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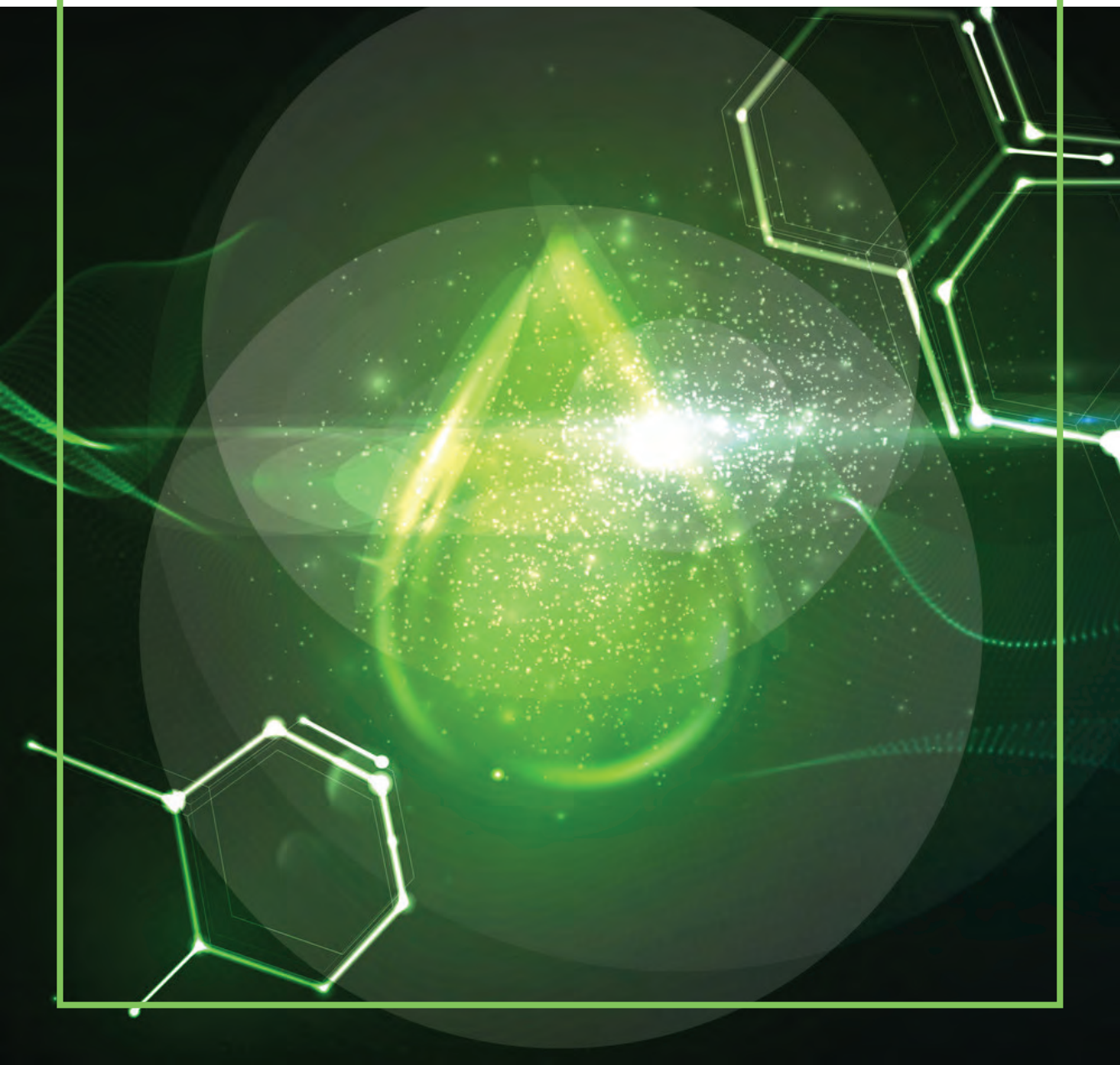
# Logistics Focus™

# Renewable Energy

## Impact on Logistics in India

January 2022



# What's Inside

# Foreword

Dear Readers,

Welcome to yet another edition of our knowledge initiative and industry reference, **"Logistics Focus"**. We appreciate your valuable patronage.

**"Renewable Energy: Impact on Logistics in India"** is a must go over set of articles. These are written by eminent personalities who are doing pioneering work in this field. We have **Mr Shirish S Garud**, Director – Renewable Energy Technologies, TERI; **Ms Bindu Madhavi**, Director - Policy & Regulatory, India Energy Storage Alliance (IESA); **Dr Robert McCormick**, Senior Research Fellow I-Chemical Engineering, NREL who have contributed with impactful insights.

Let us all move aggressively as an Industry in doing our bit towards a Greener Planet.

Please do share your candid feedback as to whether this edition was useful.

Thanks,

**Corporate Communications Team**

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# Harnessing the potential of Renewable Energy for Green logistics

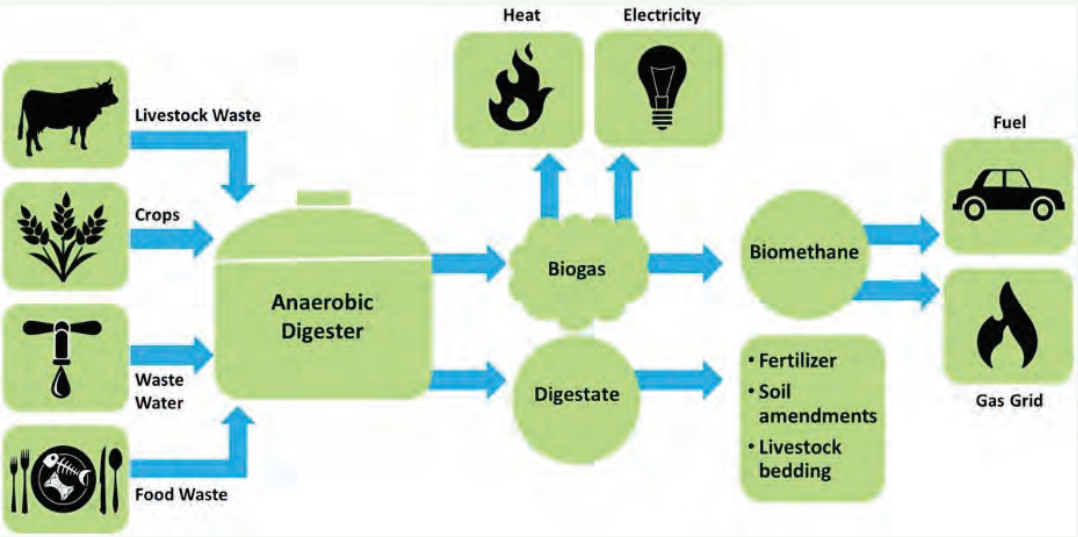
**Mr Shirish Garud,** Senior Fellow, Renewable Energy Technology Division, TERI, having more than two decades of experience in renewable energy sector, is a well-known specialist in renewable energy technologies, energy planning and renewable energy policy studies. He has rich experience in solar and wind resource assessment, technology development, and deployment. Some of his major assignments include, development of vacuum tube collectors, development of solar parabolic trough collectors, designing of solar power plants, designing and implementation of one of the world's largest solar water heating system of 120m3 day capacity for fertilizer industry. He was part of UNEP funded multi country project SWERA (Solar and Wind Resource Assessment) which mapped solar and wind resources for countries in Asia, and Africa. He led a multi-activity flagship project on 'Integrated Energy Management Master Plan for Bhutan'.

## Preamble:

Investopedia defies logistics as "Logistics refers to the overall process of managing how resources are acquired, stored, and transported to their final destination". Logistics is part of transport sector and major energy consuming areas of logistics are buildings, warehousing, internal material shifting equipment like forklifts, cranes and of course transportation of materials. According to data, transport sector consumes about 16.9% of India's total energy consumption.

Most common and accepted definition of sustainability is, 'Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs'. There are three dimensions of the sustainability; the economy, society, and the environment.

Renewable energy resources, or "renewables" are naturally replenishing energy sources that can replace coal, oil, natural gas, and nuclear power across the supply chain with clean,



safe, reliable power at low or zero carbon emissions.

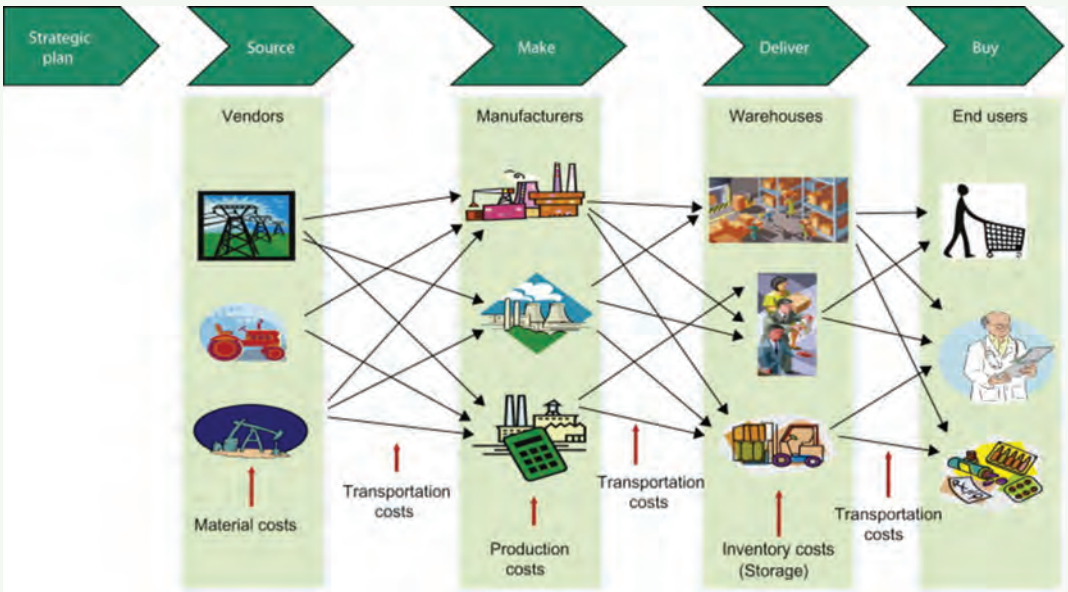
## Why is it necessary for the logistics sector to think of renewables?

India is world's third largest emitter of GHG emissions emitting about 2625.968 MtCO2e in 2019 which are responsible for Climate Change. Apart from Climate Change the transport sector is also responsible for air pollution affecting quality of air particularly in our cities. Some of the world's most polluted cities are in India. The transport sector is responsible for 13.5 per cent of the country's energy-related CO2 emissions, with road transport accounting for 90 percent of the sector's final energy. The road sector is mainly dependent on petrol, diesel and CNG to meet its energy demand. A small percentage of electric vehicles.

Currently, transport sector (passenger and freight included) is responsible for about 300 MtCO2e GHG emissions per year. According to the Climate Action Tracker published report titled 'Decarbonising the Indian transport sector pathways and policies', these are likely to grow to 1170 MtCO2e per year by 2050 if current policy scenario continues .The report also came up with two scenarios for achieving net zero emissions by 2050 namely; rail focused and road focused. These two scenarios predicts the scope for reducing transport sector GHG emissions to net zero by 2050. It is estimated that the GHG emission reduction of 150MtCO2e /year using alternate fuels and 195 MtCO2e/ year using electrification is possible under rail focus scenario. While under road focus scenario the potential for reducing GHG emissions is 205 MtCO2e per year using alternate fuel 3and 570 MtCO2e per year using electrification strategy. With Hon. Prime Minister announcing that India will be net zero carbon emitter by 2070, it is responsibility of all sector to work towards it to secure wellbeing of our future generations. Renewable energy is going to play an important role in achieving it.

## Renewable energy options for logistics sector

As mentioned above, logistics sector consumes energy in the form of fuels used for freight transport and electricity used for



lighting, powering office equipment, air-conditioning and driving electric forklifts and cranes etc.

Freight movement is either through road, rail, shipping or aviation. Road transport dominates India's transport sector.

In the following section we will look at the possible options for decarbonizing the logistics sector through use of renewable energy.

## Building Energy Needs

It is estimated that buildings consume about 30% of the total energy consumption. Majority of this is in HVAC (Heating Ventilation and Air Conditioning system) following by lighting, equipment and other uses. In logistics sector large warehouses are now becoming common. Growth of Ecommerce is also fueling growth of warehousing. The rooftops of these warehouses can be used for installing solar rooftop PV power plants which can not only meet the energy requirement of the building but also export surplus power to the grid and can become revenue earners. A typical solar system on roof top is shown in Photo 1. The Government of India has set target of 40GW for solar roof top sector and warehouses and office and factory buildings are expected to play a major role in meeting this target.

## Material handling in the buildings

Fork lifts and cranes are used for material handling in the buildings. Forklifts mostly use lead acid batteries for powering them.


New technologies which are replacing the conventional lead acid batteries which are heavy, take, longer time to charge and are less efficient include Li-ion batteries and hydrogen fuel cells. Companies like Toyota have developed hydrogen fuel cell powered forklifts. Hydrogen can be produced using renewable based electricity. The hydrogen thus produced is called as 'Green hydrogen' as it does not emit any emission while production. Fuel cells are devices like batteries which combine hydrogen and oxygen from

air to produce electricity and water. Thus fuel cells are environment friendly options. A photograph of hydrogen fuel cell powered fork lift is shown in figure above.

Over 3000 fuel cell powered forklifts are running in the USA and Canada and major players like IKEA are introducing these advanced technologies in their routine operations.

## Renewable Energy in Transportation

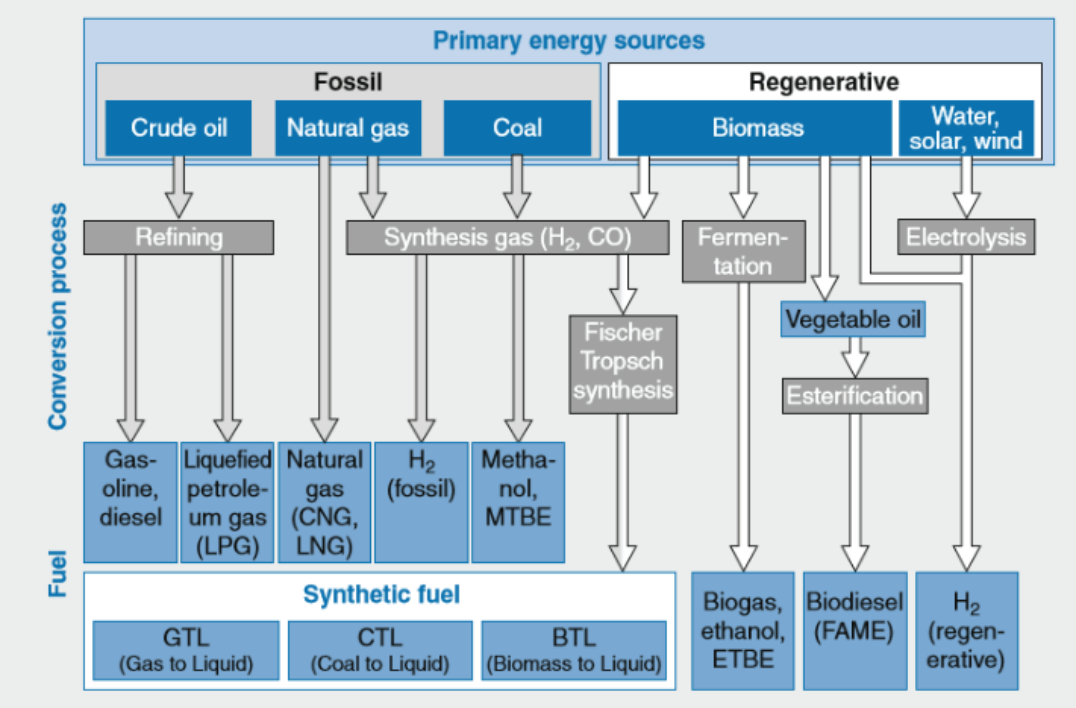
Freight transport is major consumer of petroleum fuels and GHG emissions. In India, road transport dominates the sector followed by rail, shipping and aviation. Transport sector is one of the hard to abet sectors as far as fuel replacement is considered.

## Road transport

Electric mobility with electricity coming from renewables is one of the best options for road transport as far as passenger vehicles and two and three wheelers are concerned. The government of India is promoting electric vehicles through its FAME II scheme under which capital subsidy is offered to electric vehicles. These vehicles do not emit any emissions during operations and hence local pollution can be reduced. However, electric vehicles have limitations on the range and capacity and hence are not suitable for long distance freight and bus transport. Hydrogen fuel cell vehicles are expected to fill this gap. Tata Motors in India has developed such fuel cell powered buses and IOCL and Tata Motors are working together to develop fuel cell powered trucks and commercial vehicles.

## Alternate biofuels for IC engines

Biofuels are transportation fuels such as ethanol and biomass-based diesel fuel that are made from biomass materials. These fuels are usually blended with petroleum fuels (gasoline and distillate/diesel fuel and heating oil), but they can also be used on their own . India has embarked upon an ambitious program for use of biofuels by announcing National Policy for Biofuel 2018. An indicative target of 20% blending of ethanol in petrol and 5%

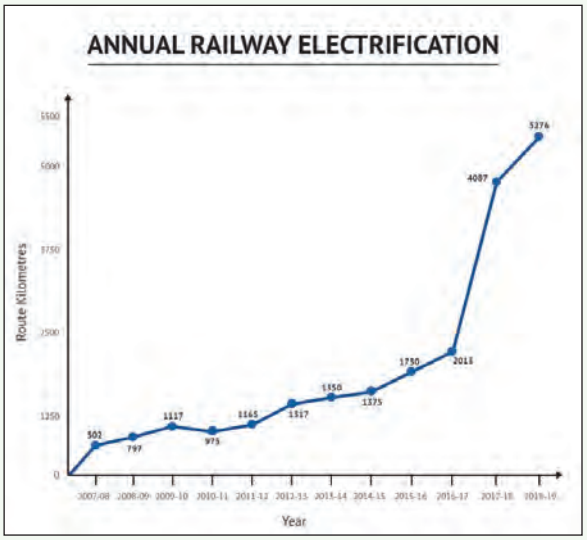


blending of biodiesel in diesel is proposed by 2030.

Compressed Biogas is promoted through SATAT scheme which aims to install 5000 biogas plants for compressed biogas production by 2025. SATAT stands for Sustainable Alternatives Towards Affordable Transportation. Public Sector Oil Marketing Companies will procure the compressed biogas for use in the vehicles.

## Rail transport

Rail transport is fast adopting electrification of rail routes for cleaner transport. Indian Railways are also increasingly using solar energy in its operations. Railways are buying solar and wind electricity from solar and wind power plants to meet their power requirement through cleaner energy. Additionally, railways are also considering fuel cell powered train systems in future.




## Shipping

Internationally, shipping industry is gearing up to adopt clean energy. International Wind Ship Association (IWSA) is promoting direct wind powered shipping for sea going vessels including large vessels. Various technologies are being developed and deployed by major shipping companies.


**Conclusion**

**Renewable energies are going to play an important role in creating sustainable future for our generations. Logistics sector is an important sector for modern civilization. Demand for logistics is ever increasing. It is prudent to plan and take action for decarbonizing the logistics sector on priority. Alternate fuels, renewable electricity and green hydrogen based solutions offer options for decarbonizing the logistics sector. Globally, research and technology development is focusing on developing suitable technologies. The government of India, through its various initiatives is focused on decarbonizing various sectors including logistics sector.**

# Role of Energy Storage Clean Transportation

**Ms Bindu Madhavi** currently associated with Customised Energy Solutions, actively supports them in consulting projects and leading Policy & Regulatory activities for India Energy Storage Alliance, leading association for Energy Storage and Electric Vehicle Industry. She takes lead in policy advocacy, planning, monitoring, implementation & interventions at the Center & State level related to Energy Storage, Electric Vehicle and Manufacturing (ACC) sectors. She is also chairing Policy Working Group Committee, an initiative of IESA with Member companies, set out the priorities needed for the sector growth and working towards achieving these targets, developing regulatory plans and industrial positioning in collaboration with the member companies. She is also acting as a mentor in the "Energising Women to Advance the Energy Transition" Mentorship Program by GWNET: Global Women's Network for the Energy Transition.

Access to reliable, affordable electricity and clean transportation are the key drivers of economic growth in modern economies. World has realised the importance of transiting into clean energy and clean transportation to achieve sustainable growth and avoid catastrophic climate change. Many countries including India have leapfrogged in the past 5 years, its transition towards sustainable goals in terms of clean energy and mobility.

Over the decade, share of renewables grew almost 5% per year between 2009 and

2019, outpacing fossil fuels (1.7%). Globally Renewable targets has become a defining feature of the Energy landscape and set another record for installed power capacity in 2020, meaning that we now produce around 29% of our energy from renewables. India also shown significant achievements in terms of keeping its Paris Climate Change (COP21) commitments along with an exponential increase in renewable energy capacity. The Indian Power Sector have achieved the coveted milestone of 100 GW of installed Renewable Energy Capacity. As on 31st July 2021, 38.5% of India's installed power generation capacity is based on clean renewable energy sources and with this pace we will reach the target of 40% by 2023. As per Central Power Ministry, it is anticipated that by 2050, 80-85% of India's overall power capacity will come from renewables.

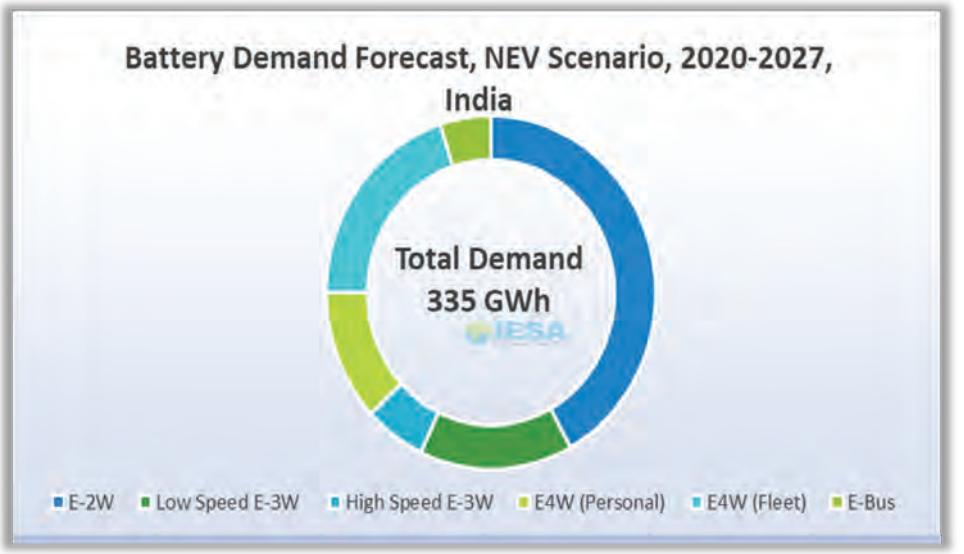
Similar curve is also expected in Transport Industry. India has started making its progress towards clear transportation goals in terms of Electric vehicles, hybrid vehicles etc.

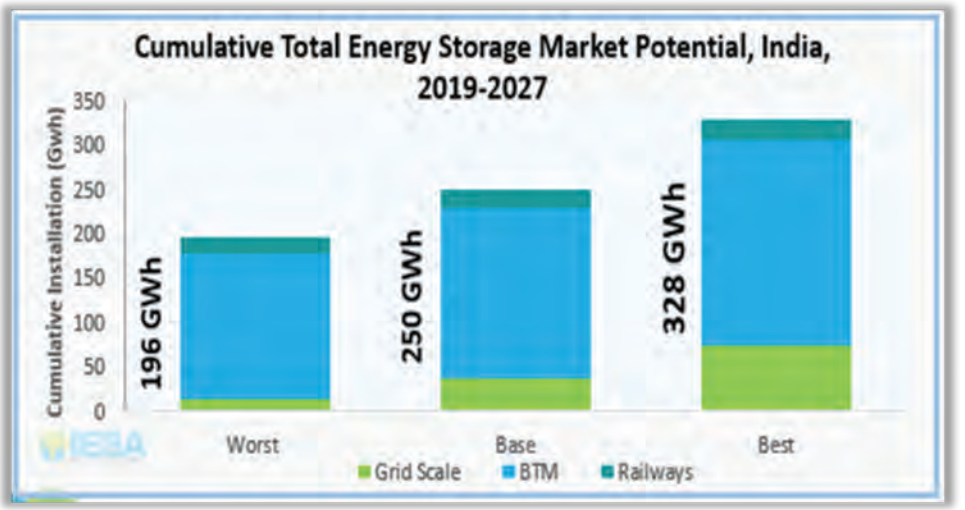
However, we have to agree that this will be only possible by adapting Power requirement of Electric Vehicle Industry must entirely be dependent on Renewable Energy. 100% renewable is the only lasting solution to the challenges raised by climate change, energy security, sustainability, and pollution. Coming to Indian Scenario, India is currently aiming towards reaching its climate goals in transportation by reducing vehicular pollution by pushing electric mobility under the Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles Phase II.

## Need for storage in Renewable Integration and EV Industry

Electric vehicles play an important role in integration of renewable energies into the grid. The peak power generation is expected during sunny hours, and the peak demand is expected in the evening. Hence there is a need to shift massive energy during a day. Besides, there is a need for flexible resources to balance the grid as well as to meet the peak demand. Presently, hydro plants, pumped storage, battery storage, open cycle gas plants, gas engines, gas power plants and coal-based plants are operating as flexible resources. Coal power plants generally designed to

support base load are not considered for flexible operation. However, with retrofit, coal plants can be modified as a flexible asset, however this goes against the governments low carbon growth strategy. Gas power plants are expensive due to non-availability of gas and low PLF of plants. Several pumped hydro plants are non-operational due to seasonality




issues and irrigation commitments.

In such a scenario, higher penetration of rooftop solar PV, integration of EV chargers, and rising commercial loads can create a major challenge for the operators in maintaining network reliability. Storage systems, as witnessed across the world, can provide flexibility at low and medium-voltage electricity networks

India Energy Storage Alliance (IESA) has estimated the stationary energy storage market potential in India to be around 250 GWh during the period 2020-2027. CEA projects requirement of 500 GWh (136 GW) of storage in the grid at various levels by 2030. Almost 50% demand is expected from electric vehicles. Rest of demand is expected from applications like wind and solar integration, frequency regulation, peak management, T&D deferral, diesel replacement and backup power. Hence there is a sizable opportunity for advanced

storage technologies in the new applications itself apart from opportunity for existing technologies to improve their performance for traditional applications

## Requirement for setting up of Storage + Renewable Energy based Electric Vehicle Charging Stations:

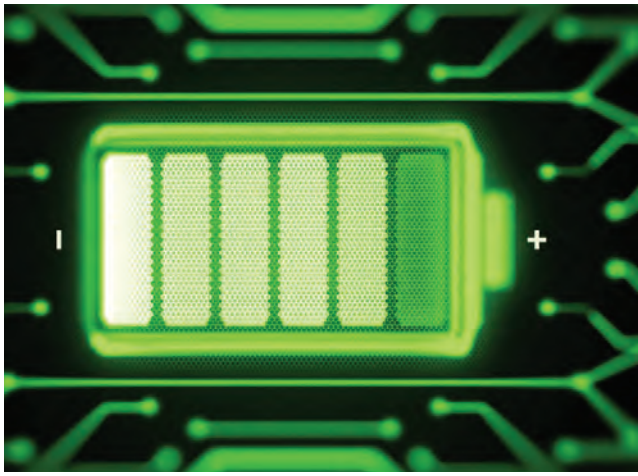
The requirement of suitable grid-grade electricity is seen as a major challenge for establishing sufficient charging stations for the EVs. Charging of EVs from electricity generated from fossil fuel based conventional sources does not reduce emission. For further reduction of carbon footprint it is essential that the EVs are charged from renewable energy sources. Energy storage technology will play a key role in the overall clean energy transition and has the potential to unlock economic and environmental


benefits in a variety of markets. As the critical technology component in electric vehicles, batteries are at the centre of the electric mobility transition. In many cases, renewable energy's intermittence requires that it be connected to energy storage to compete directly with fossil fuels In order to achieve both Central and States has to promote the use of renewable energy for charging of EVs. Deployment of Standalone storage system to supplement the grid, during peak hours or as a solar farm, using bidirectional grid tied inverter. This kind of system offers vide range of services including Grid support, RE Firm power output from both new & existing plants and align electric vehicles charging by renewable energy-based systems. Only this way, grid stability and safety shall be ensured and every state discom should be advised to plan for storage system requirement to mitigate unpredictability and variability of renewable energy, which will further strengthen the efforts of Indian government in achieving its sustainable targets and climate goals

## Need for Local Battery Manufacturing and its importance in achieving India's Targets:

ACC batteries will be crucial for India's energy security in the coming decade given their role in enabling renewable integration

and e-mobility transition. Currently, all the demand for ACCs in the country is being met purely through imports and at present India imports INR 20,000 crore worth of battery storage equipment. Most of the demand for the storage today is from renewable integration, power backup, diesel minimization, electric vehicles -- not just on roads but drones, electric planes, marine applications-- and consumer electronics devices such as cell phones etc. It is expected that the dominant battery technologies will control some of the world's largest growth sectors




Among many other developments this year, one major positive push towards bringing down the costs of storage and encourage technologies in India, certainly goes with the approval of Production Linked Incentive (PLI) Scheme 'National Programme on Advanced Chemistry Cell (ACC) Battery Storage'. The PLI scheme on ACC Battery Storage to be implemented by the Department of Heavy Industry (DHI) is aimed at achieving a manufacturing capacity of 50GWh of ACC and 5 GWh of "Niche" ACC in India with an outlay of Rs.18,100 crore. Direct investment of around Rs.45,000 crore in ACC Battery storage manufacturing projects is expected from this scheme.

**Future Prospective**

**We can conclude that renewable energy sources are appropriate sources for EV charging infrastructure. A charging facility can be either hybrid (solar and wind) or non-hybrid with the use of suitable storage capacity to support the charging process during the fluctuation of sources. The power generator's sizing depends mainly on the type of charging (fast, medium, or slow). However, with the right kind of policy and regulatory provisions, support from Central and State governments, Local Manufacturing, focus on R&D and investment opportunities, among other parameters are very important measures for India to achieve cleaner transportation supported by cleaner energy sources. This shall only be possible with the active and large-scale implementation and utilization of Storage which has proven successfully in contributing towards achieving sustainable goals globally.**

# Vehicle compatibility with ethanol-gasoline blends in seven countries including India

**Dr. Robert L. McCormick** is a Senior Research Fellow in the Fuels and Combustion Science group at the National Renewable Energy Laboratory. This group's research is focused on biofuels properties and fuel-engine interactions including biofuel quality and quality specifications, compatibility with modern engines, combustion chemistry, pollutant emissions effects, and leveraging fuel properties for design of more efficient engines.

The objective of Global Ethanol-Blended-Fuel Vehicle Compatibility Study is to understand the impact of ethanol-blended fuel at various blending levels (10%, 15%, and 20% vol.) on "in-operation" vehicles around the world. The study focuses on vehicles used in Canada, China, India, Indonesia, Japan, South Korea, and Mexico and uses historical experience in the United States and Brazil to inform the analysis.

The primary study question is:

Are vehicles in targeted countries physically and operationally compatible with ethanol blended fuel?

For a fuel to be compatible with a vehicle, the fuel must perform its function as part of the integrated fuel-vehicle system, meaning:

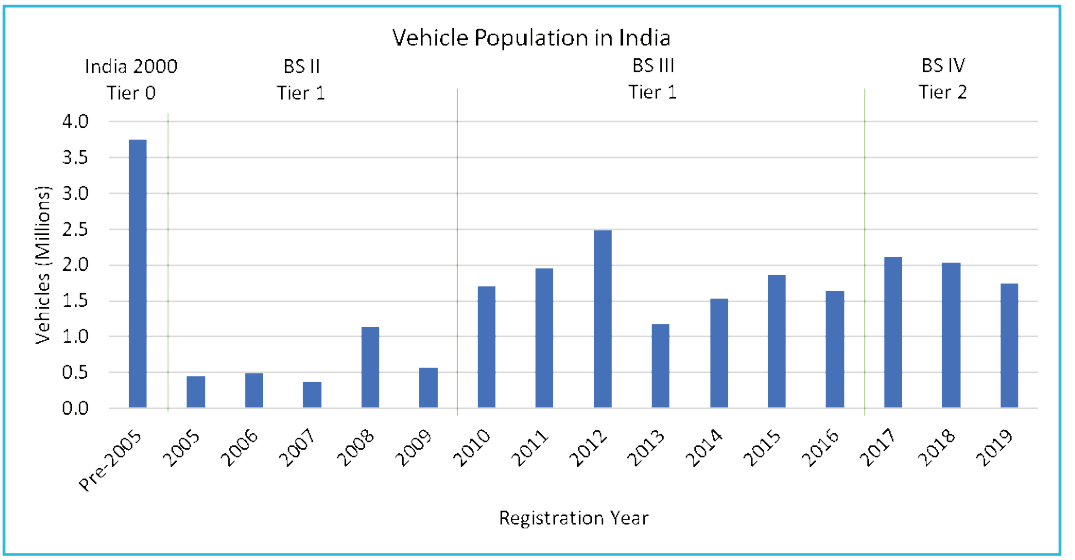
- The vehicle should start easily and drive normally
- The fuel should not cause catastrophic fuel system leaks
- The fuel should not cause corrosion or degradation of any engine or fuel system components (including emissions control components).

The history of E10 use in the United States, beginning in 1978, was evaluated and shows no reliability or operability issues for vehicles dating back to pre-emissions-control times — and likely included many vehicles manufactured in the 1960s. This


strongly supports the contention that fuel chemistry and property differences between E0 and E10 are so small any vehicle made to international standards in the last 50 years will have a very high probability of being fully compatible with E10. This conclusion is supported by the experience in Brazil in the 1970s, where E10 was also introduced, and ethanol blending for conventional vehicles rapidly ramped up to even higher blend levels. A limited number of fuel system and component manufacturers supply the global market, including Bosch, Continental, Denso, Delphi and Visteon. To reduce complexity, ethanol-compatible materials began to be integrated in fuel system designs globally. Fuel systems evolved over the following decades to incorporate ethanol-compatible materials with core subsystem families, such as in-tank fuel pumps used across several global vehicle original equipment manufacturers.

A compelling case can also be made that vehicles at the U.S. Tier 1 (or equivalent) emissions-control technology level or higher are compatible with E15 blends, based on the data evaluated by the U.S. Environmental Protection Agency and Ricardo in 2010. For vehicles at this technology level, the minor differences in fuel chemistry and properties between E10 and E15 are not significant. For E20, studies are not as extensive but are still highly significant. A long-term durability study[1] presents convincing evidence that U.S. Tier 2 technology level vehicles have materials of construction and engine control authority for compatibility with E20. However, additional studies are needed to confirm this conclusion.

The approach used to assess ethanol blend compatibility in the study countries is to first evaluate the emissions standards that have been in place historically and to correlate these standards with similar U.S. standards, as emissions standards are indicative of vehicle technology level. We then use the Experian Vehicles in Operation database to profile the fleets of light-duty vehicles in the studied countries by model year and emissions standard technology level. This leads to an initial conclusion regarding ethanol compatibility (with all vehicles considered as highly likely of being compatible with E10). Corroborating information is then sought




from other sources, such as owners manuals and surveys of fuel oxygenate content that may already be used in the study countries.

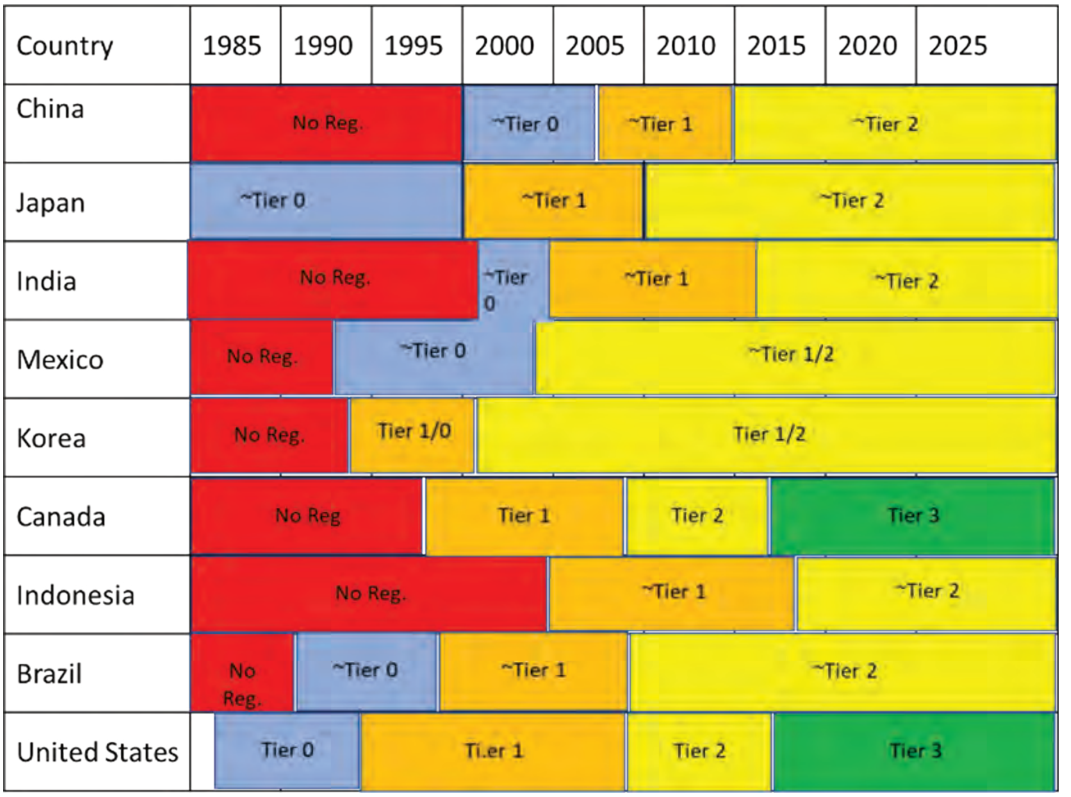
The stock of motorcycles and scooters is profiled for India and Indonesia using the MotorcyclesData database and other sources. Information from this database is compared to emissions standards in place historically, ethanol usage in other countries with similar motorcycle technology and ethanol use in the study country. Conclusions drawn are augmented by a limited owners manual survey.

While our analysis indicates all vehicles in the study countries are highly likely compatible with E10, a similar analysis for motorcycles in India and Indonesia indicates full compatibility with E10 — and that many motorcycles are also compatible with E15.

**China —** fourth-largest ethanol-producing nation. China's CN 2 standard, equivalent to Euro 2, was introduced in 2004. As Euro 2 is roughly equivalent to U.S. Tier 1, at least 98 percent of the vehicles in China should be compatible with blends up to E15. This is supported by widespread use of E10 in China.

**Japan —** adopted an emissions standard similar to U.S. Tier 0 in the early 1980s. U.S. Tier 1 emissions was required beginning in 2000, and Tier 2 beginning in 2005. At a minimum, the 80 percent of vehicles registered since 2005 should be compatible with E15, as should all vehicles registered since 2000 — although we do not know the breakdown of model years for 2005 and older vehicles. However, given that the gasoline standard only allows E3 blends, additional investigation may be required to understand ethanol compatibility in the Japanese market.

**India —** India's National Biofuel Policy has a goal of E10 by 2022 and will phase in E20 blending from 2023 to 2025. Since 2005, vehicles sold in India were required to meet the Bharat Stage (BS) II emission standard, paralleling the Euro 2 emissions standard and roughly equivalent to U.S. Tier




1, such that these and newer vehicles should be compatible with E15. Pre-2005 vehicles make up 11 percent of the gasoline vehicle fleet and should be compatible with E10. Indian motorcycles met the BS I (Euro 1) emissions standard beginning in 2000 and the BS II (Euro 2) emissions standard in 2005. In other parts of the world, motorcycles meeting these or equivalent standards are considered compatible with E10.

**Mexico —** ethanol is allowed in Mexico at up to 5.8 percent volume (except for the large metropolitan areas of Mexico City, Monterrey, and Guadalajara where ethanol blending is not allowed). However, in the northern border states, regulations have allowed importation of U.S. finished gasoline, which is largely E10. Vehicles manufactured in 2004 and later and having Tier 1 emissions technology level (56 percent of the vehicle fleet), should be compatible with blends up to E15.

**South Korea —** it appears that no fuel ethanol is currently used in South Korea. Given this and the high level of emissions-control technology for the entire fleet of vehicles there, these vehicles should be compatible with blends up to E15.

**Canada —** this market is very similar to the United States in almost every regard. It has heavy overlap in manufacturers, manufacturing facilities, engines and models. Given this and the overall high level of emissions-control technology of Canadian vehicles, it is likely that most of the vehicles sold since 1998 are E15 compatible.

**Indonesia —** even though current policy

mandates blending of E10 in 2020, ethanol is not currently being blended in Indonesia. Emissions standards equivalent to Tier 1 were introduced in 2005 and equivalent to U.S. Tier 2 in 2018. A combined 68 percent of vehicles meet these requirements. Vehicles manufactured since 2005 that have Tier 1 emissions technology level or higher should be compatible with blends up to E15. Indonesia implemented Euro 2 emissions requirements for motorcycles in 2005 and Euro 3 in 2015. In other parts of the world, motorcycles having this level of technology are compatible with E10.

**Summarised Finding**

**We did not identify any specific engine, vehicle designs or engineering practices that could cause issues when operating on ethanol.**

**[1] West, B. H., C. S. Sluder, K. E. Knoll, J. E. Orban, and J. Feng. 2012. "Intermediate Ethanol Blends Catalyst Durability Program." Report ORNL/TM-2011/234.**

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