IEA BIOENERGY T39
BIOFUEL NEWS

Issue 63
October 2023

Upcoming Events

GLOBAL ETHANOL SUMMIT

OCTOBER 16-18, 2023 RESTON, WASHINGTON USA

In this issue

Biofuels production and Development in China

IEA Bioenergy TCP Task 39
IEA Bioenergy is a Technology Collaboration Programme (TCP) set up in 1978 by the International Energy Agency (IEA) with the aim of improving cooperation and information exchange between countries that have national programmes in bioenergy research, development and deployment. Twenty five countries plus the European Commission currently participate in IEA Bioenergy.
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While Tomas Ekbom is Task Leader for IEA Bioenergy TCP Task 39, he also works for the Swedish Bioenergy Association (Svebio). Svebio is a environmental organisation for companies and individuals. We are strongly rooted in our values, and believe in renewable energy, entrepreneurship and a free market economy.
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Publisher: IEA Bioenergy TCP Task 39
Editor in chief: Tomas Ekbom
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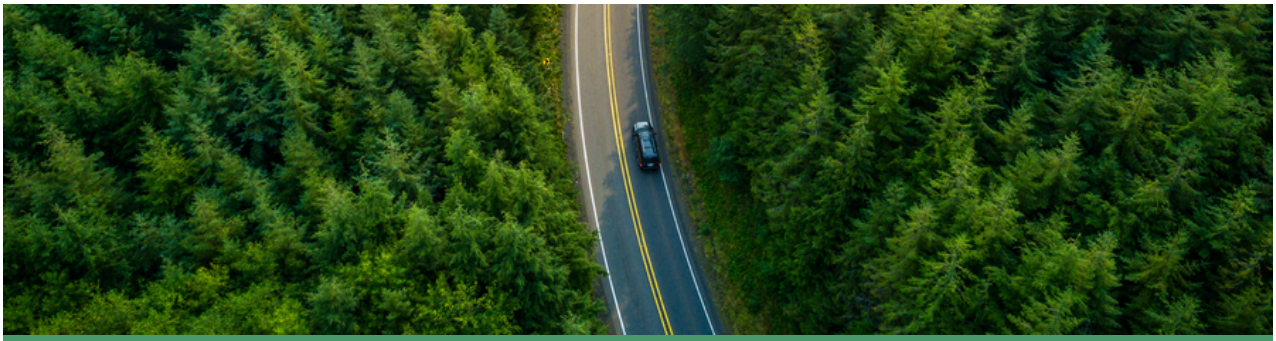
Graphic design: Hannah Edgren
Feature article: Fuli Li & Yixuan Fan

Recommended reading
Bioenergy International
Online & E-magazine

BC-SMART Low Carbon Fuels Consortium
Newsletter

ISSN 2004-7002



IN THIS ISSUE

Regaining control in the bioenergy situation room

September has come and with it our second biofuels magazine for 2023. Of special interest is the development in China, and therefore we feature an article of their biofuels and developments. We thank our colleagues at Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences in China for their contribution.

The focus for Asia has been for many places sourcing of fats, oils and grease for HVO products. However, also in increasing production is synthesis of fuels from waste offgases with interest for electro-fuels. Still, ethanol and biodiesel remains the majority of biofuels and fuel standards of E10 and E15 are on the roll-out. HVO is the strong, expanding diesel component exemplified with the Singapore biorefinery of Neste with some one million tonnes of HVO per year, which started production earlier this year.

The market of interest is very much shifting towards aviation with drop-in biofuels. We will see many Sustainable Aviation Fuel (SAF) projects and plants in the future. The maritime sector has more of alternatives to choose from being it LNG (LBG), methanol, ammonia (hydrogen) or low-sulphur diesel oil (like HVO).

In the recent 9th edition of the Advanced Biofuels Conference (ABC 2023) by the Swedish Bioenergy Association (Svebio) in Gothenburg on September 20-21, 2023 the demand for advanced biofuels was discussed. Currently, the demand significantly outpaces production capacity. Clarity and certainty on the regulatory framework are thus needed.

New greenfield plants in various stages of planning and construction will add industrial-scale capacity as they come online. Oil refineries still have the card to play for transforming their big refineries for biofuels and the trend is clear. Mega-projects can be found all around with favour for the USA and Europe and some for Asia. Will big oil go for big biofuel?

The conversion and retrofitting of existing fossil assets will continue, if investments and recent announcements made by both global oil and gas supermajors as well as national- and independent players is anything to go by.

We appreciate your readership and value your input and feedback!

Tomas Ekbom, Task Leader IEA Bioenergy TCP T39

Advanced Biofuels Conference (ABC 2023) 20-21 September 2023 in Gothenburg , Sweden

Task 39 information in the triennium

During 2023 the Task have had two Business meetings with monitoring ongoing projects and discussion of inter-task cooperation and new projects. In addition a special Project Meeting was held in May. New added material to the website about the task, projects, reports, publications, and the calendar with events. The website link to IEA Bioenergy Task 39 is here.

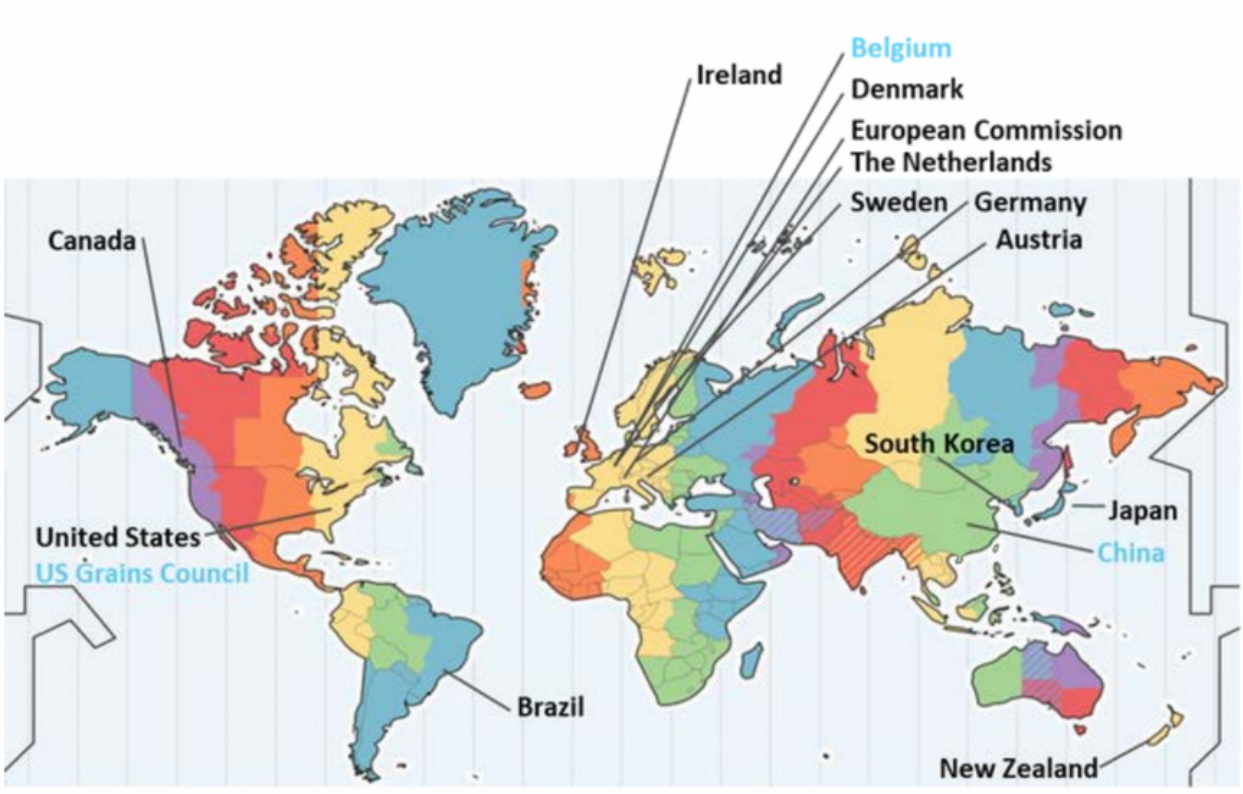
Task 39 now plans for the joint meeting in October 2023 in Leipzig, Germany at DBFZ with IEA AMF for common interest and possible cooperation and projects. IEA IETS is also present as guest. There are important considerations for both internal combustion engines and biofuels in the matter of adopting political measures for future sales where combustion engines are restricted or not allowed.

Task 39 continues to actively organize and participate in other webinars and conferences with the goal of sharing the networks insights on how decarbonization of the transport sector can contribute to a "green economic recovery".

As of September five reports have been delivered for publication to IEA Bioenergy in the Inter-task project Assessment of Success Stories and Lessons Learned in Biofuels Deployment from Task groups 39, 40 and 45 with the IEA Bioenergy webinar on 21st of September in conjunction with the ABC conference onsite. These can be found on the IEA Bioenergy website.

As of 2023 fifteen countries participate in Task 39: Austria, Belgium, Brazil, Canada, China, Denmark, European Commission, Germany, Ireland, Japan, The Netherlands, New Zealand, South Korea, Sweden, and the USA. In addition, US Grains Council participates as a Limited Sponsor (see Figure 1). Task 39 welcomes interest from other countries to participate in the Task group.

With the collaboration among these countries, Task 39 is set to deliver cooperative research projects to address and assess policy, markets, and sustainable biofuel implementation issues. T39 welcome international contact from industry and academia and authority to our group to work on common ground for further use and commercialization of biofuels to replace fossil fuels.



Members of IEA Bioenergy TCP Task 39, 15 member countries and 1 Limited Sponsor
The colors represent different time zones.

Task 39 programme of work

The mission of Task 39 is to facilitate and advance development and deployment of sustainable, lower carbon intensity biofuels to decarbonize the transport sector. Our method is to assist member countries transport biofuels stakeholders in their efforts to develop and deploy sustainable, lower carbon intensive biofuels through a coordinated focus on technology, commercialization, sustainability, policy, markets, and implementation.

The task leads and coordinates activities in three main program areas:

Technology and Commercialization (T-projects)
Technical/commercial aspects of producing and using low carbon intensity (CI) liquid and gaseous biofuels for transport, including both "conventional" and "advanced" biofuels.

Sustainability (P-projects)
Sustainability and carbon intensity metrics are playing an ever-increasing role in the policies used to develop and use biofuels. Biofuels sustainability/LCA assessment will stay a priority for the Task.

Policy (P-projects)
Policy analysis, the "right" policies (such as LCFSs) significantly influence the rate and extent of development, deployment, and use of biofuels (e.g., bioethanol, biodiesel, renewable diesel, drop-in biofuels, etc).

The list of ongoing and proposed projects is provided below:

T39-T2
Ongoing progress in the commercialization of SAF/biojet fuel

T39-T3
Progress in the commercialization of drop-in biofuels and co-processing to produce low-CI transport fuels

T39-T4
"Extend assessment of decarbonisation of the marine transport sector and evaluate the commercial production and use of biofuels"

T39-T5
"Phase 2- Successes and Lessons Learned for Advanced Biofuel Technologies Commercialization (possibly InterTask with Tasks 40 and 45)"

T39-T6
Inter-Task project 'Synergies of green hydrogen and bio-based value chains deployment'

T39-P1
Implementation Agendas compare-and-contrast report of each member country's biofuels policies that have been/are being used to develop, deploy and expand biofuels production and use

T39-P2
"Assessment of the sustainability of biofuels pathways, including social and environmental aspects of sustainability, the specific CI impact of "new/advanced" feedstocks, and also further compare and harmonize leading LCA models to support biofuels categorization and regulation (possibly InterTask with Tasks 45)"

T39-P3
Improvement opportunities for policies and certification schemes promoting sustainable biofuels with low GHG emissions. Part 2: Robustness of GHG emission certification and verification –a case study of selected biofuel value chains and policies

T39-P4
Biofuel's production and use status in "emerging" economies.

We appreciate your readership and value your input and feedback. Thank you for participating in the IEA Bioenergy Task 39 network!

Task 39 members

Starting from 2023 Task 39 will have 15 member countries participating as listed per below. Each country is represented by a National Team Leader (NTL) and additional representatives as well as an ExCo member. Furthermore, external experts may be involved as well. In addition, US Grains Council participates as a Limited Sponsor making the total number of members to 16.

Current IEA Bioenergy task 39 members (from 2023)

Member country	Task representative	Organisation	ExCo member
Austria	Andrea Sonnleitner (NTL) Dina Bacovsky	BEST BEST	Hannes Bauer
Belgium	Robert Malina	Hasselt University	Thibaut Masy
Brazil	Glaucia Mendes Souza (NTL) Rubens Maciel Filho Luiz A Horta Noguiera	BIOEN FAPESP BIOEN FAPESP BIOEN FAPESP	Marlon Arraes
Canada	Jack Saddler (NTL) Hana Mohamadi Allison Simmons	UBC UBC NRC	Oshada Mendis
China	Fuli Li (NTL)	QIBEBT	Dou Kejun
Denmark	Sune Tjalfe Thomsen (NTL)	UCPH	Katharina Paarup Meyer
European Commission	Nicolae Scarlat (NTL) Marco Buffi	EC EC	Maria Georgidaou
Germany	Franziska Mueller-Langer (NTL) Nicolaus Dahmen	DBFZ KIT	Birger Kerckow
Ireland	Tom Walsh (NTL)	Renetch	Luiz Gay-Tarazona
Japan	Yuta Shibahara	NEDO	Takahisa Yano
New Zeeland	Paul Bennett (NTL)	Scion	Paul Bennett
South Korea	Chang Hyu Ko (NTL)	CNU	Jin-Suk Lee
Sweden	Tomas Ekbom (NTL Hannah Edgren	Svebio Svebio	Jonas Lindmark
The Netherlands	Paul Sinnige (NTL) José Muisers Stephan Janbroers	RVO RVO TNO	Kees Kwant
United States	Ling Tao (NTL)	NREL	Jim Spaeth

Current IEA Bioenergy Task 39 limited sponsor(s)

Organisation	Task Representative	Alternative
U.S Grains Council	Isabelle Ausdal	Mackenzie Boubin

Biofuels production and development in China

Fuli Li and Yixuan Fan, Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences

1. Summary

- China is the world's largest liquefied natural gas import country, has the world's largest car fleet, the second largest gasoline market and the third largest diesel market
- China's fuel ethanol production was 2.57 MMT in 2021; China's fuel ethanol production was over 80% grain-based (i.e., corn, wheat, and rice) in 2022 and 10% cassava or sugarcane-based
- Policy has been issued to strictly control the corn-based fuel ethanol processing industry.
- Sugar and molasses- ethanol producers continue to struggle with low margins
- The biofuels industry is investing on advanced biofuels such as cellulosic bioethanol as well as coal and industrial flue gas-based synthetic ethanol
- In 2021, a 240,000 tonnes per year biomass project using enzymatic processing and fermentation to ethanol started operating: there are two synthetic ethanol plants in operation and an agreement to install the first syngas-based fuel ethanol plant has been signed
- The 2022 national average fuel ethanol blend is estimated at 1.8% with a plan to reach a national E10 fuel ethanol target
- Covid-19 lockdowns is believed to have had an impact on blend which peaked at 2.8% in 2012
- Fuel ethanol demand is expected to increase in the 2023 with the National VIB standard motor gasoline
- China has attached great importance to the development of syngas related technologies using flu gas from coal and other industries; the world's first bio fermentation fuel ethanol project using steel industry tail gas as raw material is located in China
- Biodiesel market penetration and production targets have been very low compared to ethanol
- The national average biodiesel blend has never moved off of 0.2 to 0.3%
- China's 2022 biodiesel production is forecast at 2.4 BL, up by over 32% from 2021, FAME is at 2.6 BL, HDRD plants have a combined annual capacity of 2.3 BL with an additional 3.4 BL capacity planned
- Nearly all plants are export-oriented to take advantage of EU tax policies; China's UCO export rebate polices stimulate UCO exports
- Internally biodiesel is used primarily to fuel electrical power generation, fishing vessels, and farm equipment
- Biodiesel consumption dropped by 50% in relation to 2019
- Biodiesel production is challenged by the availability of feedstocks, which are mostly imported, underdeveloped policies for biodiesel consumption and lack of financial support for farmers
- Policy has been issued that aims to build a sustainable raw material supply system that is suitable for the characteristics of China's resources, based on waste oil, and supplemented by wood (grass)-based non-edible oil plants
- China's 2022 fuel ethanol imports, mainly from France and the United States, due to domestic ethanol supply being sufficient, is expected to remain low; for biodiesel, the imports in 2022 increased 89% from the last year, being mostly palm oil biodiesel from Indonesia and Malaysia.
- Subsidies for conventional grain ethanol have been gradually phased out and no longer exist since 2016, subsidies for 1.5 generation ethanol (from cassava or sweet sorghum) were introduced in 2013, cellulosic ethanol started receiving a subsidy in 2014, subsidies for non-food grain feedstocks will phase out by 2018

- Subsidies for conventional grain ethanol have been gradually phased out and no longer exist since 2016, subsidies for 1.5 generation ethanol (from cassava or sweet sorghum) were introduced in 2013, cellulosic ethanol started receiving a subsidy in 2014, subsidies for non-food grain feedstocks will phase out by 2018

- Tax incentive for food crop-based fuel ethanol production gradually phased out; tax incentive for non-food crop-based fuel ethanol was retained

- With the exception of minor tax incentives for the consumption tax and export rebates, biodiesel does not receive any subsidies nor mandate support that fuel ethanol enjoys, and must compete with other markets for used cooking oil (UCO) feedstock

- The Action Plan for Carbon Dioxide Peaking before 2030 promotes the use of advanced biofuels, SAF and other alternatives; at present there are few SAF enterprises

- The Specialized Green-development Plan for Civil Aviation aims to achieve more than 20,000 tonnes of SAF consumption in 2025, as well as 50,000 tonnes of SAF consumption during the "14th Five-Year Plan" period.

- In 2022, the National Development and Reform Commission proposed to carry out a biodiesel promotion pilot in areas where conditions permit, promote the demonstration and application of bio aviation fuel; develop non grain biomass liquid fuel, and support the research, development and promotion of advanced technology and equipment in fields such as biodiesel and bio aviation kerosene

- In 2022 bio-aviation jet fuel has been first used in international freight transport (all 30,000 tonnes of products obtained in a trial operation in 2020 were exported to the EU)

- China has developed green technologies for methanol for maritime applications based on biomass gasification with a capacity, by 2024, to produce 50,000 tonnes annually; in 2023 a second project utilizing the by-product hydrogen in the coke oven gas and the carbon dioxide captured from the industrial tail gas to synthesize methanol, with a target to produce 110,000 tonnes of methanol

- Four Chinese National biofuel research centers have been established each having a different focus

2. Overview

As the world's largest energy user, China has surpassed Japan and became the largest liquefied natural gas import country in 2021. It is the first time that China has become the world's largest LNG importer since the early 1970s (Luo, 2021). China's gasoline market is now the second largest in the world. It exceeded the EU's demand a few years ago and now is only exceeded by the US. However, unlike the US market, which has slowing gasoline consumption, China's gasoline market continues to expand rapidly with year-to-year growth surpassing all other markets. Although China's transport diesel market is the third largest in the world, China's annual diesel use is growing at a rate comparable to the US and the EU, two much larger markets.

At present, the industrialization process in China has not yet ended, its carbon emissions and energy consumption are both on the rise. In 2000, China's national fleet totaled less than 20 million passenger vehicles. However, from 2005 to 2015, China's passenger car fleet increased by a factor of ten. In 2018, China surpassed the US as the largest car market in the world and now totals more than 322 million vehicles (GAIN, 2018). The proportion of energy consumed by the transportation sector also reached its maximum in 2018, as the data from the General Administration of Customs of the People's Republic of China (GACC) shown in Figure 1.1. The GHG emissions in China continues to grow, and the contribution of transportation is also increasing (Figure 1.2).

Biofuels offer a means to stretch the economic efficiency and environment value of energy utilization. In China, biodiesel is used primarily to fuel electrical power generation, fishing vessels, and farm equipment. On-road transport accounts for about one-third of total demand (GAIN, 2018). One major reason for this type of preferred usage is the low quality of the biodiesel that is produced (van Dyk et al., 2016). Very little information is available on production of biofuels other than ethanol or biodiesel. For example, there is little information on biobutanol, renewable diesel ((Hydrotreated Vegetable Oil (HVO)), Hydroprocessed Esters and Fatty Acids (HEFA) or other drop-in biofuels. Prospects for China's transportation fuel demand depend on macroeconomic factors, the adoption rate of New Energy Vehicles (NEVs) such as electric cars and advanced fuel vehicles; and implementation of China's ambitious new drive to reach a national E10 fuel ethanol target.

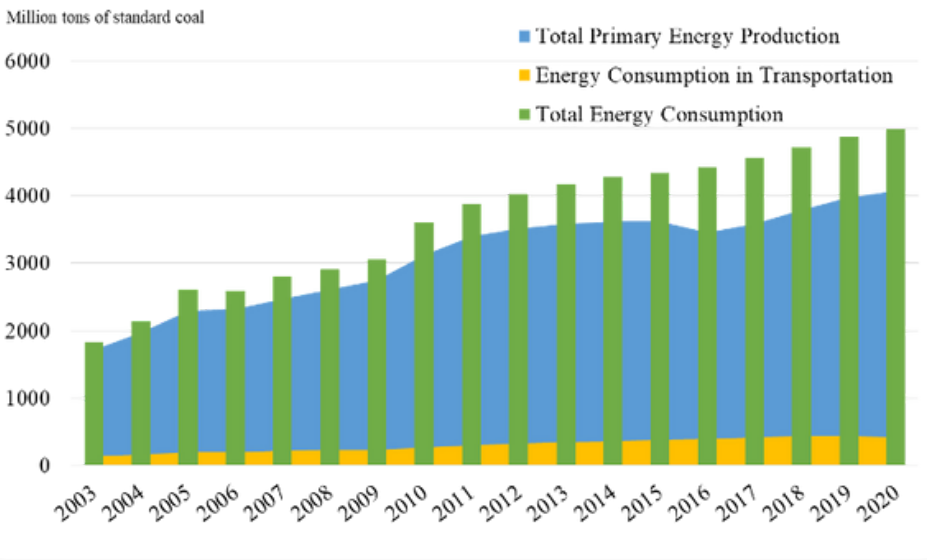


Figure 1.1. Energy production and transportation consumption in China, 2003 to 2020 (data from GACC)

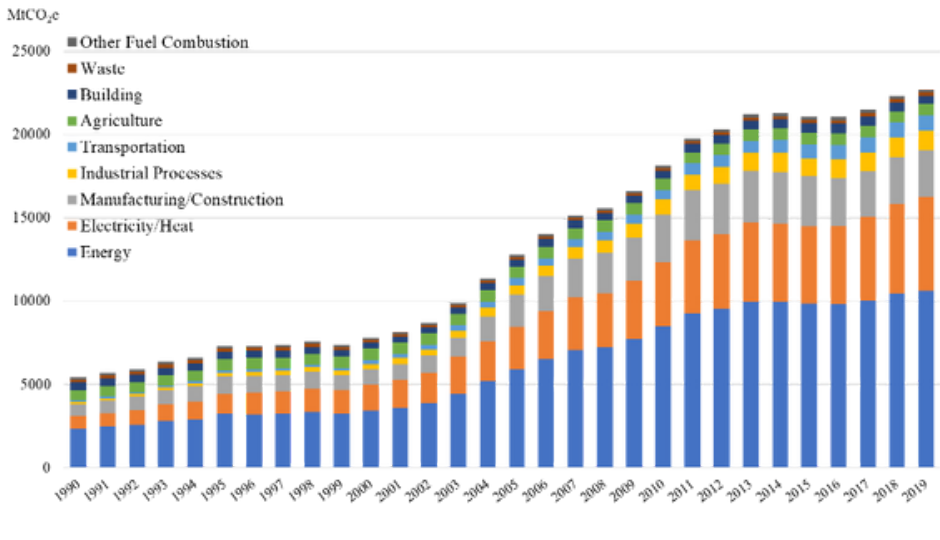


Figure 1.2. GHG emissions of various industries in China, 1990 to 2019 (data from GACC)

3. Biofuels production, consumption and feedstocks

A. Production

At this time, Chinese law restricts fuel ethanol processing to licensed facilities that produce and supply fuel ethanol to national refiners and fuel marketing companies. Provincial Development and Reform Commissions (DRCs) are responsible for the distribution of franchise licenses for fuel production, refining, and marketing. In 2021, China's fuel ethanol production was 2.57 MMT, accounting for only about 3% of global production (QYResearch, 2022). It is reported that China's fuel ethanol production capacity was about 6.25 MMT in 2022 (Sublime Chins Information, 2023), over 80% grain-based (i.e., corn, wheat, and rice) and 10% cassava or sugarcane-based. Due to limited supplies of sugarcane and record high molasses prices, sugar and molasses-ethanol producers continue to struggle with low margins. Cassava ethanol (for fuel and other industrial use) production capacity is forecast at 2.82 MMT in 2022, mainly in Shandong, Anhui, and Jiangsu, as a result of relatively low cassava prices compared to corn (Gain, 2022).

The biofuels industry is investing resources to transition to advanced biofuels such as cellulosic bioethanol as well as coal and industrial flue gas-based synthetic ethanol. In late 2021, Hebei Yigao Biofuel company reported successfully operating the first trial of their 240,000 tonnes per year biomass comprehensive use project (Paperinsight, 2022). The project produced qualified ethanol on November 14 after successful enzyme decomposition and fermentation. The project is designed to produce 25,000 tonnes of biofuel, 27,000 tonnes of other by-products. As for the synthetic ethanol, currently, one 58 ML/yr fuel ethanol facility in Hebei is operational and another 57 ML/yr production line, the Ningxia Shougang Lanza Jiyuan started production in May 2021. In September 2020, the first syngas-based fuel ethanol plant project in Guizhou held a signing ceremony. Once operational, the plant will produce 76 MLne of fuel ethanol per year.

Photo of Hebei Yigao bioethanol plant (Paperinsight, 2022)

China's 2022 biodiesel production is forecast at 2.4 BL, up by over 32% from 2021 due to strong exports. Beginning in 2020, China's production yearly capacity of fatty acid methyl esters (FAME) grew to 2.6 BL. These facilities are located mainly in Shandong, Guangdong, Shaanxi, and Jiangsu. Hydrogenation-derived Renewable Diesel (HDRD) plants have a combined annual capacity of 2.3 BL with an additional 3.4 BL capacity planned. Nearly all plants are export-oriented to take advantage of EU tax policies. Zhuoyue New Energy is the leading FAME biodiesel producer, with a new 114 ML/yr production line that will start production in October 2022. The company plans to expand capacity to 852 ML (including more than 114 ML of HDRD capacity) from the current 454 ML in 3-5 years. Zhejiang Jia'ao also plans to expand capacity to 398 ML from current capacity of 171 ML. China's only publicly traded company, Beiqing Huanneng, which focuses on used cooking oil (UCO), also plans to build 795 ML (including 454 ML of HDRD and 341 ML of FAME) of biodiesel production capacity, on top of their existing UCO business. Availability of UCO may limit biodiesel production as China's UCO export rebate polices incentive UCO exports. (GAIN, 2022)

B. Consumption

In 2022, fuel ethanol consumption is estimated at 3.8 BL, down 164 ML from 2021 resulting in a 2022 national average fuel ethanol blend rate estimated at 1.8%. While only slightly lower than the 2021 blend rate, it is significantly lower than the 2.8% peak blend rate achieved eleven years ago. This is in part attributed to continued Covid-19 lockdowns in various locations which completely halted fuel ethanol production and transportation in Northeast provinces for several months during the first half of 2022 (GAIN, 2022). Fuel ethanol demand is expected to increase in the 2023 with the promotion of National VIB standard motor gasoline (with an olefin content of 15%) throughout the country.

Although there is approximately equal demand for gasoline and diesel in China's transportation supply chain, biodiesel market penetration and production targets have been very low compared to ethanol. China's 2022 biodiesel consumption is estimated at 600 ML, slightly higher than 2021, but 50% below 2019 levels and 40% below 2018. This is attributed to the coronavirus epidemic, which caused China's demand to drop off in 2020 and 2021.

C. Feedstock

In China, there are many raw materials that can be utilized for renewable fuel production. As shown in Figure 1.3, according to different raw materials, biofuels are roughly divided into three generations. China's biofuel policy defines second generation biofuel as those made from cellulosic biomass. While cellulosic ethanol has been mentioned in various government planning documents and policies as early as 2011, including a goal to a build yearly capacity of more than 760 ML (600,000 tonnes) by 2020, little has materialized. Cellulose ethanol uses 30~50 times more enzymes than starch ethanol, which leads to the high cost of cellulosic bioethanol.

The coal and industrial flue gas mixture composed of CO, CO2, and H2, also termed as syngas, is considered as the third generation of biofuel feedstock. China has attached great importance to the development of syngas related technologies that in December 2016, the National Development and Reform Commission and the National Energy Administration issued the "Revolutionary Strategy for Energy Production and Consumption (2016-2030)", and in February 2017, the National Energy Administration issued the "13th Five-Year Plan for Demonstration of Deep Processing of Coal", which mentioned the innovation of clean and efficient coal utilization technology, breaking through the production of high carbon primary alcohol from synthetic gas, and exploring the one-step production of olefins, ethanol and other technologies from synthetic gas. Developing the technology of preparing high-value chemicals from synthetic gas is of great significance for saving the coal consumption in China and ensuring the national energy security.

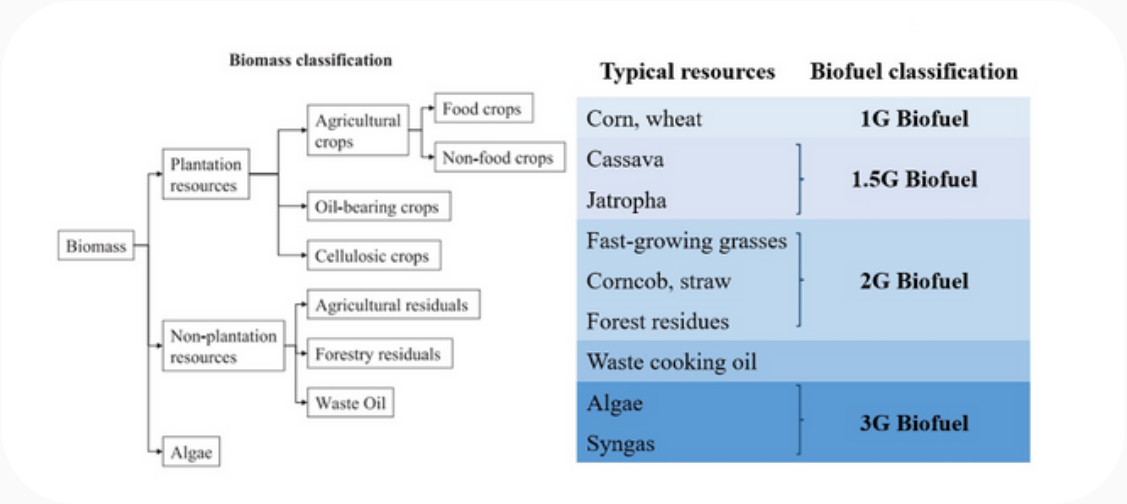


Figure 1.3. Biomass and biofuel classifications in China (Hao et al., 2018)

A major challenge limiting the expansion of biodiesel is the availability of feedstock. China is a net importer of vegetable oils (e.g., soy oil, palm oil) which are the main constituent feedstocks used to make biodiesel. One of the Chinese government's attempts to make better use of the underutilised biodiesel refinery capacity was to encourage the production of 1.5 generation feedstocks such as oilseed bearing trees. This was incorporated into the Eleventh Five-Year Plan in 2006, where planting targets of 400,000 ha of jatropha, plus another 433,000 ha of other oilseed bearing trees such as yellowhorn (Xanthoceras sorbifolia), Chinese pistachio (Pistacia chinensis), varnish tree (Koelreuteria paniculata), Chinese tallow tree (Sapium sebiferum), Swida wilsoniana, idesia (Idesia polycarpa), sumac (Rhus chinensis), aveloz (Euphorbia tirucalli), and tung tree (Vernicia fordii) (Chang et al., 2012; Li et al, 2014; van Dyk et al., 2016). It was estimated that the potential production volumes of biodiesel based on oilseed-bearing trees grown on marginal land alone could be between 20.5 and 123.1 BL (Chang et al., 2012). However, as of early 2014, the extensive development of these feedstocks has failed to materialise. Jatropha production, which was originally promoted as the most promising of all non-traditional feedstock sources used to make biodiesel, has stagnated. This has been attributed to underdeveloped policies for biodiesel consumption and lack of financial support for farmers (Li et al., 2014; van Dyk et al., 2016).

As the third-generation resources, microalgae bioenergy technology has become an international science and technology hotspot in the past two decades. It is considered as a potential future biofuel production route, which can convert carbon dioxide and solar energy into liquid biofuels in a one-stop manner. However, in terms of the current technology, the recovery and treatment of carbon dioxide from flue gas and other sources by cultivating microalgae is of certain significance in the context of the current construction of "carbon peaking - carbon neutralization", but it is not economically feasible to provide energy products. Therefore, there is no practical application progress of microalgae energy technology in China or even in the world.

4. Policies

In order to promote the application of biofuels, the Chinese government has introduced many policies. Article 4 of the Energy Law of the People's Republic of China (Draft for Comments) declares that "The state adjusts and optimizes the energy industry structure and consumption structure, gives priority to the development of renewable energy, safely and efficiently develops nuclear power, increases the proportion of non-fossil energy, and promotes the clean and efficient use of fossil energy and low-carbon development". Article 26 also states that "The state encourages the development and utilization of efficient and clean energy resources and supports the priority development of renewable energy".

China is one of the world largest fuel ethanol producers after the US, Brazil, and the EU but its fuel ethanol market has remained insular throughout its 20-year history with the exception of a few recent years. PRC law restricts fuel ethanol processing to licensed facilities that produce and supply fuel ethanol to national refiners and fuel marketing companies. In February 2022, the State Council released its annual policy guidelines on agriculture and rural development known as the “No. 1 Central Document” which stipulated those officials “strictly control the corn-based fuel ethanol processing industry.” In June 2022, the NDRC led nine ministries to publish the “14th Five-Year-Plan for Renewable Energy.” The Plan calls for the development of non-grain biofuel ethanol such as cellulosic biofuel. (GAIN, 2022; Industrial prospect, 2022).

The PRC’s commitment to peak carbon emissions is driving and creating new prospects for expanded biodiesel use and production. In January 2015, the National Energy Administration issued the Biodiesel Industry Development Policy, which proposed that “build a sustainable raw material supply system that is suitable for the characteristics of China’s resources, based on waste oil, and supplemented by wood (grass) based nonedible oil plants”. In December 2020, the White Paper on “Energy in China’s New Era” issued by the State Council Information Office clearly stated that “focus on improving the quality of biodiesel products and promoting the industrialization of non-grain biofuel technology”.

As a liquid fuel for commercial aviation, sustainable aviation fuel (SAF) has attracted much attention and been taken as an important strategic reserve for industry decarbonization. In 2021, the State Council proposed in the Action Plan for Carbon Dioxide Peaking Before 2030 to vigorously promote the use of advanced biological liquid fuels, SAF and other alternatives to traditional fuels to improve the energy efficiency of terminal fuel products. In 2022, the Specialized Green-development Plan for Civil Aviation in the “14th Five-Year-Plan” issued by the Civil Aviation Administration of China also puts forward a proposal to promote the breakthrough in commercial application of SAF, and strive to achieve more than 20,000 tonnes of SAF consumption in 2025, as well as 50,000 tonnes of SAF consumption during the “14th Five-Year Plan” period. Meanwhile, goals for oil saving and emission reduction were set that the fuel consumption per tonne kilometer of the transport aviation fleet decreased to 0.293 kg, and the CO2 emissions per tonne kilometer of transport aviation dropped to 0.886 kg. In 2022, the National Development and Reform Commission proposed in the “14th Five-Year Plan for Bio-economic Development” to carry out biodiesel promotion pilot in areas where conditions permit, and promote the demonstration and application of bio aviation fuel; as well as in the “14th Five-Year Plan for Renewable Energy” to vigorously develop non grain biomass liquid fuel, and support the research, development and promotion of advanced technology and equipment in fields such as biodiesel and bio aviation kerosene.

5. Advanced Biofuels

Ethanol from non-food grain feedstocks is considered an advanced biofuel in China. According to the 12th Five Year Plan (2011-2015) for strategic emerging industries, China aimed to develop biomass energy sources to develop second generation biofuels including production of 5,068 ML (4 MMT) of cellulosic fuel ethanol, and 1.1 BL of algae-based biodiesel. In May 2017, China’s Central Government announced its 13th FYP for Biological Innovation. The plan focuses on promoting innovation in biological-based technologies, including new energy sources using bio-based feedstocks like cellulosic ethanol. In June 2022, the NDRC led nine ministries to publish the “14th Five-Year-Plan for Renewable Energy”, which calls for the development of non-grain biofuel ethanol such as cellulosic biofuel (GAIN, 2022).

China’s efforts also include projects to convert coal and industrial waste gas into synthetic ethanol. The world's first bio fermentation fuel ethanol production project using steel industry tail gas as raw material is located in Caofeidian, Tangshan City, Hebei Province. It is put into operation in May 2018, with an annual design output of 45 000 tonnes of fuel ethanol. At the same year, Xinjiang Tianye has signed a contract with Dalian Institute of Chemical Physics, Chinese Academy of Sciences for a 1.2 MMT/yr syngas ethanol project. Other institutes, such as Qingdao Institute of Bioenergy and Bioprocess Technology, and SINOPEC Research Institute of Petroleum and Petrochemicals, are also working on the syngas fermentation. The PRC press and industry contacts report that China’s Syngas ethanol production capacity is expected to reach 2.5 BL by the end of 2022 (GAIN, 2022).

At present, there are few enterprises with actual production capacity of SAF in China. Sinopec Zhenhai Refinery established China's first SAF commercial production facilities in 2020. The company's HEFA products passed Roundtable on Sustainable Biomaterials (RSB)'s certification in 2022. On June 28, 2022, Sinopec Zhenhai Refinery produced the first test batch of SAF products which is the first time in China (Xinhuanet, 2022). And in the same year, December 15th, the bio-aviation jet fuel has been first used in international freight transport (People's Daily Online, 2022). Scientific research institutions such as Guangzhou Institute of Energy Conversion, and Qingdao Institute of Bioenergy and Bioprocess Technology, parts of Chinese Academy of Sciences, are also actively studying the process route for preparing SAF from agricultural and forestry wastes. On July 30, 2020, the QIBEBT and Shijiazhuang Changyou Bioenergy Company jointly developed the ZKBH process for the production of second-generation biodiesel by continuous hydrogenation, and realized the continuous production of biodiesel on the 200,000 t/a scale industrial plant. All 30,000 tonnes of products obtained during the trial operation were exported to the EU. (China Science Daily, 2020)

Photo of CA1027, the first commercial cargo flight in Chinese Mainland using sustainable aviation fuel (People's Daily Online, 2022)

Green methanol nowadays is the only marketable low-carbon fuel in the shipping industry. Through the development of advanced gasification technology and high-performance catalysts, QIBEBT has developed green fuel and chemical preparation technologies for methanol, dimethyl ether, gasoline, high-quality aviation oil, etc. based on biomass gasification synthesis technology. CIMC ENRIC signed a cooperation agreement with Maersk, a global shipping giant, to develop biomass methanol projects for Maersk in China. It is estimated that in 2024, the Phase I project will have the capacity to produce 50,000 tonnes of biomass green methanol annually. The annual output of green methanol in Phase II project is expected to increase to 200,000 tonnes. Sichuan Zhongming New Energy Technology Co., Ltd. also plans to use this process to build a 50,000 tonne/yr first generation biodiesel production demonstration plant which is expected to be officially put into operation within two years. In 2023, the world's biggest and the first 100 000 tonnes green low-carbon methanol plant, which is jointly established by Zhejiang Geely Holding Group and Henan Shuncheng Group Co. Ltd, is officially put into operation in Henan Province. The project comprehensively utilizes the by-product hydrogen in the coke oven gas of Shuncheng Group and the carbon dioxide captured from the industrial tail gas to synthesize green low-carbon methanol, and can produce 110,000 tonnes of methanol annually which directly reduces carbon dioxide by 160,000 tonnes.

6. Perspectives and challenges in biofuels technologies/biofuels technology development and deployment

A. Status of the technologies

From the "13th Five-Year Plan" to the "14th Five-Year Plan", China has set up national key R&D plans related to biofuels almost every year. The Chinese Academy of Sciences has taken the lead in carrying out biomass energy research in China, from rural energy development technology to modern bioenergy technology. It has integrated institutes like Qingdao Institute of Bioenergy and Bioprocess Technology (QIBEBT), GuangZhou Institute of Energy Conversion (GIEC), Dalian Institute of Chemical Physics (DICP), and Institute of Process Engineering (IPE), forming a systematic and institutionalized research system integrating multiple disciplines. For example, the Chinese Academy of Sciences Key Laboratory of Biofuels, basing on the QIBEBT, devotes to the renewable resources and transformation technologies such as bioethanol from industry flux gas and biomass, catalytic conversion of oil and fat to biodiesel, as well as biomass to high quality jet fuels (China Science Daily, 2017). With the support of relevant national funds, especially the strategic leading science and technology project of the Chinese Academy of Sciences, a group of products with independent intellectual property rights has been built, such as million tonne/yr liquid molecular catalytic production of second-generation biodiesel, 300,000 tonnes of straw ethanol and supporting cogeneration, 1000 tonnes of biological aviation oil cogeneration chemicals, 1000 tonne/yr trans aconitic acid ester, 1000 tonnes of straw sugar to ethylene glycol/furan, among others. Besides that, four Chinese National biofuel research centers have been established (Table 1.1) with each of these national biofuel research centers having a different focus. The National Energy R&D Center for Non-food Biomass, which is led by the China Agricultural University, has the major responsibility for biomass breeding, cultivation and logistics research; while the National Energy Research Center of Liquid Biofuels, which is led by COFCO (a major Chinese Energy Enterprises), is mainly focused on technology implementation. The other two national research centers put their major efforts into technology development and integration (van Dyk et al., 2016).

Table 1.1. China main biofuel research centers (van Dyk et al., 2016; China Science Daily, 2017)

China main biofuel research centers	Leading institute
National Energy R&D Center for Biorefinery	Beijing University of Chemical Technology
National Energy Research Center of Liquid Biofuels	COFCO
National Energy R&D Center for Non-food Biomass	China Agricultural University
National Energy R&D Center for Biofuels	Guanqzhou Institute of Energy Conversion
Chinese Academy of Sciences Key Laboratory of Biofuels	Qingdao Institute of Bioenergy and Bioprocess Technology, Chinese Academy of Sciences

B. Fiscal incentives and Investment subsidies

Policy support distinguishes between conventional, 1.5 generation and second-generation feedstocks. With policies that biofuel development should not compete for arable land designated for food crops, China promotes ethanol production using cassava, sweet sorghum, and other non-food grain feedstocks.

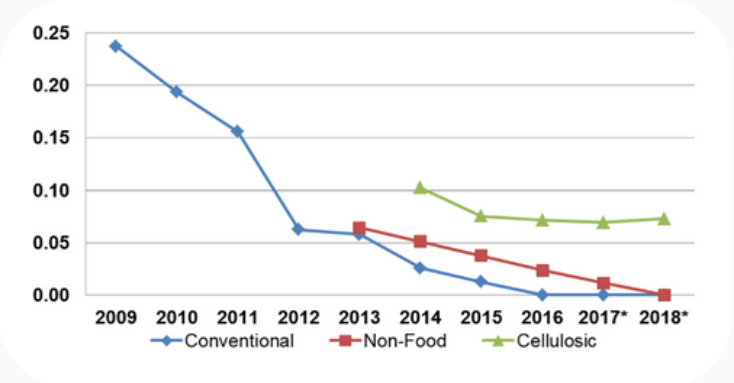


Figure 1.4. Fuel ethanol subsidies in $/liter, 2017 and 2018 exchange rates are forecasts (Innovation Center for Energy and Transportation; and Pacific Exchange Rate, GAIN, 2017)

In terms of the taxation policy, the early published government documents specified that the excise tax for fuel ethanol production is exempted, and the Value Added Tax (VAT) for fuel ethanol production is reimbursed. However, with the change of the government's attitude towards fuel ethanol development, the tax incentive for food crop-based fuel ethanol production gradually phased out. Specifically, the VAT for food crop-based fuel ethanol production was reimbursed by 80% in 2011, 60% in 2012, 40% in 2013, 20% in 2014 and no reimbursement from 2015 on. The excise tax for food crop-based fuel ethanol production was 1% in 2011; 2% in 2012; 3% in 2013; 4% in 2014; and 5% from 2015 on. Despite this, the tax incentive for non-food crop-based fuel ethanol was retained.

China's Ministry of Finance announced that effective March 2018 independent crude oil refiners, also known as "teapot" refiners, are required to pay consumption taxes of $38 per barrel of gasoline and $29 of diesel produced. Higher taxes will lower production margins, and spur refiners to seek lower-cost substitutes, like ethanol and biodiesel (GAIN, 2018).

Regarding biodiesel, the excise tax for waste oil-based biodiesel production is exempted. In addition, the Biodiesel Industrial Development Policy released in 2014 specified that China should launch dedicated price, taxation, finance and investment incentives to promote biodiesel development (Hao, et al., 2018). In 2017, China's General Department of Taxation lowered the effective VAT applied to exported ethanol products from 13% to 11%. Biodiesel exports made from used animal and vegetable oils also enjoy a 70% VAT rebate. Qualified producers also benefit from a 90% discount on taxable income from relevant products. To support biodiesel development, tax authorities have issued policies to waive consumption taxes on B100 biodiesel produced using UCO (0.8 RMB/L tax). With the exception of minor tax incentives for the consumption tax and export rebates, biodiesel does not receive any subsidies nor mandate support that fuel ethanol enjoys, and must compete with other markets for used cooking oil (UCO) feedstock. This being the case, the market for biodiesel remains very limited and the national average blend have never moved off of 0.2 to 0.3% (GAIN, 2018).

C. Market Analysis

Affected by the internal and external arbitrage activities and domestic supply and demand, China's ethanol import volume has fluctuated significantly in the past six years, with more imports in 2018 and 2021. According the statistics from the General Administration of Customs of the People's Republic of China, China's 2022 fuel ethanol imports that mainly from France and the United States were only 0.16 ML, down drastically from 2021 (Figure 1.5). In 2023, the domestic ethanol supply is sufficient, hence the import volume is expected to remain low. As for biodiesel, the imports in 2022 are 387.89 ML, increased 89% from the last year (Figure 1.6). As in the past, more than 90% of imports are palm oil biodiesel from Indonesia and Malaysia.

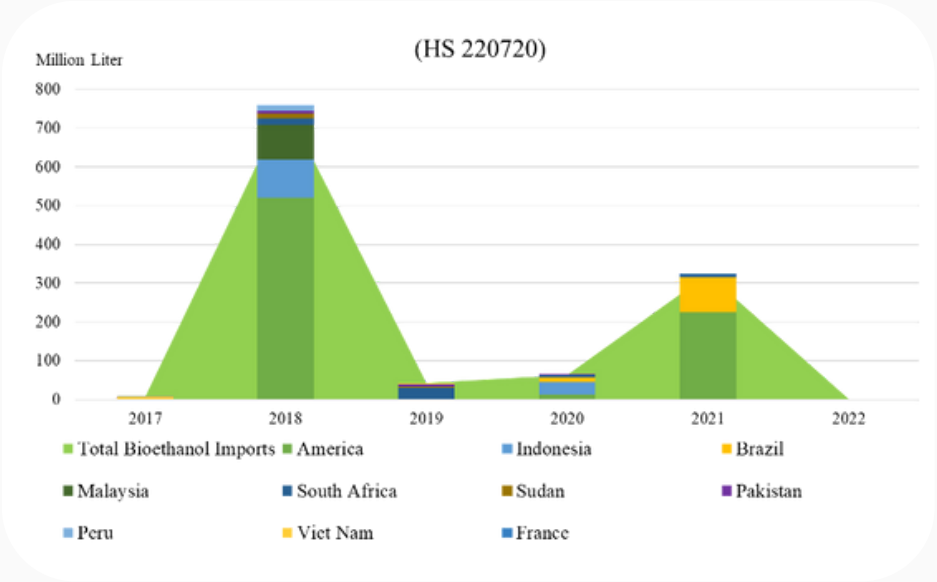


Figure 1.5. Bio-ethanol Import Statistics of China (data from GACC)

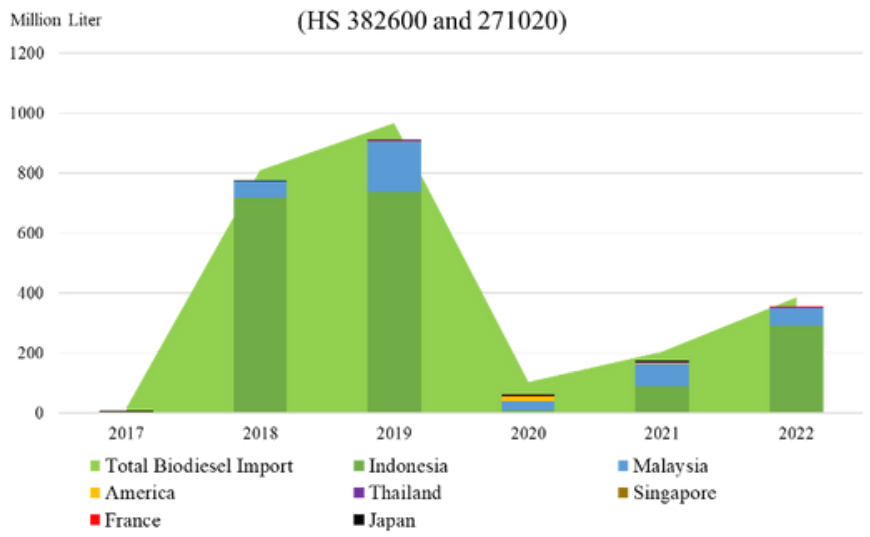


Figure 1.6. Biodiesel Import Statistics of China (data from GACC)

Under the influence of raw material cost and market demand, China's 2022 ethanol exports keep depress. In 2022, the denatured ethanol exports totaled 2.6 ML, predominantly to India, which covered 61.5%. But the export volume was still less than the previous two years. Conversely, the exports of biodiesel in China have been on the rise. In 2022, the exports surged to 2.08 BL, up 41% than last year. Due to the double-counting provisions for UCO-based biofuels of the EU's Renewable Energy Directive (REDII) and supported by a 70% VAT rebate (GAIN, 2022), over 92% exported to EU, of which about 73% were Holland (Figure 1.7 and Figure 1.8).

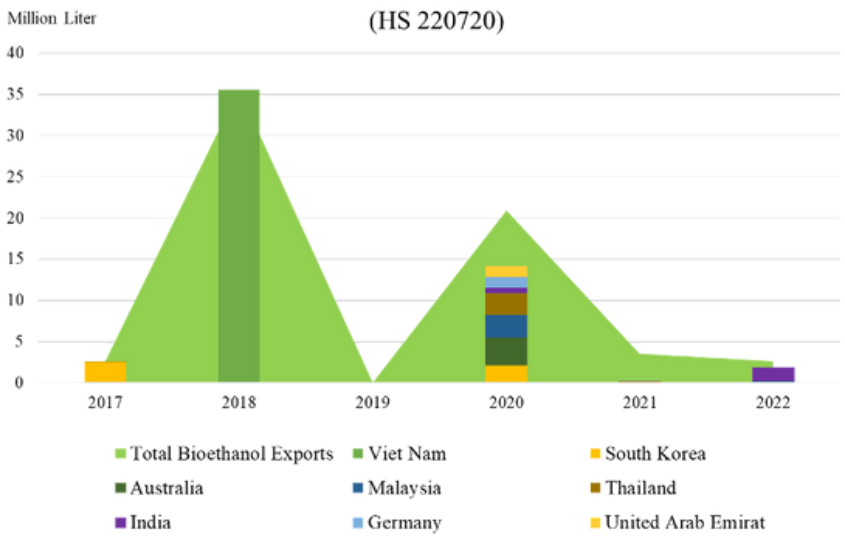


Figure 1.7. Bioethanol Export Statistics of China (data from GACC)

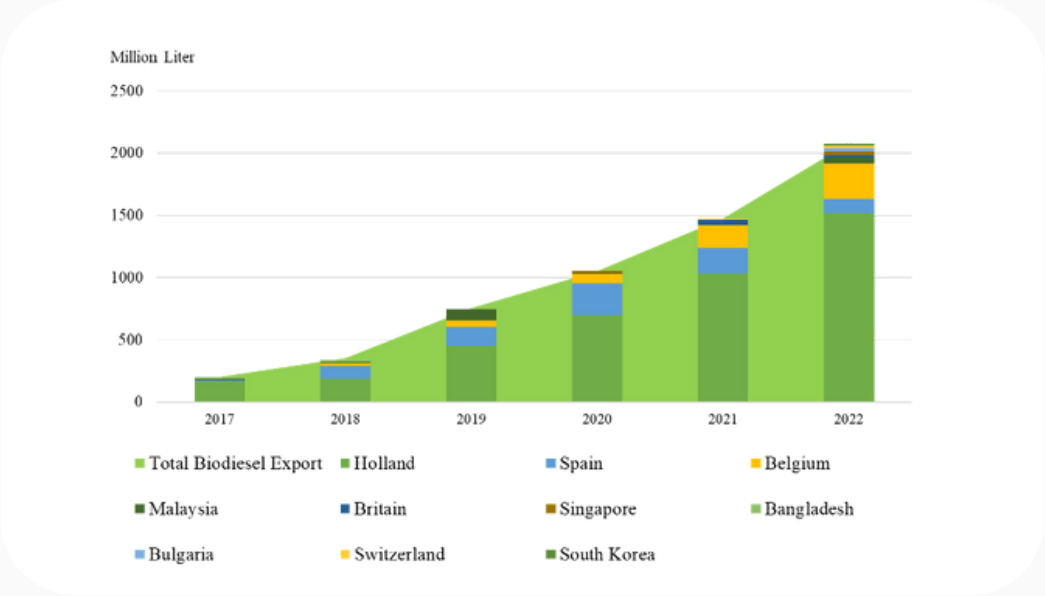


Figure 1.8. Biodiesel Export Statistics of China (data from GACC)

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In the news

Reports and research

Biofuels in Emerging Markets
Potential for sustainable production and consumption

Policy and regulations

July

Government Should Set Achievable Targets for Sustainable Aviation Fuel or Risk Higher Prices for Passengers
UKPIA is calling on the UK Government to set an achievable target for the amount of Sustainable Aviation Fuel (SAF) used by UK airlines in 2025 or risk higher prices for passengers.

IATA to publish an annual Track Zero report
IATA will publish an annual Track Zero report using its Net Zero Tracking Methodology to report industry-level progress towards aviation's commitment to Net Zero carbon emissions by 2050.

Small U.S. refiners plan to challenge biofuel blending waiver denials
A group of refiners plan to file a lawsuit challenging the Biden administration's rejection of waivers to exempt oil refiners from biofuel blending mandates which has left some on the hook for hundreds of millions of dollars, Par Pacific told Reuters on Monday.

Rotterdam backs IMO's climate-neutral ambitions
The Port of Rotterdam Authority has welcomed the ambition of the International Maritime Organisation (IMO) to be climate-neutral by 2050.

Biofuel: A Renewable Road to Net Zero, ADBA analyses IEA report on biofuel policy
India has proposed the Global Biofuel Alliance (GBA) as part of its G20 presidency to promote collaboration between countries on expanding sustainable biofuel production and use. The GBA aims to share best practices, provide technical support, and build capacity to help create new biofuel markets. This would support efforts to decarbonize transportation and heating by displacing fossil fuels with secure and affordable renewable biofuel alternatives.

August

Exclusive: Phillips 66, ADM in talks on biofuels joint venture - sources
U.S. oil refiner Phillips 66 (PSX.N) and grain trader Archer-Daniels-Midland (ADM.N) are discussing a biofuels joint venture with an aim toward producing lower-carbon jet fuel, three people familiar with the matter said.

EU Infrastructure Fund Explores African SAF Projects
The European Union (EU) is looking to invest in African sustainable aviation fuel (SAF) projects through its Global Gateway infrastructure fund, considered a competitor to China's Belt and Road Initiative. The EU has committed to allocating half of the fund's €300 billion ($324 billion) budget to Africa.

Soybean supply set to hit record high
Global soybean production in the running season is likely to amount to round 403 million tonnes, with Brazil, Argentina and the US accounting for 81% of that figure, according to the US Department of Agriculture (USDA).

Cut tax on clean fuels" say hauliers and climate campaigners
More than 30 industry leaders and environmental campaigners have today (31 August) urged ministers to cut duties on clean replacements for diesel.

September

National Energy Transition Roadmap: B30 biodiesel mandate for heavy vehicles in Malaysia by 2030
The second phase of the National Energy Transition Roadmap (NETR) was launched today by prime minister Datuk Seri Anwar Ibrahim, and the NETR has been revealed to cover a number of areas involving transport and mobility.

Sustainable Aviation welcomes SAF 'milestone' in the UK
The Department for Transport has issued an announcement titled New measures to support sustainable aviation fuel industry – highlighting a revenue certainty scheme to support sustainable aviation fuel production in the UK.

Velocys welcomes government plan for SAF 'revenue mechanism'
Velocys has welcomed the publication of the government's delivery plan for a revenue certainty mechanism for sustainable aviation fuel (SAF).

India launches global biofuel alliance at G20 summit
India's oil minister says the alliance will "focus on facilitating cooperation with sharing of best practices & raising awareness on benefits of sustainable biofuels".

IEA shares recommendations for the Global Biofuel Alliance at G20 Energy Transitions Ministerial Meeting
New report on biofuel policy in Brazil, India and the US presented to ministers from around the world as governments seek to step up co-operation

Industry Developments

July

Volvo Cars uses renewable fuels in ocean freight
Volvo Cars is reducing the CO2 emissions in its supply chain by 84% switching to renewable fuels for its ocean freight, as it becomes the first OEM to switch all intercontinental container shipments to more sustainable fuels.

Sustainable aviation fuels ready for take-off in Australia
A homegrown sustainable aviation fuel (SAF) industry could help decarbonise the hard-to-abate aviation sector and create thousands of regional jobs with grants backed by the government.

Cepsa starts selling SAF at four major airports in Spain
Spanish multinational oil and gas company Cepsa has started selling Sustainable Aviation Fuel (SAF) at Madrid, Barcelona, Palma de Mallorca and Seville airports, becoming the first company to offer SAF on a permanent basis. The fuel is produced at the La Rábida Energy Park, from agricultural wate and used cooking oil.

Indonesia focuses to produce bioethanol using sugarcane and cassava
PT Pertamina, the world's biggest palm oil biodiesel based in Indonesia is slated to start bioethanol production using sugarcane and cassava as raw materials.

August

Uniper and Sasol ecoFT continue to develop SkyFuelH2 SAF
Uniper and Sasol ecoFT (a division of Sasol) will enter the next phase of the SkyFuelH2 project for production of sustainable aviation fuel (SAF) in Långsele, Sollefteå, Sweden. The plant is subject to a final investment decision in the future.

Portugal's environment agency greenlights Galp biodiesel, biojet plant
Portugal's environment regulator on Monday said it had approved a project by Portuguese oil company Galp to launch an industrial-scale plant to produce biodiesel and biojet fuel using cooking oils at its Sines refinery.

Hapag-Lloyd and DB Schenker sign biofuel agreement
Hapag-Lloyd offers emission-reduced shipping options and this agreement will allow customers to continue their freight journey on land.

IAG signs agreement with Microsoft for the large-scale global purchase of Sustainable Aviation Fuel (SAF)
International Airlines Group (IAG) and Microsoft have signed the largest co-funded purchase agreement for Sustainable Aviation Fuel (SAF) emissions reductions globally, where both parties are funding part of the cost of the supply.

EEL Biofuels harnesses algae as biofuel feedstock
EEL Biofuels has announced an advancement in renewable energy technology with the development of its revolutionary algae-based biofuels.

September

Korean Air launches SAF program for cargo customers
The flag carrier airline will allow customers to see more information about their environmental impact and contribute to more sustainable practices.

VARO announce plan to build major SAF manufacturing facility
VARO Energy has announced the construction of a large-scale sustainable aviation fuel (SAF) manufacturing facility at the Gunvor Energy Rotterdam site, investing US$600m with the aim of helping its airline customers decarbonise.

Aemetis Receives Key Permit for 90 million gallon per year Sustainable Aviation Fuel and Renewable Diesel Plant in California
The City Council in Riverbank, California unanimously approved a Use Permit to implement the City's long-term plan for "Green Businesses" to reuse the former Army plant; City action includes CEQA approval allowing other agencies to issue permits

United Airlines Purchases 1 Billion Gallons SAF
United Airlines and Cemvita have announced an offtake arrangement in which United has agreed to purchase up to 1 billion gallons of sustainable aviation fuel (SAF) from Cemvita's SAF plant. As a part of the agreement, Cemvita will provide 50 million gallons of its SAF product to United annually for 20 years.

Portugal's Galp to invest $426 mln in biofuels with Japan's Mitsui
Portuguese oil company Galp (GALP.LS) said on Monday it had teamed up with Japan's Mitsui (8031.T) to invest 400 million euros ($426 million) in an industrial-scale plant to produce biodiesel and biojet fuel from waste at its Sines refinery.

Korean Air launches SAF program for cargo customers

Upcoming meetings, conferences & webinars

2023 Wood Energy Conference
03 - 05 Oct, 2023 Fairbanks, Alaska, USA
The Alaska Wood Energy Development Task Group (AWEDTG) consists of a coalition of federal and state agencies and not-for-profit organizations to explore opportunities to increase the utilization of wood for energy and biofuels production in Alaska.

SARDINIA 2023 – 19th International Symposium on Waste Management, Resource Recovery and Sustainable Landfilling
09 - 13 Oct, 2023 Cagliari, Italy
Following the success of the previous edition, which saw the enthusiastic participation of 354 delegates from 46 countries, we are pleased to announce SARDINIA 2023 – 19th International Symposium on Waste Management and Sustainable Landfilling to be held in person from 9th to 13th October 2023 in the traditional venue of the Forte Village Resort in Santa Margherita di Pula, Italy.

USGC Global Ethanol Summit
16 - 18 Oct, 2023 Washington, USA
Organized by the U.S. Grains Council (USGC), the event will include international participants from more than 40 countries and increase global momentum for decarbonization through expanded ethanol use.

WS30: Bioenergy in a Net Zero Future
19 Oct, 2023 Lyon, France
This workshop, organised by IEA Bioenergy in collaboration with ADEME, aims to discuss the role of bioenergy in the transition to a carbon neutral energy system. In the morning sessions, the focus will be on policies and strategies to support the role of bioenergy in the energy transition. The afternoon sessions will consider the flexibility of bioenergy in the energy system, the use of biogenic CO2 and promising developments in bioenergy concepts.

USGC Global Ethanol Summit