SIAM
Society of Indian Automobile Manufacturers

Biofuels in India: Current Scenario and The Road Ahead

जैविक पहल

BIO-INITIATIVE
by ***SIAM***

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About SIAM

SIAM works towards supporting the sustainable development of the Indian Automobile Industry with the vision that India emerges as the destination of choice in the world for design and manufacture of automobiles. It facilitates the enhancement of the competitiveness of the Indian Automobile Industry, reducing cost of vehicles, increasing productivity and achieving global standards of performance and quality.

SIAM acts as a face of Automobile Industry in India and works closely with stakeholders in the formulation of the policy and regulatory frameworks, including technical standards relating to automobiles. SIAM provides economic and statistical information as well as technical and public policy services to the stakeholders on behalf of the Indian Automobile Industry. It publishes Monthly Industry Statistics, Monthly Commodity Price Monitor and other periodic reports. It also organises international conferences, seminars and workshops on the topics of topical relevance and interest to the industry, and on global best practices with a focus on sustainable mobility.

SIAM has a profound interface with the Indian Government and with International bodies like OICA (International Organization of Motor Vehicle Manufacturers), JAMA (Japan Automobile Manufacturers Association), ACEA (European Automobile Manufacturers' Association), UNICA (Brazilian Sugarcane Industry and Bioenergy Association), USGC (U.S. Grains Council), ANFAVEA (National Association of Automotive Vehicle Manufacturers, Brazil), ABRACICLO (Brazilian Association of Motorcycle, Moped, and Bicycle Manufacturers) etc. SIAM jointly with ACMA and CII organises Auto Expo-The Bharat Mobility Global Show, a widely awaited annual auto exhibition highlighting the trends in technological advancement adopted in the Auto Industry. SIAM also organises regional as well as segment specific shows across the country.

SIAM aims to promote sustainable mobility through environmental, social, and economical sustainability, to address climate change, air quality improvement, compliance with standards and promotes sustainable growth. In October 2022, SIAM hosted a global conference on 'Biofuels – A Pathway Towards a Sustainable Future' with participation from automotive industry experts, government officials, academia, and other stakeholder associations including the ambassador and experts from Brazil. In the same conference, SIAM reiterated its dedication for Ethanol adoption in India and established a 'CLEAR' strategy for ethanol adoption in India.

In December 2022, SIAM organized a flex fuel vehicle technology demonstration attended by automobile industry leaders. SIAM launched जैविक पहल (Bio-initiative) in the presence of Shri Nitin Gadkari for continued focus on information dissemination on Ethanol blending to attain sustainable development goals 2030 and Net Zero emissions by 2070.

Background

Today, the world is grappling with the effects of climate change, manifesting in frequent and intense drought and storms, prolonged heatwaves, cold spells, and their consequences like poor agricultural yield, rising sea levels, and depleted underwater levels. The average global temperature has risen by approximately 1.1°C from 1901 to 2020, primarily due to increasing greenhouse gas emissions. In 2021, among all the greenhouse gases, CO_2 alone accounted for about two-thirds of the total heating influence[i] on the planet. Since the advent of industrial activities in the 18th century, atmospheric carbon dioxide (CO_2) level has gone up by 50%[ii]. Global CO_2 emission level is higher than any point in human history and stood at stood at 37.4 billion tonnes (Gt) in 2023, which is an increase of 1.3% over 2022. Coal burning accounted for more than 65% of the increase in 2023[iii].

The phenomenon of global warming has received continuous attention from the policy makers globally over the last few decades. In December 2015, world leaders at the United Nations Climate Change Conference (COP21) in Paris set a target to reduce global greenhouse emission to hold global temperature rise to well below 2°C above pre-industrial levels and target limiting it to 1.5 °C above pre-industrial levels.

At the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Glasgow in 2021, India presented the five nectar elements (Panchamrit[iv]) under the climate action plan:

1. Increasing non-fossil fuel electricity capacity to 500 GW by 2030
2. Meeting 50% of energy requirements from non-fossil fuels by 2030
3. Reducing projected carbon emissions by 1 billion tonnes from 2021 to 2030
4. Reducing the carbon intensity of the economy by 45% below 2005 levels by 2030
5. Achieving the target of net zero emissions by 2070

Today, India is the third largest contributor to overall global CO_2 emissions. However, India's per capita emissions remain very low, at around 2 tonnes, less than half the world average of 4.6 tonnes[iii]. As India continues its growth on the global stage, its overall carbon emissions are anticipated to rise further, with the transportation sector being a significant contributor. Currently, it accounts for over 13% of CO_2 emissions, with more than 90% coming from road transportation. Thus, the transportation will play an important role in achieving the country's decarbonisation targets.

Apart from emerging technologies such as electric vehicles, hydrogen, and fuel cell vehicles, biofuels present a viable solution for reducing carbon emissions. Derived from organic materials such as plants and agricultural waste, biofuels can significantly lower the carbon footprint due to their closed carbon loop. The CO_2 absorbed during the growth of biofuel feedstock offsets the emissions released during fuel combustion, contributing to a reduction in air pollution, particularly arising from the transportation sector.

Furthermore, adopting biofuels will reduce crude oil import dependency, enhance energy security, and support rural economies in the country. Integrating biofuels into India's energy strategy will be a critical step toward achieving climate goals, reducing greenhouse gas emissions, and fostering a sustainable environment.

Types of Biofuels

Biofuels can be categorized into different types based on the production process and feedstock. Different generation production technology utilises different type of feedstock.

1. **First-Generation Biofuels:** Produced from food crops using conventional processes. Major examples are ethanol and biodiesel. Ethanol is obtained through fermentation of sugars from crops like sugarcane, corn, and wheat, and used for direct blending in petrol. Biodiesel, made from vegetable oils (soybean, palm, and canola) or animal fats, can be used in diesel engines either pure or blended with petroleum diesel.
2. **Second-Generation Biofuels:** These biofuels are produced from non-food feedstock such as lignocellulosic biomass (corn hub, rice husk, wheat straw and sugarcane bagasse) and waste materials. Examples include cellulosic ethanol and bio-butanol.

3. **Third-Generation Biofuels:** Derived from algae and other microorganisms, these biofuels include algae-based biofuels and bio-hydrogen. They can also involve the use of CO_2 as feedstock.

4. **Fourth-Generation Biofuels:** This category involves capturing and storing CO_2 to produce biofuels using genetically engineered microorganisms, including microalgae, yeast and fungus. Major examples include electrofuels (e-fuels).

Different biofuels offer distinct benefits and challenges and require a unique set of feedstock requirements. From a technical viability and commercialization perspective, first generation (1G) ethanol production is well-established and commercialized. Second generation (2G) ethanol production solutions are available in the market but require more complex and costly processing technologies, limiting overall commercialization. Third generation (3G) technology is in a nascent stage whereas fourth generation (4G) production is still at a concept stage and needs dedicated R&D efforts for further development.

Among liquid biofuels, ethanol is the most widely used for blending with petrol. Other biofuels, such as biodiesel and bio-methanol, are produced globally, but on a much smaller scale. In India, biodiesel blending is still in its early stages. The government amended the National Policy on Biofuels - 2018 in June 2022 to put focus on biodiesel by setting an indicative target of 5% blending in diesel by 2030 whereas the target for 20% ethanol blending in petrol was advanced to 2025-26 from the earlier 2030.

In addition to the types of biofuels mentioned, there are other emerging biofuels:

1. **Biogas and Bio-CNG:** Produced from anaerobic digestion of organic waste, resulting in methane-rich biogas which is then upgraded to bio-CNG (compressed natural gas).

2. **Bio-jet Fuel/ Sustainable Aviation fuel:** Developed specifically for the aviation industry, this biofuel can be produced from various feedstock, including vegetable oils, waste oils, and algae.

There has been increased focus on adoption of biogas and Bio-CNG in India with the government announcing several key policy measures like Sustainable Alternative Towards Affordable Transportation (SATAT) 2018 scheme for set up of Compressed Biogas production plants in the country and Compressed Biogas Blending Obligation with CNG 2023. Meanwhile, India's National Biofuels Coordination Committee has set a blending target of 1% for sustainable aviation fuel with jet fuel in 2027 and 2% in 2028.[vi]

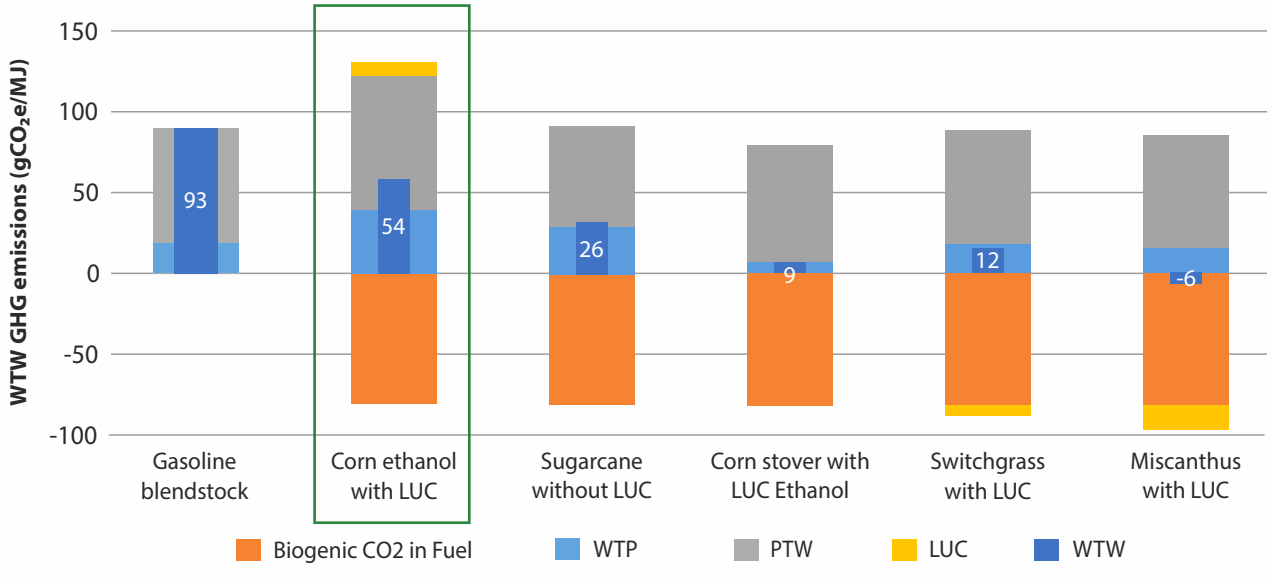
This context paper explores the current prospects of ethanol biofuel adoption in India, along with the associated benefits in terms of decarbonization of the economy, enhancement in energy security, and reduction in air pollution. It also addresses the potential challenges in this area.

Benefits of Biofuels: An organic Boon

Emission Reduction

Ethanol consists of higher hydrogen-to-carbon ratio vis-a-vis conventional petrol, leading to lower emissions. According to Alfred Szwarc, a Brazilian expert on sustainable transport "Intensive use of ethanol in flex-fuel vehicles in the last 15 years avoided emissions of over 450m tonnes of carbon dioxide (CO_2), the main contributor to global warming and climate change".

	Ethanol	Petrol
Chemical Formula	CH_3CH_2OH	CnH_2n+_2
Hydrogen to Carbon Ratio	3:1	1.6-1.8:1
Considering the CO2 absorption during the growth of crops, ethanol blended fuel's life cycle GHG emissions are lower on average by 40% when compared to traditional fossil fuels[vii]. According to expert committee, use of ethanol-blended petrol decreases emissions such as carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NO_x). Higher reductions in CO emissions were observed with E20 fuel — 50 per cent lower in two-wheelers and 30 per cent lower in four-wheelers[viii].		



Source: US Department of Energy[ix]

Lifecycle (well-to-wheels) Greenhouse Gas Emissions for Gasoline
(grams of CO_2 -equivalent GHG per magajoule of energy)

RFA

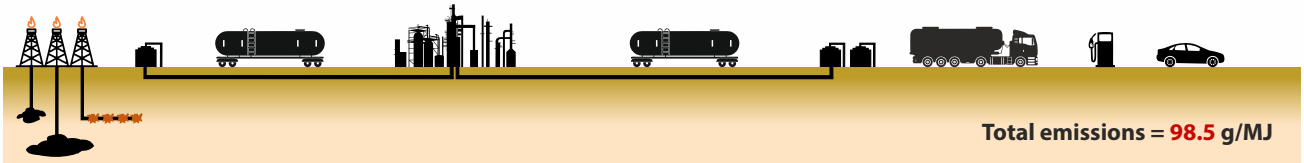
Oil Extraction, Pre-Processing and Transportation to Refinery = 11 g/MJ
- *Energy use for crude oil recovery*
- *Flaring*
- *Initial processing*
- *Energy use in pipelines, trains, barges*

OIL Refining = 14g/MJ
- *Energy use for crude oil refining*

Gasoline Distribution =0.5 g/MJ
- *Energy use in pipelines, trains, barges,trucks*
- *Energy use by fuel blenders and retailers*

Gasoline Combustion = 73 g/MJ
- *Tailpipe Co_2, Ch_4, N_2O emissions*

Land Use Change or Other Indirect Effects = ? g/MJ
- *Not included in current lifecycle analyses for petroleum*



Total emissions = 98.5 g/MJ

Lifecycle (Well-to-Wheels) Greenhouse Gas Emissions for Ethanol
(grams of Co_2 -equivalent GHG per megajoule of energy)

RFA

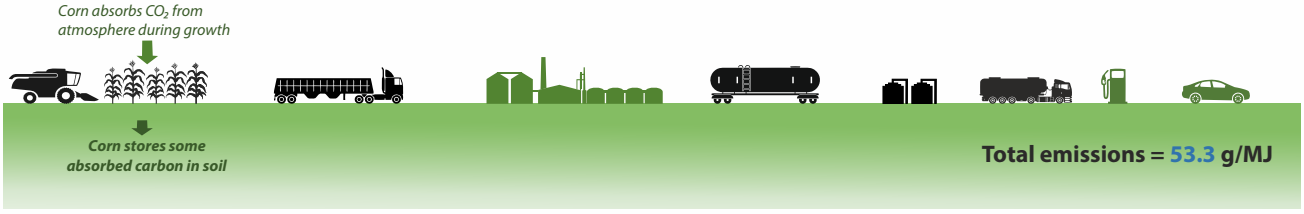
Corn Production = 22 g/MJ
- *Seed production*
- *Fertilizer production and use*
- *Chemical production and use*
- *Farm machinery energy use*
- *N_2O/CO_2 emissions from soils*
- *Animal feed co-product credit (-12)*
- *Hypothetical land use change (7)*

Ethanol Production = 28 g/MJ
- *Energy use (natgas, electricity) by ethanol biorefinery*
- *Denaturant addition*

Ethanol Combustion = 0.3 g/MJ
- *Tailpipe Co_2 emissions are biogenic*
- *Minor tailpipe CH_4 and N_2O emissions*

Corn Transport = 1.5 g/MJ
- *Energy use by trucks, trains, barges*

Ethanol Distribution = 1.5 g/MJ
- *Energy use by trucks, trains, barges*
- *Energy use by fuel blenders and retailers*



Total emissions = 53.3 g/MJ

Source: Renewable Fuels Association[x]

Additionally, for the second-generation ethanol, the raw material used is the farm waste like corn cobs, rice husks, wheat straw and sugarcane bagasse that can all be transformed into cellulose and fermented into ethanol[xi]. This process takes away farm waste that is burned in the farm lands to prepare the soil for next sowing season. Every year, the smoke produced from stubble burning by farmers in North India has been a major subject of concern due to the considerable health risks it poses[xii].

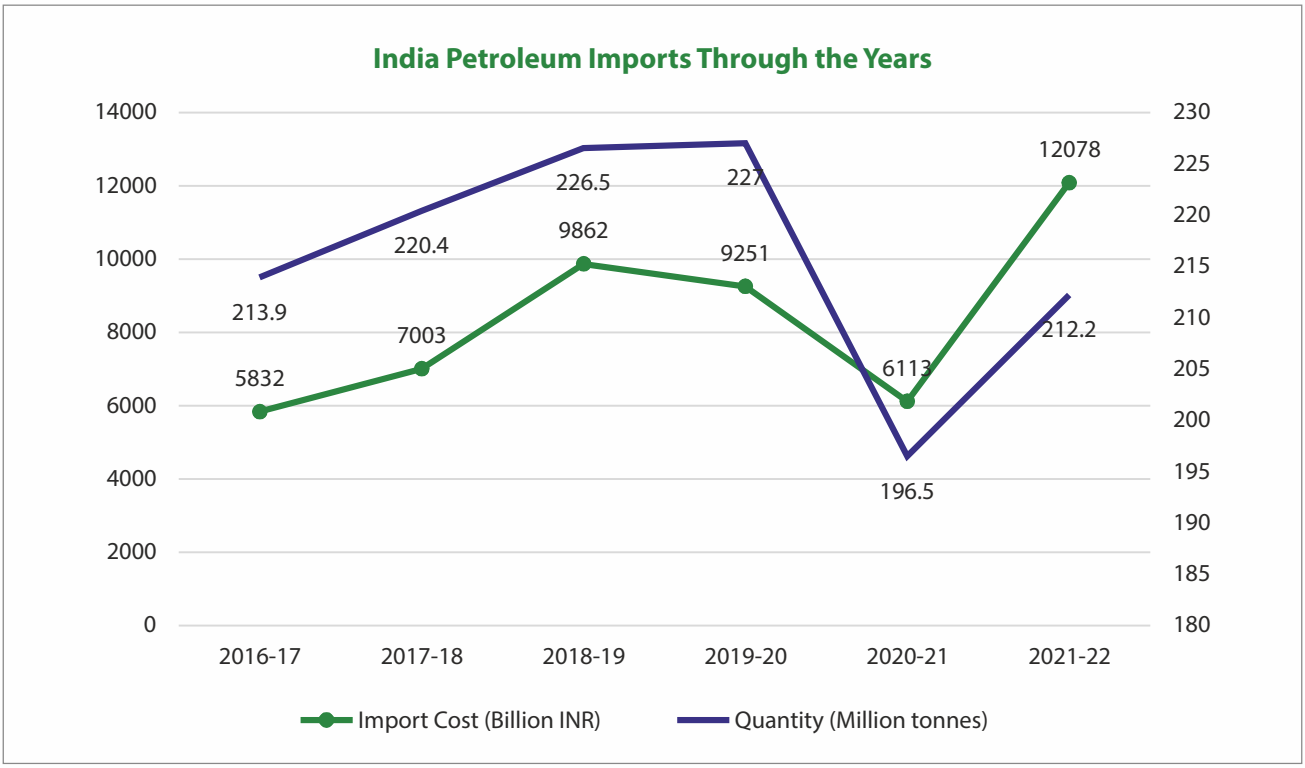
With the diversion of farm waste towards production of the biofuels like ethanol, emissions due to traditional practices like Parali burning will be curbed. The 2G ethanol plant at IOCL's Panipat refinery, which is the country's first such commercial project, which will directly manufacture 100 kilogrammes of ethanol per day from 425.5 metric tonnes of dry corn stover. According to its current capacity, this factory will consume around 4,250 quintals of paddy straw from approximately 212 acres each day and empty approximately 77,562 acres each year, thus saving emissions[xiii].

Renewable source of fuel

Unlike the mining of coal, production of petroleum and natural gas, renewables convert natural resources directly into fuel sources. Additionally, as sourcing fossil fuels is becoming harder and more expensive to procure for utilization at the cost of natural habitats and significant finances, renewable energy never runs out[xiv].

Fuel Security for the Nation

India's crude oil import bill surged 76% to $90.3 billion in the first half of 2022-23 even as the total import quantity increased by 15% to 116.6 million tonnes because of geopolitical scenario[xv].



Source: Petroleum Planning and Analysis Cell, MoPNG, Govt of India[xvi, xvii]

The current ethanol blending levels have saved approx. INR 41,000 crores worth of fuel imports for the nation[xviii]. Mixing 20% ethanol in petrol will potentially reduce Indian fuel imports by INR 30,000 Crores per annum[xix].

Diversification of Farm Economy

The major Ethanol Production methods are as follows:

Classification	Raw Material	Ethanol producing organic molecule
1st Generation	C & BH Molasses	Sugary (Glucose, Fructose, Sucrose)
	Sweet Sorghum Juice	
	Grains: Corn, Sorghum, Rice, Wheat, Millet	Starch
	Cassava (Tapioca)	
2nd Generation	Lignocellulosic biomass: Bagasse, Sugar Cane Trash, Corn Cobs, Rice Straw etc.	Cellulose & Hemicellulose
	Pet coke & Municipal Solid Waste	Complex Mixed Organics

Sugar Manufacturers

In both 1st & 2nd generation production methods, sugar producers can provide raw materials required for ethanol production. Using already available raw materials, multiple sugar manufacturers have jumped on the ethanol production bandwagon.

Due to growth in exports of sugar and ethanol, Sugar industry in India is expected to grow by 6-7% in the years 2021-2022[xx]. According to the Department of Economic Affairs, sugar mills/distilleries generated revenue of about ₹35,000 crore from the sale of ethanol to OMCs in the past four sugar seasons ending 2020-2021, which helped in clearing the sugar cane price arrears owed to farmers[xxi].

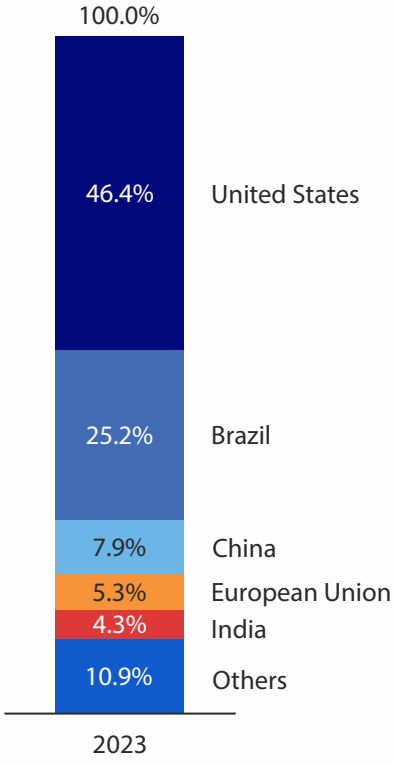
Farmers

Indian farmers, which form approx. 41 % of the total employment[xxii], earn INR 10,218 per household in a month. The net receipts from crop production increased by 22.6% as compared to the figures in 2014, net receipts from other sources increased by 92.6% with increase in overall net receipts at 59% with respect to the same figures in 2014[xxiii].

The production of ethanol in the sugar distilleries and usage as a fuel will allow diversification and thus, safer economic avenues for the households, dependent on farm incomes. Additionally, a conducive and sustainable ecosystem for 2G ethanol production method will allow usage of farm waste generated. This will once again boost income of farmers and prevent some traditional waste disposal practices that harm farm output and surrounding environment.

Adoption of Ethanol

Global Context



Global Ethanol Production Share

Data Source: OECD-FAO Agricultural Outlook 2023-2032[xxiv]

As of 2023, the global ethanol market is dominated by five major players – United States (46.4%), Brazil (25.2%), China (7.9%), European Union (5.3%) and India (4.3%).

Brazil and the United States have been leaders in biofuel production and adoption, primarily through ethanol and biodiesel over the last three decades.

Brazil produces around 7 billion gallons of ethanol annually. The country pioneered ethanol integration into the transportation sector in the 1970s, with the Proalcool plan, an initiative aimed at reducing the country's reliance on fossil fuels by blending gasoline with ethanol, investing in research and development, expanding sugarcane cultivation, and boosting ethanol plant capacities.

In March 2024, Brazil's Congress approved the "Fuel of the Future" bill, focusing on the production of sustainable aviation fuel, biodiesel, and biomethane, in addition to increasing ethanol blending targets. Today, the blending requirement for ethanol and biodiesel stands at 27% and 14%, respectively.

The U.S. is the world's largest ethanol producer, generating approximately 17.7 billion gallons of corn-based ethanol annually, which constitutes about 10% of the country's gasoline supply.

Meanwhile, the European Union focuses on biodiesel sourced from rapeseed, soybeans, and waste oils.

Indian Context

India began ethanol blending in petrol as a pilot project in 2001 to support the agriculture sector and reduce environmental pollution. The government supplied 5% ethanol-blended petrol to retail outlets and conducted R&D studies alongside field trials. The success of these trials led to the establishment of the Ethanol Blending Petrol (EBP) program in India.

In January 2003, the Indian government launched the Ethanol Blending Petrol (EBP) Programme in 9 states and 4 Union Territories, offering 5% ethanol-blended petrol. After positive outcomes, the Ministry of Petroleum & Natural Gas expanded the program to 20 states and 4 Union Territories from September 20, 2006. Public Sector Oil Marketing Companies (OMCs) were asked to sell 5% ethanol blended petrol subject to commercial viability as per Bureau of Indian Standards (BIS) specifications in the notified states and UTs[xxv].

Despite starting early, the programme faced multiple challenges leading to mixed results with average blending ranging from 0.1% to 1.5% till 2013-14.

Key challenges faced by the Ethanol Blending Programme in India were:

- Non-inclusion of conversion of grains to Ethanol, resulting in restriction of grain-based distilleries' participation in the EBP Programme (Only Molasses based distilleries were part of the EBP Programme)
- High Taxation on Ethanol (18% tax rate was applicable)
- Procurement Challenges due to poor infrastructure and multiple tenders' applications on a given Ethanol Supply Year (ESY)
- Dissatisfactory 'take home' price and irregular pricing for ethanol suppliers
- Limited feedstock (raw material) availability
- Constraints on the part of State Government Policies

However, the true potential of ethanol blending was never disputed. Since 2014, concerted interventions by the Indian Government have led to remarkable improvements. By June 2022, India achieved the 10% ethanol blending target, and by July 2024, it surpassed the United States with a 15% ethanol-blended fuel as the standard.

Interventions by the government since 2014 are tabulated below:

Timeline	Government Interventions
Dec 2014	Re-introduced administered price mechanism for ethanol to be procured under the EBP Programme
Jan 2015	Opened an alternate route for Ethanol Production (2nd Generation including Petrochemical); Also directed Oil Public Sectors Enterprises (PSEs) to set-up Bio-refineries
ESY 2014-2015	Steps taken towards easing tender conditions – Multiple EOIs being floated, transportation slabs and rates announced
May 2016	IDR (Industries Development & Regulation) Act Amendment on 14th May 2016 to clarify the roles of Central and State Government for uninterrupted supply of ethanol to be blended with petrol under the EBP Programme
ESY 2016-2017	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; The policy is aimed at taking forward the indicative target of achieving 20% blending of biofuels with fossil-based fuels by 2030; Amendment in policy was done in 2022 to revise the blending target to 20% by 2025-26
Jul 2018	Interest Subvention Scheme for Enhancement and augmentation of ethanol production capacity in the country. Government to provide interest (interest subvention) for a period of 5 years; GST on ethanol lowered from 18% to 5%; Financial assistance in the form of interest subvention at 6 per cent per annum or 50 per cent of rate of interest charged by banks, whichever is lower, on the loans to be extended by banks for five years, including one-year moratorium;
ESY 2018-2019	Allowed conversion of B heavy molasses, sugarcane juice and damaged food grains into ethanol; Fixed differentiated ex-mil 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 & Molasses
Apr 2019	Extension of EBP Programme to whole of India except Island UTs of Andaman Nicobar & Lakshadweep islands
Sep 2019	New sources sugar & sugar syrup introduced for ethanol production at fixed remunerative price
Oct 2019	Published "Ethanol Procurement Policy on a long-term basis under EBP Programme"
Aug 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; Opened a fresh window for inviting applications under interest subvention scheme for ethanol projects based on cane & Molasses;

Timeline	Government Interventions
Oct 2020	Further easing 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.; Approval of National Biofuel Coordination Committee(NBCC) to utilize 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 utilize 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 feedstock's like sorghum, sugar beet etc. apart from molasses based distilleries; DFPD extends financial assistance to project proponents for enhancement of their ethanol distillation capacity or to set up distilleries for producing 1st generation (1G) ethanol from feed stocks
Jun 2021	Roadmap for ethanol blending in India 2020-2025 report released by the Prime Minister; Pilot project of E100 dispensing from 3 locations at Pune launched
Oct 2021	Centre doubles incentives on sugar sacrificed for producing ethanol
Nov 2021	Cabinet committee on Economic Affairs gave approval for fixing higher ethanol prices derived from different sugarcane-based raw materials under EBF Programme from 01 Dec 2022 to 31 Oct 2023; Oil PSEs given the freedom to decide the pricing for 2G ethanol
Dec 2021	Government fixed higher ethanol price derived from different sugarcane based raw materials; Government lowered the GST to 5% from 18% on Ethanol meant for blending; Centre fixed 10% blending target for ESY 2021-22 & 20% by 2025-26[xxvi];
Oct 2022	To encourage the blending of fuel, the Union Budget 2022-23 announced an additional differential excise duty of Rupees Two per litre on unblended fuel from the 01 October 2022;
Sept 2023	Launch of Global Biofuel Alliance by India at G20 Event, New Delhi to expedite uptake of biofuels through collaborative efforts among the member nations
Mar 2024	E100 fuel launched at select 183 retail outlets across five states – Maharashtra, Karnataka, Uttar Pradesh, New Delhi, and Tamil Nadu

With ongoing government initiatives, the Ethanol Blending Programme is on track to achieve a 20% blending target by 2025-26.

In line with the '*Panchamrita*' announced by the Prime Minister at COP26 in Glasgow, the Government of India is increasingly pushing for use of ethanol-blended fuel. These efforts support the 'Make in India' initiative, reduce petroleum imports, and promote the "*Aatmanirbhar Bharat*" campaign, contributing to India's goal of becoming a net zero economy by 2070.

Support from Indian Government

The Indian government is actively pushing for advancement in the Ethanol Blended Petrol (EBP) programme through several policy interventions. Key measures include the National Policy on Biofuels (2018), the Long-Term Ethanol Procurement Policy (2019), and the Pradhan Mantri Ji-Van Yojana (2019) to support 2G ethanol production.

According to the Final Ethanol Procurement Policy by MoPNG, Oil Marketing Companies (OMCs) have been mandated to procure ethanol from various sources such as C heavy molasses, B heavy molasses, sugarcane juice, sugar, sugar syrup, damaged food grains, surplus food grains, and fruit and vegetable wastes[xxvii]. The government is administering the ethanol prices for the EBP programme, setting fixed prices for sugarcane-based raw materials, while OMCs[xxviii] determine prices for ethanol from damaged and surplus food grains.

An interest subvention scheme has also been introduced to boost ethanol production capacity, benefiting grain-based distilleries and those producing ethanol from alternative feedstock like sorghum and sugar beet. This measure is projected to enhance the production capacity of about 114 sugar mills by approximately 200 crore litres per annum over the next 3 years[xxix].

The Pradhan Mantri Ji-Van Yojana provided viability gap funding to support the development of 2G ethanol capacity, attracting investment in this sector. The scheme offered financial support to 12 integrated bio-ethanol projects using lignocellulosic biomass and other renewable feedstock, with a total outlay of INR 1969.50 crore for the period 2018-19 to 2023-24.

Initiatives by SIAM

The Society of Indian Automotive Manufacturers (SIAM) is dedicated to facilitating the industry's transition to low-emission fuels while ensuring sustainability. The year 2022 marked a significant milestone in the adoption of biofuels with the launch of "Jaivik Pehal" as one of SIAM's sustainability pillars. Since then, numerous events and conferences have been held, focusing on shaping the future pathway for biofuel adoption in the country.

The key initiatives taken by SIAM for promotion of biofuels in the country:

- Launch of Annual international conference – "World Biofuel Day" in Aug 2022
- International Conference announcing 'CLEAR' strategy which would give rise to Jaivik Pehal – 19 Oct 2022
- Technical Demonstration showcasing flex fuel vehicles for the first time in India – 12 Dec 2022
- Launch of "Jaivik Pehal" under SIAM's Sustainable Mobility Pillars in FY22-23
- International Symposium on thriving Eco-energy in mobility (ISTEM)'s 1st edition organized to establish the discourse of Jaivik Pehal amongst stakeholders – 13 Jan 2023
- MoU signed with Brazil for further international collaboration in 2023
- Launched Ethanol Pavilion at Auto Expo 2023 followed by Decarbonisation Pavilion at Bharat Mobility Global Expo (BMGE) 2024

International Biofuels Conference

Ethanol 'CLEAR' strategy launched

Flex Fuel Vehicle Demo in India

Ethanol Pavilion @ Auto Expo 2023

1st ISTEM @ Auto Expo 2023

Jaivik Pehal Initiative Launched

MoU signed with USGC

Decarbonization pavilion @BMGE

Images Courtesy: Events organised by SIAM

Apart from annual conferences and events, SIAM continues to engage with industry stakeholders through facility visits and green tea events.

Challenges in Biofuel Adoption

India is making significant progress towards meeting its ethanol blending targets in petrol. In the 2022-23 ethanol supply year, the country achieved a 12.1% ethanol blending rate, supported by increasing ethanol production capacity. As of August 1, 2024, India has reached an annual production capacity of 1,589 crore litres.[xxx] This capacity is sufficient to meet the E20 target requirements.

However, to sustain this momentum, we must address several challenges. These include securing a consistent supply of ethanol, expanding the availability of ethanol through enhanced storage capacity and transportation infrastructure nationwide, and ensuring vehicle compatibility with higher ethanol blends to boost customer acceptance.

Ensuring Ethanol Supply

As per estimates from NITI Aayog, to achieve the 20% ethanol blending target, India will require approximately 1,350 crore litres of ethanol annually by 2025-26, with 1,016 crore litres to be used for blending purpose, while the remaining 334 crore litres to be allocated for other industrial applications. 684 crore litres of the projected total ethanol demand will be sourced from sugarcane, with the rest (666 crore litres) being grain-based.

Indian Ethanol Projection

Values in Cr litres

ESY	For Blending			Blending %	Other uses			Total		
Sources	**Grain**	**Sugar**	**Total**		**Grain**	**Sugar**	**Total**	**Grain**	**Sugar**	**Total**
2023	123	425	542	12%	170	110	280	293	535	828
2024	208	490	698	15%	180	110	290	388	600	988
2025	438	550	988	20%	190	110	300	628	660	1288
2026	**466**	**550**	**1016**	**20%**	**200**	**134**	**334**	**666**	**684**	**1350**

Ethanol Supply Year (ESY) is from Nov to Dec; Source: Niti Aayog Report - Roadmap for Ethanol Blending in India 2020-25[xxxi]

Thus, with a 90% plant utilisation, total production capacity needed will be 1,500 crore litres against a capacity of 1,380 crore litres as of Nov 2023.

Indian Ethanol Supply Demand Balance

		ESY	2022-23	2025-26 (F)	2029-30 (F)
Government Targets	Government Ethanol Blending Target	%	12%	20%	20%
	Petrol Requirement	Cr. Ltrs	4515	5080	5600
	Targeted Ethanol Production Req.	Cr. Ltrs	542	1016	1120
Ethanol Supply	Ethanol Capacity (Plant)	Cr. Ltrs	1380	1500	1610
	Ethanol Production	Cr. Ltrs	502	1016	1124

Source: Niti Aayog Report – Roadmap for Ethanol Blending in India 2020-2025[xxviii]

Ethanol production in India currently relies heavily on molasses, a byproduct of the sugarcane production process, and rice. This dependency on these water-intensive crops raises concerns about prioritizing food versus fuel. With over half of India's cropped area dependent on monsoon rains, erratic weather patterns pose a risk to the blending program. The reliance on these crops for ethanol blending will demand large-scale land use and significantly impact water availability. For instance, meeting the blending targets through increased sugarcane production would require an additional 6.26 million hectares under cultivation.

Similarly, diverting rice from Food Corporation of India (FCI) stocks also poses challenges, as it will require ramping up the supply to 17 million tonnes, compared to just 78,000 tonnes in 2021-22. The issue of feedstock availability is quite evident, with the government limiting the use of sugarcane juice and syrup for ethanol production in December 2023 to stabilize sugar prices. Few months earlier, FCI had also suspended supply of rice to distilleries to ensure rice availability.

To address these challenges, the government is emphasizing a shift towards maize for ethanol production, which requires 75% less water. However, even this shift would require an additional 4.82 million hectares under cultivation. Furthermore, there is competition among stakeholders for feedstock crops; sugar mills may favor exporting due to higher global prices, while oil marketing companies (OMCs) require more ethanol for blending purposes.

To address these challenges, India must explore solutions beyond conventional first-generation (1G) ethanol production. Second-generation (2G) ethanol, which utilizes lignocellulosic biomass such as corn husks, rice husks, wheat straw, and sugarcane bagasse, as well as waste materials, offers a promising solution. India has an annual surplus of 160 million metric tonnes of agricultural residue, which can potentially produce 2,400 crore litres of 2G ethanol.

Under the PM JIVAN scheme, India has initiated the development of 2G ethanol plants. However, the commercialization of this technology has faced challenges due to process complexities and feedstock procurement issues. The Global Biofuel Alliance, launched in September 2023, aims to advance the development and adoption of biofuel technologies among its members. This alliance includes 19 countries and 12 international organizations, such as the World Economic Forum, the World Bank, and the Asian Development Bank. This initiative is expected to significantly enhance efforts to develop technically feasible and economically viable solutions for 2G ethanol production in India.

Expanding Ethanol Availability

To achieve large scale adoption of ethanol blends in India, it is essential to establish a robust supply chain that facilitates the efficient distribution of ethanol across the country. Initially, this involves increasing ethanol storage capacity. Oil Marketing Companies (OMCs) have already initiated work to expand capacity from the current 18 crore litres to 45 crore litres by 2025. Additionally, exploring the use of pipelines for ethanol transportation in the future could help minimize the carbon footprint associated with its distribution.

Additionally, policy interventions are needed to ensure a steady supply of biomass for fully utilizing 2G ethanol plants. This will require effective management of agricultural waste, including incentivizing farmers and developing local storage facilities to aggregate waste from villages. These measures will support a sustainable supply chain for 2G ethanol production.

Ensuring Vehicle Compatibility

From an Original Equipment Manufacturer (OEM) perspective, as India transitions to E20 petrol fuel by 2025-26, all vehicles operating on Indian roads will need to be compatible with E20. In response, OEMs have developed and showcased E20/flex-fuel vehicles, ensuring that all new vehicles sold from April 2023 onward are E20 compliant. However, most existing vehicles on the road are currently compatible only with E10, with only a small fraction optimized for this blend.

To make these vehicles compatible with E20, engine tuning and various engineering interventions in fuel systems, electrical systems, exhaust systems, and engine components will be required. Developing upgraded components for the numerous vehicle variants and retrofitting them onto the existing fleet presents a significant challenge. Therefore, ensuring the availability of protection grade E10 fuel across the country is crucial. Additionally, educating customers about their vehicle's compatibility with different fuel grades is necessary to counter any misinformation and promote the adoption of higher ethanol blends in India.

Conclusion

Biofuels offer a viable solution for India to address rising carbon emissions and fulfil its decarbonization goals. However, to fully harness the potential of biofuel adoption, it is essential to explore ethanol production beyond food crops. The government's efforts to diversify ethanol sources are a positive development for the industry.

Research and development in second generation (2G) and third generation (3G) ethanol plant technologies should be encouraged through leveraging the advancements made by major ethanol producers like Brazil and the United States. Incentives for 2G ethanol production through mechanisms such as carbon credits and green credits can further support technology development.

Awareness campaigns, combined with supportive policies, will encourage farmers to utilize farm produce and agricultural waste effectively. Implementing schemes such as Minimum Support Prices (MSP) for relevant 1G ethanol feedstock grains to ensure a stable feedstock supply will also strengthen the efforts.

Competitive ethanol pricing and Production-Linked Incentives (PLIs) will incentivize alternative fuel producers to maintain a consistent ethanol supply, regardless of raw material production cycles, thus providing Indian consumers with a stable fuel supply.

Vehicle manufacturers in India will also require policy support in the form of carbon credits / green credits or tax breaks for meeting emission norms. As key stakeholders, OEMs should actively undertake initiatives to raise consumer awareness about flex-fuel vehicles and offer more models.

Lastly, customers need attractive fuel pricing, a continuous fuel supply, and a robust vehicular support for higher ethanol blends. Achieving this will need a comprehensive policy framework, a dedicated industrial ecosystem, and effective change management strategies.

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