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BIOFUELS
ARE HERE TO STAY

A deep dive into
India's ambitious plan of E20

Our Profile

LSI Financial Services Pvt. Ltd.

LSI Financial Services Pvt. Ltd. was established in 1997 and is a SEBI registered Category 1 Merchant Banker. The vision of the company is to provide services relating to Project Finance Advisory, Techno Economic Viability Study, Financial Restructuring and Asset & Equity Valuation to esteemed Financial Institutions and corporate houses. With senior bankers and eminent industry experts, who are supported by 150 professionals in the team, the company has gathered vast experiences in almost all the sectors in the last two decades.

LSI has empowered more than 200 large corporate houses in India with its suite of financial solutions. Today LSI is present across the major Tier I and Tier II cities of the country.

The company in addition to its focus on debt syndication, Issue Management, PE Advisory, & M&A Advisory, lays significant stress on creating knowledge pools on economically important topics.

LSI Financial Services Pvt. Ltd. has three other group companies under its umbrella offering a gamut of services in the engineering, legal and financial advisory domains.

LSI Engineering & Consultants Ltd.

Established in 2015, LSI Engineering & Consultants Ltd. is a project management consultancy company. It has undertaken numerous large projects across India in road sector under NHAI and PWD. It has a strong team of very experienced engineers having domain knowledge in road, water & other infrastructure projects.

The company is also registered with Indian Banks' Association (IBA) as an Agency for Specialised Monitoring and it is handling project monitoring/cash monitoring etc. for various large corporates on behalf of esteemed financial institutions of the country.

LSI Resolution Pvt Ltd.

LSI Resolution Pvt Ltd offers a spectrum of services related to Resolution & Insolvency encompassing the Insolvency and Bankruptcy Code (IBC 2016), which was enacted to provide the legal and legislative framework to support lenders effectively to recover or restructure defaulted debts in a time bound manner. As an entrusted IBBI registered Insolvency Professional Entity, the company has helped insolvency professionals to successfully manage & resolve more than 30 corporate insolvency resolution process of big companies across sectors.

Resolute Valuers & Consultants Pvt Ltd.

Resolute Valuers & Consultants Pvt Ltd. is a key player in valuation appraisals. Its efficient and experienced team is composed of senior bankers, technical experts, industry experts, registered valuers, experienced engineers, chartered accountants, cost accountants, etc. Registered with IBBI as a Valuer Entity, the company carries out valuation of all classes of assets i.e., Land & Building, Plant & Machinery and Securities & Financial Assets. It has undertaken valuation of very large infrastructure and manufacturing companies. The company has also participated in Government of India's disinvestment projects.

As a group to ensure consistent and high-quality solutions, LSI emphasises recruitment of premium human resources and consequently, LSI has in place a highly motivated and knowledgeable team that shapes its mantra of "Creating value, Partners in growth" into reality.

The company takes pride in being client-centric and looks forward to continuing its services to aid the economy by enabling optimal financial and technical solutions in the domestic and international arena.

LSI Group Product Catalogue

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Debt Division	Debt Syndication	Debt Restructuring & Re-scheduling	Techno Economic Viability Study (TEV)
Investment Banking	Merchant Banking	Mergers & Acquisition	Due Diligence
Project Appraisal	Financial & Technical Appraisal	Qualitative Appraisal	Appraisal for Land Allotment

LSI RESOLUTION

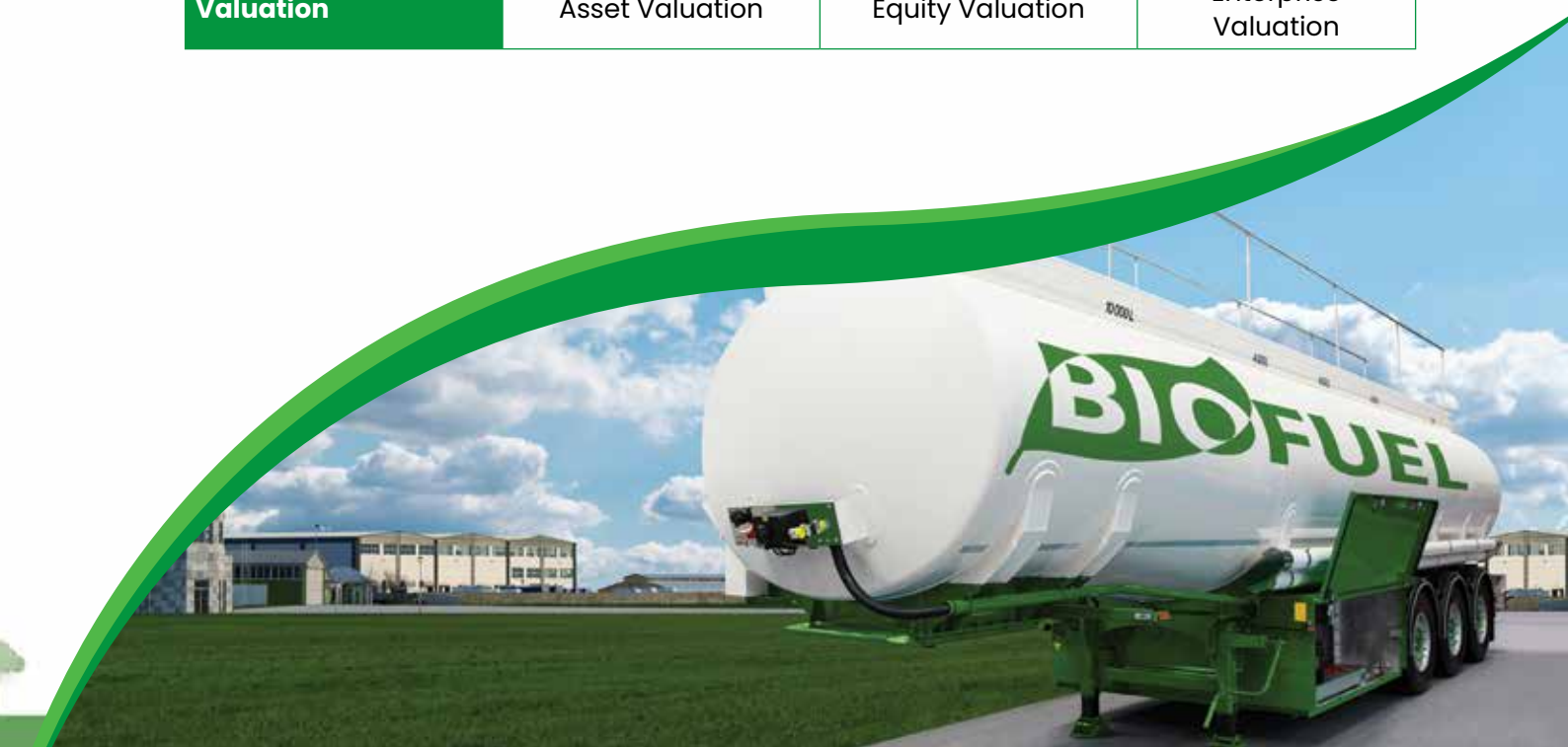
Resolution & Insolvency Division	IPE Services	Process Advisory Services	Liquidation Advisory Services

LSI ENGINEERING & CONSULTANTS

Engineering Services	DPR (detailed project report)	Lenders Independent/ Authority Engineer	Project Management consultancy
Monitorings Services	Agency for Specialised Monitoring (ASM)		

RESOLUTE VALUERS & CONSULTANTS

Valuation	Asset Valuation	Equity Valuation	Enterprise Valuation



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Executive Summary

Source: Foreign Agricultural Services, Trade Data Monitor (TDM) and Industry Sources

In January 2021, the Government decided to advance the target of 20% blending in petrol by 5 years from 2030 to 2025 while retaining its immediate goal of E-10 by 2022

Supply of ethanol has increased from 38 crore litres during Ethanol Supply Year 2013-14 to 332 crore litres during Ethanol Supply Year 2020-21 resulting in increase in blend percentage from 1.53% to 8.50% respectively.

For 2025-26, ethanol requirements is 1016 cr Litres to achieve 20% blending and total requirement of alcohol including other sectors would be 1350 Cr litres.

Effective January 13, 2021, India has allowed the use of surplus rice (available through the Food Corporation of India) and maize for use as feedstocks to produce ethanol for blending with gasoline under the Ethanol Blended Petrol (EBP) program.

For ethanol, the US is the largest producer (55%), followed by Brazil (27%), European Union (5%), and China (3%). In Biodiesel production Indonesia is the largest producer (17%), followed by the United States (14%) and Brazil (12%).

As of May 1, 2021, the Government of India has approved 422 project proposals under the interest subvention scheme which will potentially provide an additional capacity of 1680 crore litres of ethanol. Of this amount, 600 crore litres are expected to be added within the next two to four years.

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.

To produce 684 crore litres of ethanol by the sugar industry by 2025-26, sugarcane equivalent to 60 Lakh Metric Tons (LMT) of surplus sugar would be diverted to ethanol. To produce 666 crore litres of ethanol/ alcohol from food grains by 2025-26, about 165 LMT of food grains would be utilized.

1 Overview of **Global Biofuel Industry**

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Overview of Global Biofuel Industry

Biofuels involve the direct conversion of biomass into liquid fuels which can be blended with existing automotive fuels. Ethanol and biodiesel are the two main transport biofuels. These fuels can be produced from a variety of biomass. First-generation (1G) biofuels are usually produced from edible feedstock. Ethanol production primarily involves distilling carbohydrates from sugarcane and beet or distilling starch from food grains such as maize, paddy, wheat, and potatoes through fermentation. First-generation biodiesel is produced from different types of vegetable oils such as canola oil, palm oil, soybean oil, and sunflower oil. Second generation fuels are produced from lignocellulosic biomass which is obtained from energy crops or waste biomass, such as agricultural and forest residue. Recently, the production of biodiesel from algal biomass has also evolved as an option, sometimes referred to as third-generation biofuel.

In the global transport-fuel demand, the share of biofuels remains minimal, accounting for only 2.4% in 2018. To improve the situation, many countries have implemented dedicated biofuel policies with time-bound blending mandates, incentivising the setting up of distilleries and encouraging the production of energy crops. Brazil's RenovaBio programme is amongst the most ambitious and has resulted in a national ethanol blending rate of 27%. Both the EU and China have devised a roadmap to achieve a 10 % ethanol blending rate. In the US, the Environmental Protection Agency (EPA) is mandated by law to set production mandates for biofuels, which are regularly updated.

Backed by such policy support, ethanol and biodiesel production increased steadily from 2010 to 2019. Ethanol production increased at a compound annual growth rate (CAGR) of 2.4%, peaking at approximately 110 billion litres in 2018-19 and accounting for 60% of the total liquid biofuel produced. However, reduced demand and supply-chain issues brought on by the COVID-19 pandemic in 2020 led to a 10% decline in ethanol production.

For ethanol, the US is the largest producer (55%), followed by Brazil (27%), European Union (5%), and China (3%). Biodiesel production has a wider geographical spread, with the top five countries accounting for only 57% of the total production. Indonesia is the largest producer (17%), followed by the United States (14%) and Brazil (12%).

Global Production of Ethanol and Biodiesel

Exhibit 1: Ethanol Production, Global, 2016-2021

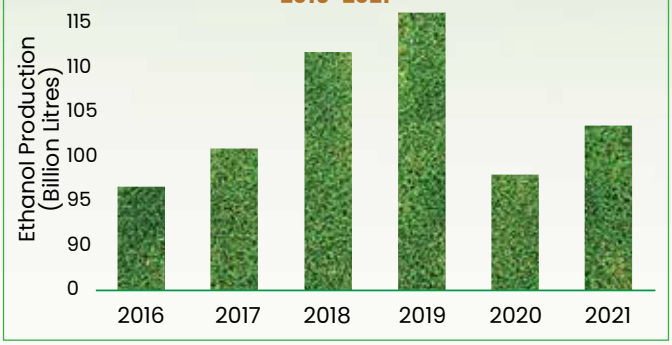


Exhibit 2: Biodiesel Production, Global, 2015-2020

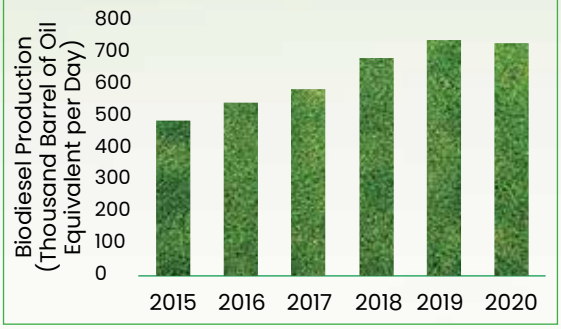


Exhibit 3: Ethanol Production, Selected Countries, 2016-2021

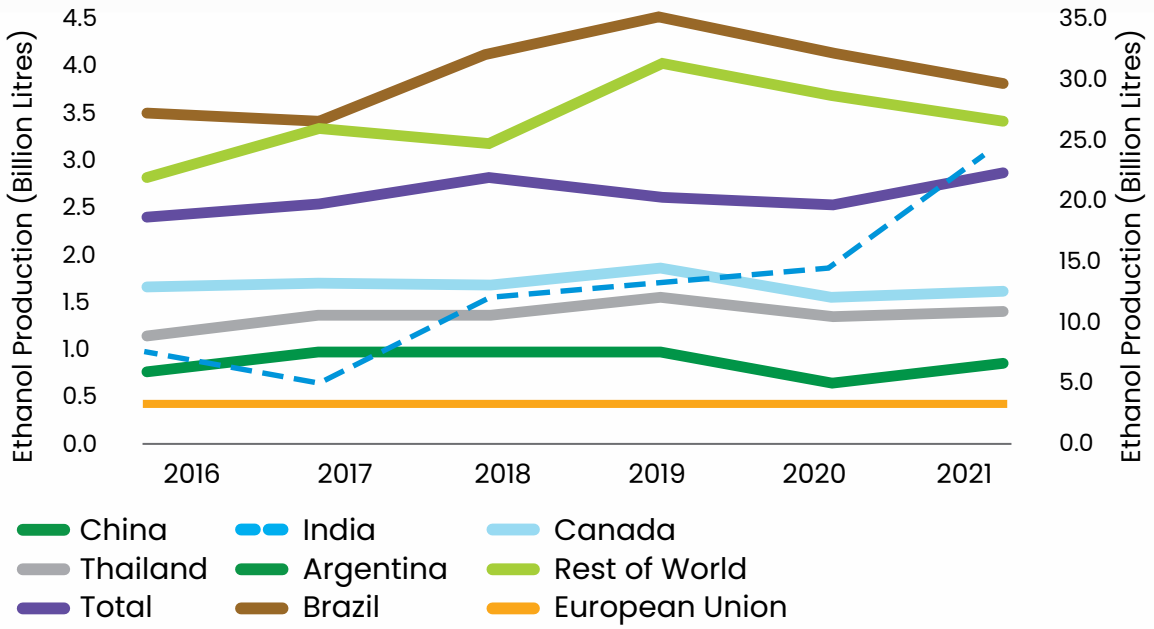


Exhibit 4: Regional Share in Global Ethanol Production (%)

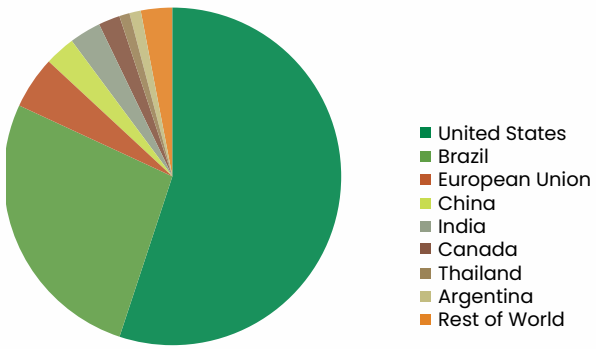
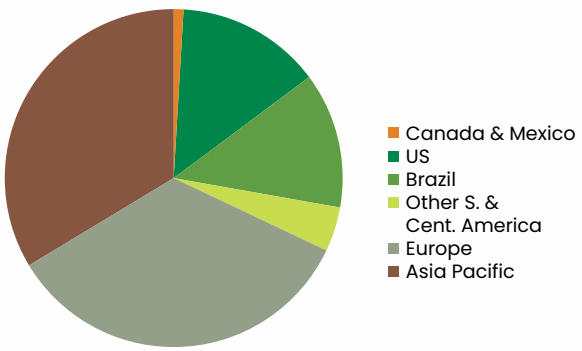


Exhibit 5: Regional Share in Global Biodiesel Production (%)



Source: Renewable Fuels Association, BP Stats Review 2021

Most of the ethanol is produced from renewable raw materials, which are essentially sources of carbohydrates as sugars (sugarcane, beet, sweet sorghum, Jerusalem artichoke, fruits), starch (corn, wheat, cassava, sweet potato), and lignocellulosic materials. Ethanol production technologies from materials rich in sugars or starches (these are sugar polymers) are called first generation, while ethanol and other biofuels production processes from lignocellulosic materials are named second generation.

Exhibit 6: Feedstock for ethanol production and their production potential

Feedstock & Ethanol production potential (Litre/ton)

Sugar cane
70 (Litre/ton)

Sugar beet
110 (Litre/ton)

Sweet potato
125 (Litre/ton)

Potato
110 (Litre/ton)

Rice
430 (Litre/ton)

Barley
250 (Litre/ton)

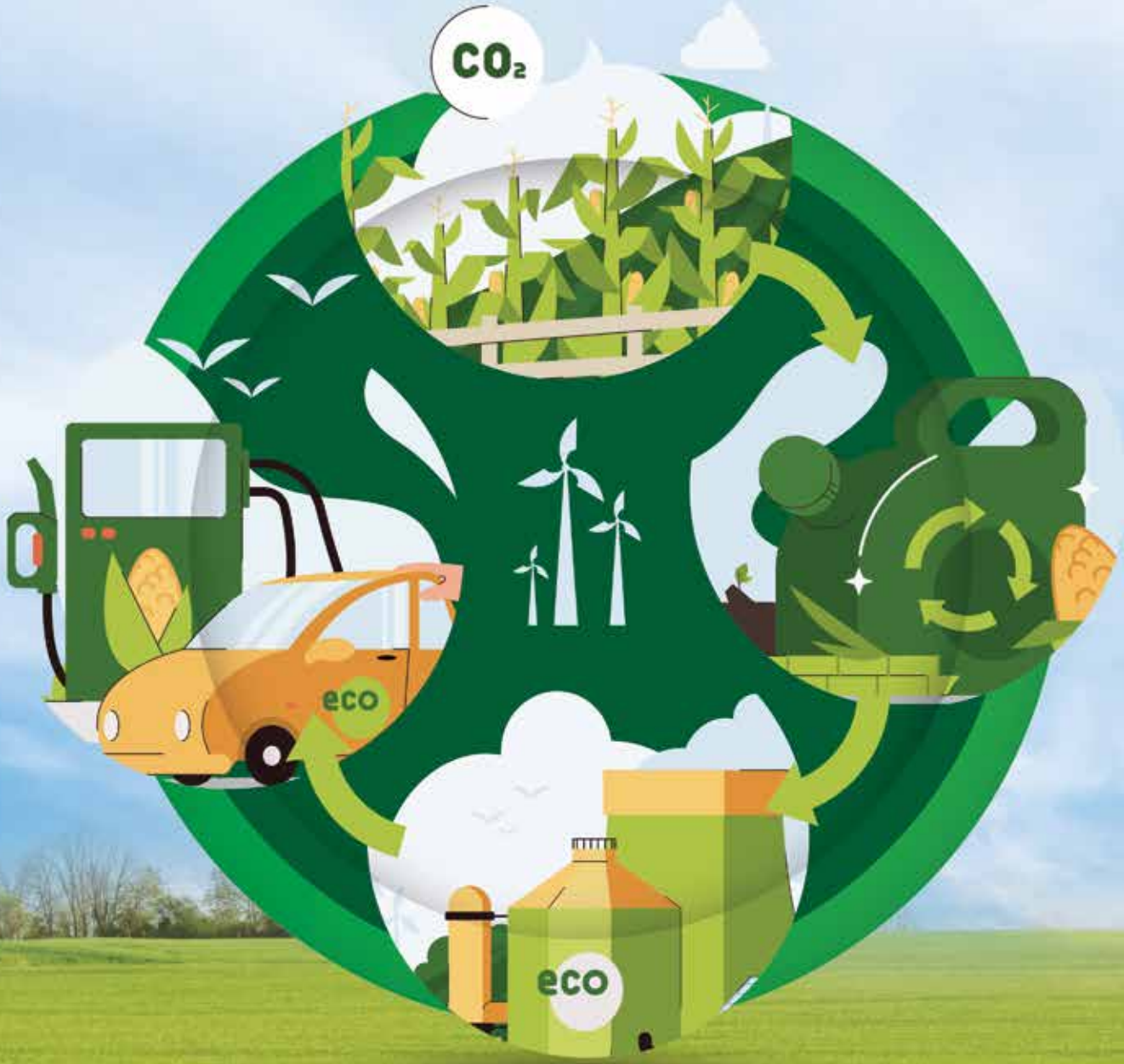
Wheat
340 (Litre/ton)

Source: LSI TEV Report

In terms of feedstock, the global transport biofuel market is heavily dependent on first generation (1G) production methods, with second generation (2G) methods and lignocellulosic feedstock producing less than 10% of the total share. In Brazil, ethanol is produced almost exclusively from sugarcane, accounting for 95% of the total production and biodiesel is produced mainly from soybean oil. In the US, ethanol production is mainly dependent on maize, and 40% of the country's total maize production is used for ethanol production. A more diverse mix of feedstock exists for biodiesel, with soybean oil and other waste oils/fats together accounting for 46% of the total production.

For new land to be brought under cultivation for biofuel production, the existing natural vegetation must be cleared, which leads to the release of the stocked carbon and, therefore, a net carbon debt. Furthermore, the use of chemical fertilisers releases nitrous oxide, whose global-warming potential is 300 times higher than that of carbon dioxide. Energy used in transporting the feedstock and blending also contributes to the overall carbon emissions. Thus, uncertainty exists at each stage of the fuel supply chain, and emissions can differ significantly based on land availability and the efficiency of the agricultural system in a particular country.

2 India's Roadmap for **Ethanol Blending**



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India's Roadmap for Ethanol Blending

India is the world's third largest energy consuming nation and a significant part of India's energy requirement is met through oil which continues to rely on imports largely. India's share in global energy consumption is set to double by 2050. A rising energy demand and high reliance on import poses significant energy security challenges. It also leads to massive foreign currency outflow. Further, excessive use of fossil fuels leads to higher carbon emissions and associated health concerns.

Domestically produced ethanol is a potential opportunity to reduce reliance on oil imports by blending it with conventional fossil fuels for consumption.

India started blending ethanol in petrol on a pilot basis in 2001. The ethanol was produced as a by-product during the process of making sugar from sugarcane. However, despite potential, no significant progress was made under the ethanol programme and the production of ethanol remained stagnated until recently when transformative reforms were carried out.

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 Biofuels – 2018 (NPB–2018) on 4.06.2018 wherein, under the Ethanol Blended Petrol (EBP) Program, and indicative target of 20% blending of ethanol in petrol by 2030 was laid out. However, in January 2021, the Government decided to advance the target of 20% blending in petrol by 5 years from 2030 to 2025 while retaining its immediate goal of E-10 by 2022. On June 2, 2021, the Indian government directed the parastatal Oil Marketing Companies (OMCs) to sell E-20 blended gasoline from April 1, 2023. The biodiesel blend for on-road use goal remains at B-5 by 2030, with no near-term blending targets. The 2018 National Biofuel Policy continues as the central directive governing India's biofuel use, policies, trade, and marketing strategy.

India's Biofuel Policy 2018

The government pushed forward the E-20 goal from 2030 to 2025 but retained its target of achieving five percent blending of biodiesel with conventional diesel by 2030. The Government of India envisions that the targets will be met through:

1) Growth in domestic biofuel production (1G, 2G and 3G),
2) Use of multiple feedstocks and
3) Encouraging biofuel blending to supplement gasoline and diesel use in vehicles and machinery, as well as in stationary and portable power applications.

Fuel Ethanol National Blend Rate - 10 Percent by 2022 and 20 Percent by 2025

Despite its pronounced objectives to ensure nationwide energy security, the government's renewable fuel policies have never included biofuel production mandates. While recent programs have attempted to augment existing sugarcane and ethanol distillation capacities and prioritize alternative feedstocks, they have been only partly successful. The EBP has never fully met blending mandates during years of surplus sugar production, and even less so during cyclical downturns in the sugarcane harvest.

The current EBP mandate aims to reach a ten percent national average blend by 2022. Previously, the Government of India instituted the requirement across all cane-growing states but could only achieve five percent due to insufficient feedstocks, demand planning inefficiencies, interstate logistical gaps, and inadequate price incentives. Despite an ambitious blending target, the government remains committed to its long-term objective of redirecting surplus sugar to drive ethanol production, including six million metric tons (MMT) of surplus sugar by 2024/25 (now 2023/24). India's goal is very ambitious, considering that in the current Marketing Year[1] (MY) 2020/21, approximately two MMT of excess sugar will be diverted, and less than one MMT of excess sugar was diverted in the previous year.

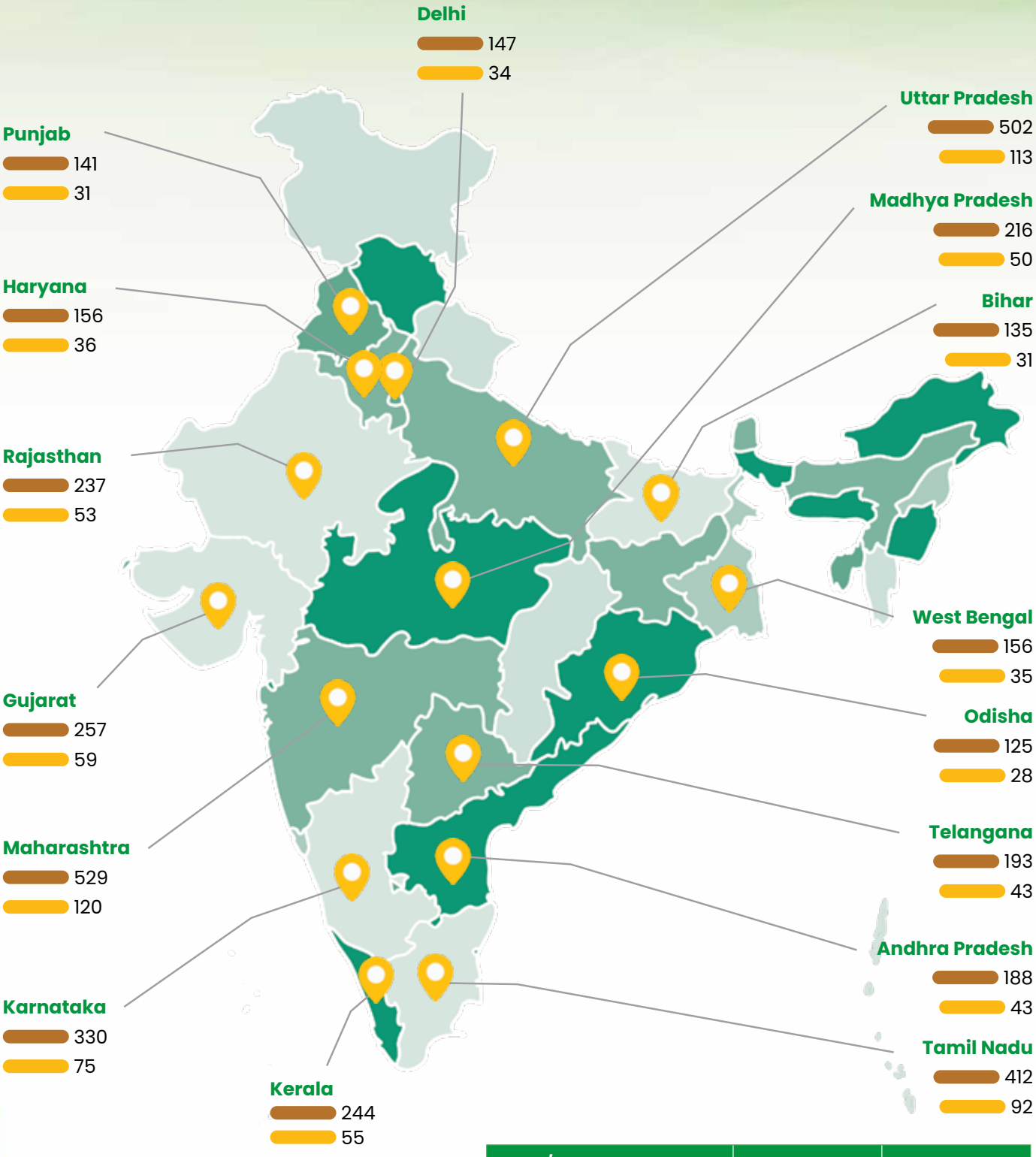
To drive more sugar toward ethanol, on May 20, 2021, the GOI reduced its sugar subsidy under Maximum Admissible Export Quota from $82/metric ton (MT) to $55/MT. India is likely to continue its sugar export subsidies until 2023, as per the World Trade Organisation's 2015 Nairobi Ministerial that allows for developing nations to provide such incentives. However, the move is predicted to have little impact this year, as India already signed contracts to export 5.7 MMT of sugar against the stipulated quota of six MMT.

To encourage 1-G ethanol production and promote fuel-grade ethanol as an indigenous, relatively less polluting fuel, the GOI established a program worth INR 300 Crores specifically for sugar mills to expand and upgrade their ethanol production capacity for fiscal year FY 2021-22. However, past ethanol investments elicited a tepid response from industry, which included soft loans up to INR 19,000 crores and INR 4,045 crores in loan interest subsidies to finance 368 projects covering 351 sugar mills and 17 molasses-based stand-alone distilleries. However, loans have been approved for only 68 projects, suggesting that only 11 new projects were approved last year. The Government of India estimates that by creating an additional 189 crore litres of capacity in the next two years, it will increase domestic ethanol production capacity from the existing 426 crore litres, to 615 crore litres.

However, to achieve E-20 by 2025, India would need an estimated output of 1016 Crore litres, implying that India will need to create 590 Crore litres of additional ethanol production capacity in the next four years, even with a relatively reduced size of the gasoline pool (supply) in 2025 (estimated at 4500 crore litres). Supplementing existing domestic production with imports would allow India to achieve E-20 within this time frame.

[1] Marketing Year (MY) or Ethanol Supply Year (ESY) is December to November

Exhibit 7: Annual Ethanol Requirement in 2025 for E-20 (Crore Litres)



State/Union Territory	Projected Gasoline Sales	Projected Ethanol Requirement
Rest of India	524	118
Total	4500	1016

Source: Biofuels Annual – June 2021, USDA, Foreign Agricultural Services

Post estimates it is very unlikely that India will achieve E-20 by 2025, given numerous sectoral challenges, including the sugarcane industry's general inability to supply feedstock for India's ethanol demand. Further, if fuel-grade ethanol imports remain prohibited, total supply capacity will remain limited. It remains likely that cellulosic (agricultural waste), algae or municipal waste-based "advanced fuels" will only be capable of covering a small portion of light-vehicle transport fuel demand in 2025, even with huge subsidy outlays.

Ethanol Policy

Effective January 13, 2021, India has allowed the use of surplus rice (available through the Food Corporation of India) and maize for use as feedstocks to produce ethanol for blending with gasoline under the EBP program.

Tripartite financial agreements for ethanol production between banks, sugar mills and OMCs to ease capital flows have been facilitated, and would require the parties to open an escrow account in the lending bank, which will sanction and disburse eligible loans to sugar mills for ethanol production that would eventually be supplied to the OMCs. In turn, the OMCs will deposit payments against each ethanol supply by the sugar mill in the escrow account. The lending bank will be entitled to periodically recover the loan amount from the same account and thereafter release the balance to the concerned sugar mill's account.

Ethanol Administered Price

The Cabinet Committee on Economic Affairs chaired by Prime Minister, Shri Narendra Modi, has given its approval for fixing higher ethanol price derived from different sugarcane based raw materials under the EBP Programme for the forthcoming sugar season 2021-22 during ESY 2021-22 from 1st December 2021 to 30th November 2022.

Approval is also given for the following prices shown in the table below.

Exhibit 8: Price of Ethanol from Different Types of Molasses

Price of Ethanol from	Price in ESY 2020-21 (INR per litre)	Price in ESY 2021-22 (INR per litre)
C Heavy Molasses	45.69	46.66
B Heavy Molasses	57.61	59.08
Sugarcane Juice	62.65	63.45

Source: Ministry of Petroleum & Natural Gas, GoI

Additionally, GST and transportation charges will also be payable. Government has decided that Oil PSEs should be given the freedom to decide the pricing for 2G ethanol as this would help in setting up advanced biofuel refineries in the country. It is important to note that grain-based ethanol prices are currently being decided by OMCs only.

The approval will not only facilitate the continued policy of the Government in providing price stability and remunerative prices for ethanol suppliers, but will also help in reducing the pending arrears of Cane farmers, dependency on crude oil imports and will also help in savings in foreign exchange and bring benefits to the environment.

The decision to allow Oil PSEs to decide the price of 2G ethanol would facilitate setting up advanced biofuel refineries in the country. All distilleries will be able to take benefit

of the scheme and large number of them are expected to supply ethanol for the EBP Programme.

Government has been implementing Ethanol Blended Petrol (EBP) Programme wherein Oil Marketing Companies (OMCs) sell petrol blended with ethanol up to 10%. This programme has been extended to whole of India except Union Territories of Andaman Nicobar and Lakshadweep islands with effect from 1st April, 2019 to promote the use of alternative and environment friendly fuels. This intervention also seeks to reduce import dependence for energy requirements and give boost to agriculture sector.

Government has notified administered price of ethanol since 2014. For the first time during 2018, differential price of ethanol based on raw material utilized for ethanol production was announced by the Government. These decisions have significantly improved the supply of ethanol thereby ethanol procurement by Public Sector OMCs has increased from 38 crore litre in Ethanol Supply Year (ESY) 2013-14 to contracted over 350 crore litre in ongoing ESY 2020-21.

With a view to provide long term perspective to the stake holders, Ministry of Petroleum & Natural Gas (MoP&NG) has published "Ethanol Procurement Policy on a long-term basis under EBP Programme." In line with this, OMCs have already completed the one-time registration of ethanol suppliers. OMCs have also published the names of eligible project proponents with whom long term agreements would be entered into for setting up ethanol plants in ethanol deficit states. Other prominent feature to provide long term perspective and attract investment includes directing OMCs to target 10% ethanol blending in petrol by the end of ensuing ESY 2021-22 and 20% by ESY 2025-26.

Consistent surplus of sugar production is depressing sugar price. Consequently, sugarcane farmer's dues have increased due to lower capability of sugar industry to pay the farmers. Government has taken many decisions for reduction of cane farmer's dues. With a view to limit sugar production in the country and to increase domestic production of ethanol, Government has taken multiple steps including, allowing diversion of B heavy molasses, sugarcane juice, sugar and sugar syrup for ethanol production. Now, as the Fair and Remunerative Price (FRP) of sugarcane and ex-mill price of sugar have undergone changes, there is a need to revise the ex-mill price of ethanol derived from different sugarcane based raw materials.

Further, to kick-start the Second Generation (2G) ethanol programme (which can be produced from agricultural and forestry residues, e.g. rice & wheat straw/corn cobs & Stover/bagasse, woody biomass), few projects are being set up by Oil PSEs taking financial assistance from the Government's "Pradhan Mantri JI-VAN Yojana" approved by The Cabinet Committee on Economic Affairs (CCEA) in the past. These projects are likely to start commissioning from ensuing ESY 2021-22.

The existing biofuels Programme showed mixed results with average blending ranging from 0.1% to 1.5% till 2013-14. However, the underlying potential of the programme was never disputed and the interventions by the government since 2014 are tabulated in the following page.

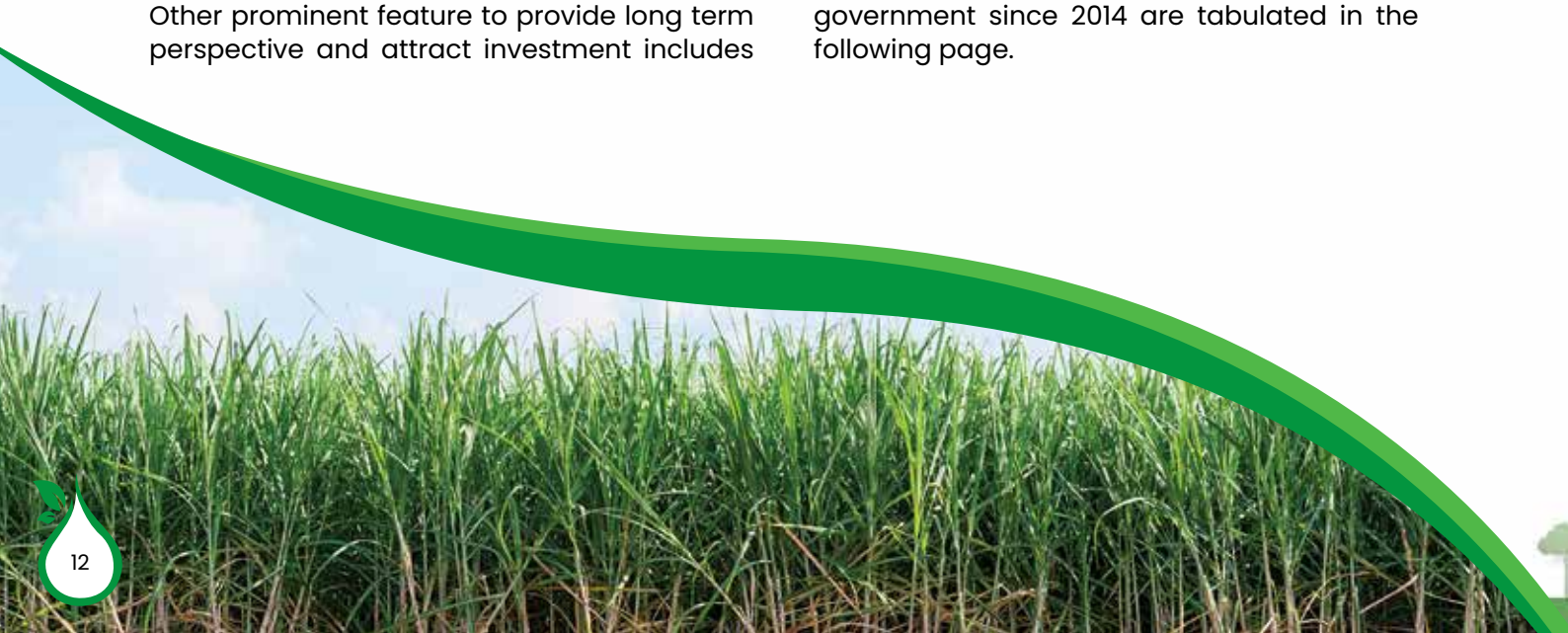


Exhibit 9: Government Stimulus Towards Ethanol Blended Petrol Program

Dec 2014	Govt. re-introduced administered price mechanism for ethanol to be procured under the EBP Programme
Jan 2015	Opened alternate route for ethanol production (2nd Generation including Petrochemical). Government has since directed Oil Public Sector Enterprises to set up bio-refineries
ESY 2014-15	Eased tender conditions - Multiple EOIs being floated, transportation slabs and rates
May 2016	Industries Development & Regulation (IDR) Act Amendment on 14th May, 2016 to clarify on the roles of Central and State Government for uninterrupted supply of ethanol to be blended with petrol under the EBP Programme
ESY 2016-17	Regular interaction with States and all other stakeholders to address issues pertaining to EBP Programme. This is a continuous exercise
Jun 2018	Notified forward looking and updated National Policy on Biofuels-2018 involving all stakeholders
Jul 2018	Interest Subvention Scheme for enhancement and augmentation of ethanol production capacity in the country
ESY 2018-19	Allowed conversion of B heavy molasses, sugarcane juice and damaged food grains to ethanol. Fixed differentiated ex-mill ethanol price and procurement priority based on raw material utilized for ethanol production. Marked beginning of an era of differentiated ethanol pricing, based on raw material utilized for ethanol production
Mar 2019	Opened a fresh window for inviting applications under interest subvention scheme for ethanol projects based on cane and molasses
Apr 2019	Extension of EBP Programme to whole of India except Island UTs of Andaman Nicobar and Lakshadweep islands

Sep 2019	New sources sugar & sugar syrup introduced for ethanol production and fixed remunerative price
Oct 2019	Published "Ethanol Procurement Policy on a long-term basis under EBP Programme"
Jun 2020	OMCs have enhanced their ethanol storage capacity from 5.39 crore litres in November, 2017 to 17.8 crore litres in December 2020.With the current capacity, about 430 crore litres of ethanol can be handled annually considering 15 days of coverage period
EAUG 2020	One time registration of ethanol suppliers for long-term including giving them visibility of ethanol demand for 5 years
Sep 2020	OMCs started to provide off take guarantee letter and consent to sign tripartite agreement with ethanol suppliers and bankers to support the ethanol capacity expansion projects
Sep 2020	Opened fresh window for inviting applications under Interest subvention scheme for ethanol projects based on cane and molasses
Oct 2020	Further ease of tender conditions by OMCs like one time document submission, quarterly bank guarantees, multiple transportation rate slabs and transportation rates being linked to retail selling price (RSP) of diesel, reduction in security deposit and applicable penalty on non-supplied quantity etc
Oct 2020	Approval of National Biofuel Coordination Committee (N8CC) to utilise surplus stock of rice lying with Food Corporation of India (FCI) to be released to the distillers for ethanol production
Nov 2020	Approval of NBCC to utilise maize for ethanol production
Jan 2021	Interest subvention scheme for enhancement and augmentation of ethanol production capacity extended to grain-based distilleries & distilleries producing ethanol from other feed stocks like sorghum sugar beet etc apart from molasses-based distilleries. Interest subvention scheme for enhancement and augmentation of ethanol production capacity extended to grain-based distilleries & distilleries producing ethanol from other feed stocks like sorghum sugar beet etc apart from molasses-based distilleries

Global transportation sector is facing three major challenges, namely depletion of fossil fuels, volatility in crude oil prices and stringent environmental regulations. Alternative fuels specific to geographies can address these issues. Ethanol is considered to be one of most suitable alternative blending, transportation fuel due to its better fuel quality (ethanol has a higher-octane number) and environmental benefits.

3 Ethanol Production & Consumption Status in India

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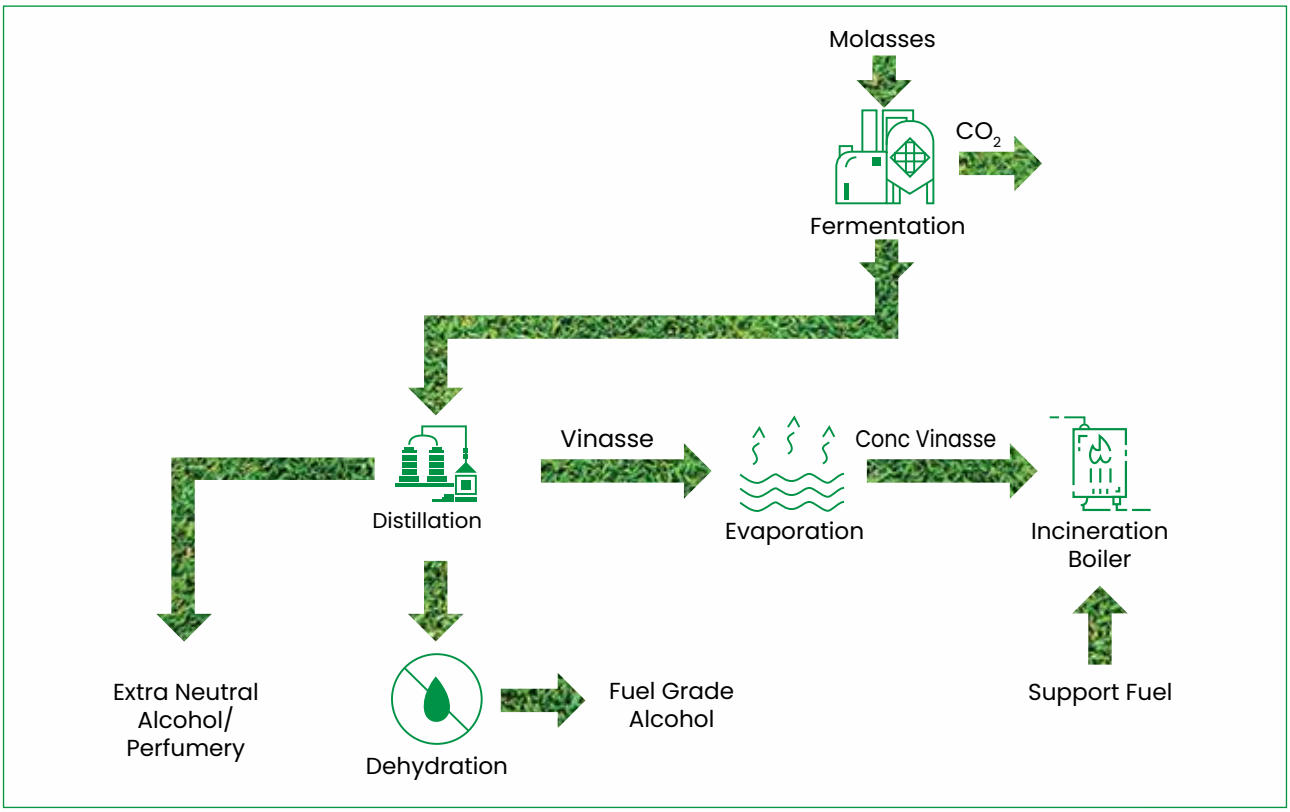
Ethanol Production & Consumption Status in India

India is the world's third-largest energy-consuming nation and a significant part of India's energy requirement is met through oil which continues to rely on imports largely. India's share in global energy consumption is set to double by 2050. Rising energy demand and high reliance on import pose significant energy security challenges. It also leads to massive foreign currency outflow. Further, excessive use of fossil fuels leads to higher carbon emissions and associated health concerns.

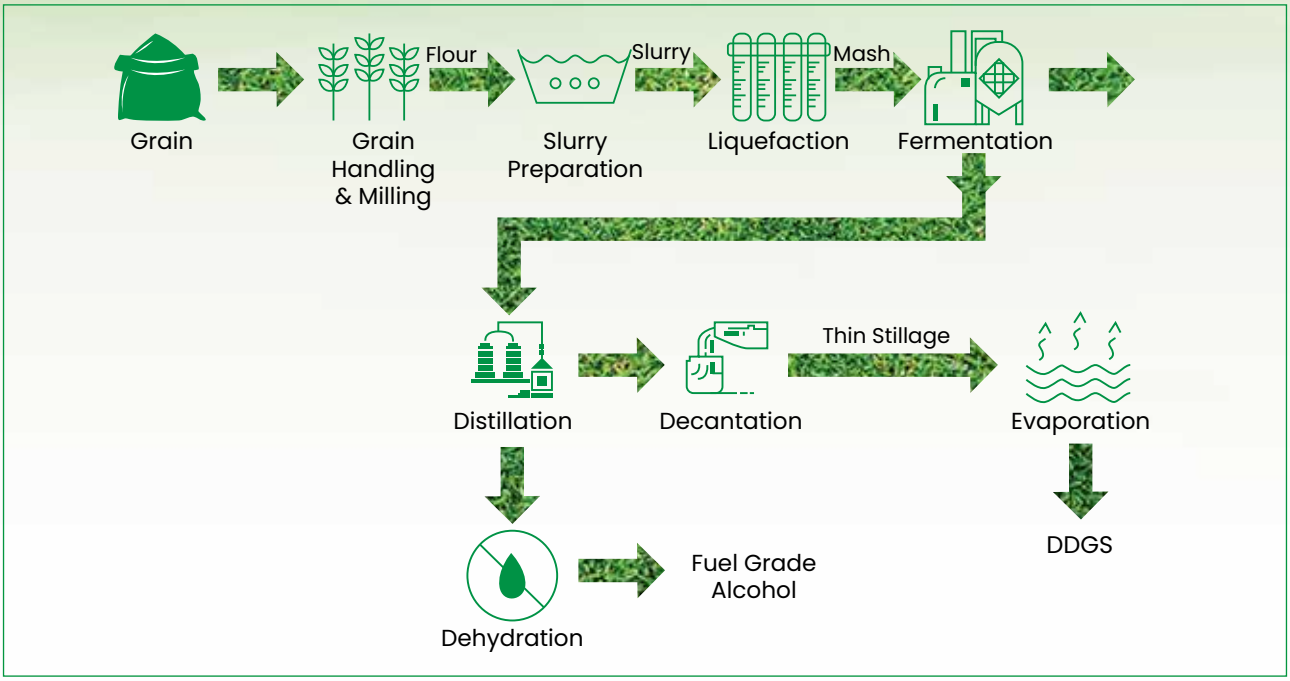
Domestically produced ethanol is a potential opportunity to reduce reliance on oil imports by blending it with conventional fossil fuels for consumption. India started blending ethanol in petrol on a pilot basis in 2001. The ethanol was produced as a by-product during the process of making sugar from sugarcane. However, despite potential, no significant progress was made under the ethanol programme and the production of ethanol remained stagnated until recently when transformative reforms were carried out. The results are set to help not only the economy but transform farmers' income and recharge the rural economy.

Exhibit 10: Molasses Plant Process Flow



Source: Ethanol Growth Story, Ministry of Petroleum & Natural Gas, GoI

Exhibit 11: Giant Plant Process Flow



Source: Ethanol Growth Story, Ministry of Petroleum & Natural Gas, GoI

Nodal Agency for Ethanol Production

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) and Maize. The raw material wise conversion efficiency is tabulated below:

Exhibit 12: Raw Material Wise Conversion Efficiency

Feedstock	Cost / MT of the feedstock (Rs.)	Quantity of ethanol per MT of feedstock
Sugarcane juice/ Sugar/ Sugar syrup	2850 (Price of sugarcane at 10% sugar recovery)	70 litre per ton of sugarcane
B Molasses	13,500	300 litre
C Molasses	7123	225 litre
Damaged Food Grains (Broken Rice#)	16,000	400 litre
Rice available with FCI	20,000	450 litre
Maize#	15000	380 litre

#The rates vary from region to region and also in accordance with demand/supply or quality.

Source: Ethanol Growth Story, Ministry of Petroleum & Natural Gas, GoI

Supply of ethanol under the EBP Programme has increased from 38 crore litres during ESY 2013-14 to 332 crore litres during ESY 2020-21 resulting in increase in blend percentage from 1.53% to 8.50% respectively. The allocation for ESY (2020-21) is 91% more in comparison to the ethanol supplies received during ESY (2019-20).

Exhibit 13: Ethanol Supply and Blending Rate

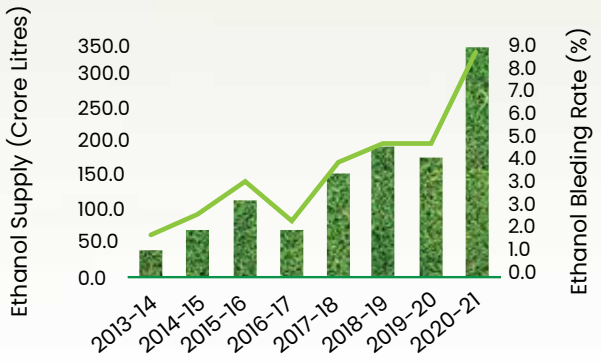
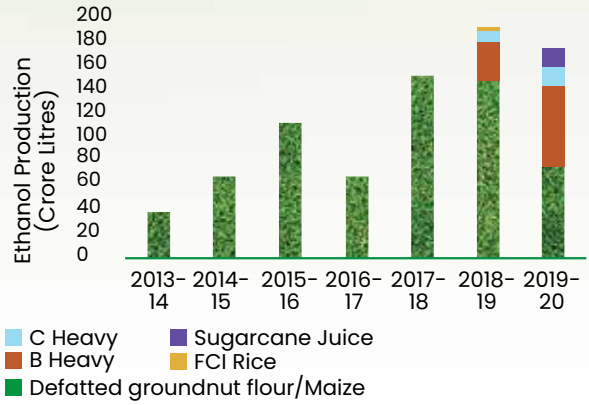


Exhibit 14: Ethanol Supply by Quality



Source: Ethanol Growth Story, Ministry of Petroleum & Natural Gas, GoI

India has a total installed ethanol capacity of 500 crore litres, of which molasses-based distilleries constitute 420 crore litres, or 85 percent of the overall production capacity while grain-based distilleries constitute 75 crore litres (15 percent). India's ethanol production remains heavily dependent on sugarcane/molasses as its primary feedstock, as it gradually expands the use of alternative viable feedstocks. However, as 84 percent of India's sugar production is located in the states of Uttar Pradesh (north), Maharashtra (west) and Karnataka (south), consistent ethanol supply nationwide remains a glaring challenge.

As of May 1, 2021, the Government of India has approved 422 project proposals under the interest subvention scheme which will potentially provide an additional capacity of 1680 crore litres. Of this amount, 600 crore litres are expected to be added within the next two to four years. However, it remains unclear if this increased production will be realized in the near term.

Of the approximate 300 crore litres of ethanol produced by the sugar industry, 130 crore litres are utilized for distilled spirits production (guaranteed offtakes for sugar mills in states where potable liquor is a major revenue source), while the remaining volume is denatured ethanol and used by the chemicals industry and OMCs. India largely relies on imported ethanol to ensure supplies for the industrial, chemical and personal care industries. Additionally, the Government of India has attempted to increase hand sanitizer production to three million litres per day, and ethanol availability will remain imperative for local manufacturers.

India requires additional feedstock supplies to boost fuel ethanol production to realize its long-term blending objectives. However, allowing surplus sugar and molasses exports undermines its capacity to produce greater fuel ethanol quantities, and limits how much India can produce domestically to meet consumption. To achieve its ethanol-use ambition, India must strengthen measures needed to divert molasses to the EBP system, while permitting imports for fuel grade ethanol to efficiently utilize idle capacities in the south, east and northeast regions. A two-tier procurement policy is needed that capitalizes on imports to supplement domestic production and enables efficient utilization of existing capacities, which will result in employment generation, clearing cane dues by enhancing sugar mills' liquidity and overall improved economic performance. Opening up the use of imported ethanol will not only aid India in achieving its blending targets, but will also support its larger "Make in India" campaign.

Ethanol Consumption

India's 2022 total ethanol consumption is forecast to rise by 25 percent to a record 515 crore litres, driven largely by ethanol for fuel blending, as India pushes to meet its 2022 E-10 and 2025 E-20 mandates. 2020-21 consumption figures have been revised downwards, reflecting the lower than anticipated ethanol offtake by the OMCs for fuel blending.

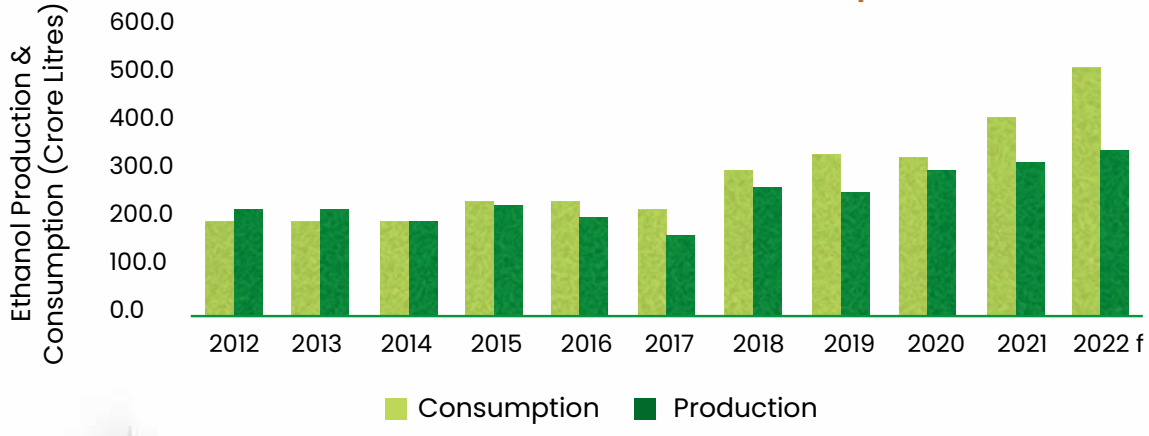
Consumption will outgrow production for the seventh consecutive year, largely driven by burgeoning fuel ethanol demand used for gasoline blending. The COVID-19 pandemic will continue to drive ethanol application in antibacterial products due to amplified domestic consumption such as hand sanitizers and disinfectants. India's annual ethanol consumption growth of 12 percent (five-year average, 2016-2021) remains strong compared to nine percent production growth in the same period. Increased domestic fuel prices, coupled with relatively appealing ethanol purchase prices are strengthening ethanol consumption, while consecutive above-average sugarcane harvests have lifted production.

Continued sugarcane availability for the EBP, increased OMC offtakes, but most importantly, lower gasoline demand due to the pandemic resulted in a 2021 national blend average of 8.5 percent, higher than last year's 5 percent rate, and a new record. The blend rate would potentially be higher if fuel-use ethanol imports were permitted, duty rates lowered, and procurement program inefficiencies rectified, such as interstate trade barriers and region-specific supply and demand mapping. Of the 457 crore litres requirement initially established by OMCs for 2021, approximately 318 crore litres of ethanol have been contracted (quantity as per Letter of Intent (LOI)) against 140 Crore litres which was planned to be blended as of May 17, 2021. Post estimates 2021 fuel use supply per LOI at approximately 270 crore litres. Since the ethanol quantity demanded at higher prices may be reduced, the industrial and potable liquor sectors will need to supplement their supplies from grain-based distilleries, partly from raw material imports or by directly importing finished products.

Ethanol demand for the EBP program is much higher than last year due to surplus 2020/21 sugarcane production, remunerative tender prices, and a gradual improvement of logistical performance that have ensured ethanol from surplus areas to be transported to deficient regions in India.

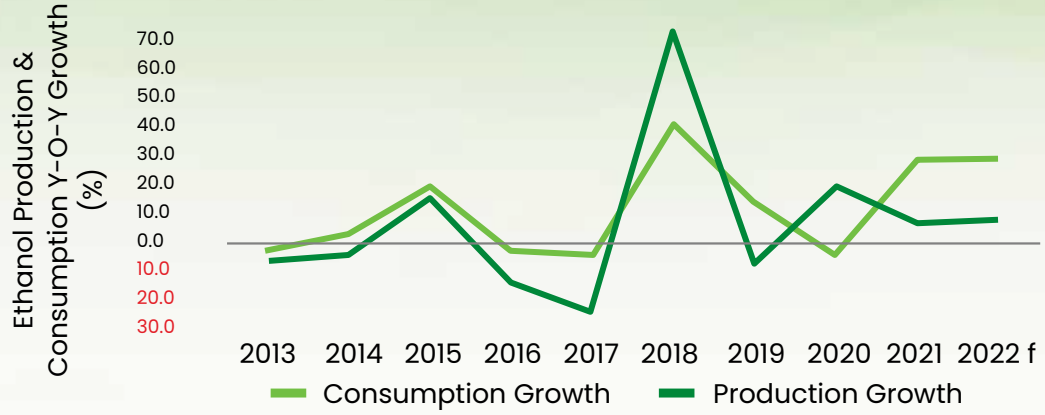
Increased industrial ethanol demand for chemicals (paints, lacquers, inks, varnishes), personal care products (cosmetics, perfumes), food additives (flavorings, food extracts) and antibacterial products (hand sanitizers, disinfectants) will continue to drive domestic consumption. Potable liquor sector demand will be relatively subdued this year on account of retail restrictions for these beverages; however, sales are expected to rebound should India's economy open up in the latter half of 2022.

Exhibit 15: Ethanol Production & Consumption



Note: 'f' denotes forecast. Source: Biofuels Annual – June 2021, USDA, Foreign Agricultural Services

Exhibit 16: Ethanol Production and Consumption Growth



Note: 'f' denotes forecast. Source: Biofuels Annual – June 2021, USDA, Foreign Agricultural Services

Import Export Scenario of Ethanol

Imports

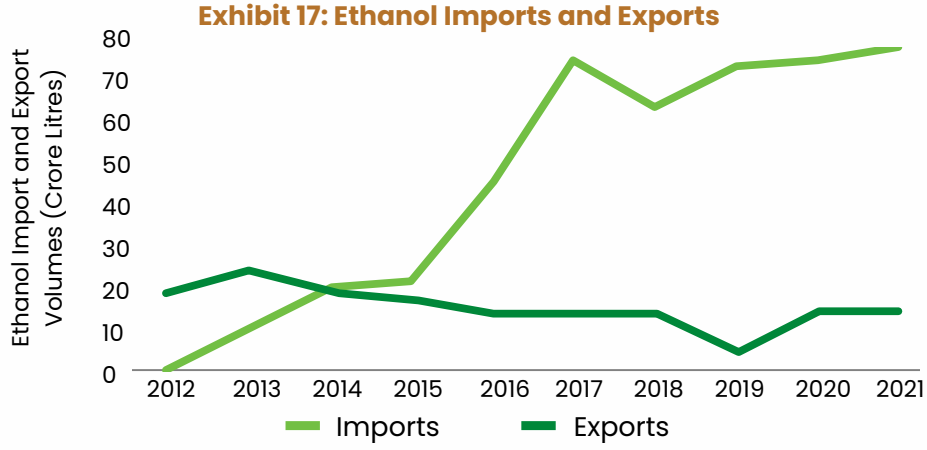
Despite increased domestic production, India remains a net ethanol importer. In 2020, Indian ethanol imports increased three percent to 72.2 crore litres. For the eighth consecutive year, the United States remained the largest ethanol (denatured) supplier to India at 96 percent of India's total ethanol imports. Strong local demand for industrial and medical-grade ethanol continues to drive U.S. exports. Other suppliers to India in the period included Singapore, Sri Lanka, Pakistan, China, and Brazil.

Post estimates India's imports will grow four percent to an estimated 75 crore litres, (mostly denatured) the highest in a decade, with the United States remaining the largest supplier. India's industrial ethanol users require imports to augment their cumulative supply, particularly when local output is short. Indian ethanol imports will maintain their positive momentum in the coming years, as industrial and chemical manufacturers capitalize on both domestic and global demand for pharmaceutical and antibacterial products.

Exports

In 2020, India's ethanol exports were 13.3 crore litres, regaining their normal levels after a drop in 2019 (mostly undenatured). Exports increased to an estimated 14 crore litres in 2021, owing to increased demand by traditional African buyers (Ghana, Nigeria, Angola, among others) while Sierra Leone and the UAE emerged as high growth markets.

Exhibit 17: Ethanol Imports and Exports



Source: Biofuels Annual – June 2021, USDA, Foreign Agricultural Services

4 Vehicle Technology

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Vehicle Technology

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.

Joint studies reported by Massachusetts Institute of Technology and Honda R&D indicate that the improvement in relative efficiency up to 20% can be achieved with E20 compared to normal gasoline, when the engine is properly tuned. 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 CO_2 reduction of 5%.

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 by INR 17000 to INR 25000. The two-wheeled flex fuel vehicles would be costlier by INR 5000 to INR 12000 compared to normal petrol vehicles as per the research by Society of Indian Automobile Manufacturers (SIAM).

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 on E20 only and will provide high performance.

Impact Assessment of Usage of E20 Fuel

An ambitious calibrated transition towards E20 Program will expectedly impact multiple stakeholders in the ecosystem in myriad ways. The Impact Assessment is discussed in this section.

Impact on Environment

Vehicular emissions such as Carbon Monoxide (CO), Hydrocarbons (HC) and Oxides of Nitrogen (NOx) are currently under regulation in India. Use of ethanol blended gasoline decreases these emissions. A summary of emission benefits with E10 and E20 fuels compared to neat gasoline are presented in the table below:

Exhibit 18: Emission reduction potential of ethanol-gasoline blends

Emissions	Gasoline	Two-wheelers		Four-wheelers	
		E10*	E20*	E10*	E20*
Carbon Monoxide	Baseline	20% lower	50% lower	20% lower	30% lower
Hydrocarbons	Baseline	20% lower	20% lower	20% lower	20% lower
Oxides of nitrogen	Baseline	No significant trend	10% higher	No significant trend	same

*E10 project was carried out in 2009 -10, E20 project in 2014 -15. Hence, the test vehicles were not the same. However, the emission trend is similar.

Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI

Higher reductions in Carbon Monoxide emissions were observed with E20 fuel – 50% lower in two-wheelers and 30% lower in four-wheelers. Hydrocarbon emissions reduced by 20% with ethanol blends compared to normal gasoline. Nitrous Oxide emissions did not show a significant trend as it depended on the vehicle/engine type and engine operating conditions. The unregulated carbonyl emissions, such as acetaldehyde emission were, however, higher with E10 and E20 compared to normal gasoline, due to the presence of hydroxyl groups in ethanol. However, these emissions were relatively minor (in few micrograms) compared to regulated emissions (which were in grams). Evaporative emission test results with E20 fuel were similar to E0. Overall, ethanol blending can help decrease emissions from both two-wheelers and four-wheelers.

Impact on the Consumer

Fuel Efficiency: While using E20 fuel, there will be a drop in fuel efficiency by nearly by:

a) 6-7% for 4 wheelers designed for E0 and calibrated for E10.

b) 3-4% for 2 wheelers designed for E0 and calibrated for E10.

c) 1-2% for 4 wheelers designed for E10 and calibrated for E20.

However, with the modifications in engines (hardware and tuning), the loss in efficiency due to blended fuel can be reduced.

Startability: In the E20 project, the results indicated that the test vehicles passed startability and drivability tests at hot and cold conditions with E0 and E20 test fuel. In all the cases, there was no severe malfunction or stall observed at any stage of vehicle operation.

Impact on the Vehicle Manufacturer

The following changes in the production line will be necessary to produce compatible vehicles.

1. Engines and components will need to be tested and calibrated with E20 as fuel.

2. Vendors need to be developed for the procurement of additional components

compatible with E20. All the components required can be made available in the country.

3. No significant change in the assembly line is expected.

Impact on Component Manufacturer

1. There will be no major structural change in the components in migrating from E10 to E20.

2. There will be changes in material of piston rings, piston heads, O-rings, seals, fuel pumps etc., all of which can be produced in the country.

Views of Automobile Industry

The following inputs are given by Society of Indian Automobile Manufacturers (SIAM):

Vehicles made in India since 2008 are material compatible with E10 and fuel-efficient compliant with E5. At the next stage when E10 is made available across the country, new vehicles can be made fuel efficient compliant by engine modification with E10.

Shift to E20 fuel is a logical, direct progression from E10 rather than going through intermediate steps of E12 and E15. However, following concerns are to be taken care:

- E20 should be made available on a pan India basis.

- E10 should be made available on a pan India basis as protection grade fuel for existing pool of vehicles

E100/Flex Fuel Vehicles: The cost of E100/ Flex fuel vehicles will be higher in comparison to E0/ E10 vehicles which may result in an increase in total cost of ownership (TCO) for the customer. SIAM has suggested that only when E100 can be sold at 30% lower cost as compared to gasoline and if E100 fuel is available across the country can the flex fuel vehicles be a possible solution. Hence, SIAM has not recommended pursuing an E100 implementation / flex fuel approach for the time being. However, once fuel is available on a pan-India basis, a decision on promoting E100 vehicles can be taken.

Retro-fitment on existing Vehicles: The existing vehicles on road are material compatible to E10 but their engine/vehicles are not tuned to E10 for optimum performance efficiency. Developing parts with upgraded material for a large number of vintage variants with a wide range of fuel system component designs and then getting the customers to get their vehicles upgraded is a mammoth task. Keeping this complexity in view, a recommendation to continue dispensing E10 as a protection grade fuel all over the country has been made.

Alignment of changes with emission regulations: Adopting engines with higher ethanol blend means changes in engine hardware and also engine calibration (tuning). Auto Industry is already working on the engine upgradation work for the next level of regulations (BS 6.2). Being a huge, unmodifiable task, which cannot be course corrected, it is important that fuel changes are also aligned with these regulations to derive complete benefit from all the perspectives.

One Nation One Fuel specification: In the past, OMCs and OEMs (Oil and Auto industry) moved together for implementation of BS6 emission regulations and specification of a single fuel across the country. This needs to continue in future also to ensure portability of vehicles by customer, especially for vehicles designed for higher blends of ethanol keeping in mind the customer's acceptance and requirements.

5 Ethanol Demand Mapping and **Supply Projections**

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Ethanol Demand Mapping and Supply Projections

Ethanol (also called ethyl alcohol, or alcohol) is an organic chemical compound with chemical formula C_2H_5OH. 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.

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 gasoline-based vehicles in the country is given in table below:

Growth in Vehicle Population

Exhibit 19: 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 estimate 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 vehicles will be 83% of the total passenger vehicle sale

Source: SIAM

Demand Projection in Gasoline

The demand projection of gasoline is given in the table below based on the growth of vehicle population.

Exhibit 20: 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 (Million Metric Ton per Annum) *	28	31	32	33	35	36	37	39	40	41
Motor Gasoline (Crore litres)	3908	4374	4515	4656	4939	5080	5221	5503	5644	5785

*Interim figures from Petroleum Planning & Analysis Cell (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.

Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI

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:

Exhibit 21: Ethanol demand projection

Ethanol Supply Year	Projected Petrol Sale (Million Metric Ton)	Projected Petrol Sale (Cr. litres)	Blending (in %)	Requirement of ethanol for blending in Petrol (Cr. litres)**
A	B	B1=B X 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
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. The demand for ethanol will, however, increase due to penetration of E100 two wheelers, which are now being manufactured in the country.

Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI

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 the 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:

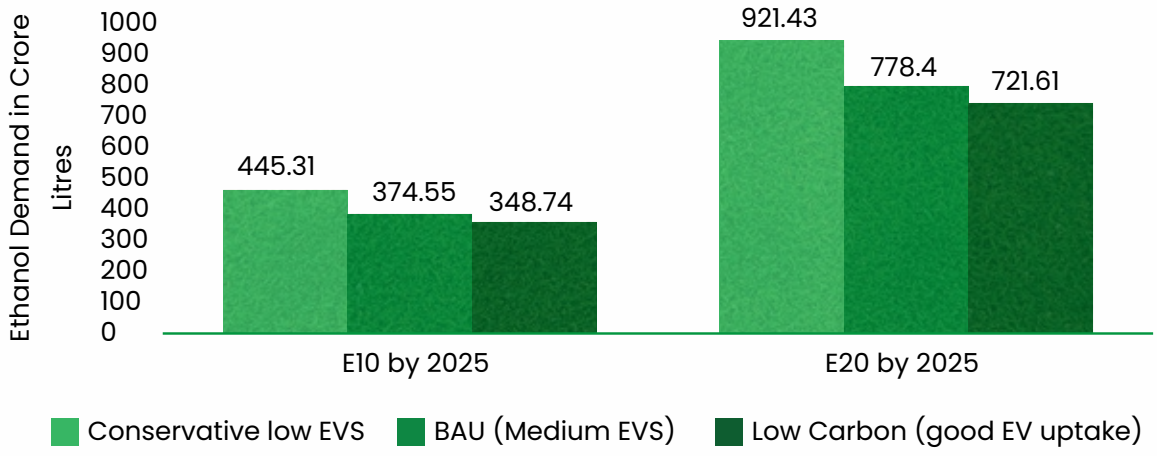
1. Conservative (low EVs) – negligible uptake of electric mobility up to 2030.

2. 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.

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

The figure below 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 20 targets. In this report, we have assumed an enhanced ethanol demand of 1016 crore litres based on expected growth in the vehicle population. The SAFARI model gives us confidence that our projections would cover the most ambitious scenario of ethanol demand in the country, and thus gives robustness to our roadmap for rollout of E20 by 2025.

Exhibit 22: Ethanol Fuel Demand in 2025 under Various Scenarios



Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI

Ethanol Supply Projections

During the meeting of the Committee of Secretaries on 13.11.2020, The Department of Food and Public Distribution (DFPD) informed that the fuel 20% ethanol requirement by 2025 will be met from sugar as well as grains sectors. The table below provides the Year-wise and Sector-wise Ethanol Production Projections as per increasing Blending Percentages.

Exhibit 23: Year wise & Sector wise Ethanol Production Projections (in Crore litres)

ESY	For Blending			Blending (in %)	For other uses			Total		
	Grain	Sugar	Total		Grain	Sugar	Total	Grain	Sugar	Total
2019-20	16	157	173	5.0	150	100	250	166	257	423
2020-21	42	290	332	8.5	150	110	260	192	400	592
2021-22	107	330	437	10.5	160	110	270	267	440	707
2022-23	123	425	542	12.0	170	110	280	293	535	828
2023-24	208	490	698	15.0	180	110	290	388	600	988
2024-25	438	550	988	20.0	190	110	300	628	660	1288
2025-26	466	550	1016	20.0	200	134	334	666	684	1350

Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI

The following table details the Grains and Molasses based Ethanol Production Capacity necessary to meet the Production Projections above:

Exhibit 24: Ethanol capacity requirement by Year and Raw Material

Capacity Augmentation (in Crore Liters)			
Year	Capacity Requirement		
	Grain	Molasses	Total
2019-20	258	426	684
2020-21	260	450	710
2021-22	300	519	819
2022-23	350	625	975
2023-24	450	725	1175
2024-25	700	730	1430
2025-26	740	760	1500

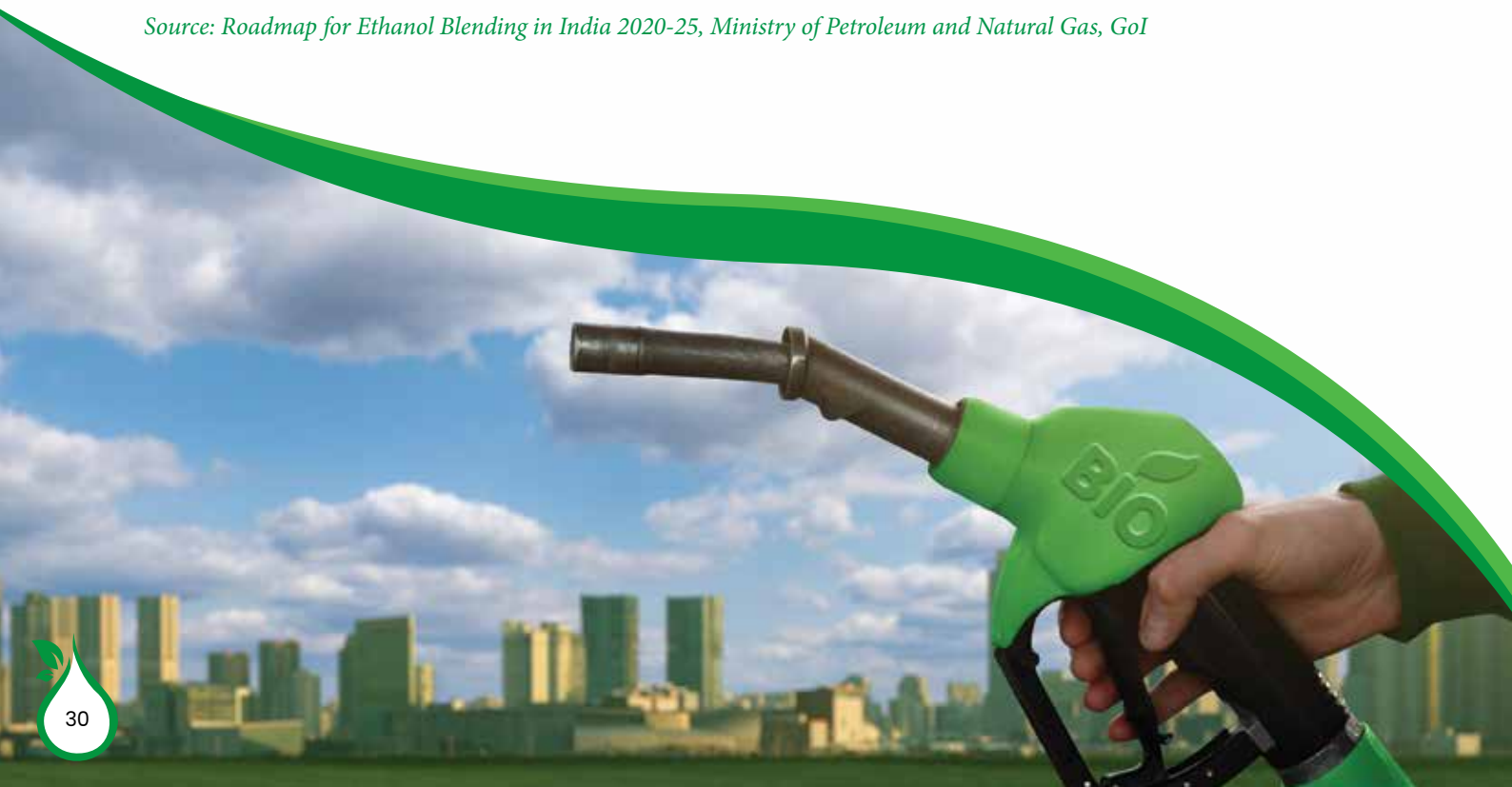
Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI

Minor shortfall in capacity in any year can be compensated as sugar mills are also using sugar rich feed stocks like B heavy molasses /sugar syrup which produces 20% more ethanol of rated capacity. Now many mills have started using these feed stocks in place of C heavy molasses. The capacity utilisation in these 5 years vary from 84 percent to 90 percent. Exhibit 25 below lays down the capacity augmentation plans for 2025-26, and its year wise breakup.

Exhibit 25: Ethanol Capacity augmentation (20% blending by 2025-26)

Ethanol Supply			
Ethanol Supply (in Cr. Lt.)	**Fuel ethanol**	**Other uses**	**Total**
(A) From sugar sector	550	134	684
B) From grain/ maize etc.	466	200	666
Total Supply	1016	334	1350
Capacity Augmentation			
Ethanol Capacity (in Cr. Lt.)	Molasses based	Grain based	Total
Existing ethanol/alcohol capacity	426 (231 distilleries)	258 (113 distilleries)	684
Capacity addition from sanctioned projects	93 (will be added by March,2022)	0	93
New capacity to be added	241	482	723
Total Capacity required by Nov 2026 to reach 1350 Cr litres supply	760	740	1500

Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI



Additional capacity (90 % of 1500 = 1350) has been taken into account as operational efficiency, raw material availability in various parts of the country due to natural calamity etc., increase in demand in ethanol due to economic factors and anticipated demand of ethanol in flex-fuel vehicles.

Molasses based distilleries can produce 20% additional ethanol if sugar rich feed stocks like B- heavy molasses are used as the same capacity can cater the higher demand of ethanol.

Total planned capacity is 1500 crore litres per annum, distribution between grain and molasses may change depending on various factors.

It is relevant to mention that earlier on the inputs obtained from MoP&NG, 900 cr litres ethanol was estimated to achieve 20% blending and 300 Cr litres was the requirement of other sectors, thus, the total requirement was assessed to be 1200 cr litres by 2024-25. However, as per the revised estimates of gasoline consumption obtained from MoP&NG, about 988 Cr litres is required to achieve 20% blending by 2024-25 and total requirement of alcohol including other sectors would be 1288Cr litres. For 2025-26, ethanol requirements is 1016 Cr litres to achieve 20% blending and total requirement of alcohol including other sectors would be 1350 Cr litres.

Availability of Feedstocks

To produce 684 crore litres of ethanol by the sugar industry by 2025-26, sugarcane equivalent to 60 Lakh Metric Tons (LMT) of surplus sugar would be diverted to ethanol. In the current sugar season 2020-21 more than 20 LMT of sugar is estimated to be diverted. To produce 666 crore litres of ethanol/ alcohol from food grains by 2025-26, about 165 LMT of food grains would be utilised. At present damaged food grain availability is around 40 lakh ton in the country. In 2020-21 approximately 20 lakh ton maize is surplus; FCI Rice is also sufficient in stock (266 LMT) and it will continue to remain robust as procurement of paddy/rice at MSP continues at expected levels. The country is producing sufficient food grains and sugar to meet the requirement for ethanol.

Molasses-based distilleries have also been offered interest subvention to convert them to dual feed, to convert both food-grains & molasses into ethanol. Thus, it is expected that there would be sufficient ethanol distillation capacity to achieve blending targets. DFPD is effectively monitoring the situation and encouraging states and investors to set up new industries and make sufficient availability of ethanol for blending.

Under PM-JIVAN scheme, 12 commercial plants and 10 demonstration plants of Second Generation (2G) Bio-Refineries (using ligno-cellulosic biomass as feedstock) are planned to be set up in areas having sufficient availability of biomass so that ethanol is available for blending throughout the country. Already Rs. 1969.50 Crores have been earmarked for this scheme. These plants can use feedstocks such as rice straw, wheat straw, corn cobs, corn stover, bagasse, bamboo and woody biomass, etc.

Exhibit 26: Availability of feed-stock for Ethanol in the Country (In Lakh Ton)

Feed-stock	Annual production	Annual Consumption	Surplus
Sugar	320	260	60
FCI rice *	520 (Annual Procurement)	350 (Annual issue)	309 # (Stock in central pool)
Maize **	285	165	103 ##

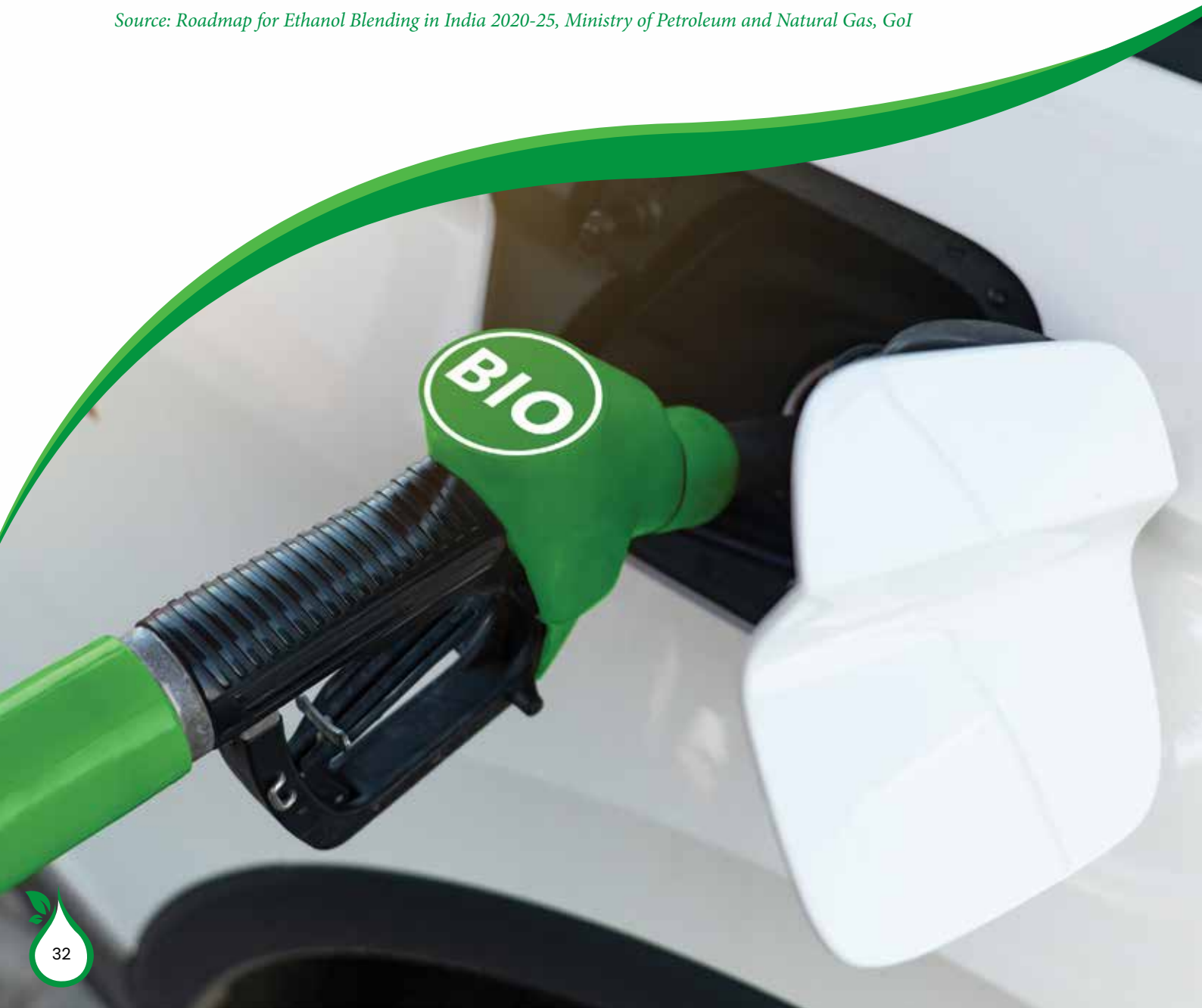
*FY 2019-20,

**as per Market Begin year,

stock in central pool as on 31.03.2020,

expected after export

Source: Roadmap for Ethanol Blending in India 2020-25, Ministry of Petroleum and Natural Gas, GoI



6 Challenges for E20 Program Rollout

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Challenges for E20 Program Rollout

There are some possible challenges to stakeholders, and suggested measures to anticipate and counter these for a successful roll-out of the EBP Program.

Challenges to Procedures

The following are the challenges that the producers need to overcome in order to facilitate higher production of ethanol:

1. Availability of sufficient feedstock on a sustainable basis viz., sugarcane, food grains: Current regulations in the country allow production of ethanol from sugarcane, sugar, molasses, maize and damaged foodgrains unfit for human consumption. Further, surplus rice with FCI is also allowed. States like Chattisgarh have raised the issue of permitting rice procured by the state government to be allowed for production of ethanol. The list of feedstocks allowed for production of ethanol needs to be expanded.
2. Augmentation of ethanol production facilities as planned.
3. Inter-state movement of ethanol–There are some states which produce ethanol more than the requirement for blending within the State. This has to be transported to other states where the availability of ethanol is less. While an amendment has been made to the IDR Act which legislates exclusive control of denatured ethanol by the central government for smooth movement of ethanol across the country, the same has not been implemented by states thereby restricting this movement of ethanol.
4. Weather related issues – floods/drought thereby affecting the crop.
5. Prices of feed-stock and ethanol.

Challenges To Oil Marketing Companies (OMCs)

The following are the challenges that the OMCs need to overcome in order to facilitate higher use of ethanol in gasoline and also to ensure pan-India supply of the same.

Availability of raw materials:

1. Ethanol is not produced or available in some states for blending with gasoline.
2. About 50% of total pump nozzles in India are supplying only E0.

3. Restrictions on inter-state movement of ethanol due to non-implementation of the amended provisions of Industries (Development & Regulation) Act, 1951 by all the States. As on date only 14 states have implemented the amended provisions. The other states with a large consumption of petrol where implementation is pending includes Delhi, Uttar Pradesh, Rajasthan, West Bengal, Telangana, Odisha and Kerala.
4. Ethanol blending has not been taken up in North-East states due to non-availability of feedstock or industries.
5. Transport of ethanol to different places for blending will increase the cost of logistics and transport related emissions.

Changes in marketing infrastructure:

1. Need for additional storage tanks for ethanol at marketing terminals/ depots.
2. Need for ethanol compliant dispensing units.
3. Changes in nozzle calibration & legal metrology.
4. Need for an additional underground tank, pipes/ hoses and dispensing units for ethanol blended gasoline supply at retail outlets. Dispensing infrastructure for E100 will be required for E100 two-wheelers introduced in the country. Due to this, there would be space constraints at various retail outlets for setting up of such extra infrastructural facilities.
5. Policy guidelines for differential pricing and labelling of various ethanol blended motor spirits.

Challenges to Vehicle Manufacturers

The following are the challenges the vehicle manufacturers need to overcome in order to facilitate the roll out of the compatible vehicles for higher ethanol blended gasoline in the country.

1. Handhold vendors to develop ethanol compatible parts
2. optimisation of engine for higher ethanol blends
3. Conduct of durability studies on engines and field trials before introducing E20 compliant vehicles.

7 Policy Recommendations

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Policy Recommendations

For a sustainable transition, the long-term biofuel pathway should be based on waste (2G) and algal biomass (3G). Such approaches will ensure reductions not only in oil imports but also in carbon emissions. Estimates by the IEA suggest that halving carbon emissions by 2050 will require 90 percent of all biofuels to be produced from wastes. Furthermore, a waste-based pathway will ensure higher levels of biofuel production, since a larger part of the biomass can be apportioned for fuel production, without posing a threat to food security and land. In the long run, waste-based biofuels will also be cheaper for consumers, since the raw materials are cheaper than edible feedstock. In India, the cost of ethanol is significantly higher than in other countries, due to government-regulated pricing of agricultural commodities. It can also be an effective solution to the problem of air pollution arising from the burning of agricultural wastes.

The following are some policy suggestions for ensuring long-term and sustainable increase in biofuel production:

Expanding 1G biofuel, rooted in sustainable land use: Instead of a topdown target-based approach, the proliferation of sugarcane and maize for ethanol should be part of a broader, sustainable land-use strategy. The GoI must develop a criterion for identifying land with potential for conversion to energy crops; such criteria must not be restricted to the simplistic classification of wetlands prevalent today. Global standards, such as the ones developed by the Roundtable on Sustainable Bio-material (RSB), can provide a guide but will have to be adapted to the Indian context. Overall, the standards must account for crucial factors such as net GHG emissions, local pollution, food security, land laws, and resource availability. Newer institutional arrangements must be made, to monitor compliance to the standards, before implementing specific projects.

Developing sustainable supply chains for 2G feedstock: There is currently little data on the suitability of different 2G feedstock. Each potential lignocellulosic feedstock has its advantages and disadvantages (Exhibit 27). It is imperative to formulate a roadmap for 2G feedstock, with a focus on those that minimise land-use change and promote a circular economy. Since most of these feedstocks have a low density, transport costs are usually high. An integrated 2G biofuel roadmap must address this, taking into account spatial and temporal constraints. This will require an understanding of the availability of feedstock as well as the technological requirements for conversion to biofuels. Already, a significant amount of research has been done on models for optimising supply chains for 2G fuels. Going forward, the GoI must collaborate with research institutes to develop a viable model for India.

Exhibit 27: Snapshot of Lignocellulosic Biomass Options for 2G Biofuels

	Feedstock	Advantages	Constraints	Availability
Forestry residues	Treetops, branches, stumps	Cheap, no land-use change, prevents forest fires	Competing uses for fuel and fodder, low energy density, loss of organic matter; and biodiversity habitat	Year-round
Secondary Residues				
Crop Processing	Coffee, rice, corn, cacao	No land use change, concentrated at processing site, reduces disposal costs	Competition with heat and electricity generation	Year-round
Sugar ethanol production	Sweet sorghum, bagasse, pulp		Animal feed	Only harvesting season
Forestry processing	Sawdust, bark		Competition with heat and electricity generation	Year-round
Tertiary Residue				
Municipal solid waste	Palettes, furniture, timber	Concentrated at landfill sites, reduces disposal costs, no additional land	Competition with heat and electricity generation	Year-round
Dedicated energy Crops				
Short-rotation crops	Poplar, willow, eucalyptus, locust	Fast-growing, prevention of soil erosion, increased soil fertility in some cases	Invasive species leading, potential for land-use changes, low energy density	Year-round
Perennial crops	Miscanthus switchgrass, reed canary grass and other grasses	Useful for reviving degraded land, prevention of soil erosion, increased soil fertility in some cases	Invasive species, potential for land use changes, low energy density	Summer and Autumn

	Feedstock	Advantages	Constraints	Availability
Primary Residues				
Agriculture	Straw, stover	Cheap, promotes a circular economy, no land-use change, additional value creation for farmers, reduced pollution from waste burning	Low energy density, reduced nutrient cycling	Only during crop harvesting season

Source: The Implications of India's Revised Roadmap for Biofuels, Observer Research Foundation, March 2022 Issue

Financing research and development for 2G biofuels: Most of the 2G biofuels, such as cellulosic ethanol and biomass to biodiesel, are in the early phases of commercialisation. Faster uptake of these fuels is hindered by the high costs of production and high risks, which throttle innovation. To tackle this issue, public enterprises should scale up investment in pilot projects for 2G biofuels. The Pradhan Mantri JI-VAN Yojana already aims to provide INR 1,969 crores to develop 22 projects focused on 2G technologies. The scope and budgetary outlay for such schemes should be expanded. Further, international grants and loans should be redirected towards 2G fuels, and existing frameworks (e.g., the Clean Development Mechanism) can be leveraged to direct funding to this sector. To this end, it will be crucial to establish the value proposition for 2G fuels, starting with a comprehensive lifecycle emissions inventory of 1G and 2G. Government policy and mandates can help accelerate the demand for these products and enable the creation of viable markets for these fuels. Innovation will also need to be encouraged through fiscal incentives, such as tax credits for the production of cellulosic biofuel and loan guarantees for pilot projects. Some of the measures have already been successfully applied in other countries.

Support for alternative feedstock for biodiesel production: While using Jatropha for biodiesel production eschews the food-security issue, it accounts for limited production. Thus, the Biofuel Policy must expand the list of feedstocks that can be sustainably used. This will require a twofold approach. First, alternative non-edible vegetable oils should be considered for plantations and biodiesel production. India has 11 tree species that have high oil content in their seeds and can be used for producing biodiesel. The GoI must focus on a comprehensive mapping of these and formulate a roadmap for utilising them. Further, government support should be provided to projects aimed at developing more efficient methods of extracting oil from oilseeds. Second, the use of waste or recycled oil for biodiesel must be enhanced. While India has approximately biodiesel units that can utilise repurposed cooking oil, most suffer from a lack of feedstock availability. According to the Food Safety and Standards Authority of India (FSSAI), India produces around three million tonnes of used cooking oil (UCO), 60 percent of which goes back to the food chain, leading to adverse health impacts. Currently, the FSSAI does not have the resources required to enforce the established standards for the disposal of used cooking oil. Thus, larger agencies such as State Pollution Control Boards must be deployed, and the procurement of UCO for conversion to biodiesel strengthened. OMCs have already issued an EOI seeking biodiesel made from UCOs, and the government has announced a scheme for greater procurement of UCO. Going forward, such efforts need to be sustained and amplified.

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