Biofuel Policy in Brazil, India and the United States

Insights for the Global Biofuel Alliance

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Abstract

As part of its G20 presidency, India has proposed a Global Biofuel Alliance (GBA) to bring countries together to expand and create new markets for sustainable biofuels. The sharing of best practices, the technical support and the capacity building that the GBA would bring are welcome additions to international efforts to expand sustainable biofuel production and use, a key step to decarbonising transportation and heat services with secure and affordable energy supplies.

This report aims to inform and focus the Alliance's work by sharing biofuel policy insights from Brazil, India and the United States. We find that these countries have expanded biofuel production and use by designing long-term strategies, implementing the right investment signals, supporting innovation, ensuring supplies are secure and affordable, addressing sustainability concerns early and collaborating with the international community. Further, there are three priority areas that would facilitate sustainable biofuel deployment in support of the global energy transition: Identifying and helping develop markets with high potential for sustainable biofuels production, accelerating technology deployment and seeking consensus on performance-based sustainability assessments and frameworks.

Acknowledgements, contributors and credits

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Table of contents

Executive summary

India has proposed a Global Biofuel Alliance that aims to support worldwide development and deployment of sustainable biofuels. The Global Biofuel Alliance (GBA) aims to establish a global partnership of national governments, agencies, industries and other stakeholders to advance sustainable biofuels technology deployment and expand sustainable biofuels market penetration. The GBA recognises that sustainable biofuels are a pillar of the global energy transition. The GBA's governance framework and action plan will be developed over the coming months.

Biofuels offer numerous advantages. Liquid biofuels in 2022 avoided near 2 million barrels of oil per day in the transport sector, over 4% of global transport demand, helping secure energy supplies during the energy crisis. Biofuels are also compatible with existing infrastructure, can be made using wastes and residues and offer economic and employment opportunities for rural communities.

Sustainable biofuel production is not on track for a net zero trajectory: Global biofuel growth through 2028 is running at less than half the rate needed to help achieve net zero emissions by mid-century based on current policies and market trends. In the IEA's Net Zero Emissions by 2050 (NZE) Scenario, sustainable biofuel production needs to triple by 2030 to help reduce emissions from new and existing trucks, planes, ships and passenger vehicles that have few other mitigation options.

Over 80% of global production is concentrated in just four markets: the United States, Brazil, Europe and Indonesia. These markets account for only half of global transport fuel demand. This share is forecast to decline to near 40% by 2028. Expanding sustainable biofuels will therefore require developing new markets and higher use in existing ones.

Brazil, India and the United States showcase policies that have driven considerable growth in supply. Brazil, India and the United States have deployed policies which sustained annual growth rates above 20% over at least a five-year period. As a result, biofuels provided 22% of Brazil's and 7% of the United States transport energy in 2022. In India, ethanol's share of energy use in gasoline vehicles reached 6% in 2022, double 2019 levels.

Six policy pillars have supported biofuel growth: Brazil, India and the United States have expanded biofuel production and use by designing long-term strategies, implementing the right investment signals, supporting innovation, ensuring supplies are secure and affordable, addressing sustainability concerns early and collaborating with the international community.

Sustainable feedstock supplies are sufficient to triple biofuels production by 2030. Advanced biofuels made from organic wastes and residues, for instance, could support an additional 2.4 mboe/d by 2030, more than total biofuel production in 2022. This level of growth requires a fifteen-fold increase in advanced biofuel deployment. Conventional biofuels also expand in the IEA's NZE Scenario, but to a lesser extent, with no net increase in cropland use for biofuels and no biofuel crops on existing forested land. The mix of advanced and conventional fuels will vary with each country.

More technology development and innovation efforts are needed to expand sustainable feedstocks. The scale and pace of growth in the IEA's NZE Scenario requires: 1) Enhancing land productivity to make the most of existing cropland and marginal land 2) Improving waste and residue collection of those feedstocks compatible with existing biofuel technologies such as residue vegetable oils 3) Deploying technologies that can process different feedstocks such as agricultural and forest residues.

The Global Biofuel Alliance can accelerate the deployment of sustainable, secure and affordable biofuels. There are three priority areas that would facilitate sustainable biofuel deployment in support of the global energy transition:

- **Identify and help develop markets with high potential for sustainable biofuels production:** Expanding biofuels production requires distinguishing high potential regions in both existing and new markets. Growing these markets will also require:
  - **Enhancing measurement and monitoring for sustainable supplies:** For priority markets, develop and apply a consistent sustainable feedstock assessment, monitoring, and reporting approach.
  - **Assessing mixed technology development pathways:** Each priority market will have its own potential for conventional and advanced biofuel technologies, as well as greenhouse gas (GHG) reduction technologies like carbon capture utilisation and storage.
  - **Developing regional-specific policy packages learning from existing experiences.** Brazil, India and the United States offer examples of six policy pillars that have worked and common challenges that can be used to support policy packages in new markets.
- **Accelerate technology deployment to commercialise advanced biofuels:** Coordinated, international efforts are necessary to commercialise advanced biofuels at scale, vital to realising the potential of biofuels.
- **Seek consensus on performance-based sustainability assessments and frameworks:** More consistent and internationally recognised sustainability frameworks would help improve measurement and reporting, improve GHG reductions, encourage sustainable biofuels trade and help new markets incorporate lifecycle GHG accounting into their biofuel policies.

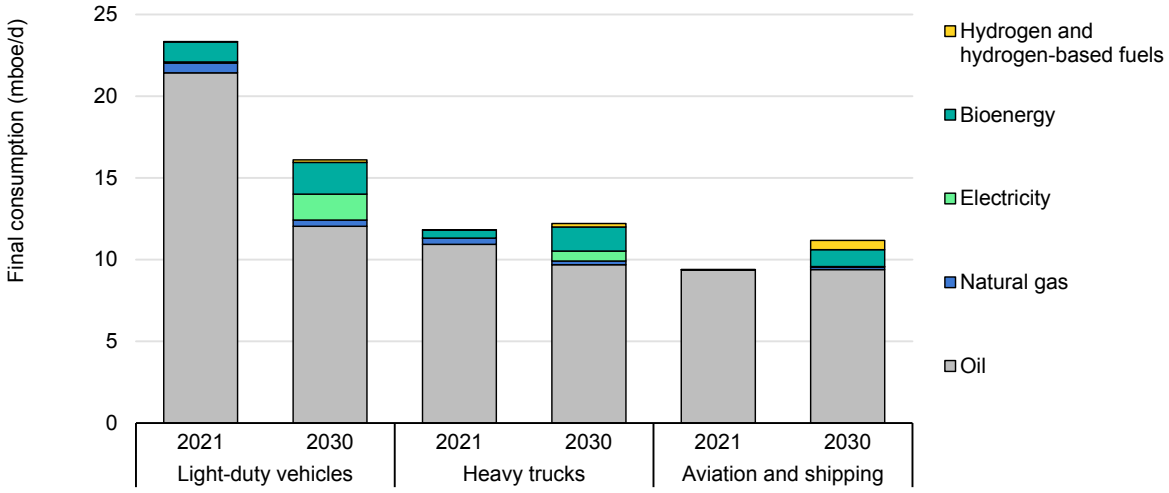
Introduction

India has proposed a Global Biofuel Alliance (GBA) to bring countries together to expand and create new markets for sustainable biofuels. The sharing of best practices, the technical support and the capacity building that the GBA would bring are welcome additions to international efforts to expand sustainable biofuel production and use, a key step to decarbonising transportation and heat services with secure and affordable energy supplies. This document aims to inform and focus the Alliance's work by sharing policy lessons from three successful biofuel countries about the role sustainable biofuels can play in energy transitions in the transport sector.

Sustainable biofuel production must triple by 2030 on a net zero trajectory

In the IEA's Net Zero Emissions by 2050 Scenario (NZE), sustainable biofuels play an important role in reducing greenhouse gas (GHG) emissions in the transportation sector, along with electric vehicles, more efficient engines, changes in transport modes and other clean fuels such as hydrogen. Under the NZE Scenario, sustainable biofuel demand more than triples from 2021 to 2030 across all transportation segments, including light-duty vehicles, heavy duty trucks, aviation and shipping. Only if they are sustainable, can biofuels contribute to this scenario. In the NZE, total modern, sustainable bioenergy use expands to 100 EJ by 2050, with no net increase in cropland used for bioenergy and no bioenergy crops grown on existing forested land. The NZE also meets other energy related Sustainable Development Goals such as energy access.

Transport energy demand by vehicle type and energy supply in the Net Zero by 2050 Scenario, 2021-2030



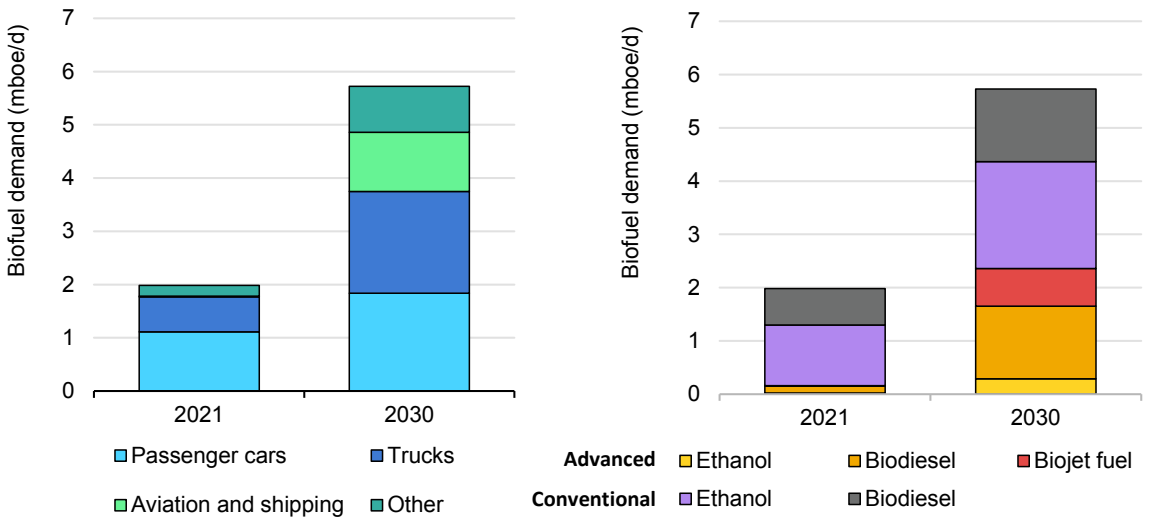
Source: IEA (2022), World Energy Outlook.

Both conventional and advanced fuels expand

In the IEA's NZE Scenario, demand for ethanol (blended with gasoline), biodiesel (blended with diesel) and biojet fuel (blended with jet fuel) expands to 2030. Most biofuels today are made from corn, sugar cane and soybeans (soyoil) with a growing share of residues such as used cooking oil[1]. However, the scale and pace of growth in the NZE Scenario requires more efficient agricultural production and new processing technologies that can use feedstocks that do not compete for land with food and animal feed. Advanced fuels account for almost half of total production in 2030, a fifteen time increase from 2021 levels.

[1] Conventional biofuels include those produced from food crop feedstocks. Also known as first generation biofuels, they include sugar cane ethanol, starch-based ethanol, fatty acid methyl ester (FAME), hydrotreated vegetable oil (HVO) produced from vegetable oils such as palm, rapeseed, and soybean oil. Advanced biofuels include those produced from non-food crop feedstocks, which can deliver significant lifecycle GHG emission savings compared with fossil fuel alternatives, and which do not directly compete with food and feed crops for agricultural land or cause adverse sustainability impacts. In the IEA's NZE Scenario, sustainable bioenergy and biofuels are those that are responsibly managed, do not compete with other land uses and otherwise contribute to the NZE Scenario, including helping to stabilise global average temperatures at 1.5°C above pre-industrial levels while meeting key energy-related UN Sustainable Development Goals including energy access and improving air quality.

Biofuel demand (left) and supply (right) current and in the Net Zero by 2050 Scenario, 2021-2030

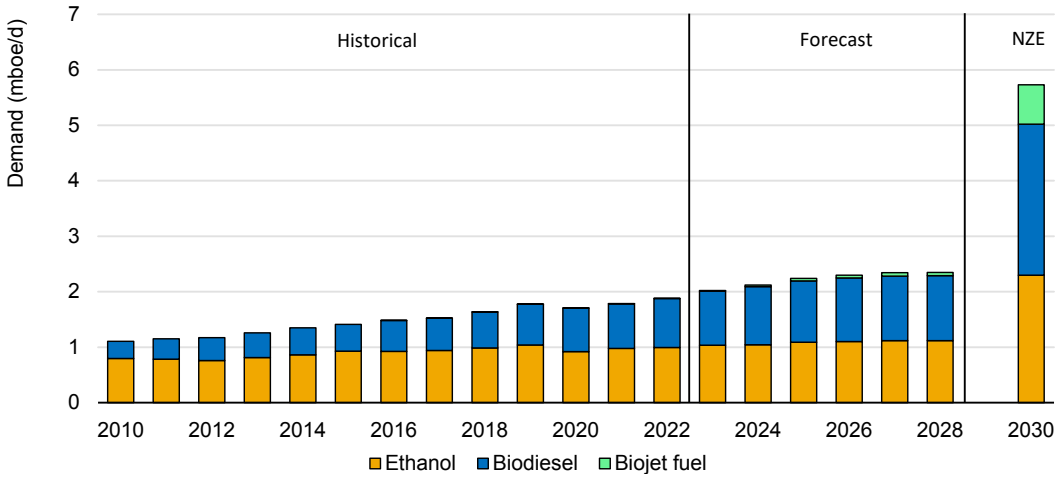


Source: IEA (2022), World Energy Outlook.

Learning from policy implementation can help expand sustainable supplies

Based on current policies and market trends, global biofuel growth expected through 2028 is running at less than half the rate needed to help achieve global net zero emissions by mid-century. Moreover, biofuel production from residues or from crops grown on marginal land currently stands at only 7% of what is needed by 2030.

Biofuel production by fuel: historical, forecast and in the Net Zero by 2050 Scenario, 2010-2030



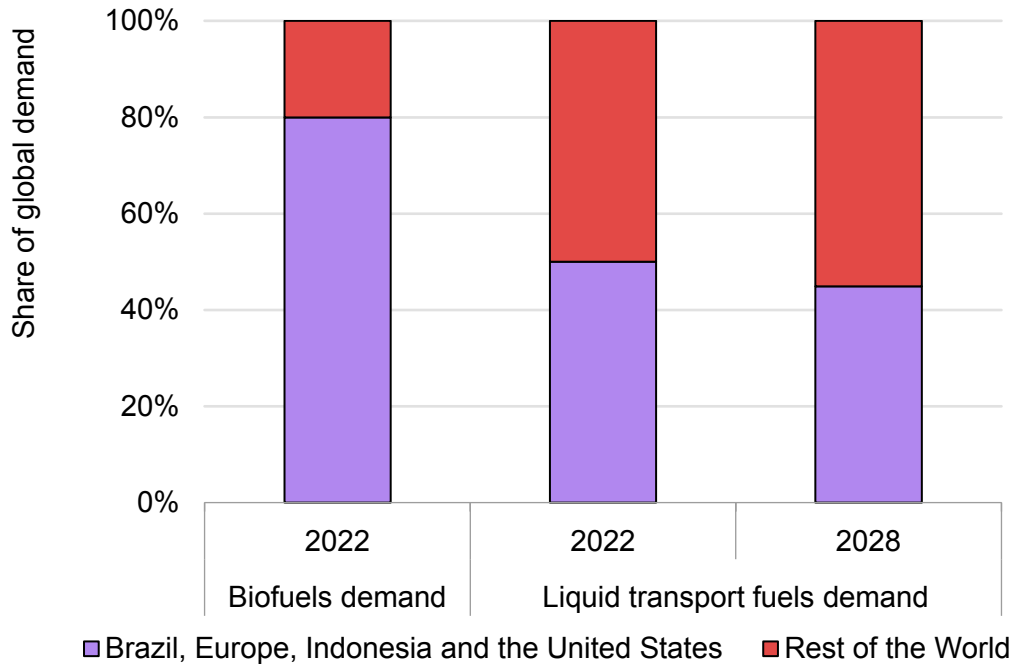
Source: IEA (2023), Renewable Market Update – June 2023 and IEA (2022), World Energy Outlook. Biodiesel includes renewable diesel.

There are, however, policy lessons that can be learned from countries such as Brazil, the United States and India that have successfully increased biofuels production at the required pace and scale. The GBA can help disseminate these lessons to other countries and regions.

Expanding sustainable feedstock supply and developing new markets requires particular attention

Expanding biofuel production at a pace and scale consistent with the NZE Scenario requires developing new markets and expanding production in existing markets, while also expanding sustainable feedstock supply. More than 80% of biofuels production occurs in just four markets – the United States, Brazil, Europe and Indonesia – even if these regions will represent a declining share of total fuel demand in the coming years. Lessons learned from Brazil, India and the United States to expand biofuel use in other markets must be combined with more substantial efforts to expand sustainable feedstock supply.

Share of biofuel and liquid transport fuel demand in top four biofuel demand regions, 2022-2028



Notes: Biofuel demand estimates from IEA (2023), Renewable Market Update – June 2023 and Liquid transport fuels from IEA (2023), Oil 2023.

There are sufficient sustainable feedstocks available to support a tripling of biofuel production by 2030 within strict sustainability bounds. However, there is evidence that feedstock availability may constrain some biofuel growth in the coming years,

particularly biodiesel. Addressing near-term feedstock availability and supporting growth on a net zero trajectory requires three broad strategies. First, improving land productivity to make the most of existing cropland and marginal land. Second, improving waste and residue collection of those feedstocks compatible with existing biofuel technologies such as residue vegetable oils. Third, deploying technologies that can process different feedstocks such as cellulosic ethanol. In addition, significantly reducing the lifecycle carbon intensity of biofuels with technologies like carbon capture utilisation and storage (CCUS) and efficiency improvements can also help reduce feedstock pressure in markets that aim to reduce GHG emissions. The right combination of approaches depends on the unique conditions of each country.

Brazil

Key points

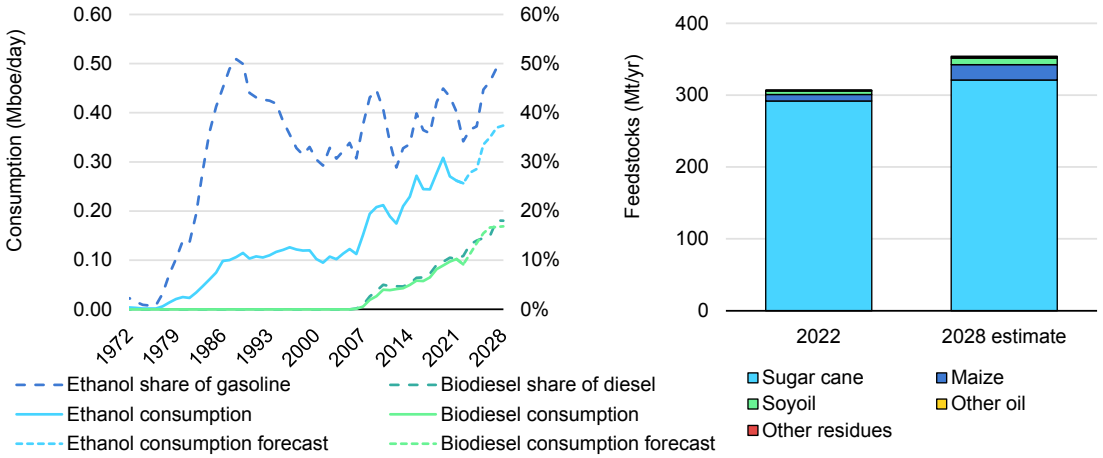
Brazil is the second largest biofuels producer in the world with biofuels supplying 22% of its transport energy in 2022.

Brazil enshrined biofuels in its long-term energy strategy and used a mix of mandates, financial incentives, vehicle requirements and sustainability requirements to expand production and demand.

Brazil's use of biofuels has been challenged in recent years by rising costs and issues linked to land use protection.

Brazil is a global pioneer in biofuels production and deployment, successfully combining biofuel mandates, financial incentives and sustainability requirements to expand secure and affordable biofuel supplies. Ethanol blending mandates began in earnest in 1975 with the ProAlcohol programme and blending has since progressively increased to the current 27% blending requirement (volume basis). Flex-fuel vehicles, which can run on gasoline or ethanol, comprise near 90% of Brazil's light-duty vehicle fleet, allowing Brazilian consumers to choose higher ethanol blends when ethanol prices are advantageous. In 2022, total ethanol blending stood at 34% on an energy basis.

Biofuel consumption and share on an energy basis (left) and feedstock demand (right), Brazil, 1972-2028



Sources: IEA (2023), World Energy Balances, IEA (2023), Renewable Market Update – June 2023, IEA feedstock calculations based on IEA (2022) Renewables.

For biodiesel, blending targets were established in 2005 at 2%, progressively increased to 12% in 2023, with a target of 15% by 2026. However, Brazil had initially targeted 15% blending in 2023 but slowed the increase in 2022 because of high biodiesel and diesel prices.

Ethanol and biodiesel are also covered by the RenovaBio programme which sets lifecycle GHG intensity reduction targets for the transportation sector. The policy aims to improve biofuel plant performance, reduce GHGs and establish long-term incentive for liquid biofuels.

Success elements and policies

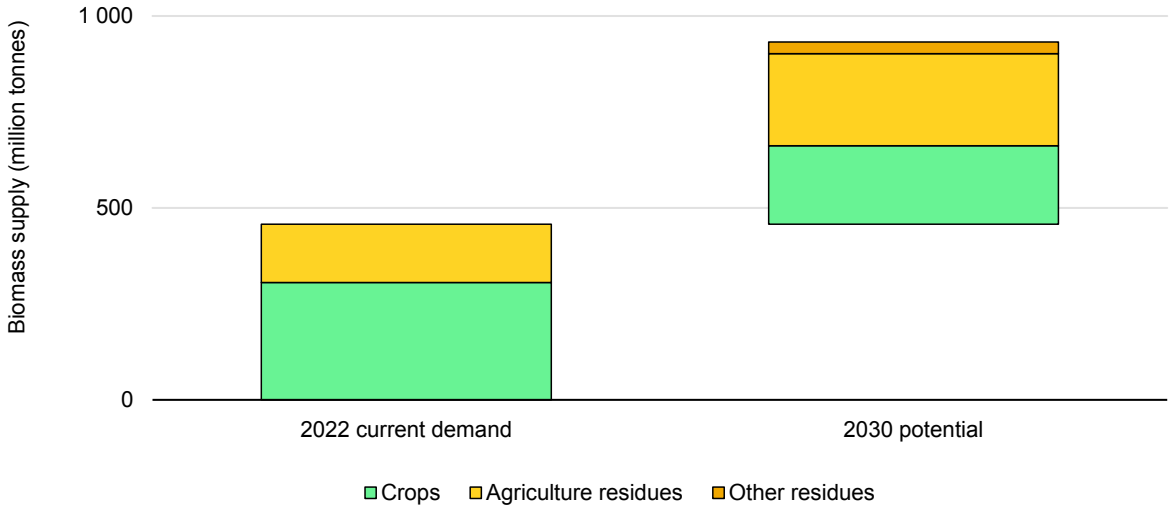
Success element	Policies and programmes
Long-term strategy	Biofuels are part of Brazil's National Energy Plan which helps set direction for energy supply and demand across the country.
Investment signals	**Mandates:** Brazil has a 27% ethanol mandate and a biodiesel mandate set at 12% and to expand to 15% by 2026. Brazil is also considering increasing ethanol blending up to 30%, pending studies of technical viability. **Financial Incentives:** Brazil offers a number of supports such as preferential tax treatment for flex-fuel vehicles amounting 1 to 3 percentage points less tax for flex-fuel vehicles primarily through lower Tax on Industrialised Products. There is also preferential tax treatment for ethanol compared to gasoline under federal taxes (Contribution for Intervention in the Economic Domain) and import taxes) as well as tax exemptions and incentives for biodiesel depending on the raw material, scale of the production and the region of the production and different state level taxes. The Brazil National Bank for Social and Economic Development also provides credit lines for sugar, ethanol, cogeneration, logistics and transport and feedstock investment and a separate climate fund to reduce carbon intensity. The Ministry of Energy and Mines can also incentivise and provide special tax regimes for bioenergy projects.
Secure and affordable supplies	Ethanol has historically been below or near the price of gasoline. The Brazilian government can modify support levels and blending requirements to ensure supplies remain affordable. However, since 2015 there has been no need to modify the 27% blending requirement for ethanol within the National Agency of Petroleum, Natural Gas and Biofuels

Success element	Policies and programmes
	regulatory framework which specifies contracts that secure regular ethanol supply.
Sustainability	RenovaBio, launched in December 2016, sets annual carbon intensity reductions, certifies the life cycle GHG intensity of biofuels and establishes a market for credit trading. Brazil maintains land use protection via its Forest Code, agroecological zoning and voluntary measures such as the Soy Moratorium. Although there remain challenges, agroecological zoning for sugarcane remains part of an unresolved lawsuit for instance which could limit protections.
Innovation	Brazil's Fuel of the Future Programme has the objective of proposing measures to increase the use of sustainable and low-carbon fuels, including biofuels.
International collaboration	Brazil participates in a number of international bodies including the Biofuture Platform (founder and core member country), the Global Bioenergy Partnership, the IEA Bioenergy Technology Collaboration Programme (TCP) and several ongoing bilateral relationships such as the Memorandum of Understanding (MoU) between the Brazil and India on Bioenergy Cooperation.

Looking to the future, Brazil announced its Fuel of the Future Programme in 2021 which aims to support sustainable and low-carbon fuels. The programme identifies sustainable aviation fuel, cellulosic ethanol and CCUS as research priorities.

Key to realising these efforts is accessing and diversifying feedstocks used to produce biofuels. The Brazilian government estimates ethanol use can expand by 55% to 46 billion litres by 2030 and biodiesel by 85% to 11.5 billion litres from 2022 levels. This level of expansion could occur in parallel with Amazon protection and reforestation efforts by increasing crop yields, intercropping, expanding production on marginal lands and expanding waste and residues use. Brazil has considerable quantities of agricultural residues that could be used to produce transport biofuels. There are currently four cellulosic ethanol facilities under construction that plan to use agricultural residues to produce ethanol at commercial quantities.

Estimated biomass use and supply potential in Brazil, 2022-2030



Notes: 2022 current demand based on the Brazilian Energy Planning Agency's (EPE) conversion factors and 2022 ethanol and biodiesel production. Current agricultural residues is an estimate of bagasse used for cogeneration, forestry residues in the pulp and paper industry and other bioenergy use in households. Crops are for ethanol and biodiesel. 2030 agriculture residues and other residues potential based on La Picirelli de Souza, et al. (2021) Theoretical and technical assessment of agroforestry residue potential for electricity generation in Brazil towards 2050. Energy Report 7, 2574-2578. Values exclude existing demand for residues in agricultural production processes. Future crop potential based on EPE's estimates of 2030 ethanol and biodiesel demand assuming the majority of new supplies are based on sugar cane, corn and soybeans.

United States

Key points

The United States produces 70 billion litres of biofuels per year, making it the largest global producer.

The United States combines volume obligations, long-term tax credits, R&D spending, state level policies and long-term vision via the Sustainable Aviation Fuel (SAF) Grand Challenge to continue to drive biofuels deployment.

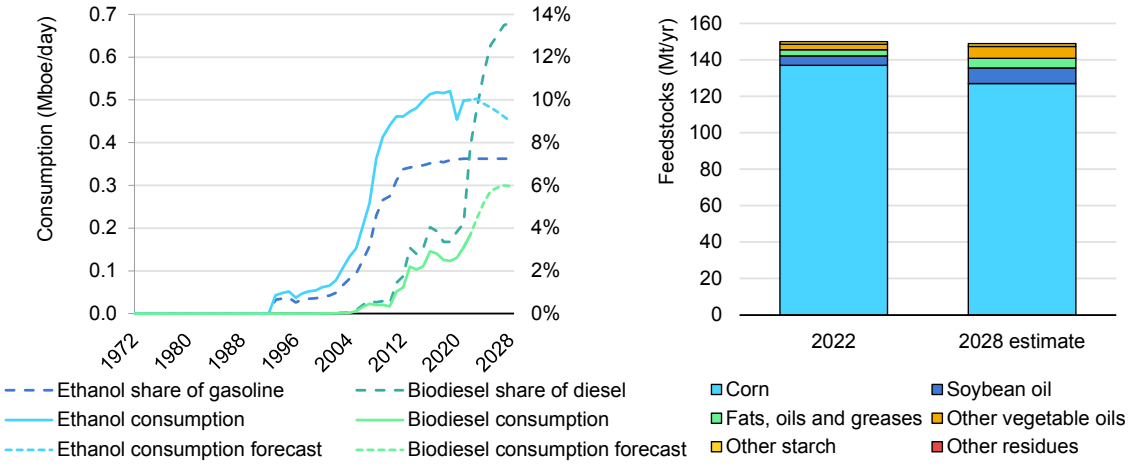
Future growth depends on expanding feedstock supply chains, reducing GHG intensities and commercialising new technologies.

The United States is by far the largest biofuel producer in the world with 40% of global production. National ethanol and biodiesel blending began with the introduction of the Renewable Fuel Standard (RFS) in 2005 via the Energy Policy Act which was then amended and expanded under the Energy Independence and Security Act of 2007. The RFS obligates fuel distributors to achieve mandated annual renewable volume obligations based on their market share. Fuel providers demonstrate their compliance via Renewable Identification Numbers which can be traded.

The United States has and continues to support RFS blending obligations through a mix of tax credits, grants and agricultural policy. In 2022, for instance, the United States released the Inflation Reduction Act (IRA) with production, investment and infrastructure tax credits and grants for biofuels that extend as far as 2032. State level policies, such as California's low-carbon fuel standard, provide additional biofuel incentives, especially for lower GHG emitting fuels.

These programmes drove ethanol production to 58 billion litres in 2022 equivalent to almost 7% of gasoline demand on an energy basis. US biofuel producers nearly tripled volumes between 2005 and 2010, and this pace of growth would need to be replicated globally to be consistent with the NZE 2030 biofuel production estimates. Ethanol production and use expanded quickly because there was readily available commercial technology, the United States had ample corn supplies, there was a clear policy signal in the RFS and oil prices were relatively high. Over the past three years, however, ethanol prices have averaged more than 30% higher than gasoline prices.

Biofuel consumption and share on an energy basis (left) and feedstock demand (right) in the United States, 1972-2028



Sources: IEA (2023), World Energy Balances, IEA (2023), Renewable Market Update – June 2023, IEA feedstock calculations based on IEA (2022), Renewables.

Ethanol blending rates have plateaued at near 7% on an energy basis (10% volume basis). Expanding blending levels will require infrastructure investment that is compatible with E15 blends and ongoing legal authority to blend at this level. The RFS and its supporting policies were also unable to prompt growth in ethanol using woody residues (cellulosic ethanol). The initial policy planned for 60 billion litres of cellulosic ethanol by 2022, which currently stands at 2 billion litres because of a lack of development. Technology challenges, a long period of low oil prices, feedstock collection challenges, and policy uncertainty all contributed to a lack of commercialisation for cellulosic ethanol in the United States.

For biodiesel, the RFS, combined with the biodiesel blender credit and low-carbon fuel standard, have expanded production and use to 12 billion litres, 20% of global demand. Biodiesel, including renewable diesel, now provides 8% of energy supply for diesel vehicles in the United States, higher than ethanol's share for gasoline vehicles. Over the past three years, renewable diesel production has led biodiesel growth in the United States because it can be blended at higher levels, can be produced from residues and attains low GHG intensities. In 2022, near 70% of biodiesel was produced from vegetable oils with the remainder from residue fats, oils and greases.

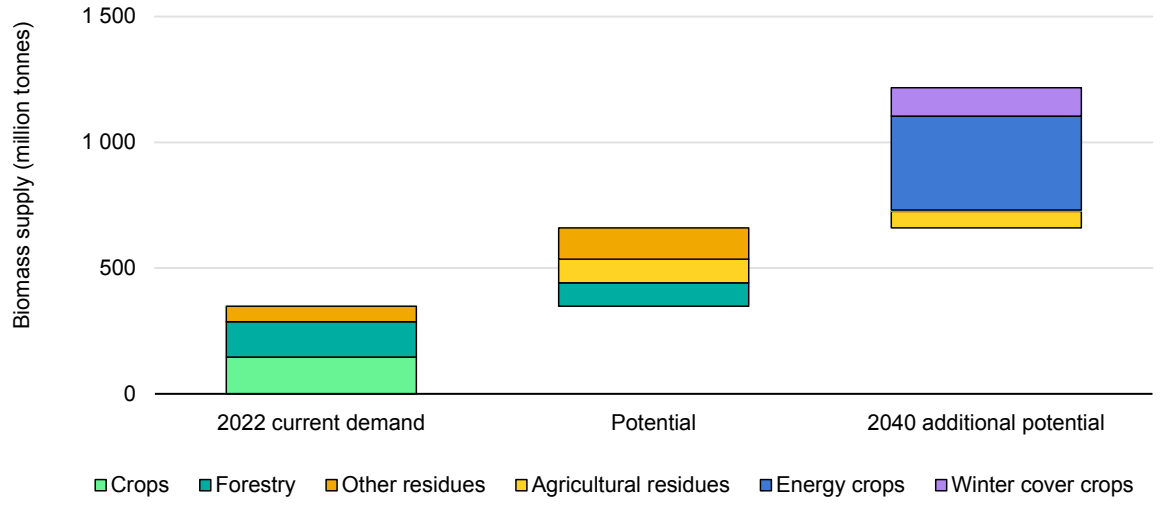
While biodiesel and renewable diesel have expanded, rising costs and feedstock supply have created challenges. Biodiesel and renewable diesel remain 50% more expensive than fossil diesel in 2023, but at current blending levels this translates to only a 4% premium at the pump. In its latest impact assessment for the RFS, the Environmental Protection Agency noted that it is more likely that feedstock limitations will limit renewable diesel production in the United States than production capacity.

Success elements and policies

Policy	Description
Long-term strategy	The Energy Policy Act (2005) and Energy Independence and Security Act (2007) established coordinated policy actions with decade long implementation periods helping to establish biofuel production and use. More recently, the United States Sustainable Aviation Grand Challenge sets a target and roadmap to expand sustainable aviation fuels to 11 billion litres by 2030, and then 100% of all aviation fuels by 2050.
Investment signals	**Mandate:** The United States RFS, established in 2005, sets renewable fuel volume obligations for transportation, heating oil or jet fuel. The current most recent version extends requirements to 2025. **Financial Incentives:** The United States has a long history of financial support for liquid biofuels including the biodiesel blender credit, and advanced biofuel credit. The IRA extends many of these credits, including tax credits for production, infrastructure and investment and grants for SAF technologies and plants.
Secure and affordable supplies	RFS volume targets are set to ensure secure and affordable supplies based on impact assessments including feedstock availability, cost impacts and energy security benefits.
Sustainability	Sustainability measures include minimum GHG performance as part of the RFS, financial incentives tied to GHG performance and state level policies, such as low-carbon fuel standards, which set declining GHG intensity targets. The RFS impact assessment also considers impacts on ecosystems, soil and water quality, rural economic development and employment.
Innovation	Existing policies, including the RFS, IRA and state level low-carbon fuel standards all support innovation by providing incremental value for every unit of GHG reduction, dedicated financial support for new technologies and targeted volume obligations for advanced fuels. Several programmes supplement these policies including the Department of Energy's Bioenergy Technologies Office, the Department of Agriculture's Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Program.
International collaboration	The United States participates in numerous international collaborations including the Biofuture Platform (current chair and founding country), the Carbon Offsetting and Reduction Scheme for International Aviation, IEA Bioenergy TCP and many other programmes.

The Sustainable Aviation Grand Challenge Roadmap, IRA tax credits and state level low-carbon fuel standards continue to chart a course for biofuels. In the aviation sector the United States Sustainable Aviation Grand Challenge targets 11 billion litres of sustainable aviation fuel by 2030. This target is supported by production and investment tax credits to 2031. Achieving it requires commercialising technologies and expanding feedstocks beyond those that are used today, while maintaining low emission intensities. The United States has significant feedstock potential, especially for agriculture and other residues. However, processing these residues requires developing and commercialising new biofuel technologies.

Estimated biomass use and supply potential in the United States, 2022-2040



Source: Field, John. Kline, Keith. Et al. (2023), Sustainably sourcing biomass feedstocks for bioenergy with carbon capture and storage in the United States.

India

Key points

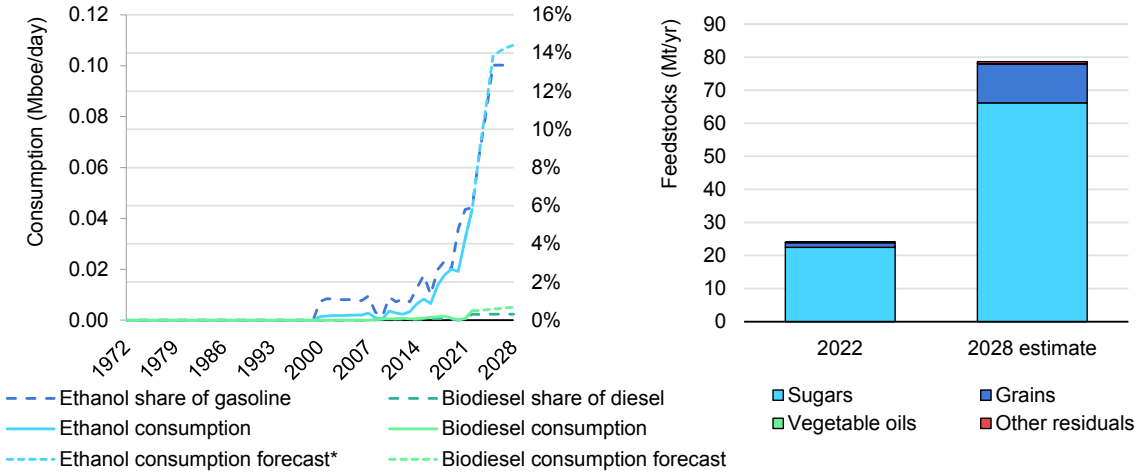
India is now the world's third largest producer and user of ethanol thanks to nearly tripling production in the past five years.

In 2018 India released its National Policy on Biofuels, combined with guaranteed ethanol pricing, feedstock guidance and investment support for new ethanol facilities.

Biodiesel has yet to follow ethanol's rise and continued ethanol expansion requires expanding feedstocks.

India has quickly joined the ranks of major biofuel producer and consumer thanks to a set of coordinated policies, high political support, and an abundance of feedstocks. In 2018 India released its National Policy on Biofuels which set blending targets for ethanol (20% blending by 2030) and biodiesel (5% by 2030), feedstock requirements for different fuels and laid out the responsibilities of 11 ministries to coordinate government actions. Beyond blending targets, India established guaranteed pricing, long-term ethanol contracts, technical standards and codes and financial support for building new facilities and upgrading existing ones. Buoyed by its success, the Government moved the ethanol 20% volume blending target forward by 5 years to 2025-26, which was enshrined in an updated National Policy on Biofuels in 2022.

Biofuel consumption and share on an energy basis (left) and feedstock demand (right) in India, 1972-2028



*India ethanol forecast based on an accelerated case, assuming vehicle compatibility issues are addressed, and sufficient production capacity installed.

Sources: IEA (2023), World Energy Balances, IEA (2023), Renewable Market Update – June 2023, IEA feedstock calculations based on IEA (2022), Renewables.

Supported by these policies, ethanol for blending in gasoline production and demand nearly tripled between 2018 and 2023 and now stands at near 12% (7% on an energy basis). Sugar cane provides most ethanol production with the remainder from food grains such as maize and surplus rice stocks determined by the Food Corporation of India. To diversify feedstocks beyond sugar cane, India provides separate pricing for maize-based ethanol and includes ethanol produced from agricultural residues such as cotton stalks, wheat straw, rice straw, bagasse and bamboo. Increasing the fleet of vehicles capable of accepting higher ethanol blending levels will require additional attention as India pursues its 20% blending target. India is encouraging flex-fuel vehicles and retrofits are possible for older vehicles, including two wheelers. In addition, a GHG measurement and reporting requirement would help India assure and improve GHG reductions from biofuel use in the transport sector.

Biodiesel production in India stands at less than 1% of diesel demand. India has established targets, feedstock requirements, and initiatives to establish used cooking supply chains, and its oil marketing companies have published expressions of interest for biodiesel produced from used cooking oil. Nevertheless, biofuel production remains low and additional supports will likely be

required to increase production and use. The IEA estimates biodiesel produced from used cooking oil could displace 2.5% of diesel use[2].

Success elements and policies

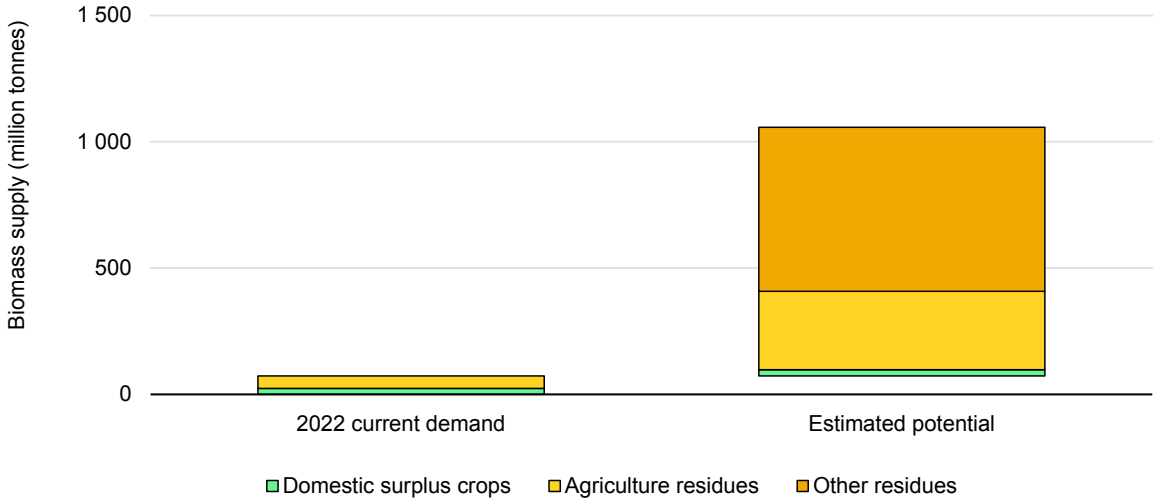
Policy	Description
Long-term strategy	The National Policy on Biofuels sets targets and direction to 2030 for liquid biofuel use in the transport sector.
Investment signals	**Mandates:** India's National Policy on Biofuels 2018, amended in 2022, sets targets for 20% ethanol by 2025-26 and 5% biodiesel blending by 2030. **Financial Incentives:** India sets, and regularly updates, fixed pricing for ethanol based on feedstock type which helps ensure sales and reduced its Goods & Service Tax from 18% to 5%. India also provides an interest subvention scheme for establishing new or modifying existing facilities.
Secure and affordable supplies	The Roadmap for Ethanol Blending in India 2020-25 provides guidance to meet the target of 20% blending of ethanol in petrol by 2025-26. Apart from molasses and damaged food grains, surplus sugar and grains are used to increase ethanol production. Biodiesel feedstocks are limited to non-edible oilseeds, used cooking, animal tallow and other non-food oils.
Sustainability	The Indian government has estimated GHG reductions from ethanol at 22 $MtCO_2eq$ over between 2014 and 2022 but has yet to establish a GHG measurement system.
Innovation	India is providing USD 300 million to a maximum of 20% of project costs to 2024 for companies establishing commercial and demonstration scale ethanol production projects using agricultural residues.
International collaboration	India is a member of the Biofuture Platform (founding and core member country), the IEA Bioenergy TCP and has established an MoU with Brazil on bioenergy cooperation.

India's estimated available organic, solid feedstocks stood at over 1 billion tonnes in 2022, including feedstocks for biomethane. Ethanol production from agricultural residues can also make up for crop-based ethanol production during years with less surplus agricultural production. Expanding biodiesel, renewable diesel and biojet fuel remain important pathways since diesel and jet fuel represented more than 60% of India's total fuel use in 2022 and demand is expected to expand by

[2] India has an estimated 1.5 million tonnes of used cooking oil collection potential, which could meet 2.5% of India's diesel demand in 2027.

25% over the next five years. Biomethane made from organic wastes and residues is also already used in the transport sector under the Sustainable Alternative Towards Affordable Transportation scheme. So far, 48 compressed biogas and biogas plants have been commissioned under the initiative.

Estimated biomass use and supply potential in India, 2022



Source: Current crop demand based on IEA (2022), Renewables (feedstock assessment), current agricultural residues based on MNRE (2021), Evaluation study for assessment of biomass power and bagasse cogeneration potential in the country. Estimated crop potential based on NITI Aayog & MoPNG (2021), Roadmap for Ethanol Blending in India 2020-25 and agricultural residues from MNRE (2021), Evaluation study for assessment of biomass power and bagasse cogeneration potential in the country. Other residues includes solids from animal, fruits and vegetables and urban organic wastes not included in the agricultural residues grouping, some residues such as manure are primarily suitable for biogas production, while others could support liquid biofuels or biogas. Based on MNRE (2016), Mapping the available urban and industrial organic waste in various locations in India. Accessed July 2023.

Lessons learned

Brazil, India and the United States have all successfully expanded biofuels supply to reduce GHG emissions from the transport sector while supporting energy security and rural development objectives. While each country's approach and challenges are different, there are broad similarities that the GBA can use to support other countries to scale up biofuels. These six pillars form the foundation of biofuel support:

- **Develop and maintain a long-term strategy:** Successful biofuel policies rest on a long-term strategy that considers feedstock supply, energy security, food security, investment needs, economic impacts, technical standards and codes, trade policy, and coordination with broader government objectives.
- **Provide the right investment signals:** Clear and long-term policies are essential to attract investment. These often include a package of mandates, financial incentives, and performance-based GHG intensity targets.
- **Continue to innovate:** GHG performance policies, financial incentives for new technologies and improved efficiency and feedstock requirements can all drive innovation.
- **Ensure supplies are secure and affordable:** A thorough understanding of biomass feedstock availability (targets set in context of available supplies), flexible policies (conditions under which policies may be modified) and measures to reduce costs (credit markets, performance-based policies and cost thresholds) are all policy features that can help ensure secure and affordable supplies.
- **Address sustainability concerns early:** Only sustainable biofuels have a place in an energy transition. Policy design must include clear guidance, measurement, reporting and verification practices. For instance:
  - **Greenhouse gas emissions:** Lifecycle GHG thresholds and preferably performance-based targets can ensure GHG reductions and encourage more efficient plant operation.
  - **Food security:** A core principle in biofuel policy development is to protect and enhance food security. Annual cost and feedstock assessments, flexible policy design, feedstock guidance and technical flexibility to shift between food and fuel supplies are all options to protect and enhance food security while expanding biofuel production.
- **Collaborate with the international community:** International forums and bilateral agreements help to share policy lessons, transfer technology, harmonise sustainability requirements and accelerate innovation. These actions in turn can hasten sustainable biofuels deployment and improve trade.

While there are common lessons from all three countries, feedstock availability issues remain a common challenge. Most existing and planned biofuels production in Brazil, India and the United States plans to use crops or a small subset of wastes and residues compatible with existing, commercial biofuels technologies. However, the vast majority of future feedstock potential comes from agricultural and forestry woody wastes and residues or crops grown on marginal land. Accessing these feedstocks depends on three key strategies:

- Investing in land productivity to make the most of existing cropland and marginal land.
- Improving waste and residue collection of those feedstocks compatible with existing biofuel technologies, such as residue vegetable oils.
- Deploying technologies that can process different feedstocks such as cellulosic ethanol.

In addition, significantly reducing the lifecycle carbon intensity of biofuels through technologies such as CCUS can also help reduce feedstock pressure in markets with policies based on lifecycle GHG intensity improvements.

Implications for the Global Biofuel Alliance

The GBA would be a welcome addition to international and domestic efforts to expand sustainable biofuel supplies in line with a net zero trajectory. Despite the urgent need to increase sustainable biofuels production to cut transport emissions and ensure energy security, current growth is lagging what is needed to achieve global net zero emissions by mid-century according to the IEA's NZE Scenario. However, with the right policies and practices, rapid sustainable biofuel deployment is achievable. The GBA can help get sustainable biofuels on track by focusing on three main areas:

- **Identify and help develop markets with high potential for biofuels production:** Over 80% of sustainable biofuels production and use is in the United States, Brazil, Europe and Indonesia, however all together they account for less than half of global transport fuel demand. Expanding sustainable biofuels use will therefore require expansion into new markets and expanded production in existing markets. Augmenting sustainable supplies in each market requires enhancing measurement and monitoring for sustainable supplies, assessing mixed technology deployment pathways and developing regional-specific policy packages, while learning from existing experiences. The GBA may therefore consider answering the following questions: What regions have high potential for biofuel growth in existing and new markets? What biomass assessment and monitoring/reporting/validation programmes should be instituted at the country level to ensure common understanding regarding present and future supplies of sustainable biomass? What combination of conventional and advanced production technologies are needed to meet national sustainable development and emissions reduction targets in priority markets, given feedstock availability and renewable blending or GHG reduction targets? What package of policies, programmes and investment support would help expand sustainable biofuels production in these high potential areas?
- **Accelerate technology deployment to commercialise advanced biofuels:** Advanced biofuels must grow 15 times by 2030 from 2021 levels in the IEA's NZE Scenario, doubling total biofuels production over the same time period. However, planned investments to date remain well below this level of growth. The GBA may consider answering these questions: What coordinated international efforts between GBA members could accelerate the commercialisation and deployment of advanced biofuels at the pace and scale required for global net zero commitments? What actions and investments are needed to commercialise advanced biofuels at the pace and scale necessary to meet net zero commitments?

- **Seek consensus on performance-based sustainability assessments and frameworks:** More consistent and internationally recognised sustainability frameworks would help improve measurement and reporting, improve GHG reductions, encourage sustainable biofuels trade and help new markets incorporate lifecycle GHG accounting into their biofuel policies. The GBA may consider answering: What framework could seek consensus on transparent, practical and evidence-based carbon accounting methods to ensure domestic reductions, improve production efficiency, drive costs lower, and facilitate trade?

The International Energy Agency looks forward to supporting the GBA via:

- **Sharing the results of ongoing analysis:** The IEA regularly updates its World Energy Outlook (including the NZE), Renewables Market Forecast and many other publications relevant to the GBA.
- **Advising and informing the GBA executive committee:** The IEA is also well positioned to provide regular and timely advice in support of the GBA mission and activities.
- **Collaboration via the Biofuture Platform and IEA Bioenergy TCP:** The Biofuture Platform covers five workstreams – CEM/G20, Biomass quantification & sustainability, policy best practices, advancing biochemicals & biomaterials and de-risking project finance – that are relevant and complementary to the GBA. The IEA Bioenergy TCP works to increase knowledge and understanding of bioenergy systems to facilitate commercialisation and market deployment, and to advise policy and industrial decision makers.

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