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### **Report Highlights:**

India's average ethanol blending rate with petroleum for calendar year 2023 is estimated at 11.5 percent. The National Biofuels Policy of India, amended in May 2022, strengthens efforts to increase domestic ethanol output from sugarcane and multi-feed stocks by expediting pace toward blending goals. FAS New Delhi (Post) forecasts India to remain a net ethanol importer for industrial, medical and beverage usage, and exports to remain limited at 120 million liters due to increased domestic demand and lower sugar feedstock availability. India's biodiesel market remains fragmented and unorganized due to the lack of raw materials, high feedstock prices, and the Indian government's policies which prioritize ethanol production over other biofuels.

**NOTE:** Unless otherwise stated, calendar year (January to December) is the reference period used throughout the report. Indian Fiscal year (IFY) is April to March, and Ethanol Supply Year (ESY) is from December to November.

## **SECTION I. EXECUTIVE SUMMARY**

In 2023, India is estimated to maintain an average annual national ethanol blend rate of 11.5 percent, a new record, and a 13 percent increase over last year. India's average monthly blending rate went above 11 percent for the first time in April 2023, and is expected to remain at nearly 12 percent for the remainder of the year. The range and volume of feedstock supplies for the Ethanol Blended Petrol (EBP) program are forecast to increase in Ethanol Supply Year (ESY) (December-November) as India attempts to meet the E-20 national target by 2025. Additionally, FAS New Delhi (Post) has revised its 2022 ethanol blending rate with petroleum estimate upward to 10.2 percent due to increased diversion of sugarcane and sugar syrup, B-heavy molasses, damaged food grains, surplus rice available with the Food Corporation of India (FCI). For the ninth consecutive year, domestic consumption will surpass domestic production. In 2023, imported ethanol will continue to supply industrial, alcoholic beverage, and medical industries.

India has developed over the last five years into a significant sugarcane surplus producer, operating a stabilized pricing system under the EBP program and ensuring an appropriate flow of feedstocks. Government's policies have tried to augment domestic production, along with the continued prohibition of imported ethanol for fuel blending. India's greater focus on ethanol to reach E-20 by 2025 is also anticipated to limit sugar exports due to less than anticipated sugarcane production from last year. Still, Post estimates that ethanol production for fuel blending will increase in 2023 due to the government's rigorous and significant attempts to support greater multi-feedstock and grain-based distillery units that have rapidly expanded last year. Despite this increase in distillation capacity, Post ascertains that India will struggle to reach a 20 percent national blend rate by ESY 2025 due to the government's continued ban on ethanol imports for use in gasoline blending and the lack of sufficient 1G and 2G feedstocks.

India maintains its biodiesel blending goal target of 5 percent for on-road use by 2030. The national average blend rate remains unchanged at 0.1 percent for 2023. Due to import restrictions on palm stearin, a disorganized supply chain of used cooking oil (UCO) and animal fats, high feedstock costs, and a shortage of supply of palm oil, India's biodiesel usage remains extremely low. Post forecasts that India will produce approximately 200 million liters of biodiesel in the forecast year, up from 185 million liters in 2022. Due to government incentives and interventions, Post estimates consumption slightly upward to 190 million liters in 2023.

According to Indian government, the EBP program in ESY 2021/2022 resulted in a foreign exchange equivalent savings of approximately \$289 million or Indian rupee (INR) 2.3 billion, and greenhouse gas emissions (GHG) have been reduced by over 2.7 million metric tons (MMT) through the entirety of the initiative.<sup>1</sup> For India to meet its long-term biofuel blending targets for ethanol and biodiesel, Post continues to ascertain that biofuels and biofuel feedstock imports are needed to supplement domestic production. As India expands its production capacity under the amended National Biofuels Program, imported feedstocks will be needed to augment domestic supply, boost domestic production, and align with the government's "Make in India" campaign.

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<sup>1</sup> For purposes of this report, USD \$1.00 equals INR 81.00.

## SECTION II. POLICY AND PROGRAMS

### India's Biofuel Policy 2018

The Indian government has made key amendments to its [2018 National Policy on Biofuels](#) to support greater domestic biofuels production. The policy includes an accelerated national E-20 mandate from 2030 to 2025, which aims to increase the capacity of ethanol production in India from 7 billion liters (BL) in 2021 to 15 BL in 2025.

The National Biofuel Coordination Committee, which consists of 14 different ministries, amended the policy to allow conversion of excess cereal grains for ethanol under the EBP program.<sup>2</sup> The amended policy permits additional feedstocks for biofuel production. The revisions allow for the manufacturing of ethanol from corn (maize), food grains including broken rice, wheat, non-suitable grains for human use, and other non-food sources (2G). Other additions to the policy include the domestic production and sale of flexible-fuel vehicles (FFV), and the promotion of domestic biofuel production of biofuels through Special Economic Zones and Export Oriented Units under the “Make in India” campaign.

The policy focuses on four points:

- i. **Lower cost of oil imports and increased self-sufficiency** – According to the Ministry of Petroleum and Natural Gas (MoPNG), for March 2023, India's net import bill for crude oil grew to 20.5 MMT, valued at \$11.6 billion (see: [Petroleum Planning and Analysis Cell](#)). From March-April 2023, crude oil imports increased by 9.4 percent compared to the corresponding period last year. In that time, India's national blending average touched 12.1 percent, a new achievement, and cumulative ethanol blending from December 2022-March 2023 reached 11.6 percent.
- ii. **Safeguarding farmer financial stakes** – Over the last seven years, India's Oil Marketing Companies (OMC) reimbursed sugar mills approximately INR 818 billion (\$10.09 billion) under the EBP, which provided capital to repay cane farmer arrears.<sup>3</sup> Additionally, the use of surplus rice available with Food Corporation of India (FCI), prioritizing corn and other feedstocks are emphasized by the Indian government.
- iii. **Emphasize lower carbon emissions** – According to the Indian government, between Ethanol Supply Years (ESY) 2014-2022, greenhouse gas (GHG) emissions fell by 31.8 MMT on account of EBP Program interventions.<sup>4</sup>
- iv. **Enhanced economic efficacy due to innovation** – Previously, the Indian government enacted the Industrial Amendment Bill 2015 to implement and allow state governments to execute business friendly activities like e-approvals, online permits, and other activities to fast-track the approval and construction of new ethanol plants.<sup>5</sup>

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<sup>2</sup> Source: “Cabinet Approves Amendments to the National Policy on Biofuels.” [MoPNG](#), May 18, 2022.

<sup>3</sup> Source: [Petroleum Planning and Analysis Cell](#), March 2023.

<sup>4</sup> India's ethanol supply year runs from December to November.

<sup>5</sup> See: [Industries \(Development and Regulation\) Amendment Bill, 2015](#).

## Green Hydrogen

On January 4, 2022, the Union Cabinet of India announced National Green Hydrogen Mission with a financial budget of \$2.4 billion (INR 197 billion), to become a global leader in green hydrogen production, reduce carbon emissions and fossil fuel dependency, and generate economic growth. India's targets include developing a capacity of 5 MMT of green hydrogen and 125 gigawatts (GW) of renewable energy capacity by 2030, and establishing green hydrogen bunkering and refueling facilities at major ports by 2035.<sup>6,7</sup> The Mission is in its early stages—a government committee has been formed to facilitate activities in the production, storage, and distribution, for applications to be used in application for automobiles, rail, shipping, agricultural equipment and generator sets. Despite state-level incentives to attract venture capital, constraints in India's renewable energy setting, insufficient regulations and certifications, and a lack of scientific and technical knowledge challenges achieving the ambitious green hydrogen goal.

## Flex Fuel and Electric Vehicles

In late 2022, international automobile manufacturers introduced FFVs and E-20 fuel compliant vehicles into the Indian market. Concurrently, the Indian government has been actively promoting domestic manufacturing of FFV and electric vehicles (EV) under the “Make in India” initiative. According to Post sources, as of April 2023, 20 million FFVs are operating in India, but access to E-20 fuel remains sporadic and available at only 100 stations in certain metropolitan cities with limited storage infrastructure.

Increasing the EV fleet into the Indian market faces certain challenges. A lack of infrastructure for charging batteries, excessive cost of vehicle acquisition, non-availability of financing/car loans for EVs, and customer anxiety regarding safety measure are among the issues being addressed by manufacturers. Post sources note that by 2030, 40 percent of the vehicle fleet will operate as EVs, including buses, three-wheelers, and taxis. India's EV market is anticipated to grow at a compound annual growth rate of more than 44 percent, from \$5 billion (INR 413 billion) in 2020 to \$47 billion (INR 3.89 trillion) by 2026.<sup>8</sup> The Indian government is supporting additional EV industry growth through financial incentives totaling approximately \$8.3 billion (INR 686.2 billion).<sup>9</sup>

## Selected Specifics on Ethanol, Biodiesel, and “Other” Biofuel Policy

### *National Ethanol Blend Rate - Ten Percent Achieved in 2022 and 20 Percent Goal by 2025*

The Indian government set targets for the national average ethanol blend rates in gasoline of 10 percent (E-10) and 20 percent (E-20) by 2022 and 2025, respectively, under the 2018 National Biofuels Policy. The program's objective is to boost the production of ethanol from a range of feedstocks, most notably sugarcane, grains, and derivative products. The government maintains that E-20 will be achieved by increasing domestic yields of biofuel (1G, 2G, and 3G), through

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<sup>6</sup> Source: MoPNG, [National Green Hydrogen Mission](#).

<sup>7</sup> “India Eyes Green Hydrogen Bunkering at Major Ports by 2035.” [Indian Express](#); published May 10, 2023.

<sup>8</sup> “Opportunities and Anticipated EV Trends in 2023.” [Times of India](#), published on January 4, 2023.

<sup>9</sup> “Auto Giants are Setting their Sights on a New Growth Market for EVs: India.” [CNBC](#), published on May 4, 2023.

the diverse application of feedstocks.<sup>10</sup> This is in addition to promoting biofuel blending to supplement gasoline and diesel use in cars, machinery, stationary power applications, and portable power applications.<sup>11</sup>

To achieve E-20 by ESY 2024/2025, the Indian government is encouraging sugar mills and stand-alone distilleries to divert surplus sugar and derivatives and procure excess grains from FCI to produce ethanol under the EBP. India first met its E-10 target, briefly reaching a national blending average of 10.1 percent in June 2022, and additional projects are in place in its push to reach its E-20 targets.<sup>12</sup> Excluding union territories, OMCs are responsible for nationwide blending ethanol into gasoline. The Cabinet Committee of Economic Affairs (CCEA) approved the government’s [Pradhan Mantri JI-VAN Yojana](#) to provide “viability gap funding” to 2G bio-ethanol manufacturing projects for increasing ethanol production for blending.<sup>13</sup>

The EBP has established an organized, regulated domestic marketplace where ethanol produced by sugar mills or standalone distilleries can enter into long-term agreements to sell ethanol to the OMCs at fixed rates. This initiative prohibits scattered ethanol diversion from mills for localized purchasing and attempts to safeguard mills with safe purchasing alternatives, secure transportation costs and timely payments.

According to MoPNG, as of November 2022, OMCs invested \$91 million (INR 7.5 billion) to enhance their ethanol storage capacity totally 344 million liters, providing ethanol storage for a 20-day turnaround period at their depots (see: [Ethanol growth story, MoPNG](#)). The government’s financial assistance program to sugar mills for ethanol production increased by 54 percent in Indian Fiscal Year (IFY) 2023/2024, compared to IFY 2022/2023 (Table 1).

**Table 1. Indian Government Budget Allocation-Sugar Industry (USD million/INR billion)**

Allocation	IFY 2021/2022	IFY 2022/2023		2023/2024	% Change
	Realized Outlays	Initial Budget	Revised Budget	Budget	
Scheme for extending financial assistance to sugar mills to enhance and augment ethanol production capacity	\$19.35 million (INR 1.6 billion)	\$36.29 million (INR 3 billion)	\$31.43 million (INR 2.6 billion)	\$48.38 million (INR 4 billion)	54

Note: Percent change depicted for IFY 2023/2024 with initial budget estimate over the IFT 2022/2023 revised budget estimate. Source: Department of Food and Public Distribution.

The Indian government think-tank NITI-Aayog previously estimated that gasoline demand in Indian fiscal year (IFY) 2025-2026 would reach 50.8 BL, and about 10.2 BL of ethanol would need to be produced domestically (assuming imports are not permitted) to reach E-20. However, India’s gasoline pool will likely surpass 53 BL in the current IFY placing even greater ethanol

<sup>10</sup> The Indian government has proposed a National Biomass Repository.

<sup>11</sup> Other applications include diesel generators or water pumps for irrigation.

<sup>12</sup> See: “What is E20 Petrol, and How Will it Affect Your Vehicle?” [Times of India](#); published February 7, 2023.

<sup>13</sup> Funding provided to support infrastructure projects is considered economically justified but lacks financial viability.

volumes supplied for blending. Post maintains that imports of biofuel or biofuel feedstocks will be necessary to supplement domestic ethanol production for India to meet this blending target.

The previous five years have seen India transform into an integral surplus producer of sugarcane, ensuring an adequate flow of feedstock and managing a stabilized pricing mechanism under the EBP program. With a downward production in sugarcane in the current market year, India's increased diversion toward ethanol is to likely constrain sugar exports.<sup>14</sup> As sugarcane is the primary source for India's ethanol production, reaching E-20 by 2025 will be difficult to attain due to greater demand of both sugar exports and domestic potable alcohol production.

With reduced sugarcane volumes becoming apparent, the Indian government is exploring various corn production strategies to increase yields to use for ethanol.<sup>15</sup> Other domestic feedstock sources will likely remain insufficient to reach the target, as the government will require to strike a balance between its blending goals and feedstock supplies utilized for other purposes.

### *International Collaboration*

Beginning April 2022, the governments of India and Brazil announced a joint project to emphasize efficient ethanol production from sugarcane/molasses including activities through a "Center of Excellence on Ethanol." The program was launched in January 2023, in partnership with the Society of Indian Automobile Manufacturers and the Brazilian Sugarcane Industry Association to promote greater ethanol usage and FFV adaptation in the automobile industry. Concurrently, both governments developed a "Joint Working Group on Bioenergy Cooperation" to intensify biofuels cooperation, flex vehicle, Sustainable Aviation Fuel (SAF), 2G ethanol production, and other activities.<sup>16</sup>

Under India's 2023 G20 presidency, a "Global Biofuel Alliance" is under consideration that would include the governments of India, Brazil, and the United States, among others, as a cooperative effort to increase the use of sustainable biofuels, notably in the transportation industry, technical knowledge transfer, enabling and assessing the international biofuel market.<sup>17</sup>

### *Sugar Policy*

On May 31, 2021, the Indian government amended its 1966 Sugarcane Control Order to allow the development of independent ethanol manufacturing plants. Standalone operations where ethanol production is derived from molasses or sugar juice cannot procure from any informal *Khandsari* unit (see: [Ministry of Consumer Affairs](#)).<sup>18</sup> India's ethanol distillation capacity remains insufficient to manage surplus ethanol feedstocks (Table 2).

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<sup>14</sup> Market year 2023/2024 (October-September) See: [USDA GAIN: India Sugar Annual 2023, IN-0035](#).

<sup>15</sup> Source: "Growth of Ethanol Sector is an Example for the World." [Ministry of Consumer Affairs](#), published on May 2, 2023.

<sup>16</sup> Source: "Joint Statement on meeting between Minister of Petroleum and Natural Gas of India..." [MoPNG](#), published on April 21, 2022.

<sup>17</sup> Source: "Global Biofuel Alliance: One of the Priorities Under India's G20 Presidency." MoPNG, published on February 11, 2023.

<sup>18</sup> Khandsari is simple sugar physically extracted from liquid jaggery.

**Table 2. India - Annual Ethanol Capacity in BL (as of April 2023)**

<b>Current and Required Distillation Capacities</b>	<b>Sugarcane Molasses</b>	<b>Grains</b>	<b>Total</b>
Current ethanol capacity	7.89	2.91	10.82
Capacity required by 2025	10.79	5.31	16.10
Additional Capacity needed	2.9	2.4	5.2

Data source: FAS New Delhi research and historical data series.

On August 3, 2022, the Cabinet Committee on Economic Affairs updated its Fair and Remunerative Price (FRP) for sugarcane for MY 2022/2023, from INR 290 per quintal (\$3.54/quintal) to a new high of INR 305 per quintal (USD \$3.72/quintal), based on a revised 10.25 percent sugar recovery rate.<sup>19</sup>

#### *Ethanol Administered Price*

On December 1, 2022, MoPNG raised the procurement prices for ethanol from sugarcane derivatives under the EPB program for ESY 2022/2023 (Table 3).<sup>20</sup> As of November 2022, the government reports that ethanol procurement for blending has increased from 380 million liters in ESY 2013/2014, to 4.3 BL in ESY 2021/2022. Ethanol production capacity has increased more than 2.5 times, and the number of distilleries increased by 66 percent in the past eight years. India’s national average blend rate has increased from 1.5 percent in ESY 2013/2014 to around 10 percent in ESY 2021/2022.

**Table 3: India: Feedstock Prices for ESYs 2021/2022 and 2022/2023 (INR/Liter)**

<b>Feedstock</b>	<b>ESY 2021/2022</b>	<b>ESY 2022/2023</b>
<b>Sugarcane Juice/Sugar Syrup/Sugar</b>	63.45	65.61
<b>B-Heavy Molasses</b>	59.08	60.73
<b>C-Heavy Molasses</b>	46.66	49.41
<b>Damaged Food Grains/Maize</b>	51.55	55.54
<b>Surplus Rice (from Food Corporation of India)</b>	56.87	58.50
<b>Corn (Maize)</b>	51.55	51.55

Source: MoPNG.

Note: B-heavy molasses, sugarcane juice and damaged food grains were allowed only from ESY 2018-2019 onward. Surplus rice by FCI and maize as feedstocks were allowed beginning ESY 2020-2021.

<sup>19</sup> See: USDA GAIN, India: Sugar Annual - 2023, [IN2023-0035](#). The sugar industry has routinely requested that the Indian government raise the minimum support price for sugar, which was last changed in 2019.

<sup>20</sup> Source: “Cabinet Approves Mechanism for Procurement of Ethanol” [MoPNG](#), published on November 2, 2022.

## *Biodiesel Policy*

India maintains an ambitious diesel blending goal (on-road use) target of 5 percent with biodiesel by 2030. According to the Indian government, the national average blend rate has marginally increased from 0.07 percent in 2022 to 0.10 percent in 2023.<sup>21</sup> India's biodiesel production is primarily produced from animal fats, limited quantities of non-edible oils, UCO, and imported palm oil and palm stearin. Biodiesel utilization in India remains exceptionally low due to import limitations, a lack of an organized supply chain, and excessive costs and non-availability of feedstocks. Approximately 3 MMT of UCO are produced annually, but a lack of stable procurement mechanisms results in limited uptake. Around 80 percent of biodiesel production expenses stem from feedstock procurement.

## *Import Policies*

The Indian government requires import licenses to import biofuels. However, the import of biofuels for fuel blending remains prohibited. The import 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.<sup>22</sup>

On April 1, 2023, the basic customs duty (BCD) on denatured ethyl alcohol (ethanol) dropped from 5 percent to 0 percent, for use in the manufacture of industrial chemicals through the Import of Goods at Concessional Rate Rules (2022) (Table 4). The import duties for biodiesel remain unchanged from 2022 (Table 5).

**Table 4. India: Ethanol Import Duty (Percent ad valorem on Customs Insurance, and Freight [CIF] Value)**

<b>ITC HS Tariff Number</b>	<b>Total Import Duty</b>
Ethyl alcohol and other spirits, denatured, of any strength; denatured ethanol; and denatured spirits [2207 2000]	Basic customs duty on denatured ethanol for manufacture of excisable goods is zero 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: Central Board of Indirect Taxes and Customs (Updated as of May 1, 2023).

Note: If the importer follows the procedure set out in the Customs Rules, 2017 (import of goods at concessional rate of duty), the central excise duty is a fixed amount and not a percentage on price.

(\*) Ethyl alcohol supplied to OMCs for blending with gasoline will be assessed a five percent Integrated Goods and Service Tax.

<sup>21</sup> [Remarks by Nirmala Sitharaman: Union Budget 2023-2024](#), Government of India, February 1, 2023.

<sup>22</sup> See: USDA GAIN, India: Biofuels Annual - 2022, [IN2022-0056](#).



**Table 5. 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]	10 percent BCD per KG
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] *	5 percent BCD per KG
Automotive diesel fuel, containing biodiesel, Conforming to standard IS 1460 (2710 2010)	2.5 percent BCD per KG

Data source: CBIC (Updated as of May 1, 2023).

(\*) For the purposes of the sub-headings of 2710, the term “biodiesel” means mono-alkyl esters of fatty acids of a kind used as a fuel, derived from animal, vegetable or microbial fats and oils, whether used or not used.

### *Excise Policy*

On December 30, 2022, the Central Board of Indirect Taxes and Customs (CBIC) submitted Notification No. 12/2022 Central Tax which revises the goods and services tax (GST) on ethanol supplied to OMCs for blending. The revised GST, which went into effect on January 1, 2023, fell from 18 percent to 5 percent. Denatured ethyl alcohol and other spirits of any strength not used for blending will continue to be charged an 18 percent rate.<sup>23</sup> To encourage greater biofuels blending, in July 2022, the CBIC expanded its tax exemption for E-10 gasoline to include E-12 and E-15 ethanol blends. For biodiesel, the tax exemption was expanded to 20 percent blends produced from vegetable oils.<sup>24</sup>

Further, on February 1, 2022, the CBIC amended its Central Excise Act (No. 11/2017) which now applies a tax on unblended gasoline and diesel sold at retail to consumers. According to the Indian government, the intent of the tax is to spur additional biofuel production and blending and reduce its crude oil and petroleum products import bill. For non-blended gasoline and diesel fuels, the excise charges went into effect on November 1, 2022, and April 1, 2023, respectively (Table 6).

**Table 6. India: Unblended Gasoline and Diesel Excise Fees for Retail Sale (INR/liter)**

	Gasoline	Diesel
Brand Name	\$0.056/Liter INR 4.6/Liter	\$0.075/Liter INR 6.2/Liter
Without Brand Name*	\$0.041/Liter INR3.4/Liter	\$0.046/Liter INR 3.8/Liter

Source: [CBIC](#), published in the Gazette of India.

(\*) Typically consist of informal markets with infrequent supply.

<sup>23</sup> Source: “India lowers GST Rate on Ethanol Meant for Blending to 5%.” [Indian Chemical News](#), published on December 20, 2022.

<sup>24</sup> Source: “Centre Defers Additional Excise Duty on Un-blended Auto Fuels.” [Mint](#), published on October 1, 2022.

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

On November 2, 2022, the Ministry of New and Renewable Energy (MNRE) extended its National Bioenergy Program from IFY 2021/2022 to 2025/2026, to focus on three areas, notably waste to energy, biomass, and biogas.<sup>25</sup> On December 15, 2022, the Indian government announced various initiatives for establishing domestic bio-compressed natural gas (CNG) plants, including via the Sustainable Alternative Towards Affordable Transportation program (SATAT), which has the goal to establish 5,000 bio-CNG operations to produce a cumulative 15 MMT of bio-CNG by IFY 2023/2024.<sup>26</sup>

First launched in 2018, the goal of SATAT is enhancing the application various biomass feedstocks including municipal solid waste, press mud and agricultural residues (bio-manure). The compressed biogas would be sold at OMC fuel stations as a green transport fuel alternative. According to MoPNG, 38 compressed biogas plants have been commissioned with an installed capacity of 125 million metric tons.<sup>27</sup> In June 2022, a compressed biogas/bio-CNG plant was commissioned in Sangrur, Punjab to produce 33 metric tons (MT) of compressed biogas and 600 MT of organic manure daily. According to some estimates, India is using only 0.5 percent of its potential and producing 80,000 MT of CBG per day.<sup>28</sup>

The Ministry of Science and Technology has invested in technologies to scale enhanced biofuels production including biohydrogen, biobutanol, and synthetic hydrocarbons.<sup>29</sup> The Department of Biotechnology-Indian Oil Corporation Center established the first pilot program to produce biodiesel using carbon dioxide through “high value” lipids technology.<sup>30</sup> The laboratory is also producing biohydrogen using sugars derived from various biomass sources through anaerobic fermentation.

## **Renewable Energy, Greenhouse Gas Emissions and Climate Change**

### *Renewable Energy*

India remains a growing and an attractive market as the third largest producer of renewable energy in 2022. India has an installed capacity of 125 GW for 2023, which is 30.5 percent of country’s total installed capacity that includes fossil, non-fossil, and nuclear energy sources (Table 7). The share of solar power was highest at 67 GW, followed by wind power (42.86 GW), biomass power (10.8 GW), and hydropower (4.94 GW) (Tables 7 and 8).

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<sup>25</sup> Source: “MNRE Notifies National Bio Energy Programme.” [MNRE](#), published November 7, 2022.

<sup>26</sup> Source: “Establishment of Bio-CNG Plants.” [Press Information Bureau](#), published on December 15, 2022

<sup>27</sup> “38 CBG/Biogas Plants with Installed Capacity of 225 MT per annum Commissioned”, [ICN Bureau](#), published on December 9, 2022.

<sup>28</sup> See: S. Kalamdhad, A. and Singh, P., [2022](#). Biomethane Plants Based on Municipal Solid Waste and Wastewater and its Impact on Vehicle Sector in India - An Environmental-Economic-Resource Assessment, Environmental Technology & Innovation.

<sup>29</sup> See: [Scientific Decision Units](#), Department of Biotechnology, Ministry of Science and Technology.

<sup>30</sup> The process separates chemical production from commodity feedstocks and converts carbon dioxide into acetic acid and the later to lipids (algal oil) including omega 3-fatty acids and biodiesel.

The Indian government has planned \$3.5 billion in incentives over a five-year period through 2026 to address transport and mobility emissions across biofuels (ethanol and biodiesel), EVs, and improve fuel efficiency standards. On April 5, 2023, the Indian government announced it would produce 50 GW of renewable energy in the next five years and 10 GW of wind energy annually over a five-year period to reach India’s broader target of 500 GW of installed power generation by 2030.<sup>31</sup> According to the Central Electricity Authority (CEA), India will need to increase the non-fossil fuel capacity by 400 GW to meet its 817 GW power demand by 2030. As on April 30, 2023, solar power has the largest market share of 16.1 percent (Table 7).<sup>32</sup>

The Indian government has designated “green growth” as one of the seven priorities in its IFY 2023/2024 budget.<sup>33</sup> The financial plan for the current year also includes a range of renewable energy projects, including a 13 GW renewable energy grid in Ladakh (Kashmir), and reduced emissions activities through the Indian Railways.

**Table 7. India: Installed Generation Capacity (GW) as on April 30, 2023**

Category	Wind Power	Solar Power	BM Power/ Bagasse Cogeneration	Waste to Energy	Small Hydro Power	Total
<b>Installed Generation Capacity</b>	42,868	67,078	9,434	306	4,944	124,630
<b>% Share of Total</b>	10.2	16.1	2.5	0.1%	1.2%	30.5%

Data source: MNRE, Government of India.

**Table 8. India: Installed Capacity of Renewables (In Gigawatts) by State**

State/Union Territory	Small Hydro Power	Wind Power	Bio-Power				Total Bio-Power	Solar Power	Total Capacity
			Biomass Power/Bagasse Cogeneration	Biomass Cogen. Non-Bagasse	Waste to Energy	Waste to Energy (Off-grid)			
Andhra Pradesh	163.31	4096.65	378.1	105.57	53.16	29.21	566.04	4534.19	9360.18
Gujarat	91.64	10144.02	65.3	12	7.5	25.93	110.73	9313.23	19659.62
Karnataka	1280.73	5294.95	1867.1	20.2	1	13.85	1902.15	7617.2	16725.75
Maharashtra	381.08	5026.33	2568	16.4	12.59	43.7	2640.69	4722.9	12771
Rajasthan	23.85	5193.42	119.25	2	0	3.83	125.08	17143.3	22485.65
Tamil Nadu	123.05	10073.52	969.1	43.55	6.4	24.65	1043.7	6768.65	18008.92
Others	2880.64	3039.19	3466.71	614.73	167.49	164.72	4413.65	16978.44	26681.21
<b>Total (in MW)</b>	<b>4944.3</b>	<b>42868.08</b>	<b>9433.56</b>	<b>814.45</b>	<b>248.14</b>	<b>305.89</b>	<b>10802.04</b>	<b>67077.91</b>	<b>125692.33</b>
<b>Total (in GW)</b>	<b>4.94</b>	<b>42.86</b>	<b>9.43</b>	<b>0.81</b>	<b>0.24</b>	<b>0.3</b>	<b>10.8</b>	<b>67.07</b>	<b>125.6</b>

Note: All figures as on April 30, 2023.

Data source: MNRE, Government of India.

<sup>31</sup> Source: “Government Declares Plan to Add 50 GW of Renewable Energy Capacity Annually for the Next 5 Years to Achieve the Target of 500 GW by 2030.” [Press Information Bureau](#), published on April 5, 2023.

<sup>32</sup> The MNRE has Extended the Deadline of PM-KUSUM until September 30, 2023, for Renewable Energy-based Solar Power Projects (See, USDA Biofuels Annual - 2022).

<sup>33</sup> See: [Remarks by Minister Nirmala Sitharaman: Union Budget 2023-2024](#), Government of India, February 1, 2023.

According to CEA, India's installed biomass capacity was 10.2 GW in IFY 2022, nearly 1.9 GW higher than its 2017 capacity.<sup>34</sup> Biomass bagasse (sugarcane waste) is the largest source, and the third largest renewable energy source behind solar and wind. By 2024, the Indian government intends to establish approximately 5,000 compressed biogas (CBG) plant facilities with a total annual production capacity of 15 MMT of CBG per year. In November 2022, MNRE launched various activities through the National Bioenergy Program to establish biogas plants to produce clean cooking fuel, develop clean energy power generation for small businesses, and support rural employment.

### *Greenhouse Gas Emissions*

India is in its eighth year of the Nationally Determined Contributions (NDC) under the 2015 Paris Climate Agreement, where it pledged to reach three major climate change goals by 2030. On August 3, 2022, India updated its NDC to reduce emissions by 45 percent by 2030 compared to 2005 levels, and to generate approximately 50 percent of the total installed capacity of electric power from non-fossil fuel sources.<sup>35</sup>

India's total GHG emissions remain the third largest in the world, although per capita emissions remain well below the global average. In the government's IFY 2023/2024 budget, the Ministry of Environment, Forest, and Climate Change received approximately \$395 million for programs to promote forest cover, afforestation, and pollution control. Concurrently, in IFY 2023/2024, MNRE received \$1.23 billion (INR 102.2 billion) for programs to support reaching the government's renewable energy targets.<sup>36</sup>

Under the National Mission for Electric Mobility 2020, the Indian government launched the "Faster Adoption and Manufacturing of Hybrid and Electric Vehicles" program. Post sources note that this program will facilitate the electrification of India's total vehicle fleet, including buses, three-wheelers (rickshaws and other vehicles), and taxis. Through March 3, 2023, approximately 6,586 public charging stations are operational, of which 419 are part of the National Highways system.<sup>37</sup>

### *National Greenhouse Gas Inventory*

In February 2021, India submitted its third biennial update report to the UNFCCC and declared that it met its voluntary goal in 2020 to reduce the emission intensity of GDP by 20-25 percent from its previous 2005-levels.

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<sup>34</sup> See: [Bioenergy](#), MNRE, Government of India.

<sup>35</sup> See: "6,586 operational Public EV Charging Stations in India." [Ministry of Heavy Industries](#), published on March 24, 2023.

<sup>36</sup> Of this amount, solar energy received the highest allocation of funds (\$644 million).

<sup>37</sup> See: "6,586 operational Public EV Charging Stations in India." [Ministry of Heavy Industries](#), published on March 24, 2023.

## *Climate Change and India's Post-2020 Climate Goals*

In accordance with the Indian government's National Action Plan on Climate Change, thirty-four states and union territories have developed their "State Action Plans on Climate Change" to address state-specific sectors and cross-sectoral priority actions.<sup>38</sup> The Indian government has formed various international collaborations, including the International Solar Alliance and the Coalition for Disaster Resilient Infrastructure.

The United States and India maintain renewable energy collaboration through the U.S.-India Climate and Clean Energy Agenda 2030 Partnership. To support clean energy transition, both countries have organized public-private committees on hydrogen and biofuels development, including an "Energy Storage Task Force" for support a clean energy transition.<sup>39</sup> Additionally, biofuels are included within the "Responsible Oil and Gas" pillar within the U.S.-India Strategic Clean Energy Partnership.

In February 2023, India, the United Arab Emirates and France agreed on a trilateral initiative to undertake projects on solar and nuclear energy, climate change and biodiversity, single-use plastic pollution, desertification, and food security. Collaboration will occur through mechanisms including the Mangrove Alliance for Climate, the Indo-Pacific Parks Partnership by India and France, as well as events through India's G-20 presidency, and various COP-28 climate change dialogues.<sup>40</sup>

For Indian government references, see: [UNFCCC: India's Intended Nationally Determined Contribution: Working Toward Climate Justice](#) and MOEFCC: [National Action Plan on Climate Change](#).

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<sup>38</sup> Source: "India is Part of the Solution and is Doing More Than its Fair Share to Address Climate Change." MOEFCC, published on February 2, 2023.

<sup>39</sup> See: "U.S.-India Strategic Clean Energy Partnership Ministerial Joint Statement." [Department of Energy](#), Office of International Affairs, published on October 7, 2022.

<sup>40</sup> "UAE, France, India to Cooperate on Energy, Climate, Emirati State News Agency Reports." [Reuters](#), published on February 4, 2023

## SECTION III. ETHANOL

### PRODUCTION, SUPPLY AND DISTRIBUTION (PSD)

**Table 9. Ethanol Used as Fuel, Other Industrial Chemicals, and Denatured (Million Liters)**

Calendar Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 <sup>f</sup>
<b>Beginning Stocks</b>	60	75	61	128	150	300	112	309	150	205
<b>Production</b>	2,002	2,292	2,061	1,671	2,692	2,552	2,981	3,280	5,300	6,300
<b>Imports</b>	193	204	432	722	607	670	669	648	370	400
<b>Exports</b>	180	165	136	141	129	50	133	87	109	120
<b>Consumption</b>	2,000	2,345	2,290	2,230	3,020	3,360	3,320	4,000	5,506	6,278
Fuel Consumption	350	425	450	675	1,500	1,890	2,100	3,695	5,140	6,110
<b>Ending Stocks</b>	75	61	128	150	300	112	309	150	205	507
<b>Production Capacity</b>										
Number of Refineries	115	160	161	161	166	170	220	231	252	400+
Nameplate Capacity	2,000	2,100	2,210	2,215	2,300	3,000	3,500	4,300	5,700	10,820
Capacity Use (%)	17.8	20.5	20.4	31.8	65.2	64.0	60.6	87.1	87.7	57.3
<b>Co-product Production (1,000 MT)</b>										
Bagasse	105,642	108,699	97,485	79,176	118,784	99,942	126,976	139,264	135,168	131,072
Press Mud*	14,086	14,493	12,852	10,438	15,660	13,176	16,740	18,360	17,820	17,280
<b>Feedstock Use for Fuel (1,000 MT)</b>										
Sugarcane (syrup)	0	0	0	0	0	1,951	5,263	10,000	14,274	18,400
B-heavy Molasses	0	0	0	0	750	2,271	3,550	6,667	9,000	11,400
C-heavy Molasses	1,600	2,000	2,125	3,150	5,500	4,500	1,200	900	800	600
Damaged Food Grains	0	0	0	0	350	603	1,600	2,000	2,000	2,100
Rice (broken)#	0	0	0	0	0	0	118	471	1,610	2,000
Corn	0	0	0	0	0	0	0	0	0	50
<b>Market Penetration (Million Liters)</b>										
Fuel Ethanol	350	425	450	675	1,500	1,890	2,100	3,695	5,140	6,110
Gasoline Pool 1/	26,628	30,823	32,994	37,098	40,367	42,496	40,741	45,453	50,150	52,986
Blend Rate %	1.3	1.4	1.4	1.8	3.7	4.4	5.2	8.1	10.2	11.5

1/ Gasoline Pool covers gasoline plus any additive including biocomponents (ethanol).

Data source: Post research and historical data series, industry sources, and official government trade data as compiled and reported by Trade Data Monitor, LLC.

<sup>f</sup> = Year 2023 is projected; # Excess rice supplied by the Food Corporation of India (FCI); \* Leftover sugarcane residue after juice extraction.

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.

## CONSUMPTION

India's 2023 total ethanol consumption is forecast to rise by 30 percent to a record 6.3 BL, driven in large part by the government's initiative for increased ethanol blending to meet its 2025 E-20 mandate. In May 2023, India achieved a blending rate of 11.65 percent with gasoline, a new record.<sup>41</sup> For the ninth year in a row, consumption will outpace production due to a surging fuel pool.

Ethanol demand for the EBP is much higher in 2023 over the previous year despite a drop in sugarcane production. Strong remunerative tender prices, and a gradual improvement of supply chains, and increased diversion of food grains for ethanol production have increased consumption. As of November 2022, OMCs maintain approximately 344 million liters of storage capacity that can annually store approximately 6.28 BL of ethanol.<sup>42</sup>

Post has revised India's ethanol consumption figures for 2021 and 2022 by 4 BL and 5.5 BL, respectively, accounting for market realities and increased ethanol production. However, Post maintains that a 20 percent national blend rate would be difficult for India to achieve by 2025, let alone sustain, due to supply constraints (import restrictions and insufficient domestic feedstock procurement) and the expected continued rapid growth in the gasoline fuel pool this decade. India's growing production and consumption of ethyl alcohol in the potable sector, as well as in chemical and industrial applications will continue to compete for sugarcane and grain feedstocks that remain insufficient to supply all sectors.

## PRODUCTION

As of May 2023, Post estimates the total annual production of ethanol (for all purposes) at 6.3 BL, 19 percent above last year owing to the increased output from both grain-based distilleries and sugarcane/molasses industries. (Table 9). Of this total, Post estimates 6.2 BL will be blended with gasoline under the EBP for 2023. However, sugarcane production is estimated to have dropped by 13 percent from the previous MY due to adverse weather conditions, primarily in Maharashtra and Karnataka. The major sugarcane producing states of Uttar Pradesh, Maharashtra, Punjab, and Karnataka have maintained high ethanol blending to gasoline rates, but this is less consistent across other states.

The lower-than-expected harvest led to an early closure of most sugar mills.<sup>43</sup> Still, the Indian government's recent and noteworthy initiatives that have rapidly established grain-based distilleries, and the increased diversion of sugarcane juice and molasses production will result in an increase of ethanol production in 2023. To comply with its E20 guidelines, the Indian government is pushing for greater multi-feedstock and grain-based distilleries (see: Ethanol growth story, [MoPNG](#)). Any import of raw materials, or grain-based/multi-feedstocks can be potential sources for India's industrial and alcoholic beverage sectors.

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<sup>41</sup> "Sugar Mills on Course to Meet 12% Ethanol Blending Target." [The Hindu Business Line](#), published on May 9, 2023

<sup>42</sup> Assumes a 20-day storage period.

<sup>43</sup> See: USDA GAIN, India: Sugar Annual - 2023, [IN2023-0035](#).

Approximately 5.13 BL of ethanol have been contracted against 5.2 BL required for OMC procurement for ESY 2022/2023. As of April 30, 2023, around 2.33 BL of ethanol have been supplied to OMCs for blending. Most ethanol feedstocks are B and C-heavy molasses, followed by sugarcane juice, damaged food grains unfit for human consumption, surplus rice, maize, and other potential raw materials.

Ethanol produced from sugarcane juice/syrup and B-heavy molasses are set to achieve record volumes, due to increased procurement prices and other incentives. Total supply in the forecast year is comprised of 18.14 million liters from sugarcane juice, 11.4 BL from B-heavy molasses, 2.1 BL in damaged food grains, 2 BL from surplus rice, 600 million liters from C-heavy molasses, and 50 thousand liters from corn (Table 10).

In 2022, 252 operating distilleries were sugarcane/molasses-based with a nameplate capacity of 5.7 BL of ethanol (denatured and undenatured) for use in fuel, industrial, personal care, food, medical-grade alcohol (sanitizers, topical disinfectants, solvents, and preservatives etc.) and portable liquor applications.<sup>44</sup> For 2023, India maintains approximately 263 sugarcane/molasses-based distilleries with a nameplate capacity of 7 BL of ethanol, and 129 grain-based distilleries with 3.8 BL of ethanol production capacity.<sup>45</sup> According to the All-India Distillers Association, the Indian government is urging multi-feedstock plants to expand operations for greater ethanol production.

## **TRADE**

### *Imports*

Post estimates India's ethanol imports lower to 400 million liters in the forecast year as greater domestic production will support industrial and beverage demand. Apart from fuel blending, India remains a net ethanol importer for all end uses. In 2022, ethanol imports declined to 370 million liters. In the last decade, the United States has been the largest ethanol supplier (denatured) to India for medical-grade and industrial ethanol, exporting 335 million liters last year.<sup>46</sup> Brazil is typically also among the top suppliers, along with Canada and China.

### *Exports*

In 2022, India's ethanol exports grew to 109 million liters (mostly undenatured), a 25 percent increase from 2021. For the current year, Post estimates exports slightly upward at 120 million liters accounting for demand from various African countries and despite the strong domestic demand in the potable sector and EBP program.

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<sup>44</sup> Estimated ethanol manufacturing capacity estimated as of the 2023 sugar season, based on the number of operational days allowed by the Pollution Control Boards.

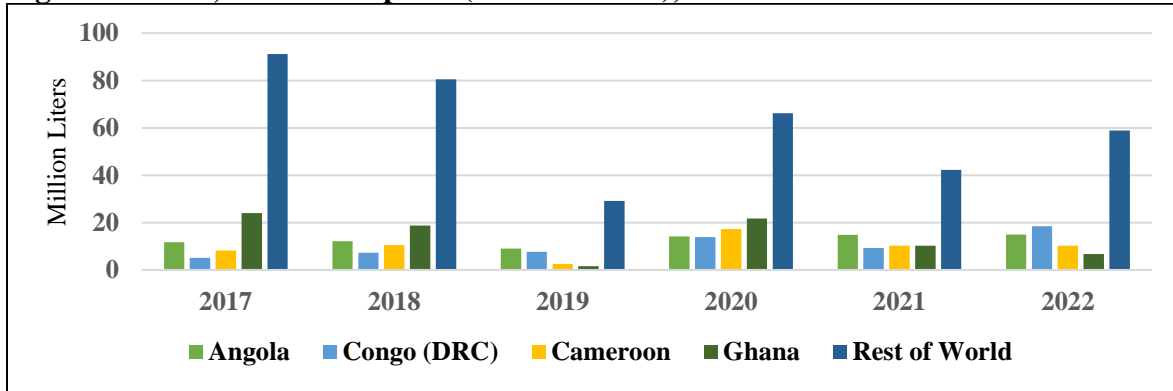
<sup>45</sup> Source: "The Current Ethanol Production Capacity for Ethanol Blending with Petrol and Other Uses..." [Ministry of Consumer Affairs](#), published on December 21, 2023.

<sup>46</sup> Ethanol prices in the United States have increased by almost 32 percent compared to last year.



Top ethanol export destinations in 2022 included Angola, Congo, and Cameroon (Figure 1). In March 2023, the Indian government stated that if the biofuel is generated using imported feed stock, then exports of biofuel from special economic zones and export-oriented units are permissible for fuel and non-fuel purposes without restrictions.<sup>47</sup>

**Figure 1: India, Ethanol Exports (Million Liters), 2017-2022**



Data source: U.S. Census Bureau, TDM and Ministry of Commerce, Government of India.

<sup>47</sup> “Government Amends Export Policy for Biofuels.” [Economic Times](#), published on March 22, 2023.

## SECTION IV. BIODIESEL

### PRODUCTION, SUPPLY AND DISTRIBUTION

**Table 10. Biodiesel Production from Multiple Feedstocks (Million Liters)**

Calendar Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 <sub>f</sub>
<b>Beginning Stocks</b>	14	11	13	13	18	25	23	16	26	22
<b>Production</b>	138	152	158	170	185	230	200	180	185	200
<b>Imports</b>	2	1	3	8	25	7	1	1	1	1
<b>Exports</b>	42	33	42	8	23	54	68	6	4	4
<b>Consumption</b>	101	118	119	165	180	185	140	165	186	190
<b>Ending Stocks</b>	11	13	13	18	25	23	16	26	22	29
<b>Production Capacity (Million Liters)</b>										
Number of Biorefineries	6	6	6	6	6	6	6	6	7	10+
Nameplate Capacity	480	500	550	600	650	670	580	520	577	600
Capacity Use (%)	28.8	30.4	28.7	28.3	28.5	34.3	34.5	34.6	32.1	33.3
<b>Feedstock Use for Fuel (1,000 MT)</b>										
Non-edible Industrial	75	85	90	100	110	140	140	95	105	115
Used Cooking Oil	51	55	55	56	60	70	45	65	65	70
Animal Fats/Tallow	6	5	6	6	7	10	6	12	7	6
<b>Market Penetration (Million Liters)</b>										
Biodiesel, On-road	32	41	48	72	83	100	50	10	40	40
Diesel Pool, On-road 1/	49,605	52,239	55,179	56,715	59,220	60,145	44,400	52,927	57,002	58,000
Blend Rate (%)	0.06	0.08	0.09	0.13	0.14	0.17	0.11	0.02	0.07	0.07
Diesel Pool, Total Use 1/	82,674	87,064	91,965	94,524	98,700	95,541	84,512	90,231	99,000	107,000

1/ Diesel Pool covers diesel plus any additive including biocomponents (biodiesel).

Data source: FAS New Delhi Research and historical data series, and official government trade data as compiled and reported by Trade Data Monitor, LLC. *f*=Year 2023 is projected; \*Indicates theoretical estimate.

The biodiesel market is fragmented, mostly unregulated, with low indigenous production. Due to high feedstock prices and anti-inflationary measures, many countries maintain biodiesel blends of B5, and several run at B10 or higher. Due to India's large transportation fleet, the biodiesel market has significant growth potential. A lack of viable feedstocks and limited government investments, including suitable infrastructure for storage and delivery inhibit the sector's expansion. Access to imports would help jumpstart the process. The development of the biodiesel industry remains hampered by India's preference for ethanol.

### CONSUMPTION

Post estimates that 190 million liters of biodiesel will be consumed in the outyear, supported primarily by government incentives and tax rebates for consumers (Table 10). Applications for blended biodiesel include OMCs fuel stations, railroads, various State Road Transport

Corporations, road transport fleets, and port authorities. With a current Integrated Goods and Services Tax rate of 12 percent, the retail price of biodiesel is benchmarked against conventional, high-speed diesel. Other consumers of biodiesel include power generators, brick kilns, water pumps for agricultural use, and mobile communication towers, among others.

## **PRODUCTION**

Post forecasts India to produce 200 million liters of biodiesel in 2023, a slight increase from 2022 figures. India maintains 10 biodiesel plants with a combined 600-million-liter capacity. Primary biodiesel feedstocks include non-edible industrial oils, UCO, animal fats, and tallows. However, limited availability of raw materials has resulted in infrequent production. In addition, the high price of crude edible oils, including palm oil and palm stearin have decreased the operational efficiency and profit margins. Aside from UCO, there are no governmental rules limiting the availability of feedstocks for the manufacturing of biodiesel.

## **TRADE**

Post has estimated 2023 biodiesel imports to remain marginal at one million liters, accounting for long-established import restrictions. Exports are projected to remain flat at 4 million liters in the forecast year. Malaysia was the primary importer of Indian biodiesel blends in the last two years. In March 2023, the Indian government clarified that biodiesel produced from imported feedstocks would face no tariff restrictions, if they be produced and exported from special economic zones.<sup>48</sup>

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<sup>48</sup> Source: “Government Amends Export Policy for Biofuels.” [Economic Times](#), published on March 22, 2023.

## SECTION V. ADVANCED BIOFUELS

The 2018 National Biofuels Policy states that 120-160 MMT of biomass is annually produced, which, if made available and converted, could produce 30 BL of cellulosic ethanol. The Indian government previously indicated that 5-10 BL of cellulosic ethanol could be in the fuel mix by 2030 but would be difficult at present to achieve. India has operational advanced biofuel plants, including pilot and a demonstration plants, with a cumulative annual production capacity of 32 million liters of cellulosic ethanol.<sup>49</sup> Advanced biofuel production is dependent on available feedstocks within the surrounding region of the plants, and multiple challenges such as high production costs, water absorbing property of cellulose ethanol and incompatible pipeline infrastructure inhibit rapid expansion.

### Expanded Eligible Feedstock and 2-G Financial Assistance

The “Pradhan Mantri JI-VAN Yojana” program has provided \$300 million to assist 2G commercial and demonstration projects using Viability Gap Funding and a total financial outlay of \$238 million (INR 19.69 billion) from ESY 2018-2019 to ESY 2023-2024.<sup>50</sup> The program includes \$217.7 million (INR 18 billion) for supporting 12 commercial ventures, \$18.14 million (INR 1.5 billion) for ten demonstration projects, and \$2.36 million (INR 195 million) to develop a “Center for High Technology.”

Technologies are available that convert waste into biofuels and other biochemicals but are mostly at a nascent stage and must be proven on a commercial scale (Table 11). However, India has taken steps in developing 2G ethanol production. The Indian Oil Corporation’s Panipat (Haryana) Refinery is the first commercial 2G ethanol plant in India, with an annual nameplate capacity of 30 million liters that utilizes about 200,000 MT of crop residue. In addition, Bharat Petroleum’s first integrated (combined 1G-2G) ethanol refinery in Bargarh, Odisha, is intended to operate by 2024 and use biomass, grains, and sugarcane feedstocks. Hindustan Petroleum Corporation Limited is fabricating a 100,000 MT capacity plant in Bhatinda using primarily waste food stocks. Meanwhile, Numaligarh Refinery Limited in Assam is developing a 2G distillery that utilizes bamboo feedstocks.

**Table 11. India: Biofuel Research and Development Classification**

Fuel	Substitute	Technologies Deployed
Diesel	*Biodiesel, **HDRD (Green Diesel), Bio-based oxygenates (alcohols and ethers)	Esterification, Hydro-Processing, Fermentation, Syngas Conversion
Aviation Turbine Fuel (ATF)	**Sustainable Aviation Fuel (or, Bio-ATF)	Hydro-Processing, 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, Hydro-Processing, Pyrolysis/Catalytic Cracking
Compressed natural gas (CNG)/piped natural	*Bio-CNG/Bio-PNG, HCNG, Bio-H2	Waste Fermentation

<sup>49</sup> Cellulosic ethanol uses bagasse, wood waste, agricultural and forestry residues, among others as feedstock sources.

<sup>50</sup> See: “Cabinet Approves Continuation and Revamping...” [Ministry of Finance](#), published on November 11, 2022.

gas (PNG)		
Marine Fuel/Industrial Fuel Oil	**Green heavy distillate, biomass-derived oils	Hydro-Processing, Pyrolysis/Fluid Catalytic Cracking, Hydrothermal Liquefaction, MSW-thermochemical processing

(\*) Indicates technologies are available.

(\*\*) Indicates emerging technologies (in development).

Source: DBT, Ministry of Science and Technology.

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 Indian government, including guaranteed buyback via ethanol purchase agreements with cellulosic ethanol suppliers 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. It has also been given offtake assurances by public sector natural gas companies.

## Sustainable Aviation Fuel (SAF)

Sources indicate that the Indian government will introduce guidelines which would require domestic airlines to utilize a one percent blend of Sustainable Aviation Fuel (SAF) by 2025 and 5 percent by 2030.<sup>51</sup> In 2022, domestic airlines (Indigo, Air India, Air Asia India, and Vistara) signed contracts with the Council of Scientific and Industrial Research–Indian Institute of Petroleum to collaborate on the creation and development of SAF blends.<sup>52</sup> Additionally, Indian Oil Corporation Limited (IOCL) is constructing a \$122 million (INR 10 billion) SAF plant at Haryana’s Panipat refinery in collaboration with U.S.-based company LanzaJet.<sup>53</sup> IOCL aims to annually generate 88,000 MT of SAF, comprising 2 percent of overall ethanol production by 2030, which is added pressure to India’s existing E-20 goal. On May 19, in a landmark moment, Air Asia India conducted the first commercial passenger flight using a 1 percent SAF blend.<sup>54</sup>

On May 19, 2023, MoPNG stated that India would require 140 and 700 million liters of SAF per year to reach one and 5 percent blending rate, respectively, by 2025.<sup>55</sup> Accordingly, by 2030, to reach a 50 percent SAF blend rate, India would require around 10 MMT of SAF per year. At the same time, the government has stated that it possesses sufficient feedstocks to produce up to 24 MMT of SAF per year.<sup>56</sup> However, Post ascertains that India will likely need to balance SAF feedstock needs against its 2G ethanol production aspirations, and that the immense costs involved in decarbonizing India’s aviation sector will constrain growth in the near term.

<sup>51</sup> “Mandatory Blended Jet Fuel Likely by ’25.” [Live Mint](#); published April 20, 2023.

<sup>52</sup> “Airbus: Will Help India Create a Sustainable Aviation Fuel Marketplace.” [Times of India](#); published February 28, 2023.

<sup>53</sup> “Indian Oil Plans Green Jet Fuel Plant to Meet Surging Demand.” [Bloomberg](#); published May 3, 2023.

<sup>54</sup> ICOL produced the SAF blend (1 percent). Source: “AirAsia India Conducts First Flight with Indigenous SAF.” [Bioenergy International](#), published on May 20, 2023.

<sup>55</sup> See: “Sustainable Aviation Fuel (SAF) using indigenous feedstock ...” [MoPNG](#), published on May 19, 2023.

<sup>56</sup> Source: “India will require 14 cr litre of SAF/annum to achieve 1% blending in jet fuel by 2025: Puri.” [Mint](#); published May 19, 2023.

## SECTION VI: NOTES ON STATISTICAL DATA

**Table 12. Select Biofuel Conversion Factors**

Damaged Food Grains – 1 MT = 250 liters (Source: Arcus Policy Research)
Broken Rice – 1 MT = 425 liters
Sugarcane (Includes Syrup/Juice) – 1 MT = 76 liters
B-Heavy Molasses – 1 MT = 300 liters (Source: Triveni, and National Sugar Institute, Kanpur)
C-Heavy Molasses – 1 MT = 217 liters (Source: Triveni)
Corn – 1 MT = 373 liters (Source: Arcus Policy Research)
Ethanol – 1 MT = 1,267 liters
Biodiesel – 1 MT = 1,136 liters
Animal Fats and Tallow – 1 MT = 1,043 liters
Used Cooking Oil – 1 MT = 1,043 liters
Non-edible Industrial (Includes Palm Stearin) – 1 MT = 1,050 liters

India's National Policy on Biofuels 2018 defines biofuels in the following manner and permits the following feedstocks:

**1) Bioethanol:** ethanol produced from biomass such as sugar containing materials, like sugar cane, sugar beet, sweet sorghum etc.; starch containing materials such as corn, cassava, rotten potatoes, agrifood/pulp industry waste, algae; and cellulosic materials such as bagasse, wood waste, agricultural and forestry residues, or other renewable resources like industrial (municipal) waste, vegetable wastes, industrial waste off gases or any mix combination of above feedstock.

**2) Biodiesel:** A methyl or ethyl ester of fatty acids produced from non-edible vegetable oils, acid oil, used cooking oil or animal fat.

**3) Advanced Biofuels:** Fuels which are (1) produced from lignocellulosic feedstocks (i.e., agricultural and forestry residues (e.g., rice and wheat straw/corn cobs and stover /bagasse, woody biomass), non-food energy crops (i.e., grasses, algae), animal dung or industrial waste and residue streams, or any mix combination of above feedstock. (2) having low CO<sub>2</sub> emission (e.g., high greenhouse gas reduction) and do not compete with food crops for land use. Fuels such as Second Generation (2G) Ethanol, biodiesel made from UCO, non-edible tree borne oils, short gestation non-edible oil rich crops; green diesel from renewable sources and Industrial waste, biofuels produced from synthesis gas, drop-in fuels from renewable sources and industrial waste, algae based 3G biofuels, halophytes based biofuels, bio-CNG, bio-methanol, Di Methyl Ether derived from bio-methanol, bio-hydrogen, drop-in-fuels from MSW resource/feedstock material.

**Drop-in Fuels:** Any liquid fuel produced from biomass, agricultural-residues, wastes such as municipal solid wastes (MSW), plastic wastes, industrial wastes etc. which meets the Indian standards for motor spirit (MS), high speed diesel (HSD) and jet fuel, in pure or blended form,

for its subsequent utilization in vehicles without any modifications in the engine systems and can utilize existing petroleum distribution system.<sup>57</sup>

**Bio-CNG:** Purified form of biogas whose composition and energy potential are the same as fossil based natural gas, and is produced from agricultural residues, animal dung, food waste, MSW and sewage water.

Potential domestic raw materials for production of biofuels in the country include:

**For Ethanol Production:** B and C-heavy molasses, sugarcane juice, sugar, sugar syrup, biomass in form of grasses, agriculture residues (rice straw, cotton stalk, corn cobs, saw dust, bagasse etc.), sugar containing materials like sugar beet, sweet sorghum, etc. and starch containing materials such as corn cassava, rotten potatoes, agri-food/pulp industry waste, etc., broken rice, food grains unfit for human consumption, food grains during surplus phase as declared by National Biofuel Coordination Committee, industrial waste, and industrial waste off-gases. Algal feedstock and cultivation of sea weeds can also be a potential feedstock.

**For Biodiesel Production:** Non-edible Oilseeds, UCO, Animal tallow, Acid Oil, Short Gestation non-edible oil rich crops, and algal feedstocks.

Refer to [2018 National Policy on Biofuels and Amendments](#) for complete information.

## **Attachments:**

No Attachments

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<sup>57</sup> Note: Regardless of feedstock or production technology platform used, all ethanol (conventional or advanced), biodiesel, and existing American Society for Testing and Materials-approved SAFs must be blended with fossil fuels and are not fully substitutable without modifying engines currently on the road. The only exception of note includes Brazil's large fleet of vehicles that can run on pure ethanol. Renewable diesel (Hydrogenation-Derived Renewable Diesel-type) and biomethane are the only drop-in biofuels for engines used today currently available at commercial scale.