IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 16, May 2023

Energy Policy - Ethanol Production in INDIA: The Roles of Policy, Price and Demand

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Abstract: *Achieving energy security and the transitioning to a thriving low carbon economy is critical for a growing nation like India. Blending locally produced ethanol with petrol will help India strengthen its energy security, enable local enterprises and farmers to participate in the energy economy and reduce vehicular emissions, The Government of India notified the National Policy on Bio-fuels –2018 (NPB–2018) on 4.06.2018 wherein, under the Ethanol Blended Petrol (EBP) Program, an indicative target of 20% blending of ethanol in petrol by 2030 was laid out.The current ethanol production capacity in India of 426 crore litres derived from molasses-based distilleries, and 258 cr. litres from grain based distilleries is proposed to be expanded to 760 cr.litres and 740 cr. litres respectively. This would be sufficient to produce 1016 cr. litres of ethanol required for EBP and 334 cr litres for other uses. This will require 60 lakh MT of sugar and 165 lakh MT of grains per annum in ESY 2025 to be used for producing ethanol, which the country can support. To get the ball rolling, MoP&NG should proclaim and lay out the target for 10% ethanol blending of gasoline fuel all over the country by April, 2022. MoP&NG should further initiate phased roll-out of 20% ethanol blending from April, 2023 onwards to enable action by all stakeholders, namely Oil Marketing Companies, vehicle manufacturers, service stations, distilleries, and entrepreneurs as per a detailed roll-out plan suggested (Figure 9.1). This should be supported by a simpler and quicker regulatory regime, preferably single window clearance by the States, MoEF&CC, PESO,DFPD and MoP&NG and the launch of educational campaigns for consumers.*
This study accelerate the adoption and transition to ethanol blended fuels,price incentives through tax relief at the retail level on ethanol blended fuel and tax incentives for vehicles compatible with E20 are suggested. The government may also encourage use of lower water consuming food grain crops like maize, and 2G feed stock for production of ethanol.

Keywords: Bio-fuels, Ethanol Blended Petrol (EBP), MoEF&CC, PESO,DFPD and MoP&NG etc

I. INTRODUCTION

The world is in the middle of a deepening energy crisis making energy transitioning the most urgent undertaking globally. India has been working towards developing green solutions and alternatives as striking a low-carbon economy has become critical for the country. Though India has been rolling out initiatives in almost all other alternative energy technologies, reducing vehicular emissions has become one of the most urgent targets for the country in recent times. The focus has thus been shifted to the endorsement of hydrogen and electric vehicles. When using E20, there is an estimated loss of 6-7% fuel efficiency for 4 wheelers which are originally designed for E0 and calibrated for E10, 3-4% for 2 wheelers designed for E0 and calibrated for E10 and 1-2% for 4 wheelers designed for E10 and calibrated for E20. SIAM has informed that with modifications in engines (hardware and tuning), the loss in efficiency due to blended fuel can be reduced. To compensate the consumers for a drop in efficiency from ethanol blended fuels, tax incentives on E10 and E20 fuel may be considered. Ethanol is one of the principal biofuels, which is naturally produced by the fermentation of sugars by yeasts or via petrochemical processes such as ethylene hydration. It has medical applications as an antiseptic and disinfectant. It is used as a chemical solvent and in the synthesis of organic compounds, apart from being an alternative fuel source.

On October 11, Central government launched Toyota's first-of-its-kind pilot project on flex fuel-strong hybrid electric vehicle (FFV-SHEV). The new vehicle can run on 100 per cent ethanol. An FFV-SHEV possesses a flex-fuel engine

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Volume 3, Issue 16, May 2023

and an electric power train. This setup extends dual advantages of higher ethanol use and greater fuel efficiency, as it can run on its EV mode for a good amount of time, while the engine stands shut off.

1.1 Objective

Ethanol Revolution and EVs- Ethanol – perhaps the most ubiquitous of the alternative bio-fuels, locally produced substance, has made its way into people's gas tanks. It is environmentally friendly that aligns with stricter emission norms. Pat few years have seen central and state governments coming together to promote the use of ethanol as a flex-fuel. Central government in one of this addresses, had highlighted that reducing the production of sugar and increasing the production of ethanol is good for future.

1.2 Background

Flex-fuel or Flexible fuel has been gaining traction on the heels of being alternative, environment-friendly fuels that can help combat both rising fuel prices & pollution levels. These are seen as an alternative fuel which are a combination of regular gasoline and methanol/ethanol. Unlike CNG fuel systems which store petrol and CNG in separate tanks and are used separately by the engine, the flex-fuel combination is stored in the same tank of fuel and is used by the engine as a blended fuel.

Ethanol as a Flex-Fuel- In flex fuels, the ratio of ethanol to petrol can be adjusted but the most commonly used flex-fuels use 85% ethanol and 15% petrol. Unlike petrol, ethanol is not a byproduct of crude oil. Instead, it is a complex derivative of biomass left by agricultural feed-stocks such as corn, sugarcane, hemp (bhang), potato, rice etc. Ethanol is extracted from sugarcane juice; from molasses – the black viscous product derived from refining sugarcane. These agricultural products are found in abundance and hence, the government has made a concerted effort to promote ethanol as an alternative fuel option. This was also reflected in the unveiling of the ambitious National Policy on Biofuels (2018).

Flex-Fuels more environment friendly- Ethanol has the quality to burn cleaner than gasoline, which simply makes flex-fuel vehicles leave fewer toxic fumes into the environment. Advanced technology is used to make flex fuel engines which also involves use of electronic sensors. Such advances make enable the vehicle to detect the fuel blend, make any necessary adjustments, etc. Usage of ethanol, which is sustainably produced, is what makes flex-fuels a green choice. By means of ethanol, India is in a quest to reduce its dependency on imported crude oil as well as to curb carbon footprints, as ethanol has the tendency to reduce carbon monoxide pollution by 35%. Unlike petrol, ethanol is not a byproduct of crude oil.

The world is in the middle of a deepening energy crisis making energy transitioning the most urgent undertaking globally. India has been working towards developing green solutions and alternatives as striking a low-carbon economy has become critical for the country. Though India has been rolling out initiatives in almost all other alternative energy technologies, reducing vehicular emissions has become one of the most urgent targets for the country in recent times. The focus has thus been shifted to the endorsement of hydrogen and electric vehicles.

II. METHODOLOGY

2.1 Vehicle Technology

Ethanol blending offers significant advantages such as increase in Research Octane Number (RON)of the blend, fuel embedded oxygen and higher flame speed. These properties of ethanol help in complete combustion and reduce vehicular emissions such as hydrocarbon, carbon monoxide and particulate matter. The calorific value of ethanol is around 2/3rd of gasoline. This indicates that the increase in ethanol content will decrease the heating value of the ethanol-gasoline blend.Hence, more fuel is required to achieve the same engine power output. However, ethanol has a higher octane number and thus the engine can be operated with a high compression ratio without knocking. This increases the efficiency of the engine considerably. This combined with optimal spark timing negates the fuel economy debit due to low calorific value of ethanol [7]. Hence, ethanol is considered as an efficient fuel provided suitable modifications are made in the vehicle.

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2.1.1 STUDIES ON E20 IN INDIA

A project to study the suitability of 20% ethanol-gasoline blend (E20) with in-use vehicles was undertaken by Automotive Research Association of India (ARAI), Indian Institute of Petroleum (IIP) and Indian Oil Corporation (R&D) during 2014-15, with a funding from Department of Heavy Industry (DHI) [8]. Material compatibility tests revealed that the metals and metal coatings had no issue with E20. Elastomers (NBR/PVC blend and Epi-chlorohydrin) had inferior performance with E20 compared to neat gasoline. Plastic PA66 had a drop in tensile strength after use with E20. In the vehicle level studies, fuel economy decreased up to 6% (depending on the vehicle type) on an average basis. The test vehicles passed startability and drivability tests at hot and cold conditions with E0 and E20 test fuels. In all the cases, there was no severe malfunction or stall observed at any stage of vehicle operation. No abnormal wear of engine components or deposits or deterioration of engine oils were observed after the on-road mileage accumulation trials.

2.1.2 MATCHING HIGHER ETHANOL BLENDS AND COMPLIANT VEHICLES

In order to use higher ethanol blends, the vehicles are supposed to be designed holistically to take care of material compatibility, engine tuning (spark timing) and optimization (compression ratio) to garner the advantage of higher octane ethanol blends. However, high compression ratio engines may face catastrophic failure due to engine knocking when operated with low or nil ethanol content (i.e. low octane fuel). Similarly, the vehicles which are designed for low or nil content of ethanol in gasoline will result in lower fuel economy if used with higher ethanol blends.

2.1.3 RESEARCH PROJECTS UNDERTAKEN IN OTHER COUNTRIES

Joint studies reported by Massachusetts Institute of Technology and Honda R&D indicate that the improvement in relative efficiency upto 20% can be achieved with E20 compared to normal gasoline, when the engine is properly tuned. [9]. Trials undertaken by Ford Motor Company concluded that the engine optimized for E20 fuel showed comparable volumetric fuel economy (mileage) and range (kilometers travelled in single fill) of normal gasoline with a CO2 reduction of 5% [10].

2.1.4 FLEX FUEL VEHICLES (FFVS)

Flex Fuel Engine technology (FFE) is a well-accepted concept in Brazil, representing over 80% of the total number of new vehicles sold in the country (2019). The Flex fuel vehicles used in Brazil operate with E27 or E100 Hydrous ethanol or any blend between these two. The vehicle technologies for ethanol are already proven along with the compatible fuel systems globally. So,the selection and optimization of technology for the engine has to be undertaken considering the availability of fuel ethanol. The cost of flex fuel vehicles (four-wheelers) would be higher in the range of Rs 17000 to Rs 25000. The two-wheeled flex fuel vehicles would be costlier in the range of Rs 5000 to Rs 12000 compared to normal petrol vehicles (SIAM).

2.1.5 REGULATORY STATUS OF ETHANOL AS A FUEL

The regulatory status and implementation details are as follows:

E5 [blending 5% Ethanol with 95% gasoline] was notified in 2015 by MoRT&H6 The rubber and plastic components used in gasoline vehicles produced since 2008 are compatible with E10 fuel.

E10 [blending 10% Ethanol with 90% gasoline] was notified in 2019 by MoRT&H7 The rubber and plastic components used in gasoline vehicles are currently compatible with E10 fuel.

The use of E-85 fuel (85% ethanol by volume) was notified in 2016 for 4 wheeled vehicles, 3 wheelers and 2 wheelers8 . E100 [pure ethanol] for use in gasoline vehicles and ED95 [95% ethanol and 5% additives (co-solvent, corrosion inhibitors and ignition improvers)] for diesel vehicles have also been included in the same notification. The emission standards of E 85 and E 100 fuels have also been notified.

The specifications of E20 as a commercial fuel have been indicated in IS: 17021: 2018 by BIS.

The Ministry has notified GSR 156(E) on 8th March 2021 for adoption of mass emission standards for E20 fuel. The compatibility of a vehicle with the level of ethanol blend of E20 or E85 or E100 or ED95 is required to be defined by the vehicle manufacturer, and the same is required to be displayed on the vehicle by putting a clearly visible sticker.

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The Safety Standard (AIS 171) for various blends of ethanol with gasoline has been notified vide G S R 343 (E) dated 25th May 20219 . The standard recommends material which is compatible with ethanol, viz., rubber, plastics etc. Ethanol blends increase electrical conductivity compared to gasoline, which causes corrosion of metal junctions.Therefore, the need to specify addition of corrosion inhibitors is also included. It also discusses (a) the toxic and carcinogenic nature of pure ethanol, (b) the necessity of personal protective equipment (PPE) for persons exposed to ethanol at the storage point (c) the need to have provisions for venting, flame arrestors and foam-based fire extinguishers for fighting ethanol flames. The standard also specifies labels for ethanol blends to be used in vehicles.

2.1.6 PRODUCTION OF ETHANOL BLENDED PETROL COMPATIBLE VEHICLES

Currently produced two-wheeler and passenger vehicles in the country are designed optimally for E5, with rubber and plastic components compatible with E10 fuel; their engine can be calibrated for E10 for better performance. As the EBP rolls out in the country, vehicles need to be produced with rubberized parts, plastic components and elastomers compatible with E20 and engines optimally designed for use of E20 fuel. SIAM has assured the committee that once a road-map for making E10 and E20 available in the country is notified by MoPNG, they would gear up to supply compatible vehicles in line with the roadmap. It is possible to roll out E20 material compliant vehicles by April 2022 and E20 Engine compatible vehicles by April 2023. However, considering the supply of Ethanol Blended Fuel, it is recommended that E20 material compliant and E10 engine tuned vehicles may be rolled out all across the country from April 2023. These vehicles can tolerate 10% to 20% of ethanol blended gasoline and also give optimal performance with E10 fuel. Vehicles with E20 tuned engines can be rolled out all across the country from April 2025. These vehicles would run E20 only and will provide high performance.

2.2 Scenarios

2.2.1 NODAL AGENCY FOR ETHANOL PRODUCTION

Table 2.1 FEEDSTOCK COST and ETHANOL YIELD

Feedstocks	Cost/MT of the Feedstocks in RS	Quantity of Ethanol per MT of Feedstocks	Ex-mill Ethanol Price RS/Litre
Sugarcane juice/Sugar/Sugar syrup	2850(price of sugarcane at 10%sugar recovery)	70 Liters per ton of sugarcane	62.65
Molasses	13,500	300 litres	57.61
Molasses	7123	225 litres	45.69
Damaged Foodgrain(Broken Rice#)	16,000	400 litres	51.55
Rice available with FCI	20,000	450 litres	56.87
Maize#	15,000	380 litres	51.55

The rate Vary from region to region and also in accordance with demand /supply and quality

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Department of Food and Public Distribution (DFPD) is the nodal department for promotion of fuel grade ethanol producing distilleries in the country. Government has allowed ethanol production/procurement from sugarcane-based raw materials viz. C & B heavy molasses, sugarcane juice/ sugar / sugar syrup, surplus rice with Food Corporation of India (FCI).10 and Maize. The raw material wise conversion efficiency is tabulated in Table 2.1 below:

Supply of ethanol under the EBP Programme has increased from 38 crore litres during ESY 2013- 14 to 173 crore litres during ESY 2019-20 resulting in increase in blend percentage from 1.53% to 5.00% respectively. Further, the allocation for the ongoing ESY (2020-21) has surged to 332 crore litres, which is 91% more in comparison to the ethanol supplies received during preceding ESY (2019-20).

Table 2.2 : Quantity Supplied (Ethanol) and %Blending Trends

Ethanol supply year	Qty supplied (crore Lit)	Blending %age(PSU/OMCs)
2013-2014	38.0	1.53 %
2014-2015	67.4	2.33 %
2015-2016	111.4	3.51 %
2016-2017	66.5	2.07 %
2017-2018	150.5	4.22 %
2018-2019	188.6	5.00 %
2019-2020	173.0	5.00 %
2020-2021	332	8.50 %

10 Ministry of Petroleum & Natural Gas Office Memorandum Dated 13th January 2021 Accessed From http://mopng.gov.in/files/article/articlefiles/OM-on-NBCC-decision-13012021.pdf

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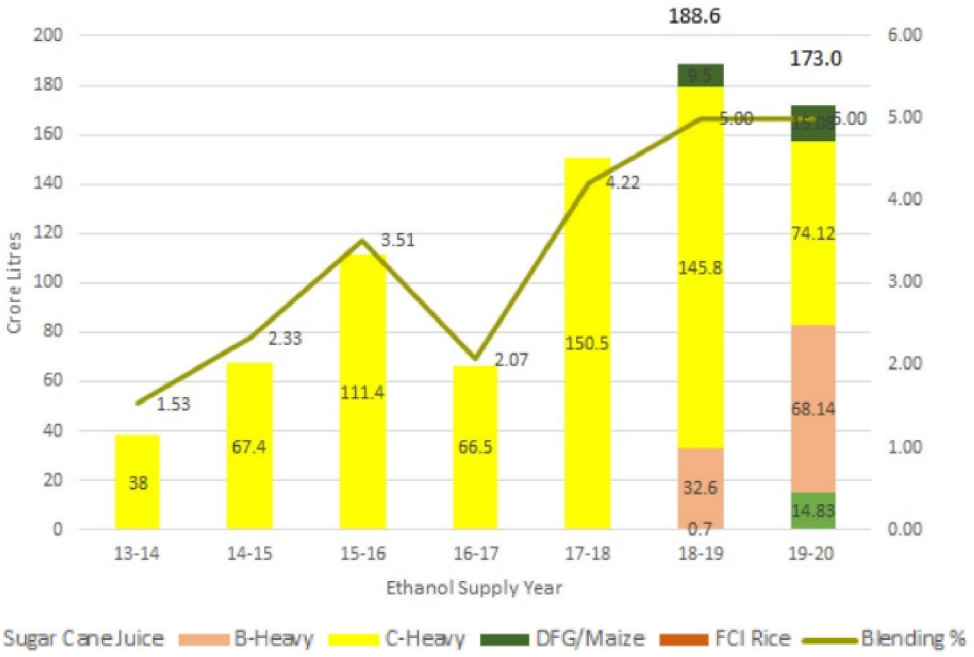

Fig. 4.2 EBP Programme Performance
Source -OMCs

III. RESULTS and DISCUSSION

3.1 REGULATORY REGIME FOR GRANT OF ENVIRONMENT CLEARANCES TO DISTILLERIES

3.1.1 Procedure for obtaining Environmental Clearance (EC)

Environmental Clearance (EC) is issued by The Ministry of Environment, Forest and Climate Change (MoEFCC) / State Environment Impact Assessment Authority (SEIAA) as per the Environment Impact Assessment Notification 2006 under the Environment (Protection) Act 1986. The project proponents are also required to obtain Consent to Establish (CTE) and Consent to Operate (CTO) under the Air (Prevention and Control of Pollution) Act- 1981 and Water (Prevention and Control of Pollution) Act, 1974 from State Pollution Control Boards (SPCB) of States/UTs.

In order to get Environment Clearance for new projects, the Project Proponent (PP) has to submit an application at Parivesh portal for Terms of Reference (TOR) which is generally issued in a month's time. Thereafter, normally one season (4 months) time is spent in Environment Impact Assessment Study and this duration should be continuous and excluding the rainy season.After preparation of a draft EIA report based on the ToR, it is submitted to SPCB for Public hearing/ Public Consultation. SPCB writes to the District Collector for conducting Public Hearing. Since one month notice period is required for conducting public hearing, so practically, it takes 2 to 4 months time in conducting public hearing. Thereafter, application for environmental clearance (EC) is submitted to MoEF&CC/SEIAA which is deliberated in the Expert Appraisal Committee (EAC) and after recommendations of EAC, Environment Clearance is granted by the MoEF&CC/SEIAA and this activity takes 2-4 months time. The whole procedure in getting EC takes at least 10 months.

3.1.2 Procurement of Ethanol and its Pricing

From the inception of the EBP Programme, various pricing models have been adopted by the government which were based on the prevailing macro-economic situation of the sugar industry and the oil sector. The ethanol procurement gained momentum after the introduction of Administered Pricing Mechanism for Ethanol from ESY 2014-15. Prices of ethanol produced from sugarcane sources is approved by the Cabinet Committee on Economic Affairs (CCEA), while that from foodgrains is decided by OMCs. Since ESY 2018- 19, Government has introduced a differential pricing policy wherein higher rates were offered to sugar mills for production of ethanol from B-heavy molasses and sugarcane juice. Further In ESY 2019-20, even higher prices were offered for conversion of sugar/sugarcane juice to ethanol. The

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ex-mill price of ethanol being paid to ethanol suppliers for ESY 2020-21 produced from various variants of sugarcane and food grains is given in Table 3.1 below.

Table 3.1 Administered Price of Ethanol By Source

Raw Materials Source	Ex-Mills Ethanol Price (Rs./Litre)
Heavy	57.61
Heavy Molasses	45.69
Sugar/Sugar Syrup	62.65
Damage Food grain/ Maize	51.55
Surplus Rice (FCI)	56.87

3.1.3 PRICING MECHANISM OF ETHANOL FROM SUGAR SECTOR

- Sugar/Sugarcane Juice/Sugar Syrup: The pricing model is based on Fair and Remunerative Price (FRP) of Sugar Cane on which cost of conversion, depreciation and cost of capital is added to compute the ex-mill price of ethanol (Rs. 62.65/litre).
- B Heavy: The pricing model followed for B Heavy is linked to the normative cost of sugar on which cost of capital is added to compute the ex-mill price of ethanol (Rs.57.61 per litre).
- C Heavy: The pricing model followed is based on prices of molasses and ex-mill price of sugar. For ESY 2020-21, an estimated all India average recovery rate of 11.2% has been considered per metric ton of sugarcane and C heavy rate of Rs. 45.69 per litre has been computed.

3.1.4 IMPACT OF EXISTING ETHANOL PRICING MECHANISM

Central Government: While petrol is subject to excise duty, GST is levied on ethanol. While GST would be in the range of Rs. 2.28/litre to Rs. 3.13 per litre of ethanol based on an ex-mill price in the range of Rs. 45.69/litre to Rs. 62.65/litre, excise duty on petrol is Rs. 32.98/litre. Considering total national ethanol blending volumes of 332 crore litre, revenue loss to the central government due to replacement of petrol by ethanol amounts to Rs. 10,950 crore per annum.

Oil PSUs: OMCs pass on to the consumers any change in the price of fuel due to blending of ethanol and are therefore not impacted by the pricing of ethanol. At present, excise duty on landed cost of petrol at oil depots is higher than GST on the landed cost of ethanol and the benefit is being passed on to the retail consumers. However, in the future, should the price of ethanol increase beyond that of petrol, consumers may have to pay more for ethanol blended fuel. In such a scenario, tax (GST) breaks on Ethanol may become necessary.

Environmental Cost: Sugarcane is a water intensive crop. On an average, one tonne of sugarcane can produce 100 kg of sugar, and 70 litres of ethanol. Cultivation of each kg of sugar requires 1600 to 2000 litres of water. Hence, one litre of ethanol from sugar requires about 2860 litres of water11. It is estimated that sugarcane and paddy combined use 70% of irrigation water of the country12. Keeping in view the need for water conservation, it is advisable to shift some of the area under sugarcane to less water intensive crops by providing suitable incentives to farmers. The Task Force on sugarcane and sugar Industry constituted under the Chairmanship of Professor Ramesh Chand,Member (Agriculture), NITI Aayog has suggested ways to minimize water consumption through various means to encourage farm diversification.

Ethanol production from non-sugar sources: Share of production of ethanol from nonsugar sources like damaged food grains and FCI rice is relatively small. The net returns from sugarcane are much higher than those from food crops; for example, in Karnataka it was about Rs. 1,13,590 per hectare as compared to Rs. 33,877 per hectare from paddy and 22,931 per hectare from maize during FY 2018-1913. The situation is similar in other states also. A high price of sugarcane leads to a higher price of sugar and its by-products like molasses, ethanol.

Environmental impact of choice of feedstock: In the interest of environmentalsustainability, making ethanol available on a pan-India basis and sharing the benefits of EBP widely, measures to promote production from non-sugarcane sources, food grains, especially maize14 and second generation sources may be promoted through suitable pricing mechanisms

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IV. FUEL ETHANOL DEMAND IN INDIA

Ethanol (also called ethyl alcohol, or alcohol) is an organic chemical compound with chemical formula C2H5OH . Besides the EBP Programme, ethanol finds competitive usage in the portable sector and the chemical & pharmaceutical industry. Demand for ethanol as a fuel is primarily driven by blending mandates, widespread availability of fuel, and compatible vehicles and fulfilment of other infrastructural requirements.

4.1 GROWTH IN VEHICLE POPULATION

The vehicle population in the country is around 22 crore two and three wheelers and around 3.6 crore four-wheelers (SIAM). The 2 wheelers account for 74% and passenger cars around 12% of the total vehicle population on the road. The two-three wheelers consume 2/3rd of the gasoline by volume, while 4 wheelers consume balance 1/3rd by volume. The growth rate of vehicles in this segment is pegged at around 8-10% per annum. An estimate of year-wise addition of gasolinebased vehicles in the country is given in Table-4.1 below:

Table 4.1: Projected addition of gasoline vehicles (in Lakhs)

Units in Lakhs	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30
Two-wheeler(gasoline)	174	139	167	181	195	211	227	246	265	287	309
Passenger Vehicle(gasoline)	20	20	22	24	26	28	30	33	35	38	41

* The Gasoline is based on the following assumptions
V-shape recovery in sales in FY22 followed by growth at CAGR of 8% in all segments
share of petrol vehicle will be 83 % of the total passenger vehicle sales
#Source- SIAM

4.2 DEMAND PROJECTIONS OF GASOLINE

Based on expected vehicle population, the demand projections of gasoline in India are given in Table-4.2.

Table 4.2: Gasoline demand projections

Projections as per the 'Report of the Working Group on Enhancing Refining Capacity by FY 2040										
Product/Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Motor Gasoline *(MMTPA)	27.7	31	32	33	35	36	37	39	40	41
Motor Gasoline(Cr. Litre)	3908	4374	4515	4656	4939	5080	5221	5503	5644	5785

* Interim figures from PPAC considering growth @ 3-4% YoY (Source: MoP&NG)
* Projection interval is for 5 years and the data has been linearly extrapolated.The effect of COVID pandemic and introduction of EVs are considered.

4.3 DEMAND PROJECTION OF FUEL ETHANOL

The projected requirement of ethanol based on petrol (gasoline) consumption and estimated average ethanol blending targets for the period ESY 2020-21 to ESY 2025-26 are calculated below:

Table 4.3: Ethanol demand projection

Ethanol Supply year	Projected petrol sale(MMT)	Projected petrol sale(Cr. Ltr)	Blending (in %)	Requirement of ethanol for blending in petrol(Cr. Ltr)**
A	B	B1=B*141.1	C	D=B1*C %
2019-20	24.1(Actual)	3413(Actual)	5	173
2020-21	27.7	3908	8.5	332
2021-22	31	4374	10	437

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2022-23	32	4515	12	542
2023-24	33	4656	15	698
2024-25*	35	4939	20	988
2025-26*	36	5080	20	1016

* The petrol projections may undergo revision due various factors like penetration of EVs, etc.

** The figures are optimistic, as the E20 fuel will be consumed by new vehicles from April 2023 only. Thedemand for ethanol will, however, increase due to penetration of E100 two wheelers, which are now being manufactured in the country.

4.4 ADDITIONAL MODELING OF ETHANOL DEMAND SCENARIOS

In addition, an Ethanol Demand modelling exercise was done by CSTEP (Center for Study of Science,Technology & Policy) using their long-term simulation model called Sustainable Alternative Futures for India (SAFARI). The SAFARI model estimates India's energy demand and emissions up to 2050 under various scenarios. It is driven by socioeconomic parameters like population and GDP, as well as development goals like food, housing, healthcare and education infrastructure,transport, and power for all. Given the inherent uncertainties in projections for the future and with electric vehicle revolution on the horizon, different scenarios have been considered. To estimate the demand for petrol and consequently ethanol, three scenarios for electric mobility uptake have been considered:

Conservative (low EVs) – negligible uptake of electric mobility up to 2030.

Business-As-Usual (BAU, medium EVs) – medium uptake of electric mobility; around 15% of car passenger-kilometres (pkms) and 30% of two-wheeler and three-wheeler pkms are assumed to be electric by 2030.

Low Carbon (high EV uptake) – 30% of car pkms and 80% of two-wheeler and threewheeler pkms are assumed to be electric by 2030.

Figure 6.1 shows the ethanol demand in 2025 under these scenarios. As per this projection, the ethanol demand will be in the range of 722-921 crore litres in 2025 to meet E20 targets. In this report, we have assumed an enhanced ethanol demand of 1016 crore litres based on expected growth in the vehicle population (Table-6.1). The SAFARI model gives us confidence that our projections would cover the most ambitious scenario of ethanol demand in the country, and thus gives a robustness to our roadmap for rollout of E20 by 2025.

4.5 ETHANOL FUEL DEMANDS IN 2025

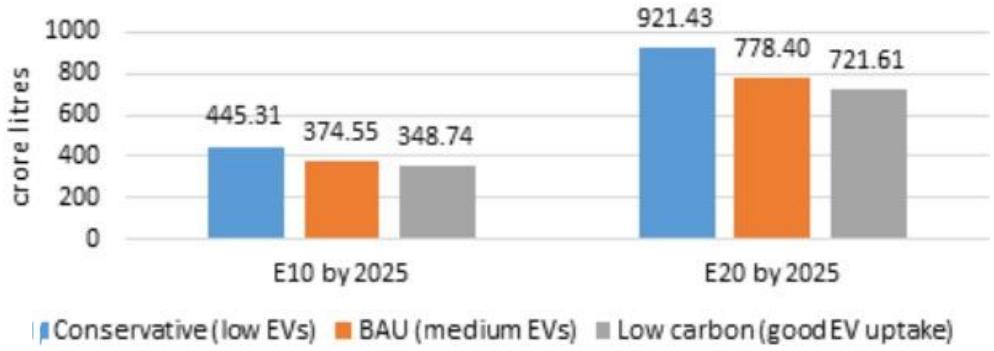

FIG1 . Ethanol Fuel Demand in 2025 under various scenarios

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ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 16, May 2023

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