the transport sector as a whole which have been flagged by committees and commissions set up by the government and need to be addressed without further delay.

Some of the critical issues include:

- i. Carbon emissions reduction has become a national priority as the contribution of transport sector globally is significant at around 24%. Urgent steps to take corrective action are indicated for the transport sector.
- ii. In face of depleting fossil energy reserves globally and nearly 80% of our needs being met through imports, there is an urgent need for conservation of energy as well as migration to, the extent possible, to renewable sources of energy.
- iii. With respect to EXIM (export import) traffic, port capacities and lack of connectivity with the hinterland are also affecting productivity and contributing to higher costs.
- iv. Skewed inter-modal mix between roads and railways which has superior characteristics in terms of low energy intensity, lesser pollution, and safety, is a serious issue because the share of rail has been steadily declining. Railways have a share of only 30% as compared to road which has a share of more than 55% in the national freight business which needs urgent correction.
- v. Inadequate investments in the transport sector in general and the more energy efficient modes, in particular (railways, inland waterways and coastal movement) is another critical factor.

Strategies to address the above challenges:

There is an urgent need to develop an Integrated National Logistics and Transport Policy for developing an appropriate logistics infrastructure for the national economy. The present government has taken up this task and assigned the responsibility of formulating a National Logistics and Transport Policy to the newly created logistics division in the Ministry of Commerce and Industry.

A corollary of this recommendation is to streamline transport pricing system by internalising the cost of externalities like environmental pollution, road congestion, safety and noise pollution. In its absence, the user gets a distorted price signal which vitiates the modal choice since the current pricing policy either ignores or underestimates the cost of these externalities.

A key requirement would be to adopt multi-modal approach through containerisation to bring about integration of different modes of transport and evolve an optimal inter-modal mix to ensure that the strengths of various modes are leveraged and transport needs of the national economy are met adequately at minimum resource cost to the community.

In the current scenario, the critical input is massive financial resources to secure investments for strengthening the basic transport infrastructure of different modes of transport in an equitable manner. There is a welcome increment in infrastructure investment by the present government which, however, needs to be further increased and sustained over the next few decades.

Increasing productivity of both material and human resources of the transport sector by cutting avoidable costs as also through induction of appropriate technology would be another imperative.

Building blocks for operationalisation

- ✓ Formulation of an integrated National Transport and Logistics Policy would have to be the starting point of the implementation strategy with multi-modalism as the underlying philosophy. An integral part of this strategy would be the development of multi-modal logistics parks (MMLPs) at strategic locations along the arterial routes of both rail, road and inland water transport (IWT) modes which can then provide aggregation and dispersal facility for the industrial enclaves in their hinterland. Ports would also qualify to be MMLPs providing interface between surface and oceanic transport.
- ✓ Another key building block to operationalise multi-modal integrated transport is to develop standardised rolling stock/containers which are inter-operable on both rail and other surface modes of transport. There is already a well-developed ecosystem for handling EXIM traffic in ISO/high cube containers. For domestic cargo, we need to develop a standardised container which could provide efficient and cost-effective movement of high value consumer goods. These require higher volume per meter length of the container which is done by enlarging the envelope in terms of both height and width. The container would also be interoperable on both modes of surface transport. The ecosystem for this would also need to be developed.
- ✓ A key component of this strategy would be to evolve a transport pricing policy which facilitates the integrated multimodal approach. This would require transport pricing to be based on internalising of costs of externalities to ensure that the individual transport user does not get distorted price signals. Failure to respect basic economic principles in transport pricing has led to distortions in making modal choices and has led to a sub-optimal inter-modal mix today. Its impact has been highlighted by an excellent exercise undertaken by RITES to make approximation for different social costs and feeding them into an econometric model Transport Allocation and Route-Mode Optimisation (TAROP model) for generating an optimal inter-modal mix. By juxtaposing these numbers with the actual flows during the base year 2007-08, the gap between actual and optimal mix was computed in terms of flows, cost and throughput. It came out with an assessment that the total throughput could go up by 44.3 million ton-kilometres (around 3%), while cost could decrease by INR 384.70 billion (nearly 16% of total cost incurred).

Closer to the Destination: Sector-wise Plans

CROSSROADS OF CHANGE



Using a similar methodology, McKinsey has come out with an extremely practical model of integrated transport for the Indian sub-continent which could be adapted based on latest data. Its broad features are:

- a) Seven long-haul corridors that link 15 high growth freight generating clusters and account for almost 50% of overall freight business. The five land corridors identified include: Delhi-Mumbai, Delhi-Chennai, Mumbai-Kolkata, Delhi-Kolkata and Mumbai-Chennai for both road and rail. The two coastal routes suggested are: Kolkata-Chennai on east coast and Kandla-Kochi on the western coast.
- b) 150 medium distance connectors linking these seven arterial corridors with state and district headquarters accounting for 10% of overall freight tonne kilometres.
- c) 750 last mile link leading to ports, mines and industry clusters.
- d) 20 multi-modal logistics parks to secure transshipment between different modes.

Railways

Railways need to push ahead with utmost speed to create the New Freight Railway through network of DFCs (dedicated freight corridors) and positioning of MMLPs at strategic locations in coordination with State governments and Ministry of Road Transport and Highways, Government of India.

It should facilitate development of a standardised container for domestic cargo as a strategy to attract high value and high-volume consumer goods, FMCG (fast moving consumer goods) and parcel traffic, and thereby develop an expanded bouquet of freight commodities in order to fill the massive increase in transport capacity on the DFCs. It should also develop commodity-specific transport solutions by factoring the specific needs of the rail issues.

Highways

Detailed regional traffic studies need to be conducted at regular intervals to enable data driven planning on the highways. The erstwhile Planning Commission had assigned this task to RITES for two such studies. NITI Aayog should now develop a dedicated Road Data Centre which can update the numbers at regular intervals.

Technology for construction and maintenance systems for highways needs to be selectively inducted.

Development of pavement with drainage systems is a proper technology which can help in increasing the current 4-5-year renewal cycle to a 12-15-year cycle.

Electronic tolling across the country can aid faster and smoother traffic flows. RFID (radio-frequency identification) technology is another proven technology for achieving this objective.

Role of National Highways Authority of India (NHAI) in providing a boost to the development of National Highways needs to be replicated at the state level for upgradation of State Highways and district roads. Alternatively, NHAI could create regional offices at the state level for this purpose.

Ports

There is an urgent need to develop two state-of-the-art mega transshipment hubs ports, one each on the West and East coasts. This can be done either by upgrading one of the existing ports or combining some nearby major and minor port to serve as transshipment hubs on the lines of Colombo or Singapore to handle both the larger capacity ships and also distribute cargoes for nearby ports through transshipment operations through coastal shipping.

Governance structures also need to be relooked and possibly the internationally accepted 'landlord model' may be considered. A mechanism of outsourcing terminal services under landlord port regime could provide the necessary autonomy to the port. While the ownership of the port authorities should remain public and function under the rental regulatory authority, subsequently, all major ports should corporatise the terminal operations as a long-term strategy.

AVOID VEHICLE KILOMETRES FOR COMMUTING, SHOPPING AND ACCESSING SERVICES

On the road to change, every small step makes a big difference.

The need for travel can be for both work and leisure. With an increase in population and rapid urbanisation, travel demand is also increasing. This will lead to an increase in demand for transport, an increase in average trip distances projecting a multi-fold increase of passenger kilometres. The National Transport Policy Development Committee (NTPDC) has estimated the travel demand to grow almost 16 times by 2032. According to the report, the total passenger traffic in the country is expected to grow at about 15% per annum to reach 168,875 bpkm (billion passenger kilometres) in 2031-32 from 10,375 bpkm in 2011-12. This growth demands a multi-fold increase in investments for smart and integrated transport infrastructure matched by an increase in transport assets.

Component 5 focuses on VKT (vehicle kilometres travelled) and looks at three different pillars – system efficiency, trip efficiency, and vehicle efficiency – separately, but will go hand in hand in providing an integrated solution for VKT. The talks on the different problems that we are facing in mobility system are going in parallel across different directions. VKT helps in unifying and measuring all of them into one single metric. This gives a more focused effort in solving the mobility system.

Heart of the Problem

Across the country today, the increase in travel demand in cities is being served in one major way – by adding vehicle kilometres leading to more congestion and pollution, in turn affecting the health of the people. Thus, passenger travel demand is the measure of the movement of passengers across different modes measured by passenger kilometres. But to achieve an efficient and sustainable transport system, this demand should be served by minimum vehicle kilometres or VKT (vehicle kilometre travelled). VKT can be calculated by multiplying the total number of trips to the average trip length.

VKT = Total number of trips x Average trip length

VKT is the total kilometres travelled by motor vehicles in a given period of time. It gives an estimate of the overall pressure on the environment from all forms of road transport, and is a mobility indicator to measure the performance of the transportation system. It is extensively used in transport planning for allocating resources, estimating vehicle emissions, computing energy consumption, assessing traffic impact, and road safety policy. It needs to be noted that the transport network of the future is based on high personal mobility characterised by a high share of low occupancy personal transport modes in the traffic mix. This will require the creation of capital-intensive road infrastructure to support the explosive growth in vehicular traffic, and result in pressure on the environment.

It is critical to cater to the increasing travel demand with the minimum possible supply in vehicle kilometres.

Existing Policy Response

The traditional approach to deal with travel demand has always been supply-oriented: where the travel demand has been met by providing additional road infrastructure. Unfortunately, far from being beneficial, it has led to increased private vehicles on the road, leading to more congestion and GHG (greenhouse gas) emissions. There are some policies in place, but they need to be fully integrated at the national level and fully enforced in a systematic manner.

1. Last-mile connectivity through pedestrian pathways, NMT (non-Motorised transport) infrastructure, and induction of facilities for paratransit modes will be essential requirements for availing any central assistance for the proposed metro rail projects.
2. Many states are encouraging mixed land use to reduce the need for commuting. Delhi master plan is a strong proponent of this.

Based on the principles of sustainability, GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) has suggested an alternative approach to address the increasing travel demand. Unlike the traditional approach, the focus is on the demand side that constitutes three components designed specifically for encouraging clean mobility solutions: and is known as the Avoid, Shift and Improve (ASI) framework.

The demand-oriented ASI approach can help promote alternate mobility solutions and develop sustainable transport systems, through three components.

Merits of Bike Taxis -

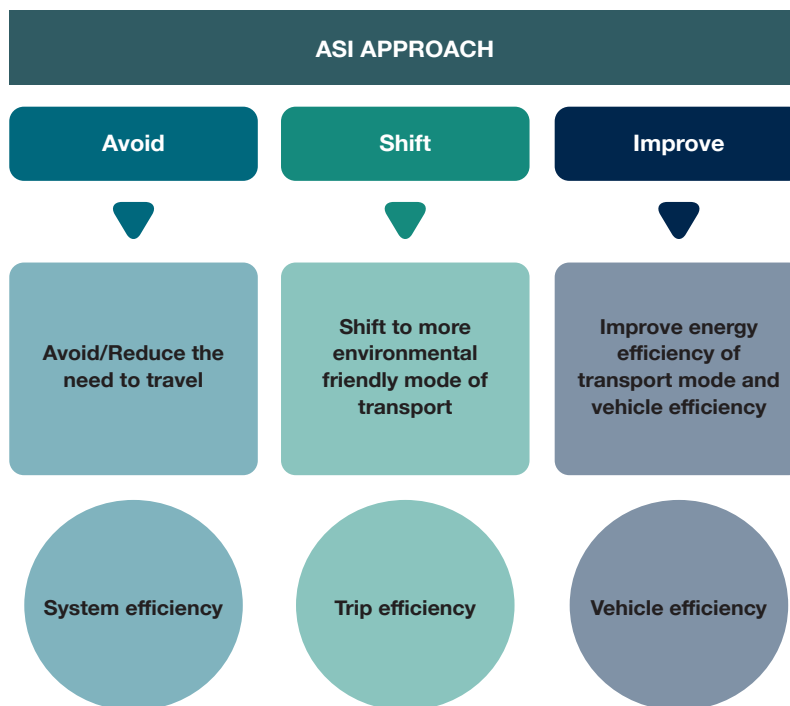
1) Avoid: the need to reduce the need to travel.

Through mixed-land use planning and smart transport demand management, the need to travel and the trip length can be reduced. This will help in improving the overall **system efficiency**.

2) Shift: shifting from the most energy-consuming transport mode to a more environmental-friendly mode of transport. The shift can happen towards alternative modes like NMT (non-motorised transport) (walking, cycling), public transport (bus, metro), personalised public transport (shared cabs, autorickshaws, cycle rickshaws and bike taxis). This shift will help in improved utilisation of the asset, reducing the per person level carbon footprint. There will be an overall improvement in the **trip efficiency**.

3) Improve: improving the energy efficiency of transport mode and vehicle technology. This can be done by sourcing power for vehicles from a clean source such as RE (renewable energy). Implementing strict vehicular emission standards and improving vehicle technology will contribute towards reducing the vehicular emission thereby improving the overall **vehicle efficiency**.

The figure below highlights the co-benefits of using the ASI approach to build a sustainable transport system. As per NITI Aayog's report, congestion has a huge cost in the form of reduced productivity and fuel waste. The study estimates that the economic loss due to congestion is over USD 22 billion annually in our top four metros. This ASI approach will lead to better energy security by devising alternatives leading to lower energy costs and less imported fuel. It will affect the country's economic development through increased private investment and reduced congestion which will save time – a precious commodity for all today.



Source: Sustainable Urban Transport, sutp.org

Challenges Along the Way

To solve the vehicle kilometres puzzle, it is important to know it better. Now VKT depends on many individual components which together contribute to high vehicle usage. To understand the existing challenges across system efficiency, trip efficiency and vehicle efficiency, there is a need to look at these individual aspects and analyse them in their specific context.

System Efficiency

It means improving the efficiency of the whole mobility system by reducing the need to travel. The key components influencing this are:

1. The increasing need for travel: Work trips contribute a major share of the trip profile in urban centres in India. As India urbanises further, the need for travel is only going to double or treble, and so would the resulting consumption of energy, emissions from transport, congestion, and a loss of productivity, with direct and indirect social costs, i.e. health costs. There is an urgent need to investigate and reconsider work-based travel behaviour and find ways to curb the same.

In rural areas, low densities provide lower opportunities for optimising vehicle kilometres. Rural economy, unlike the urban economy, is not service-based and many strategies applicable in urban areas presented here may not be applicable to rural areas. However, the principles of sustainable mobility remain the same. The mechanism of delivery of shared services in the rural areas may vary and participation by local communities is essential.

Small scale entrepreneurship models initiated by Governments and FIs (financial Institutions) can help create a robust rural shared transport network. There is a need to minimise kilometres and not just minimise the carbon footprint.

2. Lack of city planning and design: Another challenge for improving system efficiency is the absence of sustainable planning, design approach, and existence of economy driven car-oriented development of every city. The current city planning does not encourage sustainable mobility options for accessing services and shopping. Additionally, it does not have any infrastructure to support walking and cycling even for shorter distances or for last mile connectivity to public transport.

3. Lack of multiple mode commute and associated infrastructure: Existing city structures do not provide or support the idea of public transport. They also don't make provisions for intermodal passenger transport or multimode commute. There is a lack of integrated as well as hierarchical options to reach door to door – which ill competes with the reliability, comfort, affordability, and stature of a private vehicle. This is why even with a large amount of investment on mass rapid transit systems such as metro, cities are unable to achieve change in mode share, adding financial pressure on the existing infrastructure and further reducing its affordability. These systems are not supported by walking, cycling, and other modes of transport for supporting the last mile connectivity in a resourceful way. This exclusive transport system lacks empathy for physically, economically, and socially disadvantaged people as well.

4. Lack of coordinated and common governance structure: Outdated laws, multiplicity of institutions, and poor institutional capacity present a slew of challenges, such as the present permit system, including but not limited to fitness certificates. Endorsement of RC (registration certificate) with license for regulation of transport does not allow governments and regulators the flexibility to deal with the problems of urban transport of the 21st century and also hinder regulators from making full use of the technologies and innovative models at our disposal. Fragmented functional and tiered responsibilities, lack of substantive regulation, and innovation at execution level results in waste of time and energy. Diffused and inadequate institutional capacity results in delays in getting approvals and compliances, resulting in higher regulatory uncertainty, and costs for players in the mobility sector. Lack of coordination between the regulators and the enforcement authorities often leads to forward-looking policy changes not being transmitted to the ground level.

Trip Efficiency

Trip efficiency is defined as shifting from the most energy consuming to a more environment-friendly mode of transport, thereby improving the trip efficiency of the transport mode. Despite taking proactive steps towards improving planning processes and system efficiency, it can be assumed that passenger demand will rise multi-fold, considering the population growth. Serving the growing passenger demand through optimised trips, by improving occupancy through sharing and higher utilisation of seats and assets is the way forward.

Addressing the challenge directly translates to serving a majority of the passenger travel demand through mass transit and shared modes.

Mass transit and shared transport together can enable a shift from reliance on personal transport modes that often cater to the individual needs of users and technically operate at low occupancies.

In contrast, shared modes aim at higher occupancies and better asset utilisation to serve multiple passengers with a single trip and/or utilise the same vehicle across users. A long-term strategy that focuses on the above objectives can help reduce vehicle kilometres while serving the required passenger demand.

- Lack of efficient utilisation of asset
 - o Permits restricting cross utilisation of assets
 - o Personal vehicles unable to address shared mobility
- Growth of Private Modes
 - o Growing income levels and vehicle ownership
 - o Over reliance on private modes
 - o More road infrastructure encourages an increase in private users
- Lack of travel demand data and customisation
 - o Data for travel demand management
 - o For shared use cases
- Quality/efficiency and adoption of public transport services
 - o Productivity of end user which affects the commute time, waiting time
 - o Absence of seamless intermodal connectivity
 - o Lack of willingness to switch to shared mobility/public transportation
- Lack of ITS (intelligent transport systems)
 - o Lack of online routing information and inadequate technical capacity
 - o Absence of integrated ticketing
 - o Absence of inter-modal optimisation

Vehicle Efficiency

Vehicle efficiency means improving the energy efficiency of the transport mode. In order to improve environmental efficiency, there is a need to improve the vehicle and fuel technology. This can be done by enhancing the fuel economy of conventional engines; reducing the weight of vehicles and developing

alternatives such as electric and hybrid vehicles, biofuels, and hydrogen fuel technologies which will help reduce the environmental impact of each kilometre travelled.

- Integrating RE to add clean kilometres to VKT: Improving vehicle efficiency by using clean fuel will not have a direct impact on reducing VKT but will improve the environmental performance of transport modes. Integrating RE and including other technological improvements to reduce GHG emissions and air pollution will help in adding clean kilometres to VKT.
- Scaling up of EVs (electric vehicles) (in all segments starting from 2-wheelers, 3-wheelers, 4-wheelers) is a major challenge due to several associated factors such as:
 - Lack of charging stations and other charging infrastructure is a major deterrent in the adoption of EVs. This is especially true for personal EVs and those under the Rent-a-Cab Scheme/Commercial Operations.
 - Lack of standardised tariffs for electricity consumption for charging EVs and swap stations - Implementation is unclear; hence the declared rates for electricity consumptions are rarely accounted for, in the actual bills raised. EVs should be allowed to get benefits to pay tax (GST liability on services) from carbon credit. Carbon credits shall be calculated on the basis of the kilometres driven by the EVs and CO₂ emissions avoided.

Routes to Change: Proposed Solutions

The suggested ASI approach will lead to better energy security by coming up with alternatives leading to lower energy costs and less imported fuel. It will affect the country's economic development through increased private investment and reduced congestion which will save time.

System Efficiency

1. Need for Travel: Around the world, several TDM (travel demand management) strategies are deployed and have been tested. These strategies which could be voluntary or enforced through regulations aim to reduce the demand for automotive travel. Some regulations also rely on prices to reduce motorised travel demand.

TDM as a strategy aims at reducing demand for single occupancy vehicle use. In these strategies, employers emerge as the primary stakeholders that can affect change at scale. Some TDM strategies that employers and cities can adopt are:

a. Measures by employers for vehicle

kilometres reduction: Telecommuting, ride sharing, park and ride facilities, amenities within the company premises.

b. Policy Measures: Parking fees at work, trip reduction policy, flexible work schedules, restricting single occupancy, and support clean fuel technology.

c. ITS can be used for information and decision-making.

d. Better public transport including shared mobility services will go a long way too.

e. Land Use Measures can be introduced including TOD (transit-oriented development), multimodal integration, and development of NMT and infrastructure

2. City planning and design

a. Compact: Making the best use of land within the city to avoid long commutes.

b. Self-sustaining neighbourhoods: Diverse mixed land use with TOD needs to be in place.

– Creating Porosity: Street designs to ensure that all daily needs are within 20 minutes of walking distance.

– Hierarchy of streets and public spaces: Defined hierarchy of streets based on a range of public transport options rather than the width of a road, with designed infrastructure for all kinds of road users should be planned.

– Inclusive Street Design: Motor vehicle zone, non-motor/activity zone, building edges and the connectors across the street edges. These should be the focus to make streets safer, accessible, inclusive, and sustainable.

c. Need for Contextual Interventions: Diverse conditions of a city are managed using different approaches such as retrofitting, re-development, new development.

3. Multi-modal commute

a. Hierarchy of public transport: All segments of journeys to be considered while planning the public transport system.

b. Well integrated systems: A single hassle-free system to seamlessly switch from one mode of transportation to another.

c. Last mile connectivity solutions: A system needs to provide multiple solutions for

commuting from a transit hub to the first and last destination.

d. Incorporating innovative solutions: New technologies and platforms like on-demand ride sharing by cab aggregators need to be encouraged.

4. Lack of coordinated and common governance structure

e. Single window clearance system.

f. Online submission of documents.

Trip Efficiency

1. Promote high asset utilisation: To optimise existing transport assets and future vehicles, high utilisation and occupancy should be enabled through policies and permits that support high and cross utilisation for different purposes

2. Encourage non-usage of personal modes:

– Fiscal measures for deterring the use of personal vehicles, such as cess on purchase of vehicles to support sustainable city infrastructure, high parking charges, congestion charges and so on

– Non-fiscal measures such as limiting and regulating public parking through parking management, proof of private parking space for the purchase of a vehicle, creation of zero emission, shared mobility and NMT-only zones

3. Transport data consolidation for planning and optimisation

– Creation of platform by city governments, and creation of regulations around formats and privacy measures for data sharing by service providers

– Allow access for service providers to plan operations adequately

4. Development of quality and integrated public transit

– Institutional and financial capacity building of State operated public transport services

– Ensure regulations and permissions for multiple shared mobility models to co-exist and serve the needs of different use cases and segments of the society

– Creation of public transit and shared services friendly infrastructure which together can provide a seamless and quality experience for users

5. Application of ITS for demand management

– Information on accessibility and availability of

public transport and shared mobility options on a single platform to aid decision-making for choice of travel

- Ease of transactions and payments through the use of technology

Vehicle Efficiency

- o **Regulatory measures:** Regulatory instruments defining fuel standards and vehicle emission standards can be used to restrict the use of certain motorised vehicles and influence the types of vehicles used thereby promoting integration of RE.
- o **Economic measures:** Economic instruments such as vehicle and fuel taxes, road user charges and parking fees can be used to discourage the use of fossil fuel powered vehicles. Revenues from such instruments can be used to improve alternative transport modes, shared mobility, and clean fuel powered vehicles.
- o **Information measures:** Information instruments such as marketing can be used to increase the public awareness on impact of clean kilometres travelled and its effect on environment in terms of reducing air pollution. Separate labels on energy efficient vehicles can help consumers choose the most environmentally efficient vehicle.
- o **Technology measures:** Technology instruments including the development of more efficient engines, fuels, and vehicle design can help reduce the environmental burden of every kilometre driven.
- o **Policy measures:** Policy prioritising to improve vehicle efficiency by: (i) promoting and enforcing vehicle efficiency standards, (ii) setting fuel standards, (iii) promoting new vehicle technology and infrastructure, (iv) RandD (research and development) on new fuels, (v) developing ITS.

Actionable Agenda

The three different pillars of the system, trip, and vehicle efficiency will go hand in hand in providing an integrated solution for VKT.

Target smart cities of the country have been identified and the infrastructure is being built keeping not just current needs, but future needs in mind. The infrastructure will give way to more efficiently managed trips and subsequent demand will drive innovation in trip efficiency. More awareness and right guidance from the policy framework will help in realising the below recommendations into potentially viable solutions.

Regulatory measures

Considering the dynamics of technology progress, innovative solutions must be encouraged and procured through regulatory measures at different levels:

- **National level:** Guidance documents are needed such as National Urban Transport Policy and National TOD Policy
- **State level:** Enabling through legislation such as Town and Country Planning Acts and Budgetary Allocations
- **City Level:** Enabling through Development Plans which look into the context in detail such as Master Plans/Development Plans, Zonal Plans, Local Area Plans, Development Control regulations, and budgetary allocations. Considering the dynamics of technology progress, Innovative solutions must be encouraged and procurement for the same must be enabled through regulatory measures

Policy measures

At the National level, the guidance/policy documents must detail the need and purpose of adopting a compact development approach. Policy level documents must mandate the adoption of compact development measures for undertaking urban development. These include the National TOD Policy and Metro Rail Policy.

Financial measures

Budgets must prioritise and incentivise compact developments, wherein dedicated funds must be created to enable smooth implementation.

Technology measures

A comprehensive and coordinated development approach should be adopted w.r.t. sustainable habitat developments, service delivery, operations and maintenance. The focus should be customer-based interfaces for service delivery like app-based bus systems, PBS, metro services, rail services etc., and innovative solutions must be used for making the developments sustainable.

Capacity Building

Stakeholders must review their current knowledge capacities and highlight areas for which the capacity building is required. These can be based on state or city priority areas. Officials from all tiers must undertake required training programmes. The programmes can be designed as classroom training, web-based or site-visit training, based on the requirement.

Closer to the Destination: Actionable Recommendations

Short-Term (2020-2022)

- Notify a mandate to adopt sustainable transport models with focus on usage of public transport, shared mobility to reduce the numbers of private vehicles on road. This can be done by restricting the parking spots in offices by 50%, which will encourage employees to use public transport or other shared mobility options.
- Introduce emission standards for polluting vehicles like old buses, commercial vehicles. Notify a mandate to scrap all the buses and commercial vehicles older than 15 years. This will help in prioritising clean fuel usage and shifting to cleaner and efficient modes of transport like EVs (which will add clean kilometres on the road).
- An integrated system approach using National Common Mobility Card should be adopted. Like airline miles, public transport miles should be introduced to avail discounts on usage of public transport. This will be an incentive for people to use public transport.
- ITS should be adopted for seamless travel in public transport. This should include digital payments and real time information on seat availability, wait time etc.
- Flexible working options will also help in reducing the need to travel.

Medium-Term (2022-30)

- TOD plans including mixed land use, non-motorised infrastructure.
- Revisiting the city master plans to revise them as per the current needs.
- City wise targets to double the modal share of public transport.
- City level electrification targets for buses, commercial fleets. and other public transport modes. (For example – 20% of fleets to be electric in the next 5 years.)
- Adopting sustainable designs, policies, systems to promote compact city approach, integrated public transport development plans and clean fuel infrastructure plans

Long-Term (2030-50)

- Implementation and execution of master plan documents for planning, enforcement, awareness, and engagement strategies.

In conclusion, discussions around different problems around mobility systems can offshoot in different directions. VKT helps in unifying and measuring them into one single metric. This enables a more focused effort in solving the mobility system. The right start is being made by identifying the gaps and collaborating with stakeholders across different segments of the ecosystem. Focusing on this key metric and bringing this down will help several other related metrics fall in line and create visible changes.

PROVIDE LOW-CARBON SOLUTIONS FOR THE RURAL (NON-URBAN) POPULATIONS

Real change occurs when it happens from the grassroots.

This component aims to provide insights on the need for rural mobility and access to rural areas to be in line with a number of Sustainable Development Goals (SDGs), and also discusses the challenges to be addressed in providing sustainable mobility solutions for rural populations in India. It gives thrust to suggesting ways to build and strengthen rural infrastructure, creating local employment through building sustainable business solutions (such as low-cost biofuel distilleries and battery recycling units), while also deliberating upon the policy, regulations, and incentives required. Avenues for funding in rural areas in India have also been considered.

Heart of the Problem

As per the statistics of the 2011 Census of India, the rural population in India stands at 833 million, constituting almost 68% of the total population, while the rural economy constitutes 46% of the national income. As India develops rapidly, rural India continues to lag behind, grappling with issues such as declining agricultural incomes, lack of health and education facilities as well as an overall improvement in the quality of life.

Despite the rise of urbanisation, more than half of India's population is projected to be rural until 2050.

There are slated to be more opportunities in the development and promotion of advanced biofuels, horticulture and animal husbandry for women, which will lead to their empowerment. Hence for rural India, flexible, quick, efficient and predictable mobility will serve as a strong enabler for economic development and social transformation.

It is therefore, imperative to know rural mobility and how it is defined. As per the National Sample Survey Organisation (NSSO), a rural area is defined as:

- An area with a population density of up to 400 per square kilometre.

- Villages with clear surveyed boundaries but no municipal board.
- A minimum of 75% of male working population involved in agriculture and allied activities.

Rural mobility entails movement of people and goods across rural areas, as well as between rural area and the nearby town/s or urban area. The mobility should be provided for all people, affordable and equitable, supporting economic development and human well-being, and should have the qualities of reliability, resource-efficiency, sustainability, and resilience.

Mobility access comes as a ray of hope in this scenario. With mobility access, rural areas have the potential to prosper and this will also impact urban areas due to the decreasing pressure of rural-urban migration. Rural mobility can also drive the all-important transition in the composition of output and occupation from agriculture to more productive non-farm activities. This change can ultimately impact the economic fabric of the country and bring about transformation in the rural and total economy. The benefits of increased access will be multifaceted on:

- Health
- Economic development
- Alternate livelihood
- Quality of life and overall well-being
- Relation with urban development
- GDP (gross domestic product) impact for India

In addition to the above, this chapter also highlights the complexity of the subject and the added disadvantage of lack of data on travel demand and consumer behaviour patterns.

While there is no documented evidence hard enough to design a solution, scale it up and make it viable today, the roadmap offers the thought process and actionable steps to help achieve the same.

This component also highlights the current scenario of transport modes available, the difficulties faced today from the perspective of public, service provider and governing bodies. The target inputs expected to be achieved from the research work proposed is highlighted.

Existing Policy Response

This section highlights the major Government of India schemes active currently which are relevant and in synergy for increasing rural mobility:

- National Rurban Mission (NRuM).
- Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) for providing wage employment.
- National Rural Livelihoods Mission (NRLM) for self-employment and skill development: Capacity building, Green Jobs
- National Skills Development Corporation
- Pradhan Mantri Gram Sadak Yojana (PMGSY) for construction of quality roads
- Shyama Prasad Mukherjee RURBAN Mission
- Pradhan Mantri JI-VAN Yojana: This scheme was launched with the objective of making the 2G ethanol production viable while providing alternate income to farmers by utilising the crop residues.
- Sustainable Alternative Towards Affordable Transportation (SATAT): Launched in October 2018 by Ministry of Petroleum and Natural Gas, SATAT aims at providing Sustainable Alternative Towards Affordable Transportation. Under this programme, potential entrepreneurs would set up Compressed Bio-Gas (CBG) production plants and make CBG available in the market for use in automotive fuels.
- KUSUM Scheme: While pump sets are captured in this scheme, electric vehicle charging stations also need to be captured in line to create more stations in rural areas.

Challenges Along the Way

- Lack of cash flow
- Willingness to pay: Low wages and commuter profiling
- Consumer behaviour patterns of choosing inconvenience due to low purchase power
- Lack of concentrated demand – hampers scaling up of cheaper and efficient transport services
- Infrastructure: Quality of power supply, biofuel collection and processing
- No well researched and validated governance measures leading to local enterprises performing at lesser levels of sustainability, productivity, and efficiency

Routes to Change: Proposed Solutions

This section highlights the methodology adapted to the solutions and the changes proposed.

- Solutions need to necessarily be with available and modifiable products.
- Other means will bring in a lot of high cost imports and additional capital investments.
- Work on solutions which will have cost parity with the existing solutions in future (2023-2025). Solutions targeting parity today will prove to be impractical.
- Sustainability managed at a local level. Each mandal and zilla to be sustainable at its level, although can be tied up with a bigger city
- Panchayati Raj Institutions (PRIs) have to be involved in the roadmap as these institutions constitute the core of decentralised development of planning and its implementation in rural areas.
- Low carbon solutions and sustainability should not be forced as a mandate and burden the rural population. Mandates perhaps could be on bigger cities which could ideally hold responsibilities to the respective rural areas in the State.

CROSSROADS OF CHANGE



TRANSFORMING THE TRANSPORT SECTOR IN THE INDIAN SUNDARBANS

Access to clean, safe, reliable and affordable modes of transportation for last mile connectivity has always been a challenge. This becomes even more challenging in the Sundarbans landscape in India which is a cluster of low lying islands in the Bay of Bengal. Sundarbans is home to a very rich floral and faunal diversity and also a climatically vulnerable region inhabited by over 4.5 million people mostly dependent on highly polluting, unsafe and unorganized modes of transport. Recognising the need towards promoting renewable energy based transport for a cleaner and sustainable future, WWF-India has set up a pilot project on electric mobility for local transport. As part of the project, two electric vehicle solar charging stations have been installed in one of the remotest islands of Sundarbans and four government approved models of electric vehicles have been introduced to ply on the same. Moreover, rural institutions have been formed to own, manage and operate the charging stations, as well as the electric vehicles. Working in tandem with various government agencies, grassroots level organisations and other stakeholders, the project has set a precedent of successfully carrying out first of its kind institutional registration of standard and government approved models of electric vehicles in the Sundarbans, the scale up potential presents an opportunity of improving livelihoods and promoting environment conservation.



On the basis of the above considerations, following changes are proposed:

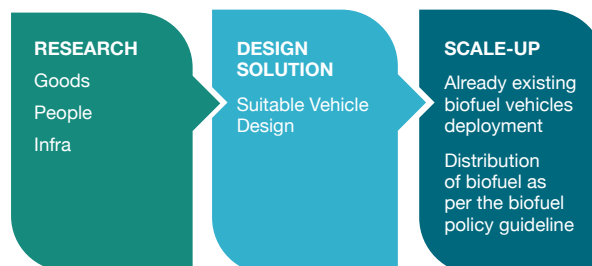
- Mobilisation of funds: Credit can dramatically speed the adoption of means of transport, but access to credit is generally poor in rural areas. Operating subsidies are a common solution in high-income countries and may be appropriate for some areas in developing countries.
- Flexibility in Fuel: Bio/EV (electric vehicle).
- Infrastructure:
 - Local generation like micro-grids should be encouraged.
 - Grid strengthening in rural areas for anticipated load from electric mobility.
 - Low cost biofuel distilleries run by local enterprises for use in modified engines.
 - Alighting and boarding points (Bus Terminals).
 - Charging points should not be captive for all operators so as to work as an efficient network
- Lowest total cost of ownership per passenger
- Promoting EVs
- Using charging in battery swapping facilities
- Unorthodox and small vehicles to be developed
- Establish recycling units in low cost real estate spaces, to bring in employment as well as lower costs for recycling
- Local employment benefit: Develop skill and increase local employment through maintenance and running of charging/fuelling stations
- Regulatory measures should be suitable for development of each geography to enable a smooth transition to low carbon transport.

Closer to the Destination: Actionable Recommendations

This section presents the action points for roadmap to achieve low carbon transport in rural areas:

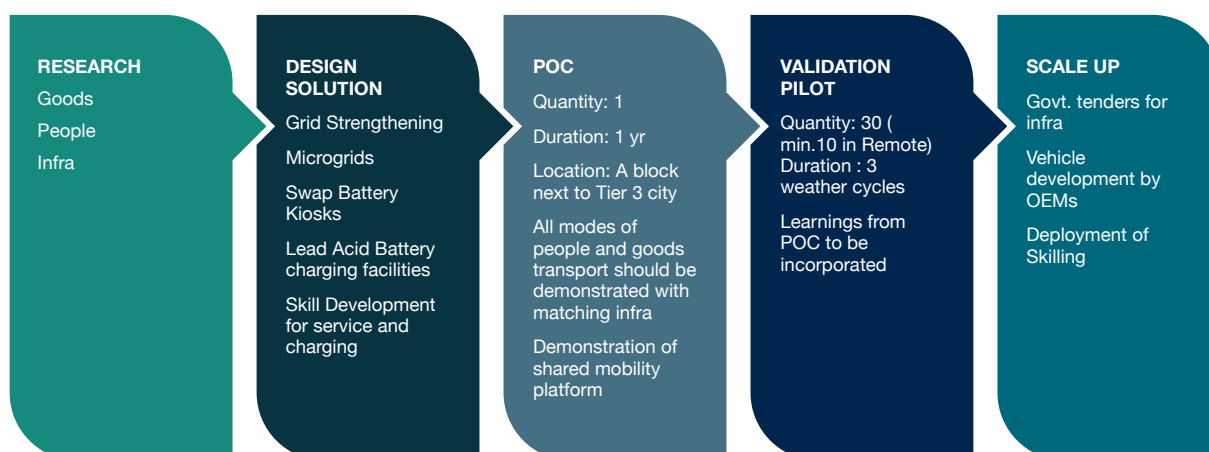
DECARBONISING FOSSIL FUELS

The roadmap starts with research into the demand data for movement of goods and people. This will provide the infrastructure requirement. The analyses of this demand will reflect the proportion that can be served by low carbon transport fuels such as biofuels and biodiesel. Thereafter, suitable modifications to vehicles are to be made, followed by deployment and scaling up of number of vehicles in this segment.



ELECTRIC MOBILITY: Vehicles: eBuses, eRicks, eBikes and the likes

For introducing electric mobility in rural areas, the roadmap first recommends for research into data for projecting travel demand for goods and peoples. Analysis is to be done for determining the proportion of that demand which can be served with electric mobility solutions. The required actions like strengthening the grid should to be performed along with development of solutions to basic problems of electric mobility but in rural context. After a ‘proof of concept’, a pilot at a relatively larger scale is needed to demonstrate the confidence and feasibility of the solution. The final steps will be scaling up through government tenders for infrastructure and industry developing dedicated EV options for rural customers. This will be accompanied by more investment in human capital in the form of skill development for the new ecosystem.



- **Increased Share of NMT (non-motorised transport) and Shared Mobility:** NMT modes are feasible for shorter distances, facilitate decongestion, and the relatively smaller size of facilities at lower cost gives them a higher penetrative value in built environments. In addition, low consumption of energy and resources make them viable options for sustainable transportation. Therefore, sustainable and improved NMT options such as bicycles, peddled rickshaws, cattle driven carts with better and efficient designs need to be developed.

• Infrastructure Requirement:

- Power: Electrification of core rural areas is not enough. Grid strengthening in rural areas for load from electric mobility pick-up will be required. Factors that will play a crucial role in charging systems are distributed generation from micro-grid to power the charging stations and low-cost charging stations. Battery swap options can be more successful where the large cost of battery ownership can be borne by energy service companies that can capitalise on aggregated demand.
- Biofuel refining: Measures for increasing predictability of availability by better storage and supply chain. Decentralised refining at the cluster level will minimise cost. Biomass supply chain collection, aggregation, storage and processing needs to be developed.
- Markets: The markets should be planned close enough to rural communities so that low-cost intermediate means of transport can be used. These markets can thereafter benefit from the use of more efficient logistics and freight services. The concentrated demand from these markets will bring the cost of these services down.
- Mobile communication: The development of IT infra will accelerate the low carbon solution, such as shared mobility by aggregating the demand and optimising the resource allocation. This will also help the penetration of digital payments and cashless transaction for rides.
- Infrastructure to facilitate mobility: While the demand for mobility will need to be captured, there needs to be sufficient focus and planning for bus stops, enclosed pick up and drop off points, traffic signals, pavements along roads, safe interjection points and markings, sanitation facilities and ATM facilities.

• New Policy Recommendations (Regulations, Standards and Incentives)

- Due to the wide diversity in usage patterns, geographies and cultures in rural areas, most means of transport will spread via small-scale

private initiative, which can be supported by the government with conducive policies. The new policies should aim to concentrate demand in rural areas. For remote areas, operational incentives to make low demand transport services viable for small entrepreneurs should be at the core of policymaking.

- Regulations: Rural transport will need to be brought under the State government planning that would finally need to arrive at regulations such as a certain fixed percentage of fleet mandated to be alternate fuel/BOV (batter operated vehicle) for state-owned transport.
- A proper procedure for registration of electric three-wheelers will need to be defined as it provides the majority of public transport. This will help them avail benefits of various financial schemes and other benefits in terms of incentives and subsidies.
- Standards: Post the Pilot phase, the size of the vehicle, micro-grids and appropriate infrastructure to be standardised for realising the scale of economy.
- Incentives: Viability Gap Funding will need to be addressed by the Governments both at State and Central level so as to invite public and private players to invest in rural mobility and logistics.

• Capacity Building:

- Formation of local formal or informal networks that bring together people who would not otherwise be linked and involve them in planning, implementation, monitoring, and evaluation.
- Village/Block/District level Entrepreneurs: Skilling for capacity building on the development of village/block/district level entrepreneurs for collection, aggregation, storage and transportation of biomass will be imperative
- Employment generation- Affordable and low carbon transport options will enhance employment generation
- Manufacturing and maintenance skills need to be provided.



It is clear that rural mobility can provide an opportunity for better living conditions— health, education, increased options for livelihood activities, increased efficiency in agriculture, last-mile connectivity - thus benefiting not only locally but even at the national level.

ACCELERATE ACTION ON ADAPTATION IN THE TRANSPORT SECTOR

Shaping with the times is a definitive sign of change.

Transport systems and services are being severely disrupted by climate-related events, with an increasing number of such events in the recent past in several countries including India. A transport system that cannot withstand the emerging impacts of climate change, will impose high costs for maintenance and repair, limit transportability and access, and result in significant economic losses. Ensuring climate resilience of transport investments is critical as it will also allow other sectors to quickly rebound after climate-related disasters.

It is immensely critical to strengthen the ongoing discussion on adaptation in the transportation industry – a factor that will play a significant role in enabling and guiding climate change adaptation strategies worldwide.

Sustainable and resilient transport is a cross-cutting issue under the 17 SDGs (Sustainable Development Goals) set by the international community in 2015. It is key to achieving the progress of several goals. The increasing impact of climate change requires countries to develop strategies for resilient transport infrastructure and systems. However, a lot of international debate and action around climate change and international transport has focused on addressing the causes (mitigation) rather than coping with the impacts (adaptation). Therefore, it is pertinent to reflect on ways to develop a proactive approach to climate change adaptation strategies through bottom-up industry consultation. It is crucial to think through ways to engage more stakeholders to practice efficient climate-resilient measures and to make recommendations for next steps.

Heart of the Problem

Transport systems are the veins of an economy. Transport interconnects all land-uses and is linked to

all aspects of human life: leisure, residential, business and commercial, and industry. Infrastructure can have an essential role in strategies to manage the risks and minimise the negative impacts of climate change. The phenomenon of climate change is causing a wide range of impacts in several ways. Excess rainfall, reduced rainfall, drought, temperature increase, extreme cold, cyclones and storms, increased radiation, sea-level rise, storm surge and flooding – these words are now common in our conversations and need to be addressed urgently. The physical impacts of climate change – such as increasing temperatures, shifting patterns of precipitation, increased intensity or recurrence of extreme weather events and rising sea levels – will affect all types of infrastructure. Infrastructure should be designed, built and operated in a way that anticipates, prepares for, and adapts to these changing climate conditions.¹⁰ A transport system will impose high costs for maintenance and repair, limit transportability and access, and result into significant economic losses if there is lack of assessment of the emerging climate change impacts.

Impacts of climate change on transport infrastructure: Sensitivity towards rainfall, winds, high temperatures, storms and flooding etc. Example: paved roads are particularly vulnerable to temperature extremes, while unpaved roads and bridges are vulnerable to precipitation extremes. It is therefore essential to build a climate resilient infrastructure.

A resilient transportation system is paramount to the prosperity of all cities. It allows people to move into, out of, and around their city despite climate shocks and stresses that degrade and damage infrastructure and lead to service disruptions. The need would be to build a climate-resilient transportation system that is flexible and changes with shifting trends and climatic conditions. Such a system:

¹⁰ OECD (2018), Climate-resilient Infrastructure, Policy Perspectives.

- Encourages maintenance of public assets with a large replacement value
- Avoids domino or cascading effects
- Is ready for disaster management, e.g., evacuation of people to shelters
- Protects the health and safety of people – for instance, reduced GHG (greenhouse gas) emissions and fossil fuel consumption
- Ensures reliable mobility
- Improvement and construction of roads
- Improved connectivity to disaster shelters
- Improved infrastructure maintenance
- Climate risk evaluation and vulnerability assessment tools for infrastructure projects.
- Climate vulnerability assessment for existing projects
- Build sufficient redundancy in the transport system to overcome climate risks and prepare for emergency route planning

Building resilience into transport will not happen overnight. It will need deeper thinking on:

- How to improve road climate resilience
- Design of emergency maintenance and response systems during a disaster
- Development of risk evaluation monitoring tools
- Improving the accuracy of weather/disaster forecasting tools/models
- Inclusion of integrated climate analysis in different maintenance plans e.g. in the operationalisation of a bridge maintenance plan

General Impacts:

Every climate factor leaves in its wake, impacts that must be considered importantly. These impacts together make up the challenges that must be surmounted in the pursuit of a climate-resilient transportation system. The transport infrastructure can be impacted by various climate factors. They are summarised in Table 1 below.

Table 1: Impacts of climate factors on the transport infrastructure

Climate Factors	Expected Impacts and Consequent Challenges
Excess Rainfall	<ul style="list-style-type: none"> • Extreme floods further damaging roads and other infrastructure • Increased moisture content leads to corrosion of metal structures
Reduced Rainfall/ Drought	<ul style="list-style-type: none"> • Affects water-borne transport • Excessive drying of soil leads to soil cracking and impacts the foundations of infrastructure
Temperature Increase and Heat Waves	<ul style="list-style-type: none"> • Damage to asphalt or rails designed for lower temperatures • Increase in demand for cooling in the transport sector adding to higher demand for electricity
Cyclones & Storms	<ul style="list-style-type: none"> • Disproportionate structural loading causes structural failure, which may lead to collapse or significant structural damage • Infrastructure in ports could face severe damage during extreme weather events
Increased Radiation	<ul style="list-style-type: none"> • Faster degradation or withering away of the surface coating
Sea-level Rise & Flooding	<ul style="list-style-type: none"> • Increased risk of a storm—surge flooding and coastal erosion • Submerging of low-lying areas and damage to the drainage system of the city

Existing Policy Response

The existing policy response for climate adaptation in the country is very minimum or non-existent. There is a lack of adequate debate and action in relation to climate change impact in the transport sector and the need for climate change adaptation. Existing infrastructure development planning is non-climate resilient. Resilience means that the risks have been considered and managed to achieve an acceptable level of performance given the available information, and that capacities to withstand and recover from shocks are in place.¹¹ Policies and regulations in the transport sector in its current form do not evaluate the resilience of the infrastructure.

Likewise, in the current scenario the development of infrastructure projects lacks a holistic approach to transport infrastructure and mobility planning. Building climate resilient transport infrastructure is as essential as the rollout of electric mobility and promotion of NMT (non-motorised transport).

The impacts of climate change on transport infrastructure are massive. Paved roads are particularly vulnerable to temperature extremes, while unpaved roads and bridges are vulnerable to precipitation extremes.

The need of the hour is to integrate climate impact adaptation by updating design standards for transport systems, according to climatic projections. Establishing emergency plans, acquiring new technologies to understand and manage climate-related challenges, and creating mechanisms for knowledge sharing among environment professionals and transport professionals, are vital steps that need to be taken urgently.

Transportation policy and planning requires a sophisticated approach to put in place systems that allow for adaptation to climate change, as an integral component of the transport sector. Clearly, the focus needs to be on:

- Mapping natural hazards and identifying locations of possible impacts
- Creating vulnerability maps for different natural hazards
- Conducting risk assessments
- Compiling recommendations for adaptation strategies and measures worldwide
- Integrating climate adaptation in project design

Climate adaptation when built into project design would aim to achieve fewer global deaths and injuries from road traffic accidents. It would also work to develop quality, reliable, sustainable, and resilient infrastructure. Good design would also integrate land-use, urban, road and transport planning. It would create transit-oriented developments and would include NMT (non-motorised transport) components in transport master plans.

Climate adaptation would entail designing of high-quality public transport services on dedicated infrastructure along major city corridors. Project designing for significant shifts to more sustainable modes for intercity passenger and goods transport would be factored in.

Design for a changing climate would bring the following goals in the spotlight: enhancing freight transport efficiencies, viewing social equality as a specific design criterion, and preparing a strategy document on 'low carbon and climate-resilient mobility plan for cities'.

To promote climate-proof urban transport design, mitigation and adaptation strategies need to be integrated into the transport planning process. There would be a need to build capacities for climate resilience and adaptation to be undertaken by promoting programmes in academia. Developing quality, reliable, sustainable, and climate-resilient infrastructure by integrating transport infrastructure into urban planning will be equally crucial.

Challenges Along the Way

The major challenge in climate change adaptation within the transportation sector is the convergence of policy directives from the different ministries and government departments. Climate change adaptation in the transport sector goes hand in hand with urban infrastructure planning. There is a need for integrating climate change impact adaptation by updating design standards for transport systems according to climatic projections, establishing emergency plans, acquiring new technologies to understand and manage climate-related challenges, and creating mechanisms for knowledge sharing among environment professionals and transport professionals. Climate change can potentially impact transport systems in more ways than one. Together, these are massive mountains that the planet needs to cross to achieve better results and a more efficient way of operating transport systems.

¹¹ OECD (2014a). Boosting Resilience through Innovative Risk Governance, OECD Reviews of Risk Management Policies, OECD Publishing

Sea-level Rise, Storm Surge, and Flooding: There can be considerable damage to port infrastructure and disruptions in port operations and shipping traffic, as also damage to, or inaccessibility of, low-lying coastal infrastructures such as roads and railway beds and tunnels. A loss of coastal waterway systems may occur and barrier islands may disappear. Aggravated coastal flooding as storm surges also build on a higher base and reach further inland leading to road, rail, and airport closures.

Strong Wind and Storms: There is a greater likelihood of infrastructure failure and disruptions of transport operations for all modes of traffic in such climatic conditions. The structural integrity of long-span bridges is vulnerable to strong winds as are auxiliary infrastructures such as road signs, traffic signals, overpasses, train stations, and toll collection stations.

There can be possible damage to overhead lines for railways, power supply, signs, lighting features, and increased tree fall leading to the closure of railway tracks and roads. Delays and cancellation of flights and unreliable air travel services are expected, as also damage to cranes and terminal facilities. Safety hazards are posed to all vehicles.

Increasing Precipitation Intensity: This leads to flooding of roads, railways, and tunnels causing traffic disruptions and road/rail closure. Slope failures and landslides (road/rail) are common and erosion and scrubbing or washout of gravel and earth roads and railway tracks happens too. There is increased sediment loading of drainage works leading to increased maintenance requirements and costs.

Extreme Heat and Rising Temperatures: Increased pavement, deterioration, softening, and cracking, rail track deformation, and thermal expansion of bridge joints are just some of the effects of such a rampant increase in temperatures. Increased energy consumption due to refrigeration of transported goods and the use of air conditioning are common too.

The other significant challenges are:

- Mapping of potential natural hazards/extreme climate events and identifying locations of potential impacts on transport infrastructure.
- Non-availability of risk assessments for potential extreme climate events.
- Compliance to standards and regulations when it comes to urban planning and transport infrastructure.

Routes to Change: Proposed Solutions

There is a need for the following measures to be implemented:

5.1 Promoting Climate Risk Screening and Vulnerability Assessment of Transport System, Services and New Projects

The journey from potential impact to actual impact depends not only on the exposure and sensitivity of the transport system but also on the adaptive capacity of the available resources for coping with impacts and minimising damage. For example, in the coastal road areas, adaptive capacity could include the ability to close the road and reroute traffic with minimal delay. Mobilisation of resources to proactively maintain drainage and pavement; and planning to ensure that new infrastructure is not sited in exposed areas. The sensitivity of a system also depends on its structural characteristics—for example, engineered dirt or gravel roads are more likely to become impassable than paved roads during heavy rains.

Poorly maintained assets of any type are more sensitive than better-maintained assets. The location also plays an important role. Settlements and hence transport assets are often concentrated in coastal zones, where climate hazards are particularly challenging. For example, a paved coastal road in the tropics could be exposed to sea-level rise and higher storm surges; hotter, longer, and more frequent heatwaves; more frequent or more intense storms; or alternating periods of dry weather and more intense rainfall.

It is also vital to identify vulnerable areas that are prone to extreme climatic events and sensitising policy planners and decision-makers in the region. The potential impacts of climate change in the incidence of extremes should be well-known: an essential building block for incorporating risk management into the local (state and district) planning process.

5.2 Routes to Promoting Climate Risk Screening

- Screening Tools for Climate Risk for Use in Early Stages of Investments: World Bank has already developed a set of climate and disaster risk-screening tools, including those relevant to transport systems. The quality of output produced by the tools depends on expert knowledge and judgement, and the quality of the available climate change and hazards information.

- **Decision-support Systems for Alternative Transport Network Investments:** Decision-support systems are needed during the investment planning process to help cities understand and evaluate the impacts on economic and social continuity of transport network investments. Such investments might cover the incremental costs of maintenance regimes and assure the provision of spare capacity, back-up systems, and alternative services during spot failures of portions of the transport network.
- **Cost-Risk Assessment Framework under a Given Climate Change Scenario:** Cost-risk assessment provides a decision-making framework for systematically evaluating the merits of investments that enhance resilience and prioritising them.
- **Decision Making under Uncertainty (DMU):** To cope up with a less predictable climate, a new decision-making tool is needed to reduce risks under conditions of deep uncertainty.

5.3 Emerging Lessons from Screening Transport Projects for Climate Risk

A recent portfolio-level review looked at the experience by using the World Bank's climate and disaster risk screening tools for transport projects financed by the World Bank's International Development Association (IDA). It yielded the following insights:

- Exposure to climate hazards, particularly extreme precipitation and flooding, but also coastal hazards, sea-level, and storm surge, is rising.
- This includes increase in the variability of temperature and precipitation, and in the intensity of extreme events like flooding and heatwaves. Extreme precipitation and flooding are especially highlighted. For instance, coastal hazards such as sea-level rise and storm surge were not prevalent in many projects analysed, but where they are present it is expected that they would present high risks to the location and physical investments. Designing projects in a way that accounts for current and future risks can help to reduce the sensitivity of transport investments in the medium and long term.
- Measures such as capacity building, data gathering, sensitisation of stakeholders, and strategic planning are important for improving the adaptive capacity of institutions. Capacity and sensitisation of people that manage and rely on transport networks should be enhanced.

Summarising the solutions as:

- Developing quality, reliable, sustainable and climate resilient infrastructure by integrating transport infrastructure into urban planning.
- Creating frameworks to evaluate the preparedness of transport infrastructure for climate change related disasters.
- Providing access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport and integrating them with the last mile connectivity provided by fleet of EVs (electric vehicles).
- Integration of land-use, urban and transport planning.
- Transit-oriented development by promoting mixed land-use, NMT infrastructure, e-commerce for service at doorstep, encouraging work from home, ZEV (zero emission vehicles) like e-Autos for last mile mobility by connecting metro infrastructures, and creating porosity by ensuring all daily needs are within walking distance
- Promoting NMT components in transport master plans.
- Designing of high-quality public transport services on dedicated infrastructure along major city corridors.
- Project designing for significant shifts to more sustainable modes for intercity passenger and freight transport.
- Enhancing freight transport efficiencies by gradually shifting them to low emission alternative fuels.
- Preparing strategy document on low carbon and climate-resilient mobility plan for cities' integrating them to form the national low carbon mobility vision.

Proposed Tools and Frameworks

Transport Infrastructure: Create frameworks to evaluate the preparedness of transport infrastructure for climate change related disasters.

Urban planning

- Design standards that account for climate resilience.
- Popularise electric 3-wheelers, buses, metros and NMT in urban commute.
- Urban planning to avoid/redesign high climate risk areas

Monitoring and Evaluation

- Climate risk evaluation and vulnerability assessment tools for infrastructure projects.
- Climate vulnerability assessment to be done for existing projects.

Potential Impacts and Adaptation Measures on Road Infrastructure

Type of Impact	Impact on Road Infrastructure	Possible Adaptation Measures
Improve road climate resilience	<ol style="list-style-type: none"> 1. Deformations on road, slowing down or disrupting of transport, melting asphalt 2. Increased asphalt rutting due to material constraints under severe exposure to heat 	<ol style="list-style-type: none"> 1. More resilient design standards 2. Planting roadside vegetation to decrease the exposure of roads to heat 3. Reduce overall exposure and provide cooling through green and blue infrastructures such as parks and lakes 4. Proper design/construction overlay with more rut-resistant asphalt 5. Risk evaluation tools and urban planning that avoid high-risk areas
More frequent droughts	<ol style="list-style-type: none"> 1. Dry soil in combination with more intense rains will lead to more landslides and subsidence 2. Road foundation degradation 3. Dust and sand on the road can lead to safety hazard 	<ol style="list-style-type: none"> 1. Assess the likeliness of impact using risk mapping tools and then avoid development in high-risk areas 2. Monitor soil conditions of existing roads 3. Increase cleaning and maintenance of roadways
Sea-level rise and coastal erosion	<ol style="list-style-type: none"> 1. Risk of inundation of road infrastructure and flooding of underground tunnels in coastal cities 2. Degradation of the road surface and base layers from salt penetration 	<ol style="list-style-type: none"> 1. Assess the likeliness of impact using risk mapping tools and then avoid development in high-risk areas 2. Integrate transport planning with coastal zone management 3. Protective features such as sea-walls 4. Manage retreat, possibly including abandoning of certain transport infrastructure in mid & long term 5. Build redundancy of roads in the system 6. Design material standards to include corrosion-resistant material 7. Improve drainage
Extreme rainfall and flooding	Road damages & decrease of structural integrity	<ol style="list-style-type: none"> 1. Assess the likeliness of impact using risk mapping tools and then avoid development in high-risk and flood-prone areas 2. Improve drainage infra with frequent audits 3. Enhance pumping facilities 4. Early warning systems and evacuation planning 5. Install signs high-above the ground that can alert pedestrians and motorists of unsafe zones and low lying areas
	Dirty roads and roads with limited foundations and no /poor drainage are at risk	<ol style="list-style-type: none"> 1. Enhance foundations 2. Build all-weather roads 3. Improve green spaces and flood protection
More intensive storms	<ol style="list-style-type: none"> 1. Damage to infrastructure 2. Obstruction of roads due to fallen trees, buildings or vehicles 	<ol style="list-style-type: none"> 1. Assess if current design standards can withstand intense storms and adapt to new standards if required to improve drainage 2. Improve weather forecasting leading to better preparation 3. Plan emergency and evacuation routes 4. Improve maintenance of roads and drainage

2.2 Impact on Vehicle (Public Transport) and Mobility Behaviour

Type of Impact	Impact on Vehicles	Possible Adaptation Measures
Increased temperature and heat-waves	<ol style="list-style-type: none"> 1. Increased temperature in buses and other modes leading to driver discomfort and exhaustion, further leading to accidents 2. Increased requirement for more intensive air-conditioning increasing energy demand 3. Wearing off/Melting tyres 4. Overheating of equipment 	<ol style="list-style-type: none"> 1. Sufficiently large and tinted windows 2. White-painted roofs 3. Improve thermal insulation and cooling systems 4. New standards to withstand higher temperatures
Extreme rainfall and flooding	<ol style="list-style-type: none"> 1. Difficult driving conditions with implications on safety, performance and operations 2. Flooding of the public transport fleet, causing economic damages 	<ol style="list-style-type: none"> 1. Manage speed limits in bad weather conditions 2. Driver training to face inclement weather and difficult driving conditions 3. Plan emergency/redundant routes 4. Early warning signs 5. Flood insurance
More intensive storms	<ol style="list-style-type: none"> 1. Difficult driving conditions 2. Overturning of vehicles 	<ol style="list-style-type: none"> 1. Driver training to face inclement weather and difficult driving conditions 2. Speed restrictions 3. Improved weather forecasting 4. Emergency planning and evacuation routes

Closer to the Destination: Actionable Recommendations

Short-Term (2020-2022)

Transport Infrastructure

- Transit- oriented developments by promoting mixed land-use, NMT infrastructure, e-commerce for service at doorstep, encouraging work from home, ZEV like e-Autos for last mile mobility by connecting metro infrastructures, and creating porosity by ensuring all daily needs are within walking distance.
- Promoting NMT components in transport master plans
- Implement stringent SOP (standard operating procedure) for drainage system
- Develop a climate risk evaluation tool to assess risks and build mitigation strategies

Public transport vehicles and mobility behaviour

- Designing of high-quality public transport services on dedicated infrastructure along major city corridors
- Driver training on disaster management to help deal with post disaster management activities
- Emergency/redundant route planning
- Better weather/disaster forecasting tools to help predict imminent dangers, and preparing in advance

Medium-Term (2022-2030)

Transport Infrastructure

- Developing quality, reliable, sustainable and climate resilient infrastructure by integrating transport infrastructure into urban planning
- Creating frameworks to evaluate the preparedness of transport infrastructure for climate change related disasters
- Preparing strategy document on low carbon and climate-resilient mobility plan for cities integrating them to form the national low carbon mobility vision
- Implement Master Plan for systemic improvement of all utilities in cities
- 3D Mapping of all major cities
- More resilient design standards for infrastructure, utilities and storm water drains
- Ensure Build-Own-Operate-Maintain (BOOM) models are implemented
- Building sufficient redundancy

Public transport vehicles and mobility behaviour

- Change in design parameters and standards
- Project designing for significant shifts to more sustainable modes for intercity passenger and freight transport
- Enhancing freight transport efficiencies by gradually shifting them to low emission alternative fuels

LARGE SCALE DEPLOYMENT OF ECONOMIC INSTRUMENTS AND LEVERAGING FINANCE

It is the first bold steps that make a journey great.

The transport sector has been one of the major contributors to the growth in GHGs (greenhouse gases). An increase in economic growth and consequently per capita incomes in the future are expected to drive the demand for transport further. This trend is expected to result in an increased share of energy demand and GHGs as well as particulate emissions from the transport sector. Going by current trends, the high dependence on fossil fuels, now and in the future, is poised to pose challenges for energy security, air pollution in cities, and climate.

India is moving towards cleaner energy fuels. However to limit GHGs as well as particulate emissions from the transport sector and improve the mobility scenario, there is a need to innovate and embrace some of the many secondary funding tools successfully used in cities, states, and countries around the world. These include incentives for low carbon transport solutions as well as alternate revenue-raising tools which facilitate TOD (transit-oriented development) such as congestion charge, vehicle tax/registration fees, fuel taxes, and so on. Furthermore, superannuation and pension funds have been dedicated funding sources for transport operations, expansions, and transitions around the globe for years.

It is crucial to capitalise on the broad benefits provided by a sustainable transport system. It is also important to continue to improve India's transport scenario, so that sustainable, long-term funding can allow for planned technology transitions as well as improvements in service offerings.

The expansion of existing infrastructure is vital too. Under this scenario, it is crucial to highlight existing gaps and challenges in financing and deployment of various economic instruments and potential solutions to channel financing towards sustainable mobility.

Heart of the Problem and Existing Policy Response

- ✓ Fiscal disincentives on public transportation compared to private vehicles in India have led to rising private vehicle ownership resulting in declining air quality, increased pollution, increased congestion in cities, decreasing share of public transportation, and resultant externalities such as air pollution, congestion, and increased health costs.
 - ✓ Lack of financing options such as low penetration of green bonds, high cost of capital, no priority sector lending for sustainable mobility.
 - ✓ Lack of resources to finance the existing gaps in infrastructure capacity as well as in anticipation of future demand. While retaining the role for public funding, private investment is also an imperative.
 - ✓ Investments in the transport sector in general and the more energy efficient modes, in particular (railways, inland waterways, and coastal waterways) is a critical factor.
 - ✓ Increasing production of biofuels and the need to incentivise biofuels.
- a) Biofuels are an integral component of a farm-based bio-economy, which addresses environment and climate change issues as well as has major impact on socio-economic development of rural areas through:
- enhancing clean energy access in rural areas,
 - creating rural jobs along with enhancing net income of farm households, and
 - stimulating growth in food processing/preservation as well as creating an eco-system for other non-farm economic activities, apart from growth in services sector linked to consumption-led demand, driven by enhanced incomes of farm households.
- b) Multiple Sustainable Development Goals (SDGs) would be met, along with GHG mitigation. Hence, biofuels projects are an appropriate case for climate financing under Article 6.4 of the Paris Agreement.

- c) There should also be possibilities to access specific financing instruments, e.g. SIFF (Sustainable India Finance Facility) and climate bonds.
- d) However, for this to happen, it is necessary to create enabling eco-system, by:
 - having standard, long term (20 years), “Off-take Agreement” for Biofuels (including CBG—Compressed Bio-gas), in similar lines to PPAs (power purchase agreements) for solar and wind power projects, developed in consultation with banks and DFIs (development finance institutions).
 - having Government policies for extending capacity building and project financing support to “Green Entrepreneurs”, who would collect and aggregate bio-waste (farm as well as urban).
- ✓ Decarbonising Current Transport Fuels – with Biofuels
 - a) Biofuels face the issue of perceived risks related to the ‘bio-resources supply chain’. What is inadequately appreciated is the advancements in bio-chemical and thermo-chemical technologies, which enable adoption of decentralised facilities for biofuels production, in proximity to sources of generation of bio-wastes.
 - b) Bio-waste, untreated, is as much an environmental hazard as particulate emissions from IC (internal combustion) engines, hence, its management needs to be equally prioritised.
 - c) With enabling policies and fiscal instruments for bio-waste management, the risks related to ‘bio-waste supply chain’ will be mitigated. They will enable bio-waste collection and aggregation to be managed as a ‘green business’.

CROSSROADS OF CHANGE



Ministry of New and Renewable Energy has notified Central Financial Assistance (CFA) of INR 0.04 billion per 4800 kg of CBG (Bio-CNG-compressed natural gas) per day with a maximum of INR 0.1 billion per project.

Initiatives taken to Incentivise the Production of Biofuels

- Pradhan Mantri JI-VAN (Jaiv Indhan-Vatavaran Anukool Fasal Awashesh Nivaran) Yojana for providing financial support to integrated bioethanol projects
- Soft loans of INR 61.39 billion being extended by the Government through banks to sugar mills for setting up new distilleries and installation of incineration boilers to augment ethanol production capacity for which Government will bear interest subvention of INR 13.32 billion)

Initiatives to Promote CBG:¹² Launched in October 2018, SATAT is aimed at providing a Sustainable Alternative Towards Affordable Transportation (SATAT) as a developmental effort that would benefit both vehicle-users as well as farmers and entrepreneurs. Under the scheme, CBG production plants will be set up by potential entrepreneurs. It has the potential to boost availability of more affordable transport fuels, better use of agricultural residue, cattle dung and municipal solid waste, as well as to provide an additional revenue source to farmers.

CROSSROADS OF CHANGE



Initiatives for Procurement of E-Buses: City-wise Analysis

BENGALURU, KARNATAKA: Bengaluru received the approval for the procurement of 40 electric buses. However, the city planned to procure 150 buses on gross cost. The tender was released by BMTC for the hiring of 150 AC electric buses along with charging stations. The city has not finalised the ratio of 9 metres non air-conditioned e-buses and 12 metres air-conditioned e-buses. BMTC agreed to consider the experience of bus operation outside the country. BMTC has proposed a

contract period of 10 years, which will be reviewed after 7 years. The assured average km is 200 km per day per bus. The cost of electricity for the charging of the buses will be borne by BMTC.

MUMBAI, MAHARASHTRA: Mumbai received the approval for the procurement of 40 electric buses from DHI. The city is already running 5 electric buses (Midi) for the last 3 months, financed by Bombay Municipal Corporation

(BMC). The tender was released by BEST Undertakings for the hiring of 40 electric buses under GCC. The city decided to hire 20 AC and 20 Non-AC buses. BEST has proposed a contract period of 7 years. The assured average km is 4,000 km per month per bus (i.e. 150 km per day). The operator is responsible for the electricity and charging of the buses.

HYDERABAD, TELANGANA: Hyderabad received the approval for the procurement of 40 electric buses from DHI. However, the city planned to procure 100 buses on gross cost. In Phase-I, the city will procure 40 buses and will procure remaining buses in Phase-II. The tender was released by TSRTC for the hiring of 40 AC electric buses. The city has not finalised the ratio of 9 metres and 12 metres air-conditioned e-buses. TSRTC has proposed a contract period of 6 years initially and extendable for further 6 years in two spells 7-9th year and 10-12th year of agreement period subject to satisfactory performance and fitness of the vehicle. The assured average km is 225 km per day per bus. The cost of electricity for the charging of the buses will be borne by TSRTC.

AHMEDABAD, GUJARAT: Ahmedabad received the approval for the procurement of 40 electric buses from DHI. The tender was released by Ahmedabad Janmarg Limited (AJL) for the hiring of 40 AC Midi electric buses under GCC. AJL has proposed a contract period of 7 years. The assured average km is 72,000 km per bus per year (i.e. 200 km per day). The operator is responsible for the electricity and charging of the buses. The city conducted its first bidding round, where Tata Motors Limited emerged as the lowest bidder for 9 metres AC e-bus and quoted INR 59 per km. Initially, the authority disqualified Goldstone Infratech Limited for the lack of technical experience. However, the city decided to cancel the full process and invite fresh bids. Ashok Leyland emerged as the lowest bidder with INR 48 per km.

JAIPUR, RAJASTHAN: Jaipur received the approval for the procurement of 40 electric buses from DHI. The tender was released by Jaipur City Transport Services Limited (JCTSL)

for the hiring of 40 AC Midi electric buses under GCC. AJL has proposed a contract period of 7 years. The assured average km is 54,000 km per bus per year (i.e. 150 km per day). The operator is responsible for the electricity and charging of the buses.

INDORE, MADHYA PRADESH: Indore received the approval for the procurement of 40 electric buses. The tender was released by Atal Indore City Transport System Limited (AICTSL) for the procurement of 40 Non-AC electric buses along with charging stations. The city decided to opt for 9 metres air-conditioned e-buses. Tata Motors Limited emerged as the lowest bidder to supply 40 electric buses. The price includes the FAME Subsidy component.

LUCKNOW, UTTAR PRADESH: Lucknow received the approval for the procurement of 40 electric buses. The tender was released by Lucknow City Transport Services Limited (LCTSL) for the procurement of 40 AC midi (9 metres) electric buses along with provisioning and installation of charging stations. LCTSL decided to procure the buses with 10 years of AMC (annual maintenance contract) with battery replacement. Further, E-Bus should consume less than 175 kWh energy per 100 Km. Tata Motors Limited emerged as the lowest bidder to supply 40 electric buses. The price includes the FAME Subsidy component.

KOLKATA, WEST BENGAL: Kolkata received the approval for the procurement of 40 electric buses. The tender was released by West Bengal Transport Corporation Limited (WBTCCL) for the procurement of 20 AC midi e-buses and 20 AC standard e-buses, with 7 years warranty. The seating capacity of 26 and 31 passengers was fixed for midi and standard bus respectively. The authority asked for supplying, installing and commissioning 30 slow-charging and 10 fast-charging facilities stations for midi and standard buses. The minimum range of the vehicle with battery should not be less than 150 km per charge. Tata Motors Limited emerged as the lowest bidder to supply 40 electric buses. The price includes the FAME Subsidy component. The price of chargers will be paid separately by the authority.

Initiative: Scrappage Policy for Old (>15 years) Commercial Vehicles from 2020 onwards

Ministry of Road Transport and Highways (MoRTH) has moved policy to scrap CVs (commercial vehicles: buses, trucks, LCVs—light commercial vehicles) which are more than 15 years old. This will open up a huge 2020 demand (replacement market for CVs) of vintage 2005 or earlier, estimated to be > 1.2 million. Thereafter, there would be recurring annual demand of the order of 0.1 million. An incentive scheme is anticipated to be approved soon, which will act as a catalyst for STUs (State Transport Undertakings) as well as private fleet owners (Buses and Trucks) to scrap (> 15 years old) inefficient diesel vehicles and buy new EVs/CNG and Bio-CNG Vehicles (with latter being 'default' choice in rural areas). Subsequently, incentives could be extended to other vehicles, estimated to be 20 million of vintage earlier than 2005. Fuel savings and reduced import of crude oil justifies such incentives (apart from the reduction in particulate/GHG emissions).

Initiative: Hydrogen-CNG (H-CNG)

H-CNG is a blend of hydrogen and CNG, the ideal hydrogen concentration being 18%.

Tests by the Automotive Research Association of India (ARAI) and Indian Oil Corporation Ltd (IOCL) have found that compared to conventional CNG, the use of H-CNG can reduce the emission of carbon monoxide up to 70%, besides enabling up to 5% savings in fuel.

Financial Planning for Urban Mobility Projects

Indian cities are witnessing tremendous urban growth which has resulted in a generation of high-level of travel demand. Therefore, in order to support such high travel demand, there is a need to develop sustainable mass transit systems in cities. Investing in large metro projects reaps huge benefits like significant travel time savings, environmental benefits, social benefits, etc.

However, to provide adequate transit facilities and to operate and maintain the same, large-scale investment is needed. With billions of dollars to be spent on various urban transit projects in the country, it is necessary to use innovative financing

mechanisms capturing the gains from various ancillary infrastructures associated with it. The financial sustainability of these systems needs to be studied in detail to opt for better and viable alternatives. The trends in the past have been to rely on the budgetary support from government organisations and loans from multilateral/financial institutions. With investment requirements being so enormous, the public sector will fall short. It is necessary to attract private capital to meet the resource deficit. PPP (public private partnerships) need to be encouraged for infrastructure investment as also for the execution and operation of infrastructure projects.

Carbon finance provides a significant influx in funds and has emerged as an alternative to the traditional funding criteria adopted for Government-run projects. It can be sought for a time period of 5 to 7 years and is applicable to all Government schemes such as FAME, Smart City, Green Mobility, etc.

The Case of Bengaluru Metro

In Bengaluru, most of the roads are over-saturated, low speeds cause heavy pollution and huge loss of precious manhours. Further, road space cannot be increased any further. These problems have compelled authorities to target a mass transit system in the metro as a possible solution.

Bengaluru Metro (or Namma Metro) is expected to save 50% to 75% of the commute time for the city dwellers. Other social benefits such as reliability, reduction in accidents, reduced VOC (volatile organic compound); increased average speed will also accrue from this initiative.

In Namma Metro, regenerative brakes reduce 1/5th energy per passenger kilometres, in comparison to road transport. The system boasts 99% efficiency in terms of punctuality. The city has largely reduced the amount of CO₂ production along with lesser noise and air pollution.

BMTC is determined to integrate this new metro rail with other existing modes of transit in the city, to provide a holistic service to the city.

The metro rail had a surge of 58% in fare box revenue in the year 2015-16 from the year 2014-15. The revenue increased to 30% and the expenditure increased to 46% from the previous year.

The Case of Maharashtra Metro (MAHA-Metro)

The consolidated project cost of Maha Metro is Rs. 8680 crores and expected project FIRR (financial internal rate of return) of 10.35% with non-fare box revenue. It has deciphered the following possible sources of non-fare box revenues:

- Collection of additional taxes in the form of 1% additional surcharge on Stamp Duty.
- TOD along the NOIDA Metro Rail Corridor (NMRC)
- Property development along the NMRC.
- Advertisement (including wrapping and station naming).

Government of Maharashtra vide notification in the Gazette, allowed for recovery of 1% of additional surcharge on the stamp duty, and has resulted in non-fare box revenue of INR 60.05 crore to date.

An additional FSI (floor space index) has been permitted at four plot sizes >2000 sq. m., three for plot sizes between 1000 and 2000 sq. m. and two for plot size less than 1000 sq. m. The organisation has also allowed for various types of property development viz., property development spaces, property business spaces, advertisement spaces, etc.

Closer to the Destination: Actionable Recommendations

A sustainable transport system is at the heart of the India of tomorrow. To enable that, long-term funding will need to allow for planned improvements in service offerings, as well as the expansion of existing infrastructure. Gaps and challenges in financing and deployment of various economic instruments need to be addressed, to enable viable solutions for sustainable mobility to emerge and become 'mainstream' alternatives, offering economic benefits, through LCCA (Life Cycle Cost Analysis), apart from addressing environmental and ecological issues. This component of the "India Roadmap for Low Carbon and Sustainable Mobility", captures the analysis/proposed solutions of other components in previous sections and makes recommendations of required economic policies and financing instruments. This component has not made recommendations related to freight transport, as these are covered under recommendations of Component 4 (Optimise Supply Chains to Manage Freight Transport Emissions). The recommendations have been grouped as follows:

- # Urban Planning and Infrastructure for Sustainable Mobility.
- # Incentivising and Enhancing Public Transport.
- # Decarbonising Current (Fossil) Transport Fuels.
- # Creating Enabling Eco-System and Economic Instruments.
- # Project Financing Issues.
- # Taxation Issues.

URBAN PLANNING and INFRASTRUCTURE FOR SUSTAINABLE MOBILITY

Passenger Mobility (with holistic perspective)

has been neglected for the last several decades. Government's focus has largely been on STUs to provide affordable public transport. This met community need of affordable transport but the inability of STUs to rapidly scale up led to huge demand and supply gap, which was filled up by private players, many in the unorganised sector.

Furthermore, a major lacuna has been lacking of planning focus, consequently, non-availability of required funds, to develop public transport infrastructure such as terminals, parking and pick up, drop points, highway amenity centres, Common EV charging infrastructure, etc. It also impeded funds availability to develop mass transit systems like City Buses, BRTS, METRO, MONORAIL, etc., as well as IT infrastructure as required to support central depository and monitoring systems.

Hence, the following recommendations are made:

- (i) All cities to have a mandatory budget for providing better passenger mobility including pedestrian and NMT (non-motorised transport) infrastructure, Mass Transit Systems, Bus (where possible) Multi-mode Terminals, Technology Platform to monitor and integrate all services, and Common EV Charging Stations.
- (ii) Cities should be funded for holistic, sustainable mobility programmes, rather than funding a specific project like Metro or BRT or City Bus project. Funds should be allocated for integrated transport systems.
- (iii) Funds should be managed and disbursed only through single SPV (special purpose vehicle) which shall fund the projects on the basis of approved plan; with priority given to a plan which will carry more people per rupee spent.

(iv) Accelerate decarbonisation of, current, city transport systems (through large-scale adoption of EVs and Bio-CNG/Advanced biofuels vehicles), with subsidy and viability gap funding schemes that facilitate scale-up, having defined duration and budgets for financial assistance.

INCENTIVISING and ENHANCING PUBLIC TRANSPORT

(i) Fiscal measures should be taken to enhance usage of public transport for daily work, thereby limiting use of private vehicle (through self-regulation) for leisure/ weekend travel or short rides within the city ward.

(ii) This could be achieved through higher motor vehicle tax, fuel taxes, and road user charges, for private vehicles. The revenue gained from increased taxation should be used to fund public transport as well as pedestrian and NMT infrastructure.

(iii) On-street parking should be priced at a rate high enough to discourage improper parking and usage of pedestrian/road space. This revenue can further be used to fund public transport.

DECARBONISING CURRENT (FOSSIL) TRANSPORT FUELS

This would relate to displacement of diesel, petrol/ Auto LPG/CNG, ATF (automatic transmission fluid) and marine fuels. In the short term, this could be done through incentivising manufacturing and use of EVs and scale-up of production and retailing of Bio-CNG (up to 15 million tons/year from farm waste, as per target set by Minister MoP&NG, while announcing the SATAT scheme). In the medium to long-term, it would be through mass production of EVs and batteries in India as well as large volume production and retailing of the entire spectrum of advanced biofuels, as defined in “National Policy on Biofuels 2018”.

(A) Electric Vehicles: It is anticipated that EVs growth would be driven by market dynamics, subject to appropriate financing instruments (correlated to LCCA) and initial support under the FAME scheme. Hence, recommendations are made with a focus on EV charging infrastructure.

Recommendations for scaling up EVSE (electric vehicle supply equipment):

(i) Electric utilities may be mandated to setup EVSE networks in strategic locations in their service area, under CAPEX model, as part of grid upgrade programmes.

(ii) Bundle EVSE as mandatory in new buildings through building codes for a category of buildings exceeding certain built area.

(iii) EV manufacturers to contribute a certain percentage of the vehicle cost towards EVSE fund utilised to build EVSE network, under capex model, in respective cities/states.

(iv) EVSE infrastructure may be clubbed with highway construction cost, under capex model, which is likely to have a negligible impact on per kilometre cost of highways.

(v) In commercial centres, tourist and religious places, large commercial establishments may be encouraged to invest in EVSE infrastructure (with limited entry of diesel/petrol vehicles).

(vi) PSUs (public sector undertakings) and large private companies may be mandated to set up EVSE infrastructure, for their vehicles.

(vii) Oil distribution companies may be encouraged to create EVSE infrastructure (already covered under new “Fuel Retail Policy”).

(viii) EV manufacturer consortiums may promote EVSE networks, under OPEX (operating expense) model, through collecting monthly subscription from EV owners, which is disbursed to EVSE facilities operators.

(ix) Fleet operators and car rental companies may be encouraged to set up EVSE networks.

(x) Fiscal incentives like tax concessions, free or concessional land on long-term lease at strategic locations, which will also have Cafes/ATMs, gyms, air/ tyre changing stations. Where such fiscal incentives are provided, the allocation should be through a transparent bidding and selection process. Where there are no fiscal incentives provided by the Government, growth should be through market-driven competitive forces, without any Government involvement, except for statutory clearances.

(B) Bio-CNG/Advanced Biofuels: There is no constraint on manufacturing of vehicles from a technology perspective or manufacturing facilities. Biofuels would be blended with diesel or petrol. Up to 2030 scenario, there should not be constraints over use of currently manufactured (ICE) vehicles. Bio-CNG would be fired in CNG vehicles, for which there are existing manufacturing facilities - these are likely to be scaled up in line with MoPandNG plans to enhance CGD (City Gas Distribution Networks) and CNG Retailing outlets.

MoPandNG's new "Fuel Retail Policy" allows all companies (with net worth of INR 250 crore) to establish retail fuel outlets, with proviso that such retailers should install one new generation alternate fuel, viz CNG, LNG, biofuels or EV charging. In rural areas, advanced biofuels would be the preferred choice (from perspective of resource availability) and, in the short term, Bio-CNG would be the default choice (from perspective of commercialised technology). Hence, the focus of recommendations are on scaling up production of Bio-CNG (from farm waste) and thereby facilitating large-scale adoption as sustainable mobility in rural areas (where CGD networks and CNG retailing outlets penetration is unlikely, in large scale). It is added that these recommendations would also be valid for advanced biofuels, as and when they reach commercial production, at large scale.

(i) Institutionalise the (more appropriate) term Bio-CNG, rather than CBG. While doing so, incorporate Bio-CNG and Bio-CNG manufacturing plants within appropriate GST (Goods and Services Tax) category. Currently, only Bio-gas and Bio-gas plants are covered under GST, which probably is the reason why the term CBG is used.

(ii) Include Bio-CNG plants (with feedstock of agriculture residues and manure) within priority sector lending, with long tenor and low interest loans (akin to solar sector), in view of the significant mitigation of environment pollution and GHG emissions that take place from processing of farm waste, apart for the CO₂ emissions mitigation by replacing petroleum fuels by Bio-CNG.

(iii) DFIs (Development Financial Institutions) and National Bank for Agriculture and Rural Development (NABARD) supported RRBs (Regional Rural Banks) and cooperative Banks to provide special financing packages for farm waste supply chain (collection, aggregation, pre-processing, storage and transport).

This could be in the form of lower equity requirement, interest subvention, minimal collateral requirement (backed by credit guarantee schemes), etc. to ensure 'bankability' of feedstock supply chain and thereby, Bio-CNG Projects.

(iii) RRBs and co-operative banks to devise special schemes, which incentivise farmers to adopt Bio-CNG tractors (instead of diesel tractors). While the Central and State Financial Assistance will be designed for specific application, in concept, it is similar as KUSUM scheme, which has goal of displacing diesel/ grid power usage in irrigation pump sets.

(iv) NABARD and Small Industries Development Bank of India (SIDBI) to develop carbon finance supported schemes for financing of Bio-CNG retailing outlets in rural areas. Federation of Indian Chambers of Commerce and Industry (FICCI) would be available to present a paper on feasibility and economic viability of such schemes.

(v) Bio-CNG programme, with feedstock of farm waste, needs to be driven by the private sector, governed by market dynamics and not be OMC (oil marketing companies)-centric (as is the case with current SATAT scheme).

The negligible commissioned plants capacity creation, till date, under the SATAT scheme emphasises the need for such transition. This is all the more necessary in current (post COVID-19) scenario, which requires significant investments in rural India to address economic distress in farmer households as well as to provide non-agriculture livelihoods, in particular, to migrant labour who have recently returned to villages.

CREATING ENABLING ECO-SYSTEM and ECONOMIC INSTRUMENTS

(i) Creation of a nodal DFI for Sustainable Mobility:

The financing required to scale-up various low carbon and sustainable transport systems in India exceeds the available traditional financing sources through banks/ NBFCs. Consequently, multilaterals/DFIs (as well as public sector banks) may find it appropriate to support such projects, through such a nodal DFI, which has domain competences and can also access climate/ ESG (environmental, social, and governance) finance.

(ii) Establishing a Green Taxonomy: Formulating green investment strategies, priority sector lending for sustainable mobility, and patient capital from pension

and sovereign wealth funds into green bonds would require the establishment of a green taxonomy for the country.

(iii) ABS (asset backed securitised) Financing: would lead to diversification of green bonds into sectors like EVs and Bio-CNG/LNG production as well as related vehicles deployment.

(iv) Credible Pipeline of Projects created through systemic policy and market interventions. This entails regulatory push/support in the form of mandates for sustainable modes of transportation.

(v) Incentivise Domestic Manufacturing of Sustainable Mobility Vehicles: To facilitate technology transfer and investments, it will be necessary to incentivise domestic manufacturing, via low-cost financing, committed off-takes, subsidy for import of machinery and tax incentives for manufacturing units.

(vi) Incentivise Demand and Use: Subsidies, tax benefits, advocacy and reduction in import duties to reduce the cost for the ultimate user and increase demand.

(vii) Regulatory Push: Mandate environment and ecologically friendly transport solutions, supported with advocacy and strategic roadmap for driving up demand and reducing cost to ultimate user, through economies of scale. Once reasonable scale has been achieved for domestic demand and manufacturing, incentives can be withdrawn and government to facilitate growth, through gradually increasing the requirement for carbon-efficient vehicles as percentage of the total fleet for the transportation sector.

(viii) Capacity Building: Capacity building among borrowers, financiers, and even policy makers and regulators on commercially viable sustainable mobility solutions as well as the opportunities presented by climate bonds. The opportunities for such investments that exist in India need to be made more visible domestically and internationally.

PROJECT FINANCING ISSUES

(i) Provide Long Tenor Project Financing: To make sustainable mobility solutions affordable, it is necessary to provide long tenor loans (as illustration,

solar tariffs came down when term loans up to 20 years were allowed and this led to greater demand and reduction in costs of construction through economies of scale).

(ii) Remove Inequities in Financing: Bus fleet operators, going for sustainable mobility solutions, should be eligible for long term project financing, which covers cost of not only vehicles but also depots and EV charging/Bio-CNG dispensing infrastructure. Currently, they can only access, relatively short tenor vehicle finance.

(iii) Adopt Appropriate Risk Distribution Mechanisms: Infrastructure for sustainable mobility solutions (e.g. EV charging/Bio-CNG dispensing) needs to precede large-scale adoption of such solutions by fleet owners or private vehicle owners. Hence, financing instruments will have to be appropriately designed, with initial moratorium and then gradual scale-up of principal repayment. Otherwise, the facility will become insolvent just as demand picks up. Lenders may be appropriately protected as per some of the recommendations that follow.

(iv) Capital Subsidy/Viability Gap Funding: In the initial phase, to mitigate risks for early stage investors in sustainable transportation projects, the disbursement can be linked to project achieving certain measurable outcomes, to ensure that there is productive utilisation of funds and weed out speculative investments.

(v) Partial Risk Sharing Facility (PRSF): The financial institution reimburses the public or private financial entity for a portion of the principal losses incurred on a portfolio of eligible projects as per the proposal.

(vi) Refinance Scheme for Loans: Public financial institution, shall act as the IA (implementing agency) for providing refinance. The lending bank/NBFC can refinance part of its loan portfolio of sustainable mobility projects, post commencement of their commercial operations, to the IA and thereby have the funds to finance further sustainable mobility projects. In concept, it is similar as NABARD refinancing for agriculture and allied activities. However, the refinancing schemes shall be formulated by IA with the approval of appointed government agency.

TAXATION ISSUES

(i) Tax Rationalisation: The way taxes are levied needs to change. Presently, personal vehicles are taxed less whereas taxation on public vehicles is more which is making public transport expensive for users and unsustainable for operators. For long-distance interstate buses, taxes are levied by multiple states simultaneously, making the journey very expensive, which leads to larger use of private vehicles. Public transport should be treated as the basic community need, which also addresses environment and ecological issues, hence being eligible for nil or concessional taxes and toll. If taxes and toll are made zero, long-distance service ticket rates would come down by at least 10 to 15%, if not more. Hence, following recommendations are made:

- To introduce uniform nominal taxes on passenger transport throughout India
- To make public transport toll free
- To provide renewable electricity at a subsidised rate to promote usage of EVs
- To incentivise production of Bio-CNG/Bio-LNG as well as establish large number of retail outlets (especially in rural areas) and thereby promote use of Bio-CNG/Bio-LNG vehicles

(ii) Remove punitive tax policies towards public transport operations: Unlike the goods segment, there is no uniformity of tax structure among states. In some states, the taxes are charged on per trip basis and in others on a per annum basis. Bus operators have to bear a disproportionately high tax burden which increases the cost of travel for all. Available data from states and cities suggest that annual road tax on a bus is far higher than the one-time road tax a car pays in any given year.

(iii) Preferential GST: This should apply to all technology options and be uniform to all sustainable mobility solutions.

CONCLUSIONS

Key Messages, Summary of Recommendations and Final Insights

A. KEY MESSAGES

- 1st. Move away from the paradigm of ‘building infrastructure to move vehicles’ to a new paradigm of ‘building infrastructure to move people’
- 2nd. Incentivise appropriate usage of vehicles rather than ownership of vehicles
- 3rd. Define and implement Citizen Charter for Urban Mobility
- 4th. Build clear governance structure and empower at national, state and local level to implement transport and mobility directives including clearances, approvals, land and funds allocation, infrastructure and operation – Establish National Transport Authority, Unified Metropolitan Transport Authority (UMTA) and Surface Port Development Authority
- 5th. Notify the ‘One Nation One Tax One Permit Scheme’
- 6th. Incentivise use of public transportation in urban and rural areas
- 7th. Integrate different modes of transport for people and goods, and adopt integrated systems approach through intelligent transport systems for all modes of public transport for seamless travel
- 8th. Facilitate transit-oriented development in cities
- 9th. Incentivise use of sustainable fuels and renewable based electricity in transport
- 10th. Integrate adaptation into urban and transport planning to combat impacts of future climate change and natural disasters on mobility
- 11th. Devise specific funds and economic instruments to facilitate transition to low carbon and sustainable mobility transport options
- 12th. Promote research into new, advanced technologies

B. SUMMARY OF ACTIONABLE RECOMMENDATIONS

The summary of actionable recommendations is provided in two sections.

Section I (B.1) provides the summary of recommendations categorised into governance and institutional; policy, regulatory and standards related; capacity building and data; technological and fuel related; and infrastructure related under short and medium terms. Long-term recommendations are provided separately. The recommendations related to fiscal, economic instruments and financing are also provided separately without any timeline specification.

Section II (B.2) provides summary of component-wise actionable recommendations based on the 8 components of the India Roadmap with short, medium and long-term specified under each component.

B.1 SECTION I: Summary of Recommendations (Category-wise)

B.1A SHORT-TERM (2020-22)

Governance/Institutional

1. Develop a Citizen Charter for Urban Mobility (CCUM) at Strategic, Tactical & Operational Level
2. Empower Unified Metropolitan Transport Authority (UMTA) with power to raise and allocate funds, plan infrastructure and operate, and adopt the Citizen Charter
3. Establish a National Transport Authority to define standards and regulation for public transport.
4. Establish Surface Port Development Authority of India (as a step-down entity to the National Transport Authority of India) to develop multimodal terminals under a PPP arrangement. Initially, these terminals can be developed in all the smart cities and the 10 biggest cities in India on the lines of airports and should be accessible to all operators
5. Redefine RTO's role to qualify bus operators for providing MAAS under direction of UMTA
6. Establish state-level innovation parks that incubate businesses with specific funds for mobility

Policy/Regulatory/Standards

1. Implement National Transport Development Policy Committee recommendations on formulation of Integrated National Transport Policy
2. Ensure closer alignment of Energy and Transport Sector in policymaking to develop joint pathway for low carbon and sustainable mobility
3. Implement 'One Nation One Permit One Tax System' to incentivise interstate shared mobility and public transport
4. Make permits for bus operators easily available with minimum 50% of the permits given to private operators.
5. Establish a Two-Permit System by amending the Motor Vehicles Act (MVA) – scheduled services to be provided by STUs /Private Operators with regulated tariff and App-Based Services to cater to Office Goers.
6. Improve fuel efficiency of vehicle fleet by introducing labelling/ratings systems, minimum efficiency standard and corporate fleet efficiency standards.
7. Amend Multimodal Transportation of Goods Act, 1993 and Carriage of Goods by Sea Act, 1925 as per the current needs and environment to optimise supply chains to reduce freight transport emissions.

8. Build a Framework for capturing all externalities for each mode of transport to develop an optimal intermodal mix. Strengthen the Administrative mechanism for implementing this Framework through the Logistics Division of Ministry of Commerce and Industry which can act as the Secretariat to the apex policymaking body.
9. Move gradually towards building appropriate infrastructure and systems for expanding Hub & Spoke Concept to decongest cities and optimise transport.
10. Modify Building Codes to make EVSEs mandatory in new buildings.
11. Develop policy framework and guidelines for phasing out vintage petrol and diesel vehicles.
12. Ensure regular supply of raw materials through trade agreements for indigenous manufacturing of lithium-ion cells, controllers and chargers.
13. Apply minimum renewable energy purchase obligations for EV charger installations.

Capacity Building / Data

1. Implement driver training on disaster management to help deal with post disaster management activities
2. Research into data for projecting travel demand for goods and people in rural areas
3. Develop a climate risk evaluation tool to assess risks and build mitigation strategies
4. Develop better weather/disaster forecasting tools to help predict imminent dangers, and prepare in advance

Technological / Fuels

1. Encourage optimum high efficiency power per square meter of solar technology for rooftop solar charging stations
2. UMTA to ensure more carbon-efficient modes of transport for the city viz Rail, Metro, LRT, Buses, taxis, NMT through optimisation and simulation tools
3. Adopt an integrated system approach using National Common Mobility Card. Like airline miles, public transport miles should be introduced to avail discounts on usage of public transport. This will be an incentive for people to use public transport
4. Adopt Intelligent Transport Systems for seamless travel in public transport, including digital payments and real time information on seat availability, wait time etc.

Infrastructural

1. Adopt an integrated approach to building modern railway stations, bus ports and air and seaports by adopting a systems approach rather than treating these as separate isolated infrastructure buildings.
2. Reserve land for development of bus depots and facilitate the addition of a minimum of 0.3 million buses on road till 2022.
3. Promote building of Multi Modal Logistics Parks (MMLPs) in predefined zones outside of cities with railroad connectivity.
4. Upgrade toll plazas to make them barrier-free without any manual intervention and with gantries.
5. Apply transit-oriented development (TOD) by promoting mixed land-use, non-motorised transport infrastructure, e-commerce for service at doorstep, encouraging work from home, Zero Emission Vehicles (ZEV) for last mile mobility by connecting metro infrastructures, and creating porosity by ensuring all daily needs are within walking distance.
6. Promote non-motorised transport (NMT) components in transport master plans developed by UMTA.
7. Implement stringent SOP for drainage system.
8. Design high-quality public transport services on dedicated infrastructure along major city corridors.
9. Implement emergency/redundant route planning

B1.B MEDIUM-TERM (2022-30)

Governance/Institutional

1. Establish a permanent institution as an epicentre for research, analysis and knowledge for the entire Integrated National Logistics System. It will provide recommendations for the Nation's Transport Policy and create the optimal transport system through specialised research and technical innovations.
2. Create a National Single Window for all logistics modes, which enables a seamless data flow between various stakeholders through a common interface, and enables them to determine the combination of modes and routes that make the most cost-effective and efficient transportation path for their goods.
3. Promote greater use of our coastline and inland waterways for passenger and freight movement. Encourage private partnership through the PPP mode in multimodal logistics to harness the power of cutting-edge technologies, such as automation, IoT, Blockchain, Big Data, etc., for making overall network highly efficient and seamless.

Policy/Regulatory/Standards

1. Adopt sustainable designs, policies, systems to promote compact city approach, integrated public transport development plans and clean fuel infrastructure plans.
2. Improve efficacy of SATAT scheme and JI-VAN scheme.
3. Extend incentives for public transport, limit registration of private vehicles in large metros, enforce congestion charging.
4. Revisit the City Master Plans in line with current and future needs using technology and data analytics to simulate city mobility needs. Build an Integrated Transport Mobility Plan based on this analysis.
5. Set city level electrification targets for buses, commercial fleets and other public transport modes.
6. Open up road transport segment completely for private buses. In public transport, promote PPP models for ordinary services and allow private operators to operate freely in long distance luxury services while keeping regulatory requirements in mind.
7. Develop more resilient design standards for infrastructure, utilities and storm water drains
8. Develop framework for recycling and disposal of solar panels
9. Closely review the progress on the implementation of goals of National Policy on Biofuels, 2018
10. Develop time-bound National Hydrogen Energy Roadmap to make hydrogen commercially available as a transportation fuel
11. Make it mandatory for ULBs to provide People Mobility Solutions (Public Transport Services) to all its citizens

Technological/Fuels

1. Implement new technologies for last-mile connectivity – urban ropeways, waterways, shared mobility, and infrastructure and technologies for non-motorised transport
2. Set up a national ITS clearing house that documents all ITS projects with details on design, implementation, lessons learned, best practices, and cost-benefit analysis
1. Create 3D Mapping of all major cities
3. Enhance injection of hydrogen in CNG
4. Develop and implement cost-effective plan for multiple fuel cell technologies on a large scale
5. Enhance freight transport efficiencies by gradually shifting them to low emission alternative fuels

Infrastructural

1. Create a national grid of common battery charging infrastructure
2. Develop bus and multimodal terminals across India on the lines of airports
3. Build multimodal logistics parks (MMLPs) around major manufacturing and production centres with seamless rail and road connectivity to nearby ports, inland waterways terminals and distribution centres.
4. Ensure optimal allocation of resources for strengthening of the basic infrastructure between the different modes based on an optimal intermodal mix.
5. Implement Transit-oriented development (TOD) plans vigorously including mixed land use, non-motorised infrastructure.
6. Facilitate commercial exploitation of Bus Ports through PPP.
7. Develop quality, reliable, sustainable and climate-resilient infrastructure by integrating transport infrastructure into urban planning.
8. Create frameworks to evaluate the preparedness of transport infrastructure for climate change related disasters.
9. Prepare strategy document on 'low carbon and climate-resilient mobility plan for cities' integrating them to form the national low carbon mobility vision.
10. Invest in infrastructure for hydrogen storage, delivery and transport system.
11. Implement project design for significant shifts to more sustainable modes for intercity passenger and freight transport.

B.1C LONG-TERM (2030-50)

- Invest in advanced technologies for electric mobility and intelligent transport systems.
- Ensure 100% EV stations are powered from renewable energy, either through decentralised renewable energy applications or by having PPAs on open access basis with renewable energy developers.
- Research on-site generation of hydrogen via electrolysis route and develop hydrogen manufacturing, storage and distribution network.
- Consider alternatives to lithium-ion batteries (sodium ion batteries, hydrogen fuel cells, supercapacitors, thermal batteries), and promote cell chemistries (e.g. LFP) that do not require import dependant metals for use in EVs.
- Make concerted efforts and investments in R&D to ensure progressive technological solutions for

sustainable mobility.

- Ensure implementation of all advanced biofuels as envisaged under the National Policy on Biofuels, 2018

B.1D RECOMMENDATIONS ON FISCAL, ECONOMIC AND FINANCIAL INSTRUMENTS

1. Establish a Nodal Development Finance Institution for Sustainable Mobility, which will fund projects, indirectly, by extending credit lines to Banks/ NBFCs, which in turn will lend to sustainable mobility projects and programmes.
2. Cities to adopt sustainable mobility through budgets for integrated transport systems (and not for specific projects, e.g. Metro or BRT or City bus projects), with goal of reducing road congestion, and effectively meeting citizens mobility needs, including Pedestrian & NMT infrastructure.
3. Earmark substantial part of the road budget towards development of public transport infrastructure, such as multi-modal terminals, surface ports, bus stations, highway amenity centres, rest areas, viewpoints, parking lots and multi-modal logistics parks.
4. Increase cost of private vehicle ownership and usage, through higher Motor Vehicle taxes, Fossil fuels taxes, Road User and On-street Parking charges. Funds, thus raised, should have dedicated application of funding Public Transport as well as Pedestrian and NMT infrastructure.
5. Introduce uniform taxes on passenger transport, on pan India basis, to remove anomaly of punitive taxes imposed by each state through which buses traverse; and do away with taxes on bus transport or keep taxes on buses minimal.
6. Apply preferential GST to all new technology options and keep it uniform for all sustainable mobility solutions.
7. Use single SPV (special purpose vehicle) – UMTA as an example – to manage and disburse funds based on approved plans.
8. Accelerate large-scale adoption of EVs and Bio-CNG/ Advanced Biofuels Vehicles), supported by viability gap funding schemes during scale-up phase.
9. Incentivise manufacturing and use of EVs and Bio-CNG/advanced biofuels vehicles, to make them market competitive, with “economies of scale”, by providing in scale-up phase, capital subsidies, interest subvention and financing instruments, correlated to LCCA (Life-Cycle Cost Analysis).
10. Introduce incentives like low interest on EV loans to

promote rural usage of EV and tax incentives for EV charging from renewable energy sources.

11. Facilitate banks to offer term loans to catalyse investments in EV Charging Infrastructure, under Capex model or Opex model.
12. Include Bio-CNG/Bio-LNG and related manufacturing plants within GST (at same rate as Biogas, i.e. 5%) and make them eligible for priority sector lending.
13. Devise measures like assured supply of segregated waste, priority sector lending, interest subvention scheme and inclusion in 'White Category' for pollution clearance for advanced biofuels.
14. NABARD supported RRBs and co-operative banks to design financing packages for Farm Waste Supply Chain (collection, aggregation, pre-processing & storage) and provide schemes to incentivise farmers to adopt Bio-CNG Tractors.
15. NABARD and SIDBI to develop Carbon Finance/ ESG Finance supported schemes, for financing of Bio-CNG/ Bio-LNG Plants as well as retailing outlets.
16. Establish a "Green Taxonomy", which would facilitate ABS (asset backed securitised) deals through diversification of Green Bonds into Sustainable Mobility sector.
17. Incentivise domestic manufacturing of Sustainable Mobility Vehicles, through bulk purchases by Central & State PSUs (e.g. EESL and STUs).
18. Build capacity among borrowers, financiers, policymakers and regulators on commercially viable sustainable mobility solutions as well as opportunities presented by Climate Bonds/ESG Finance.
19. Provide Long Tenor Project Financing (covering Vehicles + Terminuses + EV Charging & Bio-CNG/ LNG Retailing Infrastructure) to remove current inequities in financing. These should have an initial moratorium and gradual scale-up of principal repayment, to ensure appropriate risk distribution mechanism.
20. Provide refinance scheme for loans extended to Sustainable Mobility projects, post commercialisation, as this will enable Banks/ NBFCs, having domain competence to scale up lending.
21. Have dedicated funds to provide Viability Gap Funding (VGF) and Partial Risk Sharing Facility (PRSF), for holistic development of public transport systems, encompassing all modes of transport.

B.2 SECTION II: Summary of Recommendations (Component-wise)

Section II provides summary of component-wise actionable recommendations based on the 8 components of the India Roadmap with short, medium and long-term specified under each component. The 8th component recommendations are same as the section B.1D in the previous section and hence a repetition of recommendations under section B.2H.

B.2A

Component 1: Urban Transformation for Healthier, Inclusive Lifestyles and Efficient, Resilient, Prosperous Cities

Short-Term (2020-22)

- Develop a Citizen Charter for Urban Mobility (CCUM) at Strategic, Tactical & Operational Level
- CCUM to be adopted by an empowered unifying authority UMTA with power to raise & allocate funds, plan infrastructure & operate
- Establish a National Transport Authority to define standards and regulation for public transport
- One Country One Permit to incentivise interstate shared mobility & public Transport
- Redefine RTO's role to qualify bus operators for providing MAAS under direction of UMTA
- Establish state-level innovation parks that incubate businesses with specific funds for mobility

Medium-Term (2020-30)

- Extend incentives for public transport, limit registration of private vehicles in large metros, enforce congestion charging and implement Scrap Policy rigorously
- Establish a Two-Permit System by amending the Motor Vehicles Act (MVA) – scheduled services to be provided by STUs /Private Operators with regulated tariff and App-Based Services to cater to Office Goers
- Implement new technologies for last-mile connectivity – urban ropeways, waterways, shared mobility, and infrastructure and technologies for non-motorised transport
- Increase utility of Bus Ports through allowing their use by private operators under PPP model.
- Rigorous implementation of TOD
- Revisit the City Master Plans in line with current and future needs using technology and data analytics to simulate city mobility needs. Build an Integrated Transport Mobility Plan based on this analysis

Long-Term (2030-50)

- Invest in advanced technologies for electric mobility and intelligent transport systems

B.2B**Component 2: Low-carbon Energy Supply Strategy****Short-Term (2020-22)****Raise awareness for Low carbon energy mobility**

- Build public awareness, campaigns and participation about low carbon transportation
- Adopt effective pedagogy for triggering behavioural change towards sustainable, low carbon mobility options

Renewable Energy

- Encourage optimum high efficiency power per square meter of solar technology for rooftop solar charging stations
- Modify Building Codes to make EVSEs mandatory in new buildings
- Ensure closer alignment of Energy and Transport Sector in policymaking to develop joint pathway for low carbon and sustainable mobility

Electric Vehicles

- UMTA to ensure more carbon-efficient modes of transport for the city viz Rail, Metro, LRT, Buses, taxis, NMT through optimisation and simulation tools
- Develop ecosystem to convert existing ICE Vehicles to EVs and encourage large volume manufacturing of EVs to control prices
- Develop policy framework and guidelines for phasing out vintage petrol and diesel vehicles
- Develop charging standards
- Ensure regular supply of raw materials through trade agreements for indigenous manufacturing of lithium-ion cells, controllers and chargers
- Apply minimum renewable energy purchase obligations by EV charger installations
- Provide tax incentives for EV charging from renewable energy sources

Biofuels

- Create enabling ecosystem, off-take agreement and financing instruments for achieving the goals of National Policy on Biofuels 2018, Pradhan Mantri Ji-VAN Yojana, GOBAR-DHAN and SATAT schemes
- Devise measures like assured supply of segregated waste, priority sector lending, interest subvention scheme and inclusion in 'White Category' for

pollution clearance for advanced biofuels

- Improve fuel efficiency of vehicle fleet by introducing labelling/ratings systems, minimum efficiency standard and corporate fleet efficiency standards

Medium-Term (2022-30)**Renewable Energy**

- Develop framework for Recycling and disposal of solar panels

Electric Vehicles

- Optimise lifecycle of lithium-ion batteries for usage in energy storage applications post use in mobility
- Mandate for infrastructure development by City governments/ municipalities and Highway Authorities to allot space for EVSE networks on concessional lease rates under OPEX model

Biofuels

- Closely review the progress on the implementation of goals of National Policy on Biofuels, 2018

Hydrogen Energy

- Develop time-bound National Hydrogen Energy Roadmap to make hydrogen commercially available as a transportation fuel
- Enhance Injection of Hydrogen in CNG
- Develop and implement cost-effective plan for multiple fuel cell technologies on a large scale
- Utilisation of excess and stranded RE to generate hydrogen via electrolysis process at location
- Invest in infrastructure for hydrogen storage, delivery and transport system

Long-Term (2030-50)**Renewable Energy**

- Ensure 100% EV stations are powered from renewable energy, either through decentralised renewable energy applications or by having PPAs on open access basis with renewable energy developers

Hydrogen Fuel

- Research on-site generation of hydrogen via electrolysis route and develop hydrogen manufacturing, storage and distribution network

Electric Vehicles

- Consider alternatives to lithium-ion batteries, (sodium ion batteries, hydrogen fuel cells, supercapacitors, thermal batteries), and promote

cell chemistries (e.g. LFP) that do not require import dependent metals for use in EVs

- Make concerted efforts and investments in R&D to ensure progressive technological solutions for sustainable mobility

B.2C

Component 3: Improve Intermodal and Mode-wise System Efficiencies

Short-Term (2020-22)

- Build clear governance structure at national, state and local level to implement transport and mobility directives including clearances, approvals, land and funds allocation, infrastructure and operation – Establish National Transport Authority, Unified Metropolitan Transport Authority (UMTA) and Surface Port Development Authority
- Establish Surface Port Development Authority of India (as a step-down entity to the National Transport Authority of India) to develop multimodal terminals under a PPP arrangement. Initially, these terminals can be developed in all the smart cities and the 10 biggest cities in India on the lines of airports and should be accessible to all operators
- Make it mandatory for ULBs to provide People Mobility Solutions (Public Transport Services) to all its citizens
- Provide departure and arrival bus bays at the railway stations, air and seaports having enough parking space, connectivity of feeder buses with metro systems (following an integrated systems approach)
- Earmark substantial part of the road budget towards development of public transport infrastructure, such as multi-modal terminals, surface ports, bus stations, highway amenity centres, rest areas, viewpoints, parking lots and multi-modal logistics parks
- Liberalise the issuance of permits and to operate regular services by private operators, start with a 50/50 formula, wherein minimum 50% of the permits are given to private operators. For the luxury segment, notify the **‘One Nation One Tax One Permit Scheme’** to liberalise this segment of passenger road transport and allow such buses to operate regular services. Similar to GST, MV Tax also needs to be standardised to bring in seamless vehicle movement.
- To improve quality of public transport operations, it is important to introduce **‘Authorised Operator’ system**, wherein organisations will be authorised

to manage public transport services as an operator on the basis of its capability to manage quality services.

- Permits should be clearly defined for the relevant type of services to being in clarity in the type of services it is expected to provide. Permits can be of three types: i) Scheduled—Vehicle that operates on a fixed route, Schedule Metered—Vehicles that runs on time and km basis for the general public as per government approved rates, and iii) Chartered – Vehicle that is available for hire or reward for the general public.
- Amend Multimodal Transportation of Goods Act, 1993 and Carriage of Goods by Sea Act, 1925 as per the current needs and environment to optimise supply chains to reduce freight transport emissions
- Plan and develop bus, truck and multimodal terminals, parking lots for public vehicles across the country
- Reserve land for development of bus depots and facilitate the addition of a minimum of 0.3 million buses on road till 2022
- Develop electric charging infrastructure throughout India for all type of vehicles
- Warehousing zones/logistics parks to be present on ring roads
- Upgrade toll plazas to make them barrier-free without any manual intervention and with gantries

Medium-Term (2022-30)

- Make it mandatory for ULBs to provide People Mobility Solutions (Public Transport Services) to all its citizens
- Open up road transport segment completely for private buses. In public transport, promote PPP models for ordinary services and allow private operators to operate freely in long distance luxury services while keeping regulatory requirements in mind.
- Establish a permanent institution as an epicentre for research, analysis and knowledge for the entire Integrated National Logistics System. It will provide recommendations for the Nation’s Transport Policy and create the optimal transport system through specialised research and technical innovations.
- Either keep minimal taxes or do away with taxes on buses
- Spend 50% of the road budget on development of bus-based quality public transport system
- Set up a national ITS clearing house that documents all ITS projects with details on design, implementation, lessons learned, best practices,

and cost-benefit analysis

- Set up a fully functional Traffic Management Centres for coordinating the urban and regional ITS activities
- Create a National Single Window for all logistics modes, which enables a seamless data flow between various stakeholders through a common interface, and enables them to determine the combination of modes and routes that make the most cost-effective and efficient transportation path for their goods
- Promote greater use of our coastline and inland waterways for passenger and freight movement. Encourage private partnership through the PPP mode in multimodal logistics to harness the power of cutting-edge technologies, such as automation, IoT, Blockchain, Big Data, etc., for making overall network highly efficient and seamless.
- Create a national grid of common battery charging infrastructure
- Develop bus and multimodal terminals across India on the lines of airports
- Build multimodal logistics parks (MMLPs) around major manufacturing and production centres with seamless rail and road connectivity to nearby ports, inland waterways terminals and distribution centres

B.2D

Component 4: Optimise Supply Chains to Manage Freight Transport Emissions

Short-Term (2022)

- Implement National Transport Development Policy Committee recommendations on formulation of Integrated National Transport Policy
- Build a Framework for capturing all externalities for each mode of transport to develop an optimal intermodal mix. Strengthen the Administrative mechanism for implementing this Framework through the Logistics Division of Ministry of Commerce and Industry which can act as the Secretariat to the apex policymaking body.
- Adopt multi-modalism involving the Hub & Spoke Concept as the key operational strategy to implement the policy framework

Medium-Term (2030)

- Ensure optimal allocation of resources for strengthening of the basic infrastructure between the different modes based on an optimal intermodal mix

B.2E

Component 5: Avoid vehicle kilometres for commuting, shopping and accessing services

Short-Term (2022)

- Notify a mandate to adopt sustainable transport models with focus on usage of public transport, shared mobility to reduce the numbers of private vehicles on road. This can be done by restricting the parking spots in offices by 50%, which will encourage employees to use public transport or other shared mobility options
- Introduce emission standards for polluting vehicles like old buses, commercial vehicles. Notify a mandate to scrap all the buses and commercial vehicles older than 15 years. This will help in prioritising clean fuel usage and shifting to cleaner and efficient modes of transport like EVs (which will add clean kilometres on the road)
- Adopt an integrated system approach using National Common Mobility Card. Like airline miles, public transport miles should be introduced to avail discounts on usage of public transport. This will be an incentive for people to use public transport
- Adopt Intelligent Transport Systems for seamless travel in public transport, including digital payments and real time information on seat availability, wait time etc.
- Provide flexible working options will also help in reducing the need to travel

Medium-Term (2030)

- Implement Transit-oriented development (TOD) plans vigorously including mixed land use, non-motorised infrastructure
- Revisit the City Master Plans in line with current and future needs using technology and data analytics to simulate city mobility needs. Build an Integrated Transport Mobility Plan based on this analysis.
- City wise targets to double the modal share of public transport
- Set city level electrification targets for buses, commercial fleet and other public transport modes
- Adopt sustainable designs, policies, systems to promote compact city approach, integrated public transport development plans and clean fuel infrastructure plans

B.2F

Component 6: Provide Low-Carbon Solutions for the Rural (Non-Urban) Populations

Short-Term (2020-22)

- Research into data for projecting travel demand for goods and people in rural areas
- Proper planning of rural transport by State Govt.
- Proper procedure for registration of e-3-wheeler-rickshaws
- Awareness campaigns for low carbon mobility

Medium-Term (2022-30)

- Improve efficacy of SATAT and JI-VAN schemes
- Strengthening existing grids
- Develop appropriate infrastructure for EVSE
- Introduce incentives like low interest on EV loans to promote rural usage of EV

Long-Term (2030-50)

- Ensure implementation of all advanced biofuels as envisaged under the National Policy on Biofuels, 2018

B.2G

Component 7: Accelerate Action on Adaptation in the Transport Sector

Short-Term (2020-22)

- Apply transit-oriented development (TOD) by promoting mixed land-use, non-motorised transport infrastructure, e-commerce for service at doorstep, encouraging work from home, Zero Emission Vehicles (ZEV) for last mile mobility by connecting metro infrastructures, and creating porosity by ensuring all daily needs are within walking distance
- Promote non-motorised transport (NMT) components in transport master plans developed by UMTA
- Implement stringent SOP for drainage system
- Develop a climate risk evaluation tool to assess risks and build mitigation strategies
- Design high-quality public transport services on dedicated infrastructure along major city corridors
- Implement driver training on disaster management to help deal with post disaster management activities
- Implement emergency/redundant route planning
- Develop better weather/disaster forecasting tools to help predict imminent dangers, and prepare in advance

Medium-Term (2022-30)

- Developing quality, reliable, sustainable and climate resilient infrastructure by integrating transport infrastructure into urban planning
- Create frameworks to evaluate the preparedness of transport infrastructure for climate change related disasters
- Prepare strategy document on 'low carbon and climate-resilient mobility plan for cities' integrating them to form the national low carbon mobility vision
- Implement Master Plan for systemic improvement of all utilities in cities
- Create 3D Mapping of all major cities
- More resilient design standards for infrastructure, utilities and storm water drains
- Ensure Build-Own-Operate-Maintain (BOOM) models are implemented
- Building sufficient redundancy
- Change in design parameters and standards
- Project designing for significant shifts to more sustainable modes for intercity passenger and freight transport
- Enhance freight transport efficiencies by gradually shifting them to low emission alternative fuels

B.2H

Component 8: Large-scale Deployment of Economic Instruments and Leveraging Finance

- Establish a Nodal Development Finance Institution for Sustainable Mobility, which will fund projects, indirectly, by extending credit lines to Banks/NBFCs, which in turn will lend to sustainable mobility projects and programmes.
- Cities to adopt sustainable mobility through budgets for integrated transport systems (and not for specific projects, e.g. Metro or BRT or City bus projects), with goal of reducing road congestion, and effectively meeting citizens mobility needs, including Pedestrian & NMT infrastructure.
- Earmark substantial part of the road budget towards development of public transport infrastructure, such as multi-modal terminals, surface ports, bus stations, highway amenity centres, rest areas, viewpoints, parking lots and multi-modal logistics parks.
- Increase cost of private vehicle ownership and usage, through higher Motor Vehicle taxes, Fossil fuels taxes, Road User and On-street Parking charges. Funds, thus raised, should have dedicated application of funding Public Transport as well as Pedestrian and NMT infrastructure.
- Introduce uniform taxes on passenger transport,

on pan India basis, to remove anomaly of punitive taxes imposed by each state through which buses traverse; and do away with taxes on bus transport or keep taxes on buses minimal

- Apply preferential GST to all new technology options and keep it uniform for all sustainable mobility solutions
- Use single SPV (special purpose vehicle) – UMTA as an example – to manage and disburse funds based on approved plans
- Accelerate large-scale adoption of EVs and Bio-CNG/ Advanced Biofuels Vehicles), supported by viability gap funding schemes during scale-up phase
- Incentivise manufacturing and use of EVs and Bio-CNG/advanced biofuels vehicles, to make them market competitive, with “economies of scale”, by providing in scale-up phase, capital subsidies, interest subvention and financing instruments, correlated to LCCA (Life-Cycle Cost Analysis)
- Introduce incentives like low interest on EV loans to promote rural usage of EV and tax incentives for EV charging from renewable energy sources
- Facilitate banks to offer term loans to catalyse investments in EV Charging Infrastructure, under Capex model or Opex model
- Include Bio-CNG/Bio-LNG and related manufacturing plants within GST (at same rate as Biogas, i.e. 5%) and make them eligible for priority sector lending
- Devise measures like assured supply of segregated waste, priority sector lending, interest subvention scheme and inclusion in ‘White Category’ for pollution clearance for advanced biofuels
- NABARD supported RRBs and co-operative banks to design financing packages for Farm

Waste Supply Chain (collection, aggregation, pre-processing & storage) and provide schemes to incentivise farmers to adopt Bio-CNG Tractors

- NABARD and SIDBI to develop Carbon Finance/ ESG Finance supported schemes, for financing of Bio-CNG/ Bio-LNG Plants as well as retailing outlets
- Establish a “Green Taxonomy”, which would facilitate ABS (asset backed securitised) deals through diversification of Green Bonds into Sustainable Mobility sector
- Incentivise domestic manufacturing of Sustainable Mobility Vehicles, through bulk purchases by Central & State PSUs (e.g. EESL and STUs)
- Build capacity among borrowers, financiers, policymakers and regulators on commercially viable sustainable mobility solutions as well as opportunities presented by Climate Bonds/ESG Finance
- Provide Long Tenor Project Financing (covering Vehicles + Terminuses + EV Charging & Bio-CNG/ LNG Retailing Infrastructure) to remove current inequities in financing. These should have an initial moratorium and gradual scale-up of principal repayment, to ensure appropriate risk distribution mechanism
- Provide refinance scheme for loans extended to Sustainable Mobility projects, post commercialisation, as this will enable Banks/ NBFCs, having domain competence to scale up lending
- Have dedicated funds to provide Viability Gap Funding (VGF) and Partial Risk Sharing Facility (PRSF), for holistic development of public transport systems, encompassing all modes of transport

C. Final Insights

The India roadmap recognises the need for government, private sector and other stakeholders to work together in a concerted manner for building a sustainable mobility ecosystem in India. The findings and consultations of the India roadmap development process have thrown up interesting insights which point towards the scope for interventions in governance structures, policy and regulations, strategies for low carbon energy supply, policy imperatives required for optimising freight supply chains, sustainable transport models to reduce vehicle kilometres.

The roadmap gives clear actionable recommendations for each of these, many of which need to be implemented within the next two years (by 2022) and others that would ensure further implementation of policies and programmes in the medium term (between 2022 and 2030). The roadmap provides directional recommendations for the long-term (between 2030 and 2050) that focus more on R&D on advanced technologies.

The detailed insights also imply the scope for new and innovative business models as well as public-private partnership models that could be explored with the impetus on sustainable mobility in India. There is potential opportunity for collaboration in terms of multi-

modality, interoperability, development of standards, implementation of transit-oriented development and low-emission and zero-emission zones. The need to improve interconnectedness among various ministries through implementation of a common governance structure, and the need for greater technology interface to enhance smart and connected mobility is a critical requirement.

The roadmap indicates the clear thrust needed on public transportation, shifting paradigm to movement of people more than the paradigm of movement of vehicles as the effective means to reduce congestion, air pollution, and vehicle kilometres. An integrated approach that integrates governance and institutions, infrastructure and technology for different modes is a strong imperative for sustainability.

It also points out the gap in data and information, and therefore highlights the urgent need to develop data repository on mobility, especially for rural mobility, which would help extrapolate demand for rural mobility solutions. The roadmap provides recommendations on financial and economic instruments for sustainable mobility. Overall, it emphasises the need to deliver a concerted and holistic pathway towards decarbonisation by setting a strategic direction towards policy formulation and effective implementation.

ACRONYMS

AAI: Airports Authority of India	GHG: greenhouse gas
ABS: asset backed securities	GIZ: Deutsche Gesellschaft für Internationale Zusammenarbeit
AICTSL: Atal Indore City Transport System Limited	GMR: Global Macro Roadmap
AIP: All India Permit	GOBAR: Galvanising Organic Bio-Agro Resources
AITP: All India Tourist Permit	Gol: Government of India
AJL: Ahmedabad Janmarg Limited	GP: Gram Panchayat
AMC: annual maintenance contract	GST: goods and services tax
AMRUT: Atal Mission for Rejuvenation and Urban Transformation and Smart Cities Mission	H-CNG: Hydrogen-CNG
ARAI: Automotive Research Association of India	HFC: hydrofluorocarbon
ASI: Avoid, Shift and Improve	HIGG: Hydrogen Injection in the Gas Grid
ATF: automatic transmission fluid	IA: implementing agency
BAU: business-as-usual	IC: internal combustion
BIS: Bureau of Indian Standards	ICE: internal combustion engine
BMC: Bombay Municipal Corporation	ICV: internal combustion based vehicles
BMS: battery management systems	IDA: International Development Association
BMTCL: Bengaluru Metropolitan Transport Corporation	IEA: India Energy Outlook
BOOM: Build-Own-Operate-Maintain	IOCL: Indian Oil Corporation Ltd
BOV: battery operated vehicle	IPT: Intermediate Public Transport
BP: British Petroleum	IRDA: Insurance Regulatory Development Authority
BPKM: billion passenger kilometre	IT: information technology
CBG: Compressed Bio-Gas	ITS: intelligent transportation system
CCUS: Carbon Capture Utilization and Storage	IWT: inland water transport
CEA: Central Electricity Authority	JCTSL: Jaipur City Transport Services Limited
CFA: Central Financial Assistance	Jl-VAN: Jaiv Indhan-Vatavaran Anukool Fasal
CGD: City Gas Distribution Networks	Awashesh Nivara
CHT: Centre for High Technology	KPIs: key performance indicators
CI: compression ignition	LCCA: Life Cycle Cost Analysis
CMVR: Central Motor Vehicles Rules	LCTSL: Lucknow City Transport Services Limited
CNG: compressed natural gas	LCVs: light commercial vehicles
DC: Development Control	LIBs: Lithium-Ion Batteries
DFCs: dedicated freight corridors	MAHA-Metro: Maharashtra Metro
DFIs: development finance institutions	MGNREGA: Mahatma Gandhi National Rural
DHI: Department of Heavy Industries	Employment Guarantee Act
DME: Dimethyl ether	MMI: multimodal integration
DMU: Decision Making under Uncertainty	MMLPs: multimodal logistics parks
EBP: Ethanol Blending Programme	MoEFCC: Ministry of Environment, Forest and Climate Change
ESG: environmental, social, and governance	MoP: Ministry of Power
EVs: electric vehicles	MoRTH: Ministry of Road Transport and Highways
EVSE: electric vehicle supply equipment	MSW: Municipal Solid Waste
EXIM: export import	MVA: Motor Vehicles Act
FAME India Phase 2: Faster Adoption and Manufacturing of Electric Vehicles in India Phase 2	NABARD: National Bank for Agriculture and Rural Development
FIs: financial institutions	NBM: National Biodiesel Mission
FICCI: Federation of Indian Chambers of Commerce & Industry	NCAER: National Council of Applied Economic Research
FIRR: financial internal rate of return	NCAP: National Clean Air Programme
FMCG: fast moving consumer goods	NDCs: Nationally Determined Contributions
FSI: floor space index	NEMMP: National Electric Mobility Mission Plan
GCC: gross cost contract	NHA: National Highways Authority of India
GCF: Green Climate Fund	NHEB: National Hydrogen Energy Board
GDP: gross domestic product	

NHREM: National Hydrogen Road Map	RTO: Regional Transport Office
NITI Aayog: National Institution for Transforming India Aayog	SATAT: Sustainable Alternative Towards Affordable Transportation
NMRC: NOIDA Metro Rail Corridor	SBM-G: Swachh Bharat Mission-Gramin
NMT: non-motorized traffic	SDGs: Sustainable Development Goals
NRLM: National Rural Livelihoods Mission	SI: spark ignition
NRuM: National Rurban Mission	SIDBI: Small Industries Development Bank of India
NSSO: National Sample Survey Organisation	SIFF: Sustainable India Finance Facility
NTPDC: National Transport Policy Development Committee	SLWM: Solid and Liquid Waste Management
NUPF: National Urban Policy Framework	SOP: Standard Operating Procedures
NUTP: National Urban Transport Policy	SPV: special purpose vehicle
OEM: original equipment manufacturer	STUs: State Transport Undertakings
OMC: oil marketing companies	TAROP: Transport Allocation and Route-Mode Optimization
OPEX: operating expense	TDM: travel demand management
PA: Paris Agreement	ToD: Time of the Day
PKT: passenger kilometre travelled	TOD: transit-oriented development
PMGSY: Pradhan Mantri Gram Sadak Yojana	TRAI: Telecom Regulatory Authority of India
PNGRB: Petroleum and Natural Gas Regulatory Board	TSRTC: Telangana State Road Transport Corporation
PPAs: power purchase agreements	UCO: Used Cooking Oil
PPAC: Petroleum Planning & Analytical Cell	ULBs: Urban Local Bodies
PPMC: Paris Process on Mobility and Climate	UMTA: Unified Metropolitan Transport Authority
PPP: public private partnership	UNFCCC: United Nations Framework Convention on Climate Change
PRIs: Panchayati Raj Institutions	UTF: Urban Transport Fund
PRSF: Partial Risk Sharing Facility	VKT: vehicle kilometre travelled
PSUs: public sector undertakings	VOC: volatile organic compound
R&D: research & development	WBTCCL: West Bengal Transport Corporation Limited
RC: registration certificate	WHO: World Health Organization
RFID: Radio Frequency Identification Device	ZEV: zero emission vehicles
RRBs: Regional Rural Banks	
RTA: Regional Transport Authority	

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groups as well as joint meetings and workshops of all working groups was also coordinated and organised by FICCI.

The formation of working groups was preceded by a brainstorming session of experts in May 2018, thereafter the working groups after being formed met numerous times in the 20 months that followed. A joint workshop of the working groups took place in May 2019 to assess the development of the theme reports and Roadmap halfway through the project. Thereafter, extensive deliberations of the working groups were held alongside stakeholder consultations until the culmination of the final eight theme reports and the India Roadmap. The 8 Leads of the working groups met numerous times through the project period. The joint meetings of the working groups and frequent meetings of the Leads ensured there was no silo in the deliberations or formulation of the eight components of the Roadmap. We are thankful to all of them for devoting their time and energy in this manner.

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Working Group 4

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Working Group 5

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**Working Group 7
Satish Rajagopalan**

Head- Strategy &
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Working Group 8

Kolluru Krishan
Chairman, CVC India
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WORKING GROUPS

Working Group1 on “Urban Transformation for Healthier, Inclusive Lifestyles and Efficient, Resilient, Prosperous Cities”

Lead: Mr Bharat Salhotra, Chair, FICCI Core Group on Sustainable Mobility and Managing Director, Ronmas

Members:

1. Delhi Metro Rail Corporation Limited (DMRC)
Sharat Sharma
2. Ola Mobility Institute (OMI)
Shilpi Samantray
Aishwarya Raman
3. Ashok Leyland
Karthick A
4. Maruti Suzuki
Tapan Sahoo
Sumit Sharma
Ajeet Singh
5. WRI India
Amit Bhatt
Ms Revathy Pradeep

Working Group 2 on “ Low-carbon Energy Supply Strategy”

Lead: Mr Sharat Sharma, Former Director – Operations, DMRC

Members:

1. Tata Power Delhi Distribution Limited (TPDDL)
Praveen Verma
Sarang Pani Goswami
Suyash Verma
2. Indian Oil Corporation Limited
Subodh Kumar
Shantanu Gupta
3. Center for Study of Science, Technology and Policy (CSTEP)
Mridula Dixit Bhardwaj
Arunesh Karkun
4. Bharat Heavy Electricals Limited (BHEL)
Arun V Rao

5. Panitek Power AG

Pankaj Agarwal
Anjan K Merkap

6. CVC India Infrastructure Pvt. Ltd.

Kolluru Krishan

7. SUN Mobility

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Working Group 3 on “Improve Intermodal and Mode-wise System Efficiencies”

Lead: Mr Prasanna Patwardhan, Chairman & Managing Director at Purple Mobility Solutions Pvt Ltd and President at Bus & Car Operators Confederation Of India (BOCI).

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3. GoBOLT
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4. Ashok Leyland
Sriram Tirunantalwan
5. GlZ
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Abhijit Singh
Tanuj Kapta

Working Group 4 on “Optimise Supply Chains to Manage Freight Transport Emissions”

Lead: Mr Shanti Narain, Former Member Traffic, Railway Board (National Chairman, The Chartered Institute of Logistics and Transport – India)

Members:

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2. Deloitte India
Shard Chandra Misra
3. Howe Engineering Project (India) Pvt Ltd
Vinod Asthana
4. GATI
P. N. Shukla
5. GoBOLT
Sumit Sharma
6. Container Corporation of India Limited
Anil Kumar Gupta

Working Group 5 on “Avoid Vehicle Kilometres for Commuting, Shopping and Accessing Services”

Lead: Mr Carson Dalton, Senior Director, Ola Mobility Institute

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Aishwarya Raman
2. WRI India
Priyanka Sulkhlan
3. Zoomcar India Pvt Ltd
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4. Shuttl
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Working Group 6 on “Provide Low-Carbon Solutions for the Rural (Non-Urban) Populations”

Lead: Mr Karthick A, Head, EV & eMobility Solutions, Ashok Leyland

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3. India Smart Grid Forum
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Sriram Tirunantalwan
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Working Group 7 on “Accelerate Action on Adaptation in the Transport Sector”

Lead: Mr. Satish Rajagopalan, Head of Strategy and Business Development, Mahindra Electric

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Working Group 8 on “Large Scale Deployment of Economic Instruments and Leveraging Finance”

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ABOUT PARTNERS



FICCI

Established in 1927, FICCI is the largest and oldest apex business organisation in India. Its history is closely interwoven with India's struggle for independence, its industrialisation, and its emergence as one of the most rapidly growing global economies.

A non-government, not-for-profit organisation, FICCI is the voice of India's business and industry. From influencing policy to encouraging debate, engaging with policy makers and civil society, FICCI articulates the views and concerns of industry. It serves its members from the Indian Private and public corporate sectors and multinational companies, drawing its strength from diverse regional chambers of commerce and industry across states, reaching out to over 2,50,000 companies.

FICCI provides a platform for networking and consensus building within and across sectors and is the first port of call for Indian industry, policy makers and the international business community.



PPMC

The PPMC is an open and inclusive platform that actively invites all organisations and initiatives that support effective action on transport and climate change to join in the process. The PPMC is created to strengthen the voice of the sustainable transport community in the UNFCCC process, especially with a view to the upcoming Conference of Parties (COP21) in December 2015 in Paris. COP21 is expected to result in a new global agreement on climate change, which will shape climate policy in the years to come at a global, regional and national level. By bringing together different actors and stakeholders in the sustainable transport community it will be possible for the transport sector to have its voice heard and speak with one voice on the important contribution that sustainable mobility can make to the mitigation of, and adaptation to climate change.

The PPMC contributes to realising a Global Agreement on Climate Change that empowers transport sector to take action on climate change. The realisation of this objective requires an active engagement of the PPMC before, during and after COP21. It will be equally important to advocate for an agreement that incentivises the transport sector as well as work with the transport and climate community on the implementation of a new global agreement on climate change at the global, regional, national and local levels.



WWF-India

WWF-India is one of the leading conservation organizations in the country. It is a science-based organization that addresses issues such as the conservation of species and its habitats, climate change, water, and environmental education, among many others. Over the years, its perspective has broadened to reflect a more holistic understanding of the various conservation issues facing the country and seeks to proactively encourage environmental conservation by working with different stakeholders- Governments, NGOs, schools and colleges, corporates, students and other individuals.



Shakti Sustainable Energy Foundation

Shakti Sustainable Energy Foundation (Shakti) seeks to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following areas: clean power, energy efficiency, sustainable urban transport, climate change mitigation and clean energy finance.

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