IEA-Advanced Motor Fuels
ANNUAL REPORT 2023

INDIA

Technology Collaboration Programme
by IEA

India

Drivers & Policies

India is the third-largest consumer of oil in the world. However, its per-capita energy consumption is among the lowest in the world at 0.6 tons of oil equivalent (toe)— a third of the average in other countries (1.79toe). India ranks as the world's second-largest net crude importer and sixth-largest petroleum product exporter, and the country is forecast to be the single largest source of global oil demand growth from 2023 to 2030, narrowly ahead of China. Underpinned by strong economic and demographic growth, India is on track to post an increase in oil demand of almost 1.2 million barrels per day (mb/d) over the forecast period, accounting for more than one-third of the projected 3.2 mb/d global gains.

Primary energy demand will increase significantly under all three scenarios (Accelerated, Net Zero, and New Momentum), more than doubling between 2019–2050.As result of strong growth, India will account for around 14% of global primary energy consumption in 2050across all scenarios, up from around7% in 2019.The share of coal in India's total primary energy mix has been remarkably stable, consistently in line with 2019 levels (45%) over the past 40years. However, the coal share is projected to decline under all scenarios, reaching between 6%and 34% by 2050. Renewable energy growth is strong, averaging4%–6% per year, and is expected to represent between 31% and 66% of total primary energy in 2050.Electricity generation in 2050 is around four times that in 2019 in the New Momentum and Accelerated scenarios, and five times the2019 level in the Net Zero scenario, with solar and wind power accounting for 57% to 95% of that growth. Hydrogen demand grows by a factor of four in the New Momentum scenario, and by a factor of twelve in the Net Zero scenario.

Currently, India imports approximately 88% of its crude oil and 46% of its natural gas requirements. Growing concern about the nation's dependence on imported fuel in tandem with environmental pollution issues has driven India's need for alternative fuels. India plans to reduce import dependency in the oil and gas sectors by adopting a five-pronged strategy: increasing domestic production, adopting biofuels and renewables, establishing energy-efficiency norms, improving refinery processes, and implementing demand substitution.

Since 2014, the Indian government has undertaken multiple interventions to promote biofuels through structured programs such as the Ethanol Blended Petrol (EBP) program, Biodiesel Blending in Diesel, and SATAT (Sustainable Alternative Towards Affordable Transportation) — an initiative for promotion of compressed biogas (CBG). India introduced a National Policy on Biofuels in 2018 (subsequently amended in June 2022) that aims to achieve 20% blending of ethanol in petrol by ethanol supply year (ESY) 2025–26 and 5% blending of biodiesel in diesel by 2030. To enhance use and adoption of CBG, phased mandatory blending of CBG in compressed natural gas (CNG) (for transport) and piped natural gas (PNG) (for domestic use) in the city gas distribution (CGD) sector would begin in financial year (FY) 2025–26. The CBG Blending Obligation (CBO) will be 1%, 3%, and 4% of total CNG/PNG consumption for FYs 2025–26, 2026–27, and 2027–28, respectively. Beginning in 2028–2029, the CBO will be 5%.The government has also set targets of 1%, 2%, and 5% blending of sustainable aviation fuel (SAF) in aviation turbine fuel (ATF) with effect from 2027, 2028, and 2030 respectively, initially for international flights.

The major feature of India's biofuels policy is the categorization of such fuels as either "basic biofuels" (e.g., first-generation "1G" ethanol, biodiesel) and "advanced biofuels" (e.g., 2G ethanol, drop-in fuels) to expand the scope of raw material for ethanol production.To promote a hydrogen economy, the Indian government launched the National Green Hydrogen Mission on January 4, 2023.

Advanced Motor Fuels Statistics

The Indian government has been promoting and encouraging the use of advanced motor fuels in the transport sector, including the blending of biofuels— which are sustainable and have lower emissions than fossil fuels — in petrol, diesel, and natural gas. Loans for the construction of oil extraction/ processing units for production of biofuels and of storage and distribution infrastructure and loans to entrepreneurs to develop CBG plants were classified under priority sector lending by India's Central Bank on September 4, 2020.

With a view to decarbonizing the transport sector, the Indian government developed the "Roadmap for Ethanol Blending in India 2020–25," providing guidance to meet the target of 20% blending of ethanol in petrol (E20) by 2025–26. In line with its Ethanol Blending Roadmap, India launched E20 fuel in February 2023 and by January 2024, more than 10,000 retail outlets across the country were selling E20 fuel.

Ethanol Blended Petrol Programme

Under the EBP programme, the PSUOMCs (Public Sector Undertaking Oil Marketing Companies) achieved the highest-ever blending of ethanol in petrol (12.06%)in ESY 2022–23. Further, the government has already notified and allowed the oil marketing companies (OMCs) to sell E20, in accordance with the Bureau of Indian Standards (BIS) specification effective from December 15, 2022.

The Government of India has taken steps to increase the production and use of ethanol, including permitting procurement of ethanol produced from non-food feedstocks besides molasses (e.g., cellulosic) and lignocelluloses materials (e.g., cotton stalk, wheat straw, rice straw, bagasse, bamboo), and via petrochemical routes, subject to their meeting the relevant BIS standards. The government has also allowed the conversion of sugarcane and food grains (maize and surplus stocks of rice with the Food Corporation of India) to ethanol; administered a price mechanism for procuring ethanol under the EBP Programme, including an enhanced ex-mill price; lowered the goods and services tax (GST) rate to 5% on ethanol for the EBP Programme; amended the Industries (Development & Regulation) Act for free movement of ethanol across states for blending; and instituted a special incentive for maize-based ethanol, among other actions. These steps facilitated an increase in the blending of ethanol in petrol from 154 million liters during ESY 2012–13 to around 5,085 million litres during ESY 2022–23, achieving an average blending rate of 12.06% in petrol (see Table 1).During ESY 2022–23, ethanol distillation capacity increased from 9.47 billion litres to 14.44 billion litres per year (52% increase).

Table 1. Trends in Ethanol Procurement/Blending under EBP Program

Trend	Ethanol Supply Year (Dec. to Nov.)						
	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23
Ethanol procured/blended by PSU OMCs[a] (in million litres)	665	1505	1886	1730	3023	4336	5085
National average blending (percentage)	2.0	4.2	5.0	5.0	8.1	10.02	12.06

[a] Public Sector OMCs (i.e., Indian Oil Corporation Ltd. (IOCL), Bharat Petroleum Corporation Ltd. (BPCL), and Hindustan Petroleum Corporation Ltd. (HPCL).

To promote the establishment of distilleries, dedicated ethanol plants (DEPs) are being set up in states where ethanol production is low to avoid the need to transport ethanol over long distances and mitigate supply fluctuations that might impact achievement of blending requirements. DEPs have been commissioned with a design capacity of 257 crore litres per year. In addition, from July 2018 to April 2022, the government notified various ethanol interest subvention schemes for sugar mills and molasses- and grain-based stand-alone distilleries to arrange for entrepreneurs to set up new distilleries or expand existing ones in all states, including those that have a shortage of ethanol. Major developments in 2023 include constitution of a maize development task force and funding of special projects on maize research, upscaling of the maize-based silage value chain, and enhancement of maize production in the catchment area of the ethanol industry.

2G Ethanol Program

The Government of India instituted the "Pradhan Mantri JI-VAN (JaivIndhan-Vatavaran Anukoolfasalawashesh Nivaran) Yojana," to provide financial assistance of approximately $300 million USD from 2018–19 to 2023–24 to support commercial, as well as demonstration, projects for 2G ethanol. India's government has allowed the procurement of ethanol produced from other non-food feedstocks besides molasses, like cellulosic and lignocellulosic materials. The 2G feedstocks include agri-residues such as rice and wheat straw, cane trash, corn cobs and stover, cotton stalk, bagasse, and empty fruit bunches (EFB). In accordance with this decision, PSU OMCs are setting up 2G ethanol bio-refineries in various parts of the country. A 2G ethanol plant in Panipat was dedicated to the nation on World Biofuel Day (August 10, 2022).Projects at Bhatinda (Punjab), Bargarh (Odisha), and Numaligarh (Assam) are in advanced stages of construction and are likely to become operational in

2024. Financial assistance of more than 110 million USD has been approved to public and private sector companies. The government has allowed export of 2G ethanol, which will help valorization of 2G ethanol by project proponents.

Biodiesel and Sustainable Aviation Fuel

In June 2017, the government allowed the direct sale of biodiesel (B-100) for blending with high-speed diesel to all consumers, in accordance with specified blending limits and BIS standards. The government issued "Guidelines for Sale of Biodiesel for Blending with High-Speed Diesel for Transportation Purposes 2019" on May 1, 2019.Biodiesel procurement increased from 0.6 million litres in FY2021–22 to 439.9 million litres in FY 2023–24 (April 2023–March 2024).

In June 2021, the government assembled a committee to advance the SAF/bio-aviation turbine fuel (Bio-ATF) program. The committee examined various aspects of the Bio-ATF program and recently submitted a report that is currently under examination by the Ministry. To promote SAF, OMCs are setting up plants across the country that are likely to be operational between 2025 and 2027. The government has set targets of 1%, 2%, and 5% blending of SAF in ATF to take effect in 2027, 2028, and 2030, respectively, for international flights.

Compressed Biogas

As part of an initiative under the National Policy on Biofuels2018, the SATAT initiative was launched in October 2018 to promote the use of CBG along with natural gas. Under this initiative, oil and gas marketing companies (OGMCs) are inviting expressions of interest from potential investors and entrepreneurs to procure CBG for sale to automotive and commercial customers.

As of December 2023, 55 CBG plants with a total production capacity of around 340 metric tons (MT) per day have been commissioned;57 CBG plants are at various stages of construction.Sales of CBG have been initiated from more than 150 retail outlets. CBG is also being supplied to industrial customers, and CBG injection in the CGD network has started.

India's Ministry of Petroleum and Natural Gas (MoP&NG) has issued guidelines for synchronization of CBG with City Gas Distribution (CGD) network. Under the CBG-CGD synchronization scheme, CBG sales have been initiated in 22 geographical areas of the CGD network.

Under this initiative, various measures have been taken to increase the production of CBG, including establishing an assured price for off-take of CBG, central financial assistance to CBG/biogas plants under the Umbrella Scheme of the National Bio Energy Programme (of the Ministry of New and Renewable Energy), and additional central assistance to states and union territories for establishing municipal solid waste (MSW)-based CBG projects through Swachh Bharat Mission Urban 2.0 of the Ministry of Housing and Urban Affairs.

Earlier developments involve the inclusion of bio-manure produced from CBG plants as fermented organic manure (FOM) and liquid fermented organic manure (LFOM) under the Fertilizer Control Order of 1985; the inclusion of CBG projects under the "White Category" by the Central Pollution Control Board on a case-by-case basis; the inclusion of CBG projects under priority sector lending by the Reserve Bank of India (RBI); and loan products from various banks to finance CBG projects.

Major developments in 2023 include an exemption in the excise duty on the biogas or CBG portion of blended CNG; an exemption from the requirement to obtain authorization for sale of FOM/LFOM for three years; implementation of India's Policy on Promotion of Organic Fertilizer which, among other things, provides market development assistance and crop residue management guidelines (CRM-23-24),including financial assistance to facilitate establishment of a crop residue/paddy straw supply chain. In addition, the government has approved ascheme to provide financial assistance to CBG producers for 4 years to allow them to purchase aggregation machinery to collect biomass.

To promote the production and consumption of CBG in the country, the government implemented a phased blending of CBG in CNG (for transport) and PNG (for domestic use) in the CGD sector. The CBO will be voluntary until FY 2024–2025; mandatory blending will begin in FY 2025–26 at 1%, in 2026–27 at 3%, and in 2027–28 at4% of total CNG/PNG consumption. Beginning in 2028–29, the CBO will be 5%.

Green Hydrogen

The Indian Government approved the National Green Hydrogen Mission on January 4, 2023, with a total financial investment of approximately 2.5 billion USD (₹ 19,744 crore), including an outlay of about 2.2 billion USD (₹ 17,490 crore)in incentives for green hydrogen production and eletrolyser manufacturing; the remainder will be used for pilot projects, research and development (R&D), and other mission components. India's green hydrogen production capacity is likely to reach 5 million metric tons (MMT) per year by 2030, with the goals of reducing its fossil fuel imports of approximately 12 billion USD (₹ 1 lakh crore), achieving over 100 billion USD ((₹ 8 lakh crore) in total investments, creating more than 600,000 jobs, and eliminating nearly 50 MMT per year of greenhouse gas emissions.

Various government-owned entities are taking steps to aid the ambitious National Green Hydrogen Mission by establishing hydrogen projects. GAIL Ltd. has started India's maiden project of blending hydrogen in the CGD grid —2% (by volume) of hydrogen is being blended into the CNG network and 8% (by volume) is being blended into the PNG network on a pilot basis.

MoP&NG has further directed the OGMCs to setup green hydrogen projects across the country. In 2023, OGMCs identified their short-term (by 2027) and long-term (by 2030) commercial project targets. A few pilot/small-scale plants are anticipated to commence production in 2024 as a part of these initiatives.

Global Biofuel Alliance

The Global Biofuels Alliance (GBA) is a unique multi-stakeholder alliance, launched during India's G20 presidency in September 2023 in the presence of the leaders from nine countries, as chair's initiative. GBA aims to enhance global development and deployment of sustainable biofuels by bringing together the biggest consumers and producers.

Since its inception, GBA has received tremendous enthusiasm. Initially supported by 19 countries and 12 international organizations at launch, the alliance has since expanded its membership to include 24 countries and 12 international organizations, with a trajectory of ongoing growth and membership interest from more countries. In addition, the alliance has been receiving tremendous support from industry, both in India and abroad.

The alliance intends to expedite the global uptake of biofuels across a wide spectrum of stakeholders by facilitating capacity-building exercises across the value chain; providing technical support for national programs; and promoting policy lessons sharing and technology advances. GBA will also facilitate development, adoption, and implementation of internationally recognized standards, codes, sustainability principles, and regulations to incentivize biofuels adoption and trade. Finally, the alliance will act as a central repository of knowledge and an expert hub. GBA aims to serve as a catalytic platform, fostering global collaboration for the advancement and widespread adoption of biofuels.

Research and Demonstration Focus

The Centre for High Technology (CHT) — PSU OMC's research and development unit under the MoP&NG, the Department of Biotechnology (DBT), and the Council of Scientific and Industrial Research – Indian Institute of Petroleum (CSIR-IIP), Dehradun — is working on a program to support R&D pertaining to energy biosciences in India through various schemes with major emphasis on advanced biofuels. The DBT-ICT center based in Mumbai has developed lignocelluloses technology at a demonstration scale that is now being used to establish commercial plants.

India has undertaken several initiatives to increase the use of hydrogen in its energy mix. Indian Oil Corporation Ltd. has undertaken an ambitious R&D project under the aegis of MoPNG at a cost of $35.8 million USD (₹ 297 crore). It is the first scientific project in India to address all aspects of the value chain of hydrogen-based mobility. Four demonstration-scale hydrogen production units producing 1 ton per day will be set up. Of the four units, three will employ renewable sources (biomass gasification, reforming CBG, and solar photovoltaic [PV]-based electrolysis) to produce green hydrogen. To utilize green hydrogen produced from the demonstration plant, 15 fuel cell buses are being developed jointly with India's leading heavy-duty vehicle manufacturer. Initial testing of the buses is underway by original equipment manufacturers (OEMs).Seven buses have been developed and

deployed at the Indian Oil Corporation Ltd. (IOCL) R&D center; IOCL will use these 15 indigenously manufactured/integrated hydrogen fuel cell buses to conduct a 20,000-km field trial in Delhi's National Capital Region.

Studies are in advanced stages at the IOCL R&D center to install the world's first pilot plant with a capacity of 10 kgCO_2per day using gas fermentation technology. Anaerobic gas fermentation technology will convert CO_2 into acetic acid, and aerobic fermentation technology will convert acetic acid into highly valuable omega-3fatty acids (docosahexaenoic acid, or DHA) and biodiesel. This value chain makes the overall process economically feasible.

IOCL is also setting up a third generation (3G) ethanol production plant to produce around 128 KL per day of ethanol using gas fermentation technology from off gases at Panipat Refinery.

In a significant development for decarbonizing of the aviation sector, India's first commercial passenger flight using an indigenously produced SAF blend was successfully flown on May 19, 2023.

In January 2024, Praj Industries Ltd.'s R&D unit established the first pilot project for producing aviation turbine fuel from alcohol near Pune in Pirangut, which was inaugurated by the Union Minister of India.

Hindustan Petroleum Corporation, Ltd. (HPCL), in collaboration with a renowned institute, completed the assembly of an electrolyser for producing green hydrogen at a 5 Nm^3/h capacity based on indigenously developed technology (alkaline). HPCL is planning to setup CBG plants with HP-RAMP (rapid acidification for methane production) technology and utilize the CBG in a steam methane reformer to produce about 21 KTPA green hydrogen. Bharat Petroleum Corporation Ltd. (BPCL) R&D is also working on long-term solutions for hydrogen storage and indigenous fuel cell systems, along with various academic institutes. A study of the impact on the CGD network/NG pipeline resulting from various levels of hydrogen is in progress.

Current efforts are focused on the development of cost-effective and -efficient enzymes for 2G bioethanol refineries; the development of value-added products by lignin valorization; commercial production of biojet fuel; compressed biogas from biomass, food waste, and municipal solid waste; cost-effective biofuels from industrial waste gases; and green hydrogen.

Outlook

The outlook for biofuels in India remains promising, considering the government's promotion of biofuels and advanced biofuels as "environment friendly" fuels.

Ethanol blended by PSU OMCs reached 5,085 million liters in ESY 2022–23. OMCs achieved the highest-ever average blending percentage of (12.06%) during ESY2022–23. With the rollout of the roadmap for E20 in India and the commitment shown by all stakeholders, the projected annual demand for ethanol is targeted at over 10 billion liters by 2025–26.Since the government's announcement on E20 fuel in February2023, E20 availability has increased to more than10,000 outlets in less than a year.E100 fuels have been launched at 183 retail outlets across the country. Biodiesel procurement surged to its highest-ever level of 439.9 million litres during FY 2023–24 (April 2023–March 2024) with expectations of further growth, reaching a new peak in FY 2024–25.

The SATAT initiative will help India to reduce its dependence on fossil fuels, increase the share of gas in primary energy consumption, and integrate the vast retail network of companies with upcoming CBG projects. The government's phased program to blend CBG with NGin the CGD sector will increase the use of CBG to 5% by 2028–29.Public and private sector companies have undertaken initiatives to adopt green hydrogen and announced commercial projects plans, with expectations that a few pilot/small-scale green hydrogen plants will start production in 2024.

These highlighted initiatives have already begun to impact India's biofuel industry. Major developments in the advanced biofuel sector — in terms of deployment in the transport sector, investments, project establishment, and enhanced R&D — are expected in the coming years.

Additional Information Sources

- www.ppac.org.in for data on fossil fuels production, consumption, import, and export
- www.mopng.gov.in for data related to the petroleum sector
- Ministry of New and Renewable Energy for data on R&D projects
- https://www.siamindia.com for data on the automotive industry
- www.dbtindia.nic.in
- IndianOil, the Energy of India for data on R&D projects
- 1-BP Outlook 2023 Edition, India
- Roadmap for Ethanol Blending in India 2020–25
- IEA Indian Oil Market Outlook to 2030