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Report Highlights:

India's 2021 average ethanol blending rate in gasoline is estimated at 7.5 percent due to curtailed fuel pools from the COVID-19 pandemic and accelerated government efforts to divert more feedstock toward ethanol. Surplus sugar production, coupled with stronger financial incentives for fuel blending, will enable parastatal oil marketing companies to procure an estimated 2.7 billion liters in calendar year (CY) 2021, a 56 percent increase from 2020. India's strong demand for industrial grade ethanol will result in an estimated 750 million liters of imports, nearly all from the United States. As for biodiesel, the market remains limited owing to high feedstock prices and plant closures due to the pandemic, as India continues to develop the required infrastructure for used cooking oil.

THIS REPORT CONTAINS ASSESSMENTS OF COMMODITY AND TRADE ISSUES MADE BY USDA STAFF AND NOT NECESSARILY STATEMENTS OF OFFICIAL U.S. GOVERNMENT POLICY

Section I. Executive Summary

India has accelerated its efforts to reach its ambitious goal of E-20 by ESY* 2025. In January 2021, the Indian government announced its E-20 target year of ESY 2025 as opposed to 2030, while retaining its immediate goal of E-10 by ESY 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.

*Note: Unless otherwise noted, calendar year (CY) is used in this report, which is January to December. Fiscal year (FY) is April to March. Marketing Year (MY) or Ethanol Supply Year is December to November.

In 2020, the Government of India (GOI) expanded the scope of Ethanol Blending Program (EBP) to include surplus rice and maize as viable feedstocks, as well as B-heavy and C-heavy molasses, sugarcane juice and damaged food grains to reach its blending goals. Relatively weak institutional sugar consumption occurred as a result of weak demand during traditionally peak consumption months (March-May) as a result of successive COVID-19 lockdowns. This factor, along with favorable fuel ethanol procurement prices will aid India's parastatal oil marketing companies (OMC) to obtain an estimated 2.7 billion liters for blending with gasoline in 2021, a significant increase from the 1.73 billion liters procured in 2020.

India will achieve record fuel ethanol market penetration, reaching 7.5 percent blending in 2021, due to reduced gasoline demand as mobility remains limited from a series of pandemic-related lockdowns in several parts of the country. In turn, Post has revised its 2020 estimate of a 5.2 percent blend rate to five percent, reflecting final fuel ethanol volumes procured by OMCs. India may appear in reach of achieving E-10 by 2022 due to the unprecedented decline in gasoline demand. At pre-pandemic projected fuel pool estimates, India would have likely achieved a blend ratio of 3.7 percent and 5.4 percent in 2020 and 2021, respectively.

Fuel and non-fuel ethanol consumption will outgrow domestic production for the seventh consecutive year. In 2021, ethanol imports will largely fulfil supply to support the industrial and alcoholic beverage sectors. Government of India policies have attempted to augment domestic production, including an increased customs duty for denatured ethanol and the continued prohibition of imported ethanol for fuel blending. Post estimates 62 percent of India's domestically produced ethanol (undenatured and denatured) in 2021 will to be used for the EBP, indicating that significant space exists for imported non-fuel use ethanol in the near term. In 2020, the United States remained the largest ethanol supplier to India, with a market share of 99 percent. Ethanol imports are forecast to grow four percent to 750 million liters (almost all denatured) in 2021.

Biodiesel market penetration for on-road diesel remains marginal and is estimated at 0.09 percent. Contributing factors include the COVID-19 induced national lockdowns that led to plant closures, a contracted diesel pool and high feedstock prices (vegetable oils). The Indian government is working on developing a consistent used cooking oil (UCO) supply chain, having discontinued its decade- long effort to develop a viable feedstock industry based on jatropha (*Jatropha curcas*), which is grown on rain-fed, non-arable lands. Most biodiesel produced goes to informal sectors with support from OMC procurement, but demand remains insufficient. Additionally, a lack of larger feedstock supplies has prohibited market development. The government's import restrictions enacted in 2019 remain in place, while India's biodiesel exports are expected to reach 50 million liters, more than a quarter of its total production. Nearly all biodiesel exports go to Europe to capitalize on European Union (EU) incentives to waste-based biofuel exporters.

Consecutive years of national lockdowns (March-May) in response to the COVID-19 pandemic have limited consumer mobility and fuel usage. However, Post does not anticipate a significant impact on India's ethanol or biodiesel consumption, because the fuel pool size has no bearing on domestic biofuels use, which remains well below any set targets and is determined year to year by available domestic feedstock supply. Ethanol blend targets are determined by tender pricing, which in practice have secured only a portion of the aspirational mandate in any given year. However, with the increased impetus to divert surplus sugar toward ethanol and India's newly announced near-term blend targets, OMCs will be under pressure to procure significantly higher volumes. For biodiesel use, the larger pool size is irrelevant, given that market penetration is marginal and remains largely restricted to disbursed and informal groups.

With continued prohibitions on ethanol imports for fuel blending and high biodiesel import duties, India's national biofuel policy remains beneficial to the domestic sugar industry, including funds for cane arrears[1] that totaled $2.58 billion in the 2020/21 market year (MY). Additionally, domestic ethanol production aligns with the Modi Administration's "Self-Reliant India" strategy to strengthen the rural economy and generate employment, reduce oil imports and save on its crude oil import bill.[2] This biofuel policy has supported India's sugar sector with less emphasis on change, reducing air pollution and resulting human health benefits. Commercial-scale advanced biofuels production such as cellulose-based ethanol or syngas remain unviable, despite a decade of government support programs.

If India is to meet its near-term blending goals, biofuels and biofuel feedstock imports will need to be permitted to supplement domestic production, given the projected growth of the domestic fuel demand and despite the temporary drop in fuel consumption from COVID-19.

Section II. Policy and Programs

A) India's Biofuel Policy 2018

India advanced its national average target of 20 percent ethanol blended with gasoline to 2025, while allowing the sale of E-20 blended gasoline from April, 2023 (Source: Gazette of India). Originally, the 2018 National Biofuels Policy foresaw the achievement of E-20 by 2030; however, in January 2021, the government pushed forward the E-20 goal from 2030 to 2025 (Source: Press Information Bureau [PIB]). India 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 (1-G, 2-G and 3-G[3]),
2) Use of multiple feedstocks, [4] and
3) Encouraging biofuel blending to supplement gasoline and diesel use in vehicles and machinery, as well as in stationary and portable power applications.[5]

[1] Also known as debt obligations.
[2] In CY 2020, India imported $64.8 billion in crude oil a significant drop due to the COVID-19 pandemic.
[3] 1-G: First generation, 2-G: Second generation, etc.
[4] The Government of India has proposed a National Biomass Repository.
[5] Other applications include diesel generators or water pumps for irrigation.

Fuel Ethanol National Blend Rate - Ten 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 Ethanol Blending Program 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 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[6] from $82/metric ton (MT) to $55/MT. India is likely to continue its sugar export subsidies until 2023, as per the World Trade Organization'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.

On May 31, 2021, the Indian government amended the 1966 Sugarcane Control Order to allow the establishment of stand-alone ethanol units to boost production. Formerly, ethanol could only be produced from molasses or sugar juice (Source: Gazette of India). However, India's existing ethanol distillation capacity is insufficient to accommodate surplus sugar as a feedstock to produce ethanol. The Indian government began advocating for using alternative viable feedstocks like cereals (rice, wheat, barley, maize, and sorghum) along with sugarcane and sugar beet to achieve its blending mandates. On December 30, 2020, the Department of Food and Public Distribution (DFPD) under the Ministry Of Consumer Affairs, Food and Public Distribution approved an interest subvention grant[7] of $626 million (Indian Rupee [INR] 45.7 billion). The modified scheme predicts interest disbursements for five years, including a one-year moratorium against the loan availed by project proponents from banks at an interest rate of six percent annually, or 50 percent of the rate of interest charged by the banks (whichever is lower).[8] The subsidy supports augmenting ethanol capacities for the following categories:

- Establishing new, or expanding the capacity of, existing stand-alone grain-based distilleries (whether attached to sugar mills or not) and use dry milling process.
    - DFPD has received 186 proposals under this category; a list of applicants can be accessed here.
- Construction of new, or expanding the capacity of, existing molasses-based distilleries to produce ethanol and for installing any method approved by Central Pollution Control Board for achieving Zero Liquid Discharge.

[6] Source: Department of Food and Public Distribution.
[7] Interest subvention is the subsidy offered on interest rates, and is a form of waiver of some percentage of interest. It is typically offered on several lending schemes by the government to promote a particular industry or general public interest.
[8] See: DFPD announcement.

- Construction of new, or expanding existing capacity of, dual feed distilleries;
  - DFPD has received 27 proposals under this category; a list of applicants can be accessed here.
- Converting existing molasses-based and grain based distilleries (whether attached to sugar mills or not) to dual feed systems (molasses and grain/or any other feed stock producing 1G ethanol).
  - DFPD has received 80 proposals under this category; a list of applicants can be accessed here.
  - DFPD has received 113 proposals under dual feed category; a list of applicants can be accessed here.
- Construction of new, or expanding capacity of, existing distilleries using alternative feedstocks like sugar beets, cereals, sweet sorghum, etc. to produce 1G ethanol.
- Installing a Molecular Sieve Dehydration column for converting rectified spirit to ethanol in existing distilleries.
  - DFPD has received 12 proposals under this category; a list of applicants can be accessed here.

On March 17, 2021, the state of Bihar became the first to officially launch its 2021 Ethanol Production Promotion Policy under the 2018 National Biofuels Policy. The policy allows ethanol production from a variety of feedstocks and provides a subsidy equivalent to 15 percent of the cost of the plant and machinery, subject to a maximum of $0.68 million (INR five crores[9]) along with the existing incentives under the Bihar Industrial Investment Promotion Policy, 2016 (Source: Department of Industries Circular).

To encourage 1-G ethanol production and promote fuel-grade ethanol as an indigenous, relatively less polluting fuel, the GOI established a program worth $41.16 million (INR 3.0 billion) 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 $2.58 billion (INR 19,000 crores) and $534 million (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 1.89 billion liters of capacity in the next two years, it will increase domestic ethanol production capacity from the existing 4.26 billion liters, to 6.15 billion liters. However, to achieve E-20 by 2025, India would need an estimated output of nine billion liters (Table 1), implying that India will need to create three billion liters 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 45 billion liters). Supplementing existing domestic production with imports would allow India to achieve E-20 within this time frame.

Table 1: Annual Ethanol Requirement in 2025 for E-20 (Billion Liters)

State/Union Territory	Projected Gasoline Sales	Projected Ethanol Requirement
Andhra Pradesh	1.88	0.37
Bihar	1.35	0.27
Delhi	1.47	0.29
Gujarat	2.57	0.51
Haryana	1.56	0.31
Karnataka	3.30	0.66
Kerala	2.44	0.48

[9] One crore equals ten million.

Madhya Pradesh	2.16	0.43
Maharashtra	5.29	1.05
Odisha	1.25	0.25
Punjab	1.41	0.28
Rajasthan	2.37	0.47
Tamil Nadu	4.12	0.82
Telangana	1.93	0.38
Uttar Pradesh	5.02	1.00
West Bengal	1.56	0.31
Rest of India	5.24	1.04
Total	**45**	**9.0**

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 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.

B) Ethanol Policy

Expanded Eligible Feedstock and 2-G Purchasing Agreements

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 (Source: DFPD).

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[10] 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 (Source: DFPD).

Ethanol Administered Price

On October 29, 2020, the Cabinet Committee on Economic Affairs approved an increase in the ethanol purchase price for the ethanol supply period from December 1, 2020 to November 30, 2021. The price changes are as follows:

- Ethanol derived from C-heavy molasses is fixed at INR 45.69/liter ($0.61/liter), up from the previous price of INR 43.75/liter.

[10] Escrow is a contractual arrangement in which a third party receives and disburses money or property for the primary transacting parties, with the disbursement dependent on conditions agreed to by the transacting parties.

- Ethanol produced from B-heavy molasses and partial sugarcane juice is fixed at INR 57.61/liter ($0.77/liter), up from the previous price of INR 54.27/liter.
- Ethanol derived from 100 percent sugarcane juice/sugar/sugar syrup is fixed at INR 62.65/liter ($0.84/liter), up from the previous INR 59.48/liter price for mills that will divert 100 percent sugarcane juice for ethanol production.
- Ethanol derived from damaged food grains unfit for human consumption and maize is fixed at INR 51.55/liter ($0.68/liter).
- Ethanol derived from surplus rice procured from the Food Corporation of India has been fixed at INR 56.87/liter ($0.76/liter).

Further, the Government of India is reassessing the Goods and Services Tax (GST) and transportation charges. The oil marketing companies are required to fix realistic transportation charges so that long-distance ethanol transport is not discouraged. Ethanol is prioritized in the following order: 100 percent sugarcane juice, B-heavy molasses/partial sugarcane juice, C-heavy molasses, and damaged food grains and other sources (See: PIB).

Import Licenses Remain Compulsory for Biofuel (non-fuel use) Imports to India

The license applies to denatured ethyl alcohol (all strengths), undenatured ethyl alcohol (strength by volume of 80 percent or higher), pure biodiesel, biodiesel blends over 30 percent, and petroleum oils containing up to 30 percent biodiesel. The Government of India increased the fair and remunerative price (FRP) for sugarcane in MY 2020/21 to $3.87 per 100 kilograms (INR 285/quintal). Given the sugar surplus in the MY 2021 season, the FRP will still remain less attractive for sugar mills as stronger incentive exists to divert more domestic ethanol for use in the EBP. This increase may further encourage industrial-use ethanol users to seek additional imports to fill their consumption gap, creating demand for both domestically produced and imported ethanol.[11]

Table 2. India: Ethanol Import Duty (percent ad valorem on customs insurance, and Freight [CIF] value)

ITC HS Tariff Number	Total Import duty
Ethyl alcohol and other Spirits, denatured, of any strength; denatured ethanol; and denatured spirits [2207 2000]	Basic custom duty on denatured ethanol for manufacture of excisable goods is five percent. However, denatured spirits assessed five percent duty for all goods except above**
Undenatured Ethanol [2207 1000] of an alcoholic strength by volume of 80 percent or higher	150 percent (SWS of 10 percent on basic Customs duty exempted, State excise/value added tax as applicable)

Source: www.cbic.gov.in (updated as of May, 2021).
*: If the importer follows the procedure set out in the Customs (import of goods at concessional rate of duty) Rules, 2017.
**: Ethyl alcohol used for blending gasoline will be assessed a five percent Integrated Goods and Service Tax, supplied to OMCs.
***: Central excise duty is a fixed amount and not a percentage on price. Additionally, as indicated in 2019, the five percent road and infrastructure cess (tax) on ethanol-blended petrol has been abolished (Excise on Biodiesel, Excise on ten percent blend gasoline, Excise on five percent blend gasoline).

[11] This supposition assumes that international ethanol prices return to pre-COVID competitive prices and crude oil prices remain firm.

Table 3. India: Biodiesel Import Duty (percent ad valorem on CIF value)

ITC HS Tariff Number	Total Import duty
Biodiesel and mixtures thereof, not containing or containing less than 70 percent by weight of petroleum oils and oils obtained from Bituminous minerals (greater than B30 to B100) [3826 0000]	24.32 percent (ten percent basic plus ten percent Social Welfare Surcharge (SWS) on basic custom duty plus 12 percent Integrated Goods and Services Tax (IGST)***)
Petroleum oil and oils obtained from Bituminous minerals (other than crude), containing by weight more than 70 percent or more of petroleum oils, contain biodiesel, other than waste oils (B1-B30), [2710 2000]	30.98 (ten percent basic plus ten percent SWS on basic custom duty plus 18 percent IGST).

Source: www.cbic.gov.in, updated as of May, 2021.

Biodiesel Policy

India's aspirational biodiesel blend goal for on-road use is B5 by 2030. In 2021, the national average blend rate is estimated at 0.09 percent. Biodiesel is manufactured from imported palm stearin and small volumes of non-edible oils, used cooking oil (UCO), and domestically sourced animal fats. Biodiesel use remains negligible due to limited feedstock availability, a lack of an integrated and dedicated supply chain, and import restrictions. To meet its blending mandate, India would need to substantially invest in new plants to augment annual production capacity from its current effective capacity of 520 million liters, and create a supply chain infrastructure for UCO while enforcing necessary collection mechanisms. As yet, the GOI has not demonstrated a determination to induce or encourage substantially greater biodiesel production.

Domestically-sourced UCO was identified as a feedstock with a large, untapped potential for biodiesel production.[12] According to Indian Oil Corporation Limited (IOCL), there is potential for India to annually generate 2.2 billion liters of UCO. However, the lack of sufficient infrastructure for UCO collection poses a significant challenge (Source: Economic Times). On May 4, 2021, the Ministry of Petroleum and Natural Gas (MoPNG) announced a scheme for procuring UCO-based biodiesel from IOCL's Tikrikalan terminal. So far, 30 letters of intent (LOI) have been issued, of which IOCL has issued 23 LOIs for biodiesel plants aggregating to a total capacity of 229.5 million liters (557.57 MT/day). For more details on India's concerted efforts towards UCO please refer to GAIN: IN0122 and Repurposed Used Cooking Oil site).

Many biodiesel-producing countries largely rely on manufacturing units set up by large oil companies or vegetable oil refineries, whereas the space in India is dominated by entrepreneurs operating micro, small and medium enterprises who are typically fuel traders having relatively better access to the domestic fuels market. However, since biodiesel is a volume-driven industry, most traders opt for capital expenditure savings by establishing low cost biodiesel manufacturing units that largely process low free fatty acids (FFA)[13] feedstock (less than five percent) such as palm stearin, palm oil, among others that are often susceptible to the dynamics of vegetable oil markets. Market price fluctuations impact the operational viability of these units, making biodiesel production commercially less attractive than conventional diesel. Since feedstock cost is integral to

[12] Source: FSSAI Launches RUCO, and Press Note and Gazette Notification.
[13] Free fatty acids are formed when vegetable oil is subjected to high temperature during frying. One molecule of oil can yield three molecules of FFA. The levels of FFA in feedstock are critical in biodiesel production.

biodiesel production, manufacturing units must be modernized for flexibility having the required infrastructure to process all types of feedstocks, including UCO.

Other Biofuels: Drop-in-fuels, Bio-CNG, Bio-Hydrogen, Bio-methanol, Di-Methyl-Ether

The Ministry of Science and Technology's Department of Biotechnology (DBT) has supported biofuel feedstock development in the last decade through research initiatives, including international collaboration such as the Mission Innovation (IC4: Sustainable biofuels) program. The department has primarily focused on cellulosic ethanol (2G) technology development, while current research includes lignin valorization, algal biofuels, waste biomass to energy, biobutanol and biohydrogen (Source: DBT). To date, more than $30 million has been invested, and cellulosic ethanol production technology has been successfully demonstrated by one of DBT's bioenergy centers.

The National Institute for Transforming India (NITI Aayog), the Government of India's public policy expert body, estimated that India annually generates 62 MMT of municipal solid waste (MSW). This commodity has significant potential for agricultural compost, as well as for drop-in fuels[14] and energy production. Technologies are available that convert waste into biofuels and other biochemicals, but are in a nascent stage and must be proven on a commercial scale (Table 4). As of February 2021, five projects with a cumulative capacity of 74.7 megawatts (MW) have been approved in principal by the government.

On November 20, 2020, MoPNG signed a memorandum of understanding (MOU) with select oil and gas companies to establish 5,000 compressed bio-gas (CBG) plants in India with a cumulative capacity of 15 MMT by 2023/24. A financial outlay of $27.4 billion under the Sustainable Alternative Toward Affordable Transportation scheme is utilized to fund the CBG plants. According to the MoPNG, around 1,500 CBG plants remain under various stages of development (Source: PIB).

Table 4. India: Biofuel Research and Development Classification

Fuel	Substitute	Technologies Deployed
Diesel	*Biodiesel, **Green Diesel, Bio-based oxygenates (alcohols and ethers)	Esterification, Hydroprocessing, Fermentation, Syngas conversion
Aviation Turbine Fuel (ATF)	**Sustainable Aviation Fuel, or Bio-Aviation Turbine Fuel	Hydroprocessing, Sugar conversion, alcohol-to-jet, Fischer–Tropsch process
Gasoline (Petrol/Motor Spirit)	*Ethanol (1G), **Ethanol (2G), **Methanol, Green (drop-in) gasoline	Fischer–Tropsch process, Gas Fermentation, Alcohol-to-gasoline, Hydroprocessing, Pyrolysis/Catalytic Cracking
Compressed natural gas (CNG)/piped natural gas (PNG)	*Bio-CNG/Bio-PNG, HCNG, Bio-H2	Waste Fermentation
Marine Fuel/Industrial Fuel Oil	**Green heavy distillate, biomass-derived oils	Hydroprocessing, Pyrolysis/Fluid catalytic cracking, Hydrothermal Liquefaction, MSW-thermochemical processing

*Indicates technologies are available | **Indicates emerging technologies (in development)
Source: Department of Biotechnology (DBT), Ministry of Science and Technology.

[14] A drop-in fuel is a synthetic and completely interchangeable substitute for conventional petroleum-derived hydrocarbons and does not require engine, fuel system or the fuel distribution network adaptation.

C) Renewable Energy, Greenhouse Gas Emissions and Climate Change

Renewable Energy

India ranks fifth globally on installed renewable energy capacity and has an ambitious near-term target of achieving 175 gigawatts (GW) of installed capacity in renewable energy by 2022. This target includes 100 GW in solar, 60 GW in wind energy, ten GW from biomass and five GW from hydropower. India's long-term target remains at 450 GW by 2030. As of April 2021, a total capacity of 94.34 GW of renewable energy has been installed in the country, up nine percent over the corresponding period last year. With an estimated 42 percent consisting of wind energy, 42 percent in solar, 11 percent in bio-power, and five percent in hydropower, India has met its near term targets for biomass (10.3 GW) and hydropower (4.8 GW) production.[15]

Presently, there is a cumulative investment of $196 billion across 432 projects in the Indian renewable energy sector (397 federal projects and 35 private projects). Solar and wind power projects have attracted investments valued at $64.43 billion and $57.24 billion respectively. Major government initiatives in the renewable energy sector include 100 percent foreign direct investment, renewable purchase and generation obligations, the Green Energy Corridor Project with $6.5 billion to integrate renewable energy into the national grid, fiscal incentives like accelerated depreciation,[16] financing through the National Clean Energy Fund, priority sector lending from banks, and relatively easier environmental clearances for major electrical appliances (Source: Mint).

Furthermore, in April 2021, the Union Cabinet approved the Production Linked Incentive (PLI) Scheme for high efficiency solar photovoltaic modules for improving domestic manufacturing capabilities and enhancing exports under its broader "Self-Reliant India" strategy (Source: PIB). With an outlay of $612.2 million (INR 4,500 crores) the GOI aspires to generate an additional ten GW of integrated solar PV capacity and substitute imports by almost $2.4 billion (INR 17,500 crores). The "One World, One Sun, One Grid" aims to interconnect generators and loads across continents with an international power transmission grid supported by the International Solar Alliance and the World Bank.

Biomass power and cogeneration currently contributes up to 32 percent of India's total primary energy use. According to the Ministry of New and Renewable Energy, India's current biomass availability is estimated at 500 MMT, with 120-150 MMT of surplus products, including agricultural and forestry residues (bagasse, rice husk, straw, cotton stalk, coconut shells, coffee waste, etc.) and has the potential to generate an additional 18 GW of energy. The "Under the Waste to Energy" program, as cited above, envisages setting up 5,000 CBG[17] plants by 2023/24, with a production target of 15 MMT of bio-CNG and promoting MSW to power projects through central financial assistance.

India will continue to develop its regenerative economy (circular economic model[18]) as it increases electricity production from renewable sources like solar and wind, and the role of the bioenergy sector should be given more room to supplement grid stabilization and secure energy supply. Likewise, the surplus power generated

[15] Note that biofuels are not included as part of this broader renewable energy outlook.
[16] The accelerated depreciation benefit allows the commercial and industrial users of solar power in India to depreciate their investment in a solar power plant at a much higher rate than general fixed assets. This in return allows the user to claim tax benefits on the value depreciated in a given year.
[17] Compressed bio-gas is a renewable biofuel, derived by processing feedstocks such as biomass, agricultural residue, sugarcane press mud, cattle dung, etc.
[18] A circular economy is a restorative or regenerative industrial system and replaces the end-of-life concept with restoration, and the use of renewable energy.

can be utilized to produce biofuels and make bio-refinery operations more efficient to improve conversion rates and fuel output.

India is in its sixth year of Nationally Determined Contributions under the 2015 Paris Climate Agreement, where it pledged to reach three major climate change goals by 2030. The goals include a reduction in the emissions intensity of Gross Domestic Product (GDP) by 33 to 35 percent (from 2005 figures), achieving a rate of 40 percent electric power installed capacity from non-fossil fuels, and creating an additional carbon sink of 2.5-3.0 billion MT of carbon dioxide (CO_2) equivalent through additional forests and tree cover (Source: UNFCC).

Greenhouse Gas Emissions

India's total greenhouse gas (GHG) emissions are the third largest in the world, although per capita emissions remain well below the global average. In FY 2020/21, India's CO_2 emissions fell by 2.6 billion tons, or seven percent below 2019 levels due to the COVID-19 pandemic and national lockdowns. While this led to sharp reductions in emissions, those emissions will rebound as lockdowns ease and the economy recovers. The Government of India continues to encourage coal mining and increased coal production for power generation. Additionally, the International Energy Agency (IEA) forecasts a rebound in coal demand to meet rising electricity requirements, and expects 2021 CO_2 emissions to reach 30 MMT, or 1.4 percent higher than 2019 levels.

The Indian transportation sector is critical to achieving GHG reductions. Sectoral growth will continue to increase gasoline consumption, despite the temporary interval of reduced demand observed due to the national lockdowns in 2020 and 2021. Transportation consumes nearly 70 percent of the total diesel supply, 66 percent of which is used by passenger and commercial vehicles. Gasoline is also used for light-duty transportation, with 60 percent of supply used for two-wheelers such as motorcycles and scooters. Currently, diesel meets an estimated 46 percent of transportation fuel demand, followed by gasoline at 24 percent. Gasoline and on-road diesel consumption combined are forecast to rise over the next five years from the current estimate of 98 billion liters in 2018 to 126 billion liters by 2023. For 2020, the transportation sector is projected to have accounted for 21 percent of total final energy[19] use and 14 percent of primary energy use, versus 16 percent of total final energy use and 12 percent of primary energy use in 2005 (Source: IEA).

India is estimated to have more than 20 million vehicles nearing salvage by 2025, a figure that remains a significant impediment to India's environmental and pollution control goals. Concurrently, the Ministry of Road Transport and Highways introduced the Voluntary Vehicle-Fleet Modernization Program to contain the fleet size of old and defective vehicles, reduce air pollution, achieve better fuel efficiency, formalize the vehicle scrapping sector, improve road and automobile safety, and enhance cross electoral availability of low cost raw materials for domestic automotive, steel and electronics industries.

On December 22, 2020, the Ministry of Road Transport and Highways published a draft Automotive Industry Standard (AIS) containing procedural and safety requirements for ethanol, flex-fuel and ethanol-gasoline blend vehicles. The draft standards complement the Government of India's 2018 National Biofuels Policy, as it looks to introduce E-85 and E-100 vehicles into regions with an ethanol surplus (See GAIN: 2020-0197). A vehicle's E-20 compatibility will be defined by the manufacturer, and must be physically displayed on the vehicle. The government has also approved ethanol as a standalone fuel, permitting OMCs to sell E-100 that will gradually

[19] *Primary energy* is the measure of energy found in nature (e.g. crude oil, coal). *Final energy* is the finished product that users consume (e.g. ethanol, electricity).

create opportunities for more ethanol-powered vehicles. The Indian government has also allowed OMCs to sell E-20 blended gasoline throughout India beginning April 1, 2023.

Further, NITI Aayog has proposed a plan to incentivize advanced-battery production facilities to promote the use of electric vehicles (EV), reduce its oil import bill and import dependency from China, and curb air pollution. The Government of India plans to offer $4.1 billion in incentives for private sector investment, however, a formal policy is yet to be announced (Source: NITI Aayog Report, 2018). However, creating EV-charging infrastructure throughout the country will remain critical to sustain EV adoption in India.

National Greenhouse Gas Inventory

India submitted its third biennial update report to the United Nations Framework Convention on Climate Change (UNFCC) on February 20, 2021. India declared that it is on track to meet its voluntary goal to reduce the emission intensity of GDP by 20-25 percent from its previous 2005 levels by 2020. In 2016, India's emission intensity per unit of GDP decreased by 24 percent. Greenhouse gas emissions included 2.8 million giga-grams (Gg) of CO_2 equivalent without Land Use, Land-Use Change and Forestry (LULUCF). India's LULUCF sector continues to remain a net sink. Considering emissions and removals from the LULUCF sector, net national emissions were 2.5 million Gg of CO_2 equivalent. India ranks fourth globally (with China, the United States and the EU-United Kingdom (UK) the top three in overall GHG emissions.

India's energy sector accounted for 75 percent of India's total emissions. The agriculture sector contributed largely to methane (CH_4) and nitrous oxide (N_2O) emissions, arising primarily from livestock rearing (enteric fermentation and manure management), paddy cultivation and growing fertilizer application (See: GAIN: 2021-0070). A summary of emissions and removals is presented in Figure 1. Please refer to India's Third Biennial Report to UNFCC for additional information.

Figure 1. India Green House Gas Emissions by Sector (Gigagrams)

GHG sources and removals	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
Energy	2064840	NO	2072	68	NO	NO	NO	NO	2129428
IPPU	166227	NO	187	11	2	4	1	0.004	226407
Agriculture	0	NO	14423	339	NO	NO	NO	NO	407821
LULUCF	21289	330765	55	2	NO	NO	NO	NO	-307820
Waste	NO	NO	2820	52	NO	NO	NO	NO	75232
Memo Items	789305	NO	1	0.13	NO	NO	NO	NO	789359
Total without LULUCF	2231068	---	19502	469	2	4	1	0.004	2838889
Total with LULUCF	2252356	330765	19557	471	2	4	1	0.004	2531069

Abbreviation: NO – Not Occurring.

Note: Adopted from Third Biennial Report. Submitted to UNFCC by MoEFCC, February 2021.

India's ambitious biofuel policy remains focused on increasing self-sufficiency and rural development, given past investments to develop its fossil fuel resources (such as coal) and expand oil refining capacity, while ethanol imports for blending remains prohibited and high biodiesel tariffs also remain in place. Additionally, India's biofuel policy supports local resource development and diverts surplus sugar, created by India's sugar price support mechanisms and export subsidies, with less attention given to human health or environmental benefits. However, India's biofuel priorities mirror nearly all countries with renewable fuel programs.

Climate Change and India's Post-2020 Climate Goals

On April 22, 2021, the United States and India launched the "U.S.-India Climate and Clean Energy Agenda 2030 Partnership." The goals of the initiative aim to mobilize finance and speed clean energy deployment, demonstrate and scale innovative clean technologies needed to decarbonize sectors including industry, transportation, power, and buildings, and build capacity to measure, manage, and adapt to the risks of climate-related impacts. The United States has set an economy-wide target of reducing its net greenhouse gas emissions by 50–52 percent below 2005 levels by 2030; while India has set a target of installing 450 GW of renewable energy in the same period[20] (Source: U.S. Department of Energy).

On May 6, 2021, India and the UK agreed to a joint roadmap to combat climate change that includes collaboration in clean energy, e-mobility, alternative fuels, green hydrogen, and waste-to-energy to ensure an ambitious outcome at the 26th session of the Conference of Parties under the UNFCCC (Source: UK-India Business Council).

India has not committed to net-zero carbon emissions, and unlike developed counterparts such as the United States, Japan, and others, largely relies on a sustainable development approach to address its climate goals. Assuming 2050 as a net-zero year, India will have to reduce the share of fossil energy in its primary energy mix from 73 percent in 2015, to five percent in 2050. Biofuels would have to account for 98 percent of India's oil use in 2050, compared to its present negligible share. Additionally, over two-thirds of India's industrial energy use and new vehicle fleet would have to be electric, compared to the current 20.3 percent share of electricity in industrial use and negligible share in electric vehicle energy use (Source: Council on Energy, Environment and Water). Moreover, from 2015-2030, India will have required $401 billion in capital expenditures, which could lead to over 106 GW in energy savings and a 1.1 billion tons per year reduction in CO_2 emissions.[21]

Biofuels will be imperative as the National Biofuels Policy will have to factor in the quantity of GHG savings required from transportation fuels, which have been previously absent within the Government of India's biofuel policies. India will likely have to permit ethanol imports for fuel blending and supplement it with domestically produced ethanol to reap the economic and ancillary benefits of lower GHG emissions that lead to better air quality, reduced crude oil imports and more efficient vehicles.

For more information please refer: India's Intended Nationally Determined Contribution: Working toward Climate Justice, MOEF Climate Change and National Action Plan on Climate Change.

[20] See: U.S.-India Joint Statement.
[21] Source: Economic Times of India.

Section III. Ethanol

Table 5. India: Ethanol Used as Fuel and Other Industrial Chemicals (Million Liters)

Calendar Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021[f]
Beginning Stocks	33	60	60	75	61	128	150	300	146	416
Production	2,154	2,057	2,002	2,292	2,061	1,671	2,692	2,552	2,981	3,178
Imports	5	108	193	204	432	722	607	704	722	750
Exports	177	233	180	165	136	141	129	50	133	140
Consumption	1,955	1,932	2,000	2,345	2,290	2,230	3,020	3,360	3,300	4,120
Fuel Consumption	305	382	350	685	1,110	675	1,500	1,890	1,730	2,700
Ending Stocks	60	60	75	61	128	150	300	146	416	84
Balance check	(1)	0	0	0	0	0	0	0	0	0
Production Capacity										
Number of Refineries	115	115	115	160	161	161	166	170	220	231+
Nameplate Capacity	2,000	2,000	2,000	2,100	2,210	2,215	2,300	3,000	3,500	4,200
Capacity Use (percent)	108	103	100	109	93	75	117	85	85	76
Co-product Production (1,000 MT)										
Bagasse	108,309	102,360	105,642	108,699	97,485	79,176	118,784	99,942	118,374	119,603
Press Mud*	14,441	13,648	14,086	14,493	12,852	10,438	15,660	13,176	15,606	15,768
Feedstock Use for Fuel (1,000 MT)										
Molasses	1,271	1,592	1,458	2,854	4,625	2,813	6,250	7,000	6,407	9,643
Market Penetration (Million Liters)										
Fuel Ethanol	305	382	350	685	1,110	675	1,500	1,890	1,730	2,700
Gasoline	21,842	23,749	25,848	29,651	33,265	35,701	38,896	42,266	34,930	36,000
Blend Rate (percent)	1.4	1.6	1.4	2.3	3.3	1.9	3.9	4.5	5.0	7.5

Source: FAS, Trade Data Monitor (TDM) and Industry Sources.
f =Year 2021 is projected
Note: For ethanol imports originating from the United States, data used is from U.S. Census Bureau. HS codes include (a) denatured, fuel 2207.20.0010, (b) ethanol denatured, other 2207.20.0090, (c) ethanol undenatured, fuel 2207.10.6010 and (d) ethanol undenatured, other 2207.10.6090.
* Leftover sugarcane residue after juice extraction.

According to MoPNG, India's ethanol segment is estimated at $2.74 billion (INR 20,000 crores), while the total annual installed capacity of ethanol and alcohol is estimated at 6.93 billion liters. Of this total, approximately 231 distilleries have the capacity[22] to distil 4.2 billion liters of ethanol (denatured and undenatured) to be used in fuel, industrial, personal care, food, medical-grade and potable liquor applications. Final C and B-heavy molasses, sugarcane juice, damaged food grains unfit for human consumption, surplus rice, maize and any other potential raw materials available in the country may be used for making fuel-grade ethanol.

Consumption

India's 2021 total ethanol consumption is forecast to rise by 25 percent to a record 4.12 billion liters, driven largely by ethanol for fuel blending, as India pushes to meet its 2022 E-10 and 2025 E-20 mandates. Last year's consumption figures have been revised downward to 3.3 billion liters, 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

[22] Estimated ethanol manufacturing capacity estimated as of the 2020 sugar season, based on the number of operational days allowed by the Pollution Control Boards.

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 will result in a 2021 national blend average of 7.5 percent, higher than last year's five percent rate, and a new record.[23] 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 4.57 billion liters requirement initially established by OMCs for 2021, approximately 3.18 billion liters of ethanol have been contracted (quantity as per LOI) against 1.4 billion liters which will be blended as of May 17, 2021. Post estimates 2021 fuel use supply per LOI at approximately 2.7 billion liters. 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 2021.

Production

India's 2021 ethanol production is forecast at 3.17 billion liters, seven percent above last year owing to surplus sugarcane production. Molasses supply for ethanol is set to achieve record volume, owing to various factors including increased price incentives that divert B-heavy molasses and sugarcane juice to produce fuel grade ethanol. As of May 2021, MoPNG reports that three billion liters have been contracted, of which approximately 1.3 billion liters have been delivered, indicating a 42 percent increase in procured volume versus the same period last year. The supply mix is comprised of 713 million liters from B-heavy molasses, 288 million liters from sugarcane juice, 180 million liters from B-heavy molasses, 123 million liters from damaged food grains and 29 million liters from surplus rice.

In 2020, an estimated 2.98 billion liters of ethanol was produced from molasses, with 1.73 billion liters blended with gasoline to mark a 5.0 percent blend rate (revised downward from 5.2 percent). This revision accounts for the OMC's inconsistent demand estimations and inadequate storage capacities[24]; otherwise, India may have achieved a 5.6 percent blend rate. The differential and remunerative prices, along with recent policy changes to attain E-20 by 2025, will likely guarantee increased ethanol availability for the EBP in 2021.

[23] An 8.3 percent blend in 2021 could be achievable if India's total molasses supply were used for ethanol production.
[24] Source: Financial Express.

India has a total installed ethanol capacity of 5 billion liters, of which molasses-based distilleries constitute 4.2 billion liters, or 85 percent of the overall production capacity while grain based distilleries constitute 750 million liters (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[25] under the interest subvention scheme which will potentially provide an additional capacity of 16.8 billion liters. Of this amount, six billion liters 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 three billion liters of ethanol produced by the sugar industry, 1.3 billion liters 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[26] to three million liters 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.[27]

Trade

Imports

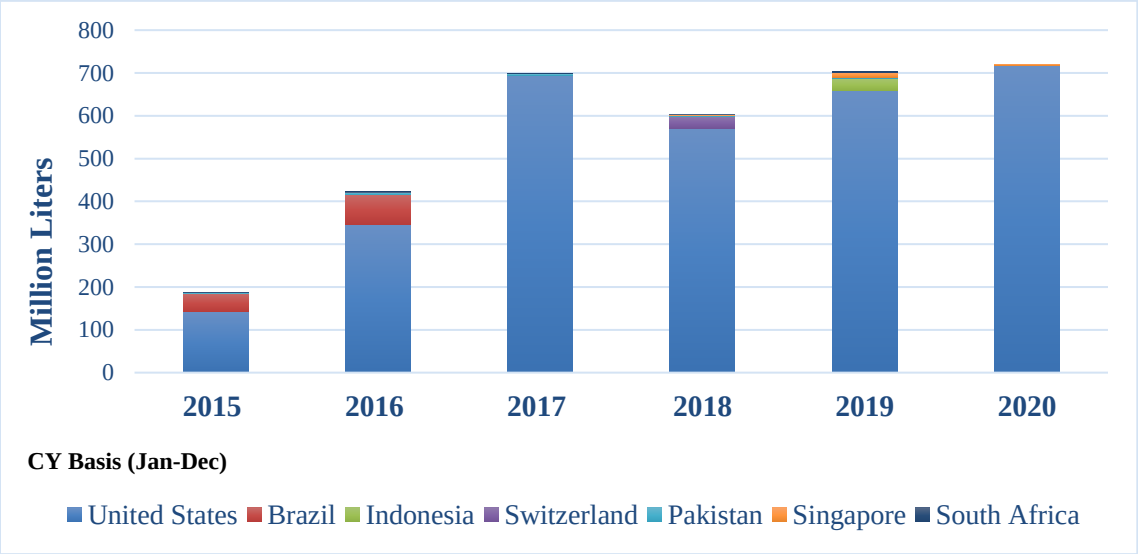
Despite increased domestic production, India remains a net ethanol importer.[28] In 2020, Indian ethanol imports increased three percent to 722 million liters, valued at $300 million. For the eighth consecutive year, the United States remained the largest ethanol (denatured) supplier to India at 96 percent 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 2021 imports will grow four percent to an estimated 750 million liters, (mostly denatured) the highest in a decade, with the United States remaining the largest supplier. India's industrial

[25] Source: PIB.
[26] Source: Department of Food and Public Distribution, 2020.
[27] *Make in India* is an initiative by the government to encourage companies to manufacture in India and incentivize dedicated investments into manufacturing.
[28] For all end-uses except fuel.

ethanol users require imports to augment their cumulative supply, particularly when local output is short. Indian ethanol imports will maintain their positive momentum in 2021, as industrial and chemical manufacturers capitalize on both domestic and global demand for pharmaceutical and antibacterial products.

Figure 2: India Ethanol Imports (Million Liters) by Top Suppliers, CY Basis

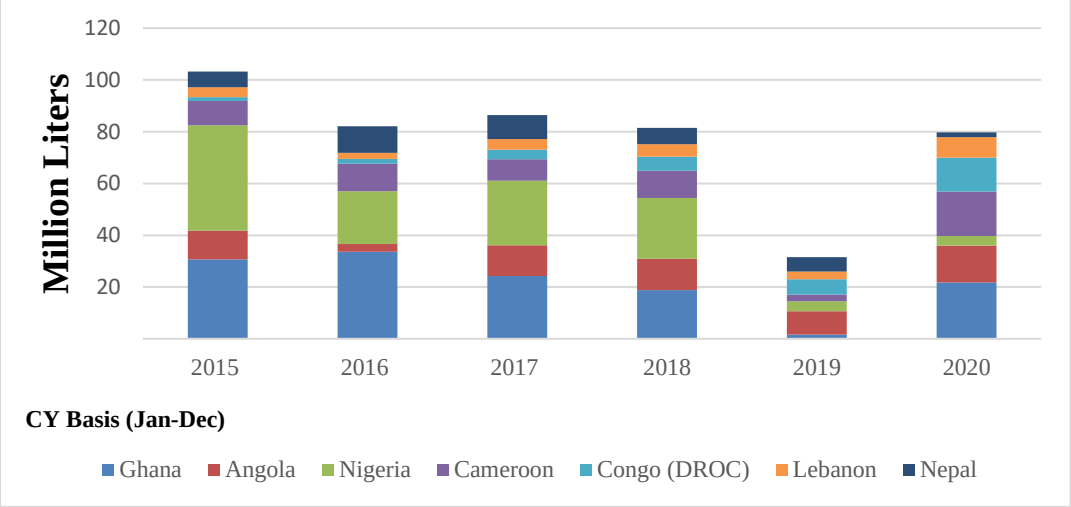


Source: Trade Data Monitor, Ministry of Commerce, Government of India; U.S. Census Bureau

Exports

In 2020, India's ethanol exports were 133 million liters, regaining their normal levels after a drop in 2019 (mostly undenatured). Exports are expected to increase to an estimated 140 million liters 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.

Figure 3: India Ethanol Exports (Million Liters) by Top Buyers, CY Basis



Source: Trade Data Monitor, Ministry of Commerce, Government of India, U.S. Census Bureau.

Section IV. Biodiesel

Table 6. India Biodiesel Production from Multiple Feedstocks (Million Liters)

Calendar Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021[f]
Beginning Stocks	15	13	14	15	11	13	13	18	25	23	16
Production	111	126	132	138	152	158	170	185	230	200	180
Imports	0.0	0.0	0.3	1.7	0.8	2.7	7.1	25.2	7.0	1	1
Exports	0	0	3.9	41.5	33.1	41.7	7.6	23.1	54.0	68	50
Consumption	113	125	128	102	118	119	165	180	185	140	140
Ending Stocks	13	14	15	11	13	13	18	25	23	16	7
Production Capacity (Million Liters)											
Number of Biorefineries	5	5	6	6	6	6	6	6	6	6*	6*
Nameplate Capacity	450	460	465	480	500	550	600	650	670	580	520
Capacity Use (%)	24.7	27.4	28.4	28.8	30.4	28.7	28.3	28.5	34.3	34.5	34.6
Feedstock Use for Fuel (1,000 MT)											
Non-edible Industrial	58	65	70	75	85	90	100	110	140	145	90
Used Cooking Oil	42	48	49	50	55	55	55	60	65	50	55
Animal Fats/Tallows	6	7	7	6	5	6	6	8	10	9	9
Total	106	120	126	131	145	151	161	178	215	204	154
Market Penetration (Million Liters)											
Biodiesel, on-road use	31	42	49	32	41	48	72	83	100	50	50
Diesel, on-road use	45,520	49,343	49,354	49,605	52,239	55,179	56,715	59,220	60,145	44,400	52,927
Blend Rate (percent)	0.07	0.08	0.10	0.06	0.08	0.09	0.13	0.14	0.17	0.11	0.09
Diesel, total use	75,866	82,238	82,256	82,674	87,064	91,965	94,524	98,700	100,241	74,000	75,000

Source: FAS, Trade Data Monitor (TDM) and Industry Sources.
f =Year 2021 is projected
* Indicates theoretical estimate.

The biodiesel market remains informal, dispersed with minimal domestic production. As many countries operate at a minimum of B5, and several including Brazil, Thailand, Argentina, Malaysia, Indonesia running at B10 or higher, India's biodiesel market has tremendous growth potential. However, India must retain a viable strategy that builds a financially sustainable domestic industry that contains sufficient feedstock availability coupled with market access for imports. Compared to the EBP, a very limited number of domestic suppliers produce biodiesel, and most of their production capacities are under-utilized, with few viable feedstock sources and limited government support mechanisms (like subsidized feedstock, tax credits or loan guarantees).

Most of India's biodiesel production is consumed by locally dispersed, informal groups through stationary power generation. Support received through OMC procurement is insufficient to build commercial sales. Past field trials have used *jatropha*,[29] some tree-borne oilseeds,[30] and other non-edible oilseeds grown on non-arable, rain-fed lands. However, these have failed to advance mainly due to low yields. India does not produce drop-in renewable diesel or Sustainable Aviation Fuel (SAF).

[29] Jatropha is a genus of flowering plants in the spurge family, Euphorbiaceae.
[30] Treeborne oilseeds include Karanja, Mahua, Neem, Jojoba, Wild Apricot, Cheura, Kokum, Simarouba, etc.

Consumption

India's annual biodiesel consumption grew by six percent for the 2011-2019 period. However, due to the COVID-19 pandemic and ensuing lockdowns, annual demand dropped by almost 24 percent in 2020. Accordingly, Post estimates demand to remain flat at 140 million liters in 2021. Due to decreased travel and transportation amid the pandemic, OMCs are estimated to have procured five million liters in 2020, which is almost 95 percent below volumes procured in 2019.

This year, the OMCs are attempting to procure the same volumes obtained in 2020. As of May 2021, OMCs have issued 30 LOIs to biodiesel suppliers and have offered periodic incremental price guarantees for five years, while guaranteed offtakes of ten years are extended to prospective biodiesel suppliers. According to sources, OMCs are currently working on procurement pricing models that reflect market sensitivities like feedstock price volatility (vegetable oils), diesel retail prices, and other macroeconomic indicators. The current procurement price of biodiesel is $0.89/liter (INR 65/liter).

With an estimated drop in diesel pool demand in 2021, Post estimates India's biodiesel blend ratio to be approximately 0.09 percent, reflecting 2020 market dynamics. The estimated biodiesel quantity procured for blending with diesel for on-road use remains near 50 percent of total use. Blended diesel buyers are limited to certain OMC retail outlets, Indian railways, certain State Road Transport Corporations, road transport fleet companies, and port authorities. Retail biodiesel prices are benchmarked with the retail diesel price in India, with the current Integrated Goods and Services Tax[31] rate at 12 percent. The remaining biodiesel demand comes from various stationary applications. Smaller buyers will continue to procure biodiesel for small and medium scale enterprises following the temporary decline in demand during the COVID-19 lockdowns. Biodiesel use applications include agriculture (operating irrigation pumps and tractors), brick kilns, mobile communication towers, and backup power generators.

Production

In 2021, India will produce close to 180 million liters of biodiesel, ten percent below 2020 levels. India has more than six plants with an installed annual biodiesel production capacity (maximum possible) of one billion liters. However, the operating capacity remains at 500-550 million liters, as the majority of the plants remain closed due to the lockdown and high feedstock prices (imported palm oil, palm stearin and domestically available animal tallows) that have reduced their operating margins. The production capacity ranges from 11 million to 225 million liters for the existing plants.

Biodiesel producers use non-edible industrial oil (palm stearin), UCO, animal fat, tallow, and other oils (sludge, acidic oils, and tree-borne oils, etc.) as primary feedstocks to produce biodiesel, utilizing 35 percent of the total installed capacity. With increasing prices of imported palm oil and domestically available animal tallow, most of the functional producers utilized palm acid oil in 2020. Production capacity has not changed over time, and except UCO, there are no official regulations for supplying available feedstocks for biodiesel production.

India's biodiesel industry remains in its nascent stage as *jatropha* and other inedible oilseeds grown on non-arable lands have failed to reach necessary yields to make cultivation economically feasible, and there is no supply of virgin (first use) animal fat or vegetable oils available for biodiesel. As a result, the majority of

[31] The Integrated Goods and Services Tax, or IGST, is levied when there is an interstate transfer of goods or services. It is one of the three components of the GST.

biodiesel manufacturers are susceptible to global vegetable oil price volatility. If India wants to achieve B-5 by 2030, it will have to increase its production capacity to more than 3.45 billion liters, assuming a projected diesel pool size for on-road use at 69 billion liters for the same year.

Trade

India's 2021 biodiesel exports are expected to decline by 26 percent to 50 million liters. Nearly all biodiesel is exported to Europe (primarily the Netherlands, Spain and Belgium), taking advantage of EU incentives provided to waste-based biofuel exporters. The GOI only allows biodiesel exports from its Special Economic Zones and Export Oriented Units. India's biodiesel imports remain negligible due to lasting import restrictions.

Section V. Advanced Biofuels

The 2018 National Biofuels Policy indicates an annual surplus biomass availability of 120-160 MMT, which, if converted, could produce 30 billion liters of cellulosic ethanol. The Government has indicated that 5-10 billion liters of cellulosic ethanol could be in the fuel mix by 2030. India has two operational advanced biofuel plants—a pilot and a demonstration plant, with a cumulative annual production capacity of 1.75 million liters of cellulosic ethanol.[32] There are several additional advanced biofuels plants under development, but far from reaching commercialization (Table 7).

According to reports, Indian OMCs have decided to suspend their expansion plans for 2G ethanol plants. The original plans involved the construction of twelve 2G ethanol plants with a cost of almost $2 billion (Source: MoPNG). Originally, Indian Oil Corporation and Bharat Petroleum Corporation had each intended to construct three 2G ethanol plants, Hindustan Petroleum Corporation to establish four, and one each by Mangalore Refineries and Petrochemicals and Numaligarh Refinery, respectively. However, the high costs of constructing a 2G ethanol plant ($136 million or INR 1,000 crores) compared to setting up a 1G plant ($13-27 million or INR 100-200 crores) are significant deterrents to advanced biofuel investments in India.

Table 7. India: Existing and Proposed Advanced Biofuels Plants

Company	Year	Status	Scale/Technology	Annual Production Capacity (Million Liters)
Indian Glycols Kashipur	2016	Operational	Demo/ Cellulosic ethanol	0.75
Praj Biofuels	2017	Operational	Demo / Cellulosic ethanol	1
Shell Bengaluru	2018	Operational	Demo / Drop-in fuels	0.6
Numaligarh Refinery Limited	2018	Planned	Commercial / Cellulosic ethanol	60
IOCL Panipat	2019	Planned	Commercial / Cellulosic ethanol	30
BPCL Bargarh	2018	Planned	Commercial / Cellulosic ethanol	30
HPCL Bhatinda	2017	Planned	Commercial / Cellulosic ethanol	30
IOCL Panipat	2019	Planned	Demo/ Cellulosic ethanol	0.75
IIOP Dehradun	2018	Operational	Pilot / HEFA Biojet	0.01
IOCL Panipat	2019	Planned	Commercial/ 3G ethanol	33

Source: Biofuture Platform, 2018.

[32] Cellulosic ethanol uses bagasse, wood waste, agricultural and forestry residues, among others as feedstock sources.

Presently, farmers are encouraged to practice intercropping with a variety of biomass crops including oilseeds. Suitable supply, distribution, collection and fair price mechanisms are planned by the government, as is guaranteed buyback via ethanol purchase agreements with cellulosic ethanol suppliers for a period of 15 years to attract greater investment. Bio-compressed natural gas is a major potential by-product of cellulosic ethanol biorefineries, and can be used as a transportation fuel. The product has also been given offtake assurances by public sector natural gas marketing companies.

The Technology Information, Forecasting and Assessment Council's 2018 report estimates total dry biomass generated in India at approximately 683 MMT across 11 crops that are available for biofuel production, of which only 178 MMT (26 percent) was found to be surplus crop residue. It is estimated that India can potentially produce 51.35 billion liters of cellulosic ethanol (2G), based on 178 MT of annual surplus crop residues (Source: TIFAC).

The aviation biofuels sector in India is currently limited to the Council of Scientific and Industrial Research–Indian Institute of Petroleum pilot program to establish a bio jet fuel production plant, using plant-derived, non-edible wastes and low-cost oils to produce drop-in biofuel for air and road transport purposes. The institute claims that their technology reduces production costs of bio-jet fuel when compared to the competing two-step technologies available in the United States and Europe (Source: Indian Institute of Petroleum). The plant has produced 4,000 liters of aviation biofuel since 2020, and a private domestic carrier has used the biofuel to operate a single flight.[33] However, limited availability of feedstock such as vegetable oils, UCO, tree borne oils, etc., along with high capital investment, operational expenditures and the threat from competing technologies impede viable commercial production for aviation biofuels in India.

Section VI: Notes on Statistical Data

For a comprehensive coverage of notes on statistical data, appendix and role of institutional stakeholders under India's Biofuel Policy, please refer to Biofuels Annual 2020 (GAIN: IN0122).

Attachments:

No Attachments

[33] See: Economic Times, 2018.