Commercializing Conventional and Advanced Transport Biofuels from Biomass and Other Renewable Feedstocks

From the Task

By Mahmood Ebadian, Jim McMillan and Jack Saddler

Since publishing our last newsletter in June 2021, IEA Bioenergy Task 39 has continued its work to advance the commercialization of lower carbon intensity biofuels to decarbonize the transport sector (particularly long-distance transport segments where electrification is more challenging, i.e., marine, aviation, rail and trucking). This issue of the newsletter provides an update of Task 39's recent business meetings, publications and information dissemination activities. It also highlights recent reports and news articles of interest to biofuels stakeholders. **We are grateful to our Norwegian colleagues for authoring this newsletter's feature article on biofuels-related developments in Norway**.

Brainstorming sessions on the Task's Program of Work for the 2022-2024 Triennium

Task 39 organized two more virtual brainstorming meetings on August 10th and 25th, 2021, to discuss and refine the projects and dissemination activities Task 39 intends to tackle in the coming triennium that will span calendar years 2022-2024. These meetings focussed on both current projects running in the 2019-2021 triennium that will likely be continued in the next triennium as well as new projects to be considered for the next triennium, and also related information dissemination activities.

Based on Task members' suggestions and ideas provided in advance of and during these brainstorming sessions, the Task's proposed program of work for the next triennium will continue to cover **technology, policy, sustainability and commercialization issues related to transport biofuels**. Task 39 will continue assisting its member countries and other transport biofuels stakeholders in their efforts to develop and deploy sustainable, low carbon intensity transport biofuels. The Task will also continue to identify and facilitate opportunities for comparative technical and life cycle assessment and to monitor the various policies being used (with varying levels of effectiveness) to increase the production and use of biofuels to decarbonize transport.

The proposed program of work builds on Task 39's already established strong and active network of experts from industry, academia and government research institutions. The active participation of industry that has developed and expanded over the last decade will continue to be emphasized. The addition of countries such as India has demonstrated the multiple benefits of gaining enthusiastic new members. As evidenced by ongoing communications, there is increasing interest from additional countries who hope to join the IEA Bioenergy TCP and Task 39.

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Image Source: esf.edu.com

Image Source: Canola Council of Canada

We welcome feedback. Please direct comments to Mahmood Ebadian

The Task's proposed program of work was submitted to the IEA Bioenergy Executive Committee (ExCo) for review and comment(s) in late August and approved by the ExCo in October 2021. More information about the Task's proposed program of work and the priority projects for the 2022-2024 triennium will be provided in the next newsletter.

End of Triennium Business Meeting, 8-9 November 2021

Similar to recent meetings, the last Task 39 business meeting of 2021 (and last meeting of the 2019-2021 triennium) was held virtually. The main focus was to review the status of current triennium projects. This covered nine Task reports and one InterTask (with Task 40 and Task 45) report which included:

- Lessons learned success stories in biofuels (InterTask project with Task 40 and Task 45)
- Feedstock-to-biofuel(s) supply chain analysis for advanced biofuels focussing on CAPEX and OPEX cost reduction opportunities
- Biofuels for marine shipping: Issues affecting use of advanced biofuels in the marine sector
- Advanced biofuels demonstration facilities geographic database
- Identify sustainability certification scheme improvement opportunities
- LCA assessments - Key metrics beyond GHG reduction
- Biofuel's production and use status in "emerging" economies
- Progress in commercialisation of biojet fuels/SAF: Technologies, potential and challenges
- Recent progress in the production of low carbon intensive drop-in fuels – Stand-alone production and coprocessing
- Implementation agendas: 2020-2021 update (compare-and-contrast biofuels policies)

Short descriptions of these projects are provided in Task 39's newsletter#54. All of Task 39's completed reports and publications can be accessed via the Task 39's website.

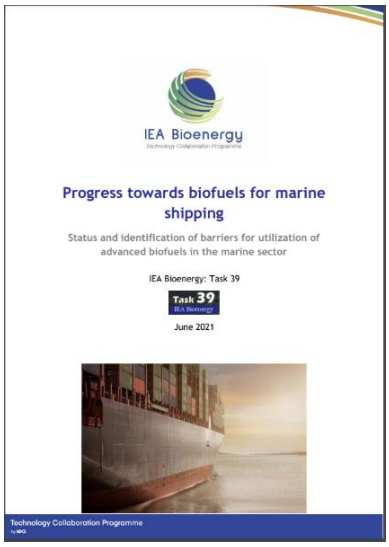
Recent publications, conferences, and information dissemination activities (June-December 2021)

Task 39's recently published commissioned reports and journal papers emphasize the important role of low carbon intensity biofuels as an immediate solution to decarbonize transport, especially the difficult to electrify long distance aviation and shipping sectors. Recent highlight publications and webinars include:

Peer-review manuscripts

- Challenges in determining the renewable content of the final fuels after co-processing biogenic feedstocks in the fluid catalytic cracker (FCC) of a commercial oil refinery (Su et al., 2021; Journal of Fuel, 294, 120526) (link)
- Determining the amount of "green" coke generated when co-processing lipids commercially by fluid catalytic cracking (FCC) (Su et al., 2021; accepted to be published in the journal of Biofuels, Bioproducts and Biorefining)
- Biofuels in Latin America: Sustainability Assessment of Argentinian, Brazilian, Colombian, and Guatemalan cases (Canabarro et al., 2021, submitted to the journal of Renewable and Sustainable Energy Reviews)

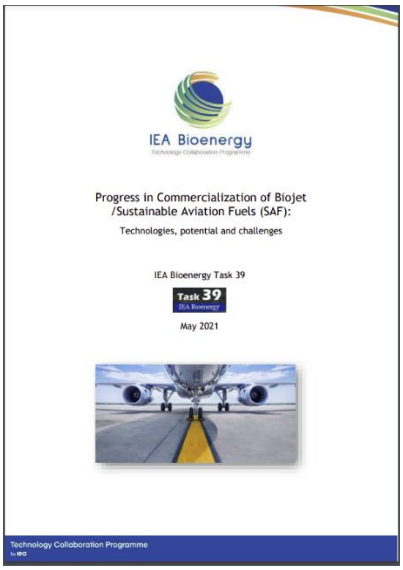
Commissioned report: Progress towards biofuels for marine shipping: Status and identification of barriers for utilization of advanced biofuels in the marine sector



The full report is available for download on Task 39's website

As a follow up to the 2017 IEA Bioenergy Task 39 report, "Biofuels for the marine shipping sector," this report highlights the most significant barriers impeding the commercialization of biofuels for the marine sector. Interviews conducted with seven key stakeholders involved in marine freight transport reveal the considerable complexity and many considerations related to transitioning the marine sector to renewable low carbon fuels. One major barrier is the lack of economic incentives for increased biofuel investment in the sector. Many stakeholders also consider major barriers to be the high level of uncertainty about the to price of biofuel feedstocks and the sustainability criteria that will be used in addition to possibly onerous regulatory policies. Interviewed stakeholders expressed relatively little concern about the technical barriers of scale-up, establishing supply chains, or adopting engine and fuel systems for new biofuels. In contrast, the uncertainty regarding enabling policies and techno-economic feasibility was a common concern. Encouragingly, a number of the stakeholders highlighted biofuels as a promising short- to mid-term solution for both reducing carbon emissions and meeting more stringent sulphur regulations. Also, with increasing international attention given to sulphur emissions and ship energy efficiency, the price gap between fossil- and biofuels is declining.

Commissioned report: Progress in commercialization of biojet/Sustainable Aviation Fuels (SAF): technologies, potential and challenges



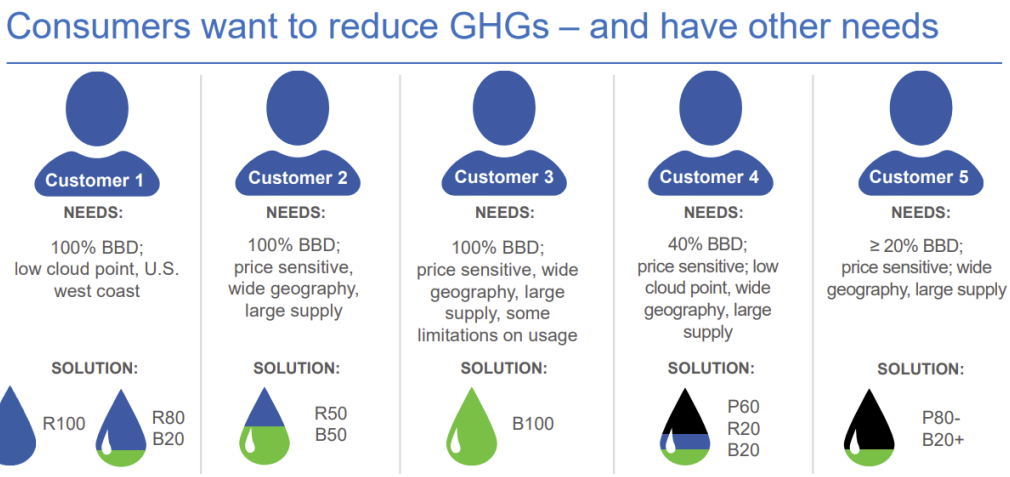
A copy of the full report can be downloaded from the IEA Bioenergy and Task 39 websites.

This report provides an extensive analysis of the current and potential technologies for production of biojet/SAF. The report also summarizes the various technologies that are currently being pursued to produce biojet/SAF, highlighting several commercial-scale facilities that are scheduled to come online over the next few years. As emphasized in the report, some of the biojet/SAF processes have encountered high capital and feedstock costs while others are dealing with technology challenges. The report recognizes that because the prices of biojet/SAF fuels are likely to remain significantly higher than conventional jet fuel, the "right" policies will be needed to bridge the price gap and incentivize the production and use of biojet fuels. The report posits that all of the technologies/pathways to biojet/SAF need to be pursued to deliver the significant fuel volumes required to decarbonize aviation. While ongoing improvements and optimization of the various processes will continue to reduce the cost of biojet/SAF production and use, meeting the sector's decarbonisation targets will be challenging.

The report authors presented the report's main findings in an IEA Bioenergy webinar on July 13, 2021. The recording of the webinar and the presentation slides can be accessed at the IEA Bioenergy website.

Webinar: BC-SMART/IEA Bioenergy Task 39 Virtual Panel Discussion: "Decarbonizing the trucking sector using low carbon-intensive fuels"

IEA Bioenergy Task 39 continues to actively organize and participate in virtual webinars and conferences with the goal of sharing the network's insights on how decarbonization of the transport sector can contribute to a "green economic recovery". On 22 November, 2021, Task 39 co-sponsored a free "virtual" panel discussion with the BC SMART Consortium on decarbonizing the trucking sector. The invited panel members represented key groups that will be needed to decarbonize the long-distance trucking sector (i.e., low carbon fuels suppliers, end users, LCA and policy development advisors). They shared their insights and experience in various potential pathways that will be needed to decarbonize the trucking sector with the focus on the low carbon intensive drop-in biofuels. The main takeaway message of the webinar was that immediate decarbonization actions are needed to minimize the compounding impact of GHG emissions accumulation in the atmosphere as a result of using fossil fuels in the trucking sector and biofuels such as biodiesel and renewable diesel are readily deployable low carbon solutions to decarbonising the trucking sector. About 100 participants attended the webinar, mainly from North America, South America and Europe. The list of panel members and their short bios as well as the presentation slides and a recording of the panel discussion are available on the Task 39's website (here).



As discussed in the panel discussion, biofuels producers such as Renewable Energy Group (REG) have been developing various biofuels blending approaches to meet the needs of their customers in the trucking sectors (Source: REG, 2021).

Conference: Task 39 sessions on Transport Biofuels in IEA Bioenergy's End of Triennium Conference 2021

Task 39 organized and held two virtual conference sessions focused on transport biofuels on 1 December 2021 within the IEA Bioenergy's End of Triennium Conference which featured a series of online sessions spread over two weeks between 29 November and 9 December 2021. The central theme of the conference was "the role of biomass in the transition towards a carbon neutral society". Short descriptions of the Task 39 organized sessions and their speakers are available via the following hyperlinks.

Session 1: Emerging biofuels markets and the importance of LCA and certification
Session 2: The potential of drop-in biofuels to decarbonise aviation

As always, we appreciate your readership and value your input and feedback. Please email us your ideas or suggestions on how we can increase the newsletter's value. Thank you for reading and participating in the IEA Bioenergy Task 39 network!

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Biofuels Policies and Market in Norway

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Summary

- Driven by its national climate policy, Norway introduced biofuels blend-in mandates for road transport in 2009. The blend-in rates started low and increased year by year. The blending mandate for biodiesel is 24.5% in 2021 and aims for 40% in 2030. The blending obligation for bioethanol in gasoline has been 4% since 2017.
- Mandatory blend-in of 0.5% biofuel in jet fuel started in 2018 (first worldwide).
- The National Climate Plan 2021-2030, approved by the Norwegian Parliament April 14, 2021, prolongs the blend-in mandate as the primary tool for biofuels until 2030. The mandate will be expanded to include the construction industry and shipping.
- The suppliers of biofuels in road transportation have only one financial incentive: no carbon tax.
- There is a growing commercial interest in utilizing forest residues as feedstock for biofuels. Two plants are in progress for pilot stage.
- The sustainability of biofuels has to be documented. When using Norwegian forest biomass as feedstock, at least 30% of the residues must be left in the forest.
- There are public grants available for developing biofuel supply chains and production plants.
- Norway currently has 40 operating biogas plants for processing municipal, food and industrial organic waste. Of these, 10 plants produce biogas for transportation.
- The world's largest liquefied biogas plant, Biokraft, is located in Norway and processes fish farming and paper mill wastes.

1. Introduction

Norway is a large fossil fuel producer and exporter. The country is also a relatively large producer of renewable electricity (mainly hydro, but in recent years also wind power). Biomass has mainly been used for heating. Table 1 shows the primary energy supply in Norway in 2019.

Norway's total GHG emissions have been relatively stable since 1990, about 50 million tonnes CO_2 equivalents per year. The primary emission sources are oil and gas extraction, industry, road traffic and other transport. About 31% of the national GHG emissions originates from transport.

Table 1. Norwegian primary energy supply in 2019 (TWh) (Source: Statistics Norway (SSB), 2019)

Feedstock	Coal	Gas	Oil	El (Hydro)	Bio *	Waste *	Total
Production	1	1,174	946	132	13	5	2271
Import	9	-	105	12	6	-	132
Export	1	1,111	957	12	1	-	2082
Bunker	-	-	15	-	-	-	15
Net energy supply	9	63	96	132	18	5	323**

*Mostly heat **Thereof energy for onshore transportation 51 TWh

Emissions from road traffic have increased by 5% since 1990. This is mainly because of growth in the volume of freight transport and an accompanying rise in emissions from vans and heavy vehicles. Despite large increases in total distance driven, emissions from passenger cars have been relatively stable. This is explained by improvements in efficiency and thus reduction in fuel consumption, and a rise in the proportion of diesel vehicles. After 2015, these emissions decline due to increased use and proportion of electric vehicles.

In 2019, the emissions from road traffic were 8.6 million tonnes CO_2 equivalents, 16% lower than in 2015. The emissions in 2019 would have been 10.3 million tonnes CO_2 if only fossil fuels had been used. Figure 1 shows how biofuels and electricity have contributed to reduce GHG emissions. Biofuels contributed to the reduced emission of CO_2 by 1.5 million tonnes. Battery Electric Vehicle (BEV) and hybrid cars contributed to the CO_2 emissions reduction by 0.6 million tonnes. The CO_2-reduction achieved, based on LCA analyses, by the biofuels blended into diesel and gasoline consumed in road transport was 73% in 2019. This reduction in GHG emissions from road traffic heavily depends on imported biofuels as domestic production is small.

Total emissions from other transport sectors rose by 25% from 1990 to 2019 (30 years). There is considerable year to year variation in emissions from these sectors. In recent years, emissions from shipping and fishing vessels have declined, while emissions from non-road mobile machinery have risen. From 2018 to 2019, there was a decline in GHG-emissions from shipping, fishing vessels, aviation, and non-road mobile machinery. This reduction is mainly due to electrification of ferries.

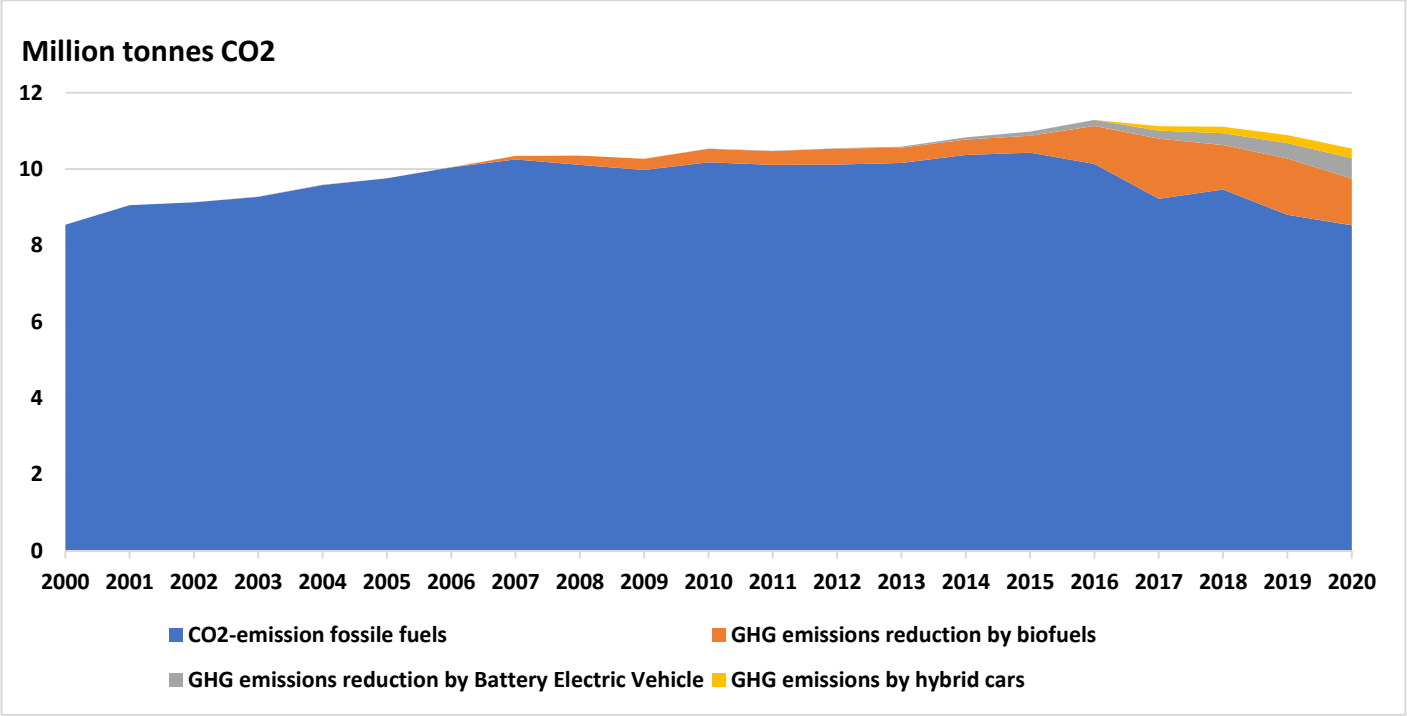
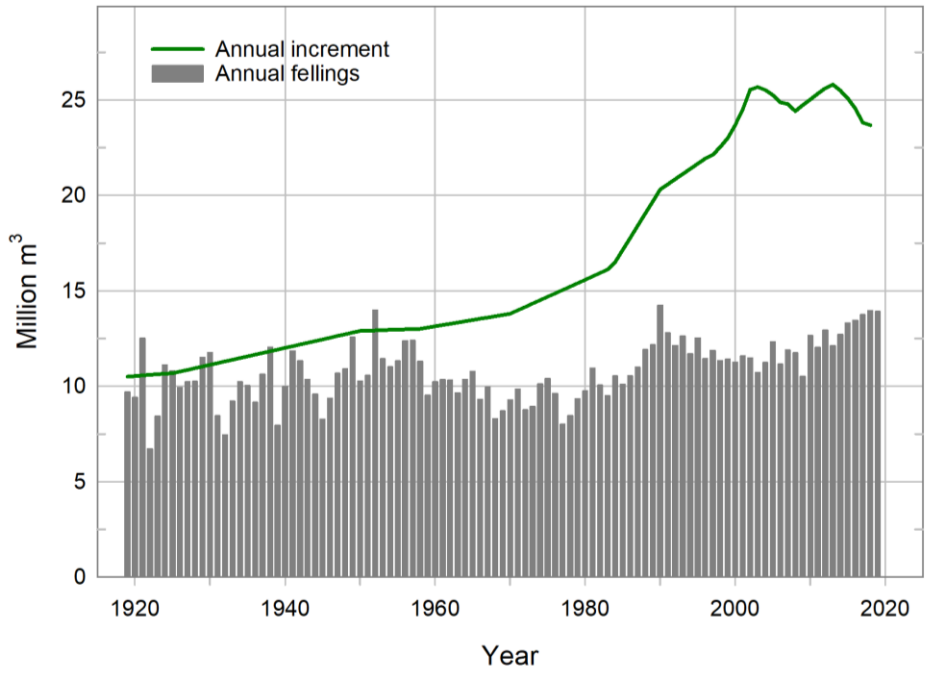


Figure 1. GHG-emissions from road traffic, million tonnes CO_2 equivalents (Drivkraft Norge)

2. Main drivers for biofuels policy in Norway

The main driver for Norway's national biofuel policy is the ambition to reduce GHG emissions. Energy security is not a driver, as the country is a large energy exporter of fossil fuels and also some hydropower. There are two drivers for developing national forest-based biofuel production: 1) increase the utilization of large forest and organic waste resources; and 2) reduce export of low-quality forest biomass.

Norway has relatively large forest resources. The standing volume of woody biomass is increasing year by year, see Figure 2. High-quality woody biomass is used to produce construction materials and the lower-quality biomass is used for other applications, such as for chemicals and paper production (moderate volumes). The lower-quality biomass represents a large feedstock resource for new biodiesel production. In 2020, only minor volumes of bioethanol were produced from Norwegian forest biomass. Almost all (98%) of the biofuels used in Norway were imported.



Source: Norwegian Institute of Bioeconomy Research & Statistics Norway

Figure 2. Norwegian forest growth and harvest

Another driver for biofuel policy development is the mandatory blending of biofuels into fossil fuels, which creates a large market for biofuels. This benefits from public regulations for handling biowaste in sustainable ways in combination with increasing interest in public and private sectors to convert low-quality woody biomass feedstocks to biofuels.

There are currently 40 operating biogas production plants in Norway, processing a variety of food wastes, other organic wastes, and sewage sludges. 1/4 of these plants produce compressed or liquid biogas for buses and trucks. Public waste regulations provide a strong driver and the number of biogas plants is increasing. The two largest biogas-to-fuel plants in Norway are producing biogas from respectively food waste mixed with livestock manure, and paper industry residues mixed with fish farming residues. In addition, several medium-sized plants produce biogas from sewage sludge and food waste. The drivers are public regulation for handling organic wastes and a push for producing fuel.

3. Biofuels policy development in Norway

The main highlights in the historical development of biofuels policy in Norway 2000-2021 include:

- 2000: Pre-2000: Tax-exception from CO2-tax on biofuels
- 2009: Introduction of sales mandate for biofuels in road transport
- 2016; Oslo: Basic platform for Climate Strategy 2030
- 2017: Initiation of national research project FME Bio4Fuels
- 2019: Oslo elected as European Environmental Capital
- 2020: Introduction of sales mandate for biofuels in aviation
- 2021: New governmental Climate Plan 2021-2030 (approved April 14, 2021)

The National Climate Plan 2021-2030 (see Figure 3), approved by the Norwegian Parliament April 14, 2021, prolongs the blend-in mandate as the primary tool for biofuels until 2030. The Climate Plan constitutes a platform for the annual national budgets over the coming ten years, predicated on continuing to replace fossil fuels with biofuels. The biofuel volume mandate for road traffic will be the same or higher than the 2021-volume in absolute volume (not in percentage). This ensures that the biofuel market remains at least at the 2021 volume or grows to higher volumes, even if the number of battery electric vehicles increases sharply.

The government will:

- Introduce a biodiesel mandate for the construction-market, starting in 2022. The blend-in rate will gradually increase to the same level as for road traffic in 2030.
- Introduce a biofuel mandate for shipping from 2022, details not yet decided.
- Evaluate the existing blend-in mandate for aviation and gradually increase the bio-part

In total, the plan states that the national biofuel market will be stable over the coming decade. The challenge will be to increase national production of advanced biofuels with high CO_2-reduction impact.

Figure 3. The Norwegian Climate Plan 2021-2030

3.1. Biofuel obligations (2009-2021)

Replacing fossil fuels by biofuels has been a national focus in Norway for over a decade:

- 2000: Exception from CO_2-tax on biofuels
- 2009: Introduction of sales mandate for biofuels in road transport
- 2020: Introduction of sales mandate for biojet fuel in aviation
- 2021: The government approves the Climate Plan 2021-2030

The only relevant biofuel policy is the blend-in-regulation given in the sales mandate defined in the Norwegian product regulation. Norway has no regulation for biofuels production. The new National climate plan prolongs and expands the blend-in mandate as the primary tool for supporting biofuels. The biofuel suppliers are obliged to report the origin (country) of the feedstock used for producing their biofuels, and the climate impact must be documented by a third party using standardized methods.

Mandates for biodiesel use started in 2009. The initial blending obligation was at 2.5%, which has gradually increased to 24.5% in 2021. The blending obligation for ethanol in gasoline has been 4% since 2017. A sales mandate for 0.5% advanced biofuels in aviation was introduced in 2020. Advanced biofuels blending started in 2017 at 0.9%, increasing to 9% for 2021.

In addition to the blending mandates, public procurements provide a substantial market for biofuels in both mass transit buses and non-road machinery (construction sites, etc).

The EU's Renewable Energy Directive and sustainability criteria are implemented in Norwegian regulations and require biofuels to achieve at least 50 % GHG reduction (in life cycle emissions) compared to fossil fuels to be eligible for use in the mandate. Norway has also implemented the EU's Fuel Quality Directive, which requires fuel suppliers to lower GHG emissions of all gasoline and diesel used for road and non-road uses by 6% in 2020.

The EU commission approves sustainability certification schemes used for certifying biofuels, and these certification schemes are also approved in Norway. The list of these schemes is available at: https://ec.europa.eu/energy/topics/renewable-energy/biofuels/voluntary-schemes_en

The non-compliance cost for obligated parties who do not meet their biofuels blending mandate obligations is in the form of fines (not pre-determined but set on a case-by-case basis) or reporting to the police.

4. Fiscal incentives

There is only one economic incentive for biofuels: no CO_2 tax. Road tax is the same for biofuels and fossil fuels, relative to their energy content. The total tax for biodiesel is about 30% lower than for fossil diesel, and about 60% lower for bioethanol compared to gasoline (see Table 2).

Table 2. Fiscal incentives for biofuels

Fuel	Unit	Road-tax	CO_2-tax	Total tax
Gasoline	NOK/liter	5.01	1.37	6.38
Diesel	NOK/liter	3.58	1.58	5.16
Bioethanol	NOK/liter	2.45	0	2.45
Biodiesel	NOK/liter	3.66	0	3.66
Natural gas	NOK/Sm^3	1.82	1.17	2.99
LPG	NOK/kg	4.27	1.77	6.04

5. Biofuels production in Norway

The production of biodiesel and bioethanol in Norway is quite limited compared to Sweden and Finland, but the commercial interest for domestic biofuel production is growing. However, biogas production from several organic wastes is significant and growing. Without a mandate, 40 biogas plants with a total production capacity of about 800 GWh annually, are in operation. The feedstocks are food waste, sewage sludge and industrial organics wastes.

The annual biofuel production is about 90 million L **biodiesel** (FAME), 20 million L wood-based **bioethanol** and about 470 GWh **biogas** transportation fuel. Production levels are increasing year by year, especially for biogas. In addition, two wood-based biodiesel plants with a total capacity of 720 ML forest-based **biodiesel** are planned. Figure 4 shows the location of biofuel plants in Norway.

Table 3 shows the current advanced biofuels production capacity in Norway. The label 'advanced biofuel' used in the blend-in regulation is linked to the feedstock. Feedstock that can be used for food production cannot be used for producing advanced biofuels. For example, HVO can be classified as conventional or advanced, depending on the feedstock type.

Table 3. Advanced biofuel production in Norway 2020

Company name and location	Status	Biofuel	Technology and feedstock	Production capacity (ML/year or GWh/year)
Biofuel producers				
Borregaard Sarpsborg	Operational	Bioethanol	Biorefinery, wood-based ethanol	20 ML ethanol
Adesso Bioprod. Fredrikstad	Operational	Biodiesel	Biorefinery, vegetable biodiesel	90 ML biodiesel
Silva Green Fuel Tofte	Pilot 2021	Biodiesel	HTL-Thermochem., forest residues	600 ML biodiesel
Biozin Åmli	Planned	Biodiesel	IH2-Thermochem., forest residues	120 ML biodiesel
Refinery				
Equinor Mongstad	Successful testing	Fossil + Bio	Catalytic cracker, co-feed vegetable oil	
Biogas for fuel producers Total 40 plants. Thereof 10 upgrading to transport biofuels			**Feedstock**	**Production** ca. 470 GWh/y
Biokraft Skogn	Operational	Liquid methane	Paper mill waste & fish farming waste	120 GWh/y Truck fuel
Greve Biogas Tønsberg	Operational	Compressed methane	Food waste & livestock manure	90 GWh/y Bus-fuel
VEAS Oslo	Operational	Compressed methane	Sewage sludge	85 GWh/y Bus-fuel

Table 3. Advanced biofuel production in Norway 2020 (continued)

Company name and location	Status	Biofuel	Technology and feedstock	Production capacity (ML/year or GWh/year)
Romerike Biogas Oslo	Operational	Liquid methane	Food waste	45 GWh/y Bus-fuel
Bekkelaget Biogas Oslo	Operational	Compressed methane	Sewage sludge	25 GWh/y Bus-fuel
IVAR Biogas Stavanger	Operational	Compressed methane	Sewage sludge	30 GWh/y Transport-fuel
Ecopro Verdal	Operational	Compressed methane	Food waste & sewage sludge	30 GWh/y Transport-fuel
Frevar Fredrikstad	Operational	Compressed methane	Food waste & sewage sludge	23 GWh/y Bus-/truck fuel
Bergen Biogass Bergen	Operational	Compressed methane	Sewage sludge	15 GWh/y Bus fuel
Lindum Drammen	Operational	Compressed methane	Sewage sludge	9 GWh/y Bus-/truck fuel

Figure 4. Location of biofuel plants in Norway 2021 (Biogas: largest plants only)

The major advanced biofuels plants are briefly discussed below.

Biokraft (biogas, in operation)

Biokraft is the largest biogas plant worldwide to produce liquid biogas (LBG) sold as fuel for heavy trucks and buses. Also fuel for ships is an option for increasing the fuel market. The plant neighbours the Norske Skog paper mill in Trøndelag. Residues from the forest-based paper production provides one of the feedstocks. Residues from fish farming plants make the other part. The plant has been in full-scale operation since 2018.

Figure 5. Biokraft biogas plant in Trøndelag, neighbour to Norske Skog papermill

Silva Green Fuel (biodiesel, demoplant in operation)

The Norwegian energy company Statkraft and the Swedish company Sødra Cell established in 2015 the company Silva Green Fuel to develop large-scale forest-based biofuel production plants in both countries. The processing technology is a new Hydrothermal Liquefaction (HTL) technology developed by the Danish company Steeper Energy. The technology involves supercritical conversion of biomass at high pressure and temperature. After several lab-tests, a long construction period, and testing on-site, the demonstration plant at Tofte was handed over to Silva Green Fuel in October 2021 and an operational crew has been on-site since summer 2021.

The test plant's operation will provide the basis for designing and building a full-scale plant with an annual capacity of 600 ML crude biodiesel. The full-scale plant will be located at Tofte at a site that includes a harbour with access to Oslofjorden. Forest residues from large forests in southern Norway will supply the feedstock. The intention is to ultimately build several such plants in the Nordic countries.

Figure 6. Planned Silva Green Fuel biodiesel plant at Tofte, close to Oslofjorden (Illustration: Silva Green Fuel)

Biozin (biodiesel, several decentralised plants, technology evaluation)

The company Biozin, established in 2017 by Bergene Holm, is the second largest saw-mill operator in Norway. Biozin will produce biocrude oil in 5 plants in southern Norway located near forest and sawmills. The biocrude oil will be sold to Preem refinery in Sweden for upgrading to advanced biofuel. The planned capacity per plant is 120 ML/year crude biodiesel from forest and sawmill by-products.

The location near the feedstock will reduce transportation cost and enable smaller and cheaper biocrude production plants. A concept study shows 90% reduced carbon footprint compared to fossil fuel. The first plant will be in Åmli.

This biofuel plant will use the same feedstock supply chain as the sawmill for harvesting and transporting forest residues and non-commercial forest biomass. The facility will be one of the first of its kind world-wide, based on the Shell-owned IH2 thermochemical processing technology. However, as of 2021 there are still unresolved processing technology challenges, and the pre-engineering study is not yet completed.

Figure 7. Bergene Holm sawmill in Åmli, the site for the first Biozin biocrude plant to be built. (Photo: Bergene Holm)

Equinor: Co-processing biomass in oil refinery, in operation

The Norwegian energy company Equinor operates a large oil refinery at Mongstad in Norway where co-feeding of vegetable oils in a catalytic cracker is on-going. The ambition is to increase the amount of biomass feedstocks compliant with the revised EU RED II (revised Renewable Energy Directive), resulting in an increased share of advanced biofuels in the final co-processed product.

Figure 8. Equinor refinery at Mongstad, Norway. (Photo: Equinor)

6. Research & Development (Research Council of Norway, RCN)

Bio4Fuels is an 8-year R&D-project within the RCN-program 'Environmental-friendly energy' being carried out over the period 2017-2024. It involves all relevant research-institutions (Figure 9) and many industries in Norway, as well as some in Sweden, Finland, Netherlands, and the UK. The scope of Bio4Fuels R&D includes the main elements of biomass feedstocks, thermochemical and biochemical processing, process design and end use (Figure 10). Values chains are essential and industry is heavily involved. The feedstocks are forest biomass and organic wastes.

Figure 9. Norwegian Research Centers for Environmentally Friendly Energy

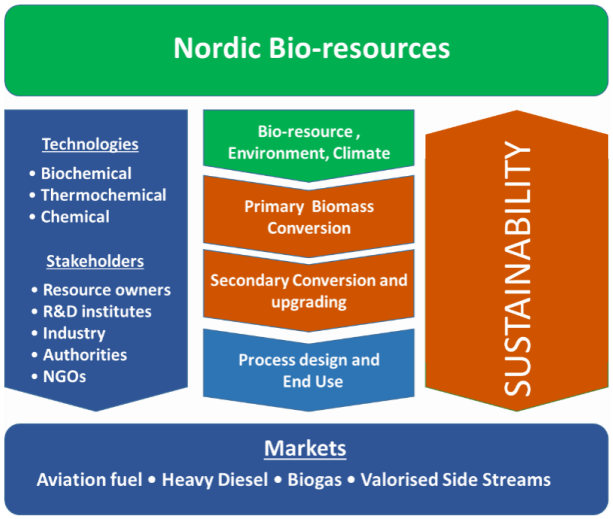


Figure 10. Structure of the centre-project Bio4Fuels on Sustainable Biofuels

7. Summary

Norway's national climate policy is clear about the need to cut GHG emissions from road traffic and the transport sector more broadly. Blend-in mandates with increasing biofuel blending rates for road transport reduced national GHG emissions by about 15% in 2019. In April 2021, the Norwegian Parliament approved a new 10-year Climate Plan that among other elements expands markets for biofuels. Biodiesel blend-in rates will increase from 2021's 24.5% to 40% in 2030.

The National production of biogas for road transport has doubled over the last few years, and new plants are being planned. Two large forest-based biofuel producing plants introducing new biomass processing technologies are in progress, one at pilot stage and one at technology concept stage. In addition, the Norwegian fossil oil company Equinor is building competence on coprocessing biocrudes with fossil crudes.

Sources

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In the News

Reports and Research

- December - IEA Bioenergy released its updated Country Reports, showing the trends in bioenergy within IEA Bioenergy member countries up to 2019, looking at the role of bioenergy in total energy supply (TES), in electricity use, total fuel/heat consumption, and in transport energy consumption. Individual country reports are available as separate reports (Click here). The summary report 'IEA Bioenergy Countries' Report – update 2021: Implementation of bioenergy in the IEA Bioenergy member countries' presents a comparative overview of the results for the different countries (Click here).

- December - The International Energy Agency (IEA) published the 'Renewable Energy Market Report 2021: Analysis and forecasts to 2026'. In addition to regional and country level forecasts for renewable electricity and for biofuels for transport and heat, this year's edition includes a chapter on renewable energy trends to watch, including: "What is the impact of increasing commodity prices on solar PV, wind and biofuels?"; "How much will renewable energy benefit from global stimulus packages?"; "Could the green hydrogen boom lead to additional renewable capacity by 2026?"; "How rapidly will the global electricity storage market grow by 2026?"; "Are conditions right for biojet fuel to take flight over the next five years?"; and "Are renewable heating options cost-competitive with fossil fuels in the residential sector?" The full report is available for download (here).

- December - The International Energy Agency (IEA) released a report comparing different pathways for carbon capture, use and storage (CCUS). The report shows almost all CCU routes have potential for lowering life cycle emissions per tonne of product compared to their counterfactual. The potential scale for deployment was much greater for fuels and building materials than for chemicals and polymers, which typically had existing markets orders of magnitude smaller (Read more).

- October - In the UK, a new study by Imperial College London Consultants concludes that the potential availability of sustainable biomass, with no harm to biodiversity, could support an advanced and waste-based biofuel production of up to 175 Mtoe in 2050 (Read more).

- September - The U.S. Department of Energy (DOE) announced more than $64 million in funding for 22 projects focused on developing technologies and processes that produce low-cost, low-carbon biofuels. Biofuels made from renewable resources can power heavy-duty vehicles that are difficult to electrify with current technologies — including airplanes and ships — to help accelerate America's transition to a net-zero emissions economy by 2050 (Read more).

Policy and Regulatory Developments

- November - The U.S. House of Representatives on Nov. 19 voted 220 to 213 to approve the Build Back Better Act, a $1.9 trillion legislative package that includes nearly $1 billion for biofuels infrastructure, extends the biodiesel tax credit, and includes incentives for sustainable aviation fuel (SAF) (Read more).

- November - In Ireland, the Minister for Transport announced the publication of the Renewable Fuels for Transport Policy Statement with the next increase in the rate of supply of biofuels blended in diesel and petrol to take effect from 1 January 2022 (Read more).

- October - According to USDA Foreign Agriculture Service analysis, China has effectively dropped its E10 blending mandate and will only achieve 2.1% in 2021. The country announced in 2017 it would achieve 10% by 2020 with the market expecting much of that volume to come from US imports until the country's domestic production caught up. Only about half a billion liters were exported to China during the first 11 months of 2020/21 while it is expected to produce 3.4 billion liters in 2021 (Read more).

- July - Industry officials say Argentine soy oil exports will likely rise, driving down prices internationally, due to a new law cutting the amount of soy oil-based biodiesel blended into common diesel fuel sold domestically. Lawmakers in Argentina, the world's No. 1 soy oil exporter, last week approved a measure allowing a reduction in the amount of soy-based biofuel to be mixed into domestically-consumed diesel (Read more).
- July - The European Commission's new 'Fit for 55' package sets important new goals for emissions reduction and creates a solid foundation for reaching them by giving renewable liquid fuels a role in decarbonising transport. Unleashing the true potential of crop-based ethanol and creating a policy environment that can spark investment in advanced ethanol are must-have components of any realistic roadmap to carbon-neutrality (Read more).
- July - In Brazil, contrary to expectations of 13%, the government has boosted the biodiesel blending mandate to 12% from the temporary cut to 10% forced by skyrocketing prices earlier this year. High soybean prices globally forced the ANP fuels agency to halt its regular biodiesel auction in late June. The oilseeds industry association Abiove said the industry could produce enough biodiesel for a 13% mandate but was sufficiently satisfied with the increase to 12% that will allow plants to boost crushing again (Read more). However, in November 2021, the National Energy Policy Council (CNPE) confirmed that the blending mandate won't return to the previous blending mandate of 13% biodiesel and will keep it at 10% throughout 2022. The CNPE first cut the blending mandate in September due to high soy prices, but the cut was meant to be temporary as the national policy increases the mandate by 1% annually until reaching 15%. High palm oil prices have slowed down the implementation of higher biodiesel blending mandates in Asia as well as prices for vegetable oils remain strong globally (Read more).

Industry Developments

- December - In Illinois, United Airlines operated an unprecedented flight that will serve as a turning point in the industry's effort to combat climate change: for the first time in aviation history, a commercial carrier will fly an aircraft full of passengers using 100% sustainable aviation fuel (SAF). United also announced the second round of corporate participants in the airline's Eco-Skies Alliance program to collectively contribute towards the purchase of SAF (Read more).

- December - In the UK, having been fully utilized this year working for Ørsted and James Fisher Marine Services supporting offshore wind farms on the UK's west coast, Tidal Transit's Kitty Petra crew transfer vessel (CTV) was recently mobilized from Barrow-in-Furness to Grimsby for scheduled winter maintenance. As part of its program of activities working towards carbon neutrality, Tidal Transit chose this long journey to fully test their MAN V12 diesel engines capability to operate on 100% renewable diesel (HVO100) (Read more).

- December - In Belgium, Brussels Airport's Stargate project, which has received a grant within the European Green deal, has been officially launched. In the next five years, Brussels Airport will be working with a consortium of 21 partners on some 30 concrete projects to make aviation and airports greener and more sustainable. Stargate includes building a biofuel blending installation at the airport, electric ground handling material and testing a new innovation that will make engine test runs much quieter (Read more).

- November - In Canada, Canadian National Railway Company (CN) and Progress Rail, a Caterpillar Company, are partnering with Renewable Energy Group (REG) to test high-level renewable fuel blends including both biodiesel and renewable diesel in support of the companies' sustainability goals. Trials and qualifications of up to 100% bio-based diesel fuel are important steps in reducing GHG emissions from CN's existing locomotive fleet while alternative propulsion locomotive technologies are being developed (Read more).

- November - In India, the Cabinet Committee on Economic Affairs agreed to increase the price of ethanol from sugarcane juice by almost 20 cents per liter to 85 cents starting in December when the new ethanol marketing season

kicks off, which is different from the sugarcane marketing year that began in October. The hope is that higher prices will encourage further production that will in turn help to achieve 20% blending by 2025. Prices for ethanol from B-Heavy molasses and C-Heavy molasses were also increased (Read more).

- October - In Illinois, ADM and Gevo, Inc. signed a memorandum of understanding (MoU) to support the production of sustainable aviation fuel (SAF) and other low carbon-footprint hydrocarbon fuels. The MoU contemplates the production of both ethanol and isobutanol that would then be transformed into renewable low carbon-footprint hydrocarbons, including SAF, using Gevo's processing technology and capabilities (Read more).

- October - In Arizona, Rolls-Royce, working with Boeing and World Energy, has carried out a successful test flight of its 747 Flying Testbed aircraft using 100% Sustainable Aviation Fuel (SAF) on a Trent 1000 engine. The aircraft flew from Tucson airport in Arizona, passing over New Mexico and Texas, with a Trent 1000 engine running solely on 100% SAF while the remaining three RB211 engines ran on standard jet fuel, arriving back at the airport three hours and 54 minutes later. Initial indications confirm there were no engineering issues, providing further proof of the fuel's suitability for commercial use (Read more).

- October - In Washington state, BP announced plans for a $45 million investment that will more than double the Cherry Point refinery's renewable diesel production capability to an estimated 2.6 million barrels a year. Renewable diesel is manufactured from biomass-based feedstocks, such as vegetable oils and rendered animal fats. The increased production capability from the Renewable Diesel Optimization project is expected to reduce the CO2 emissions resulting from the diesel produced by Cherry Point by approximately 400,000 – 600,000 tons per year (Read more).

- September - In Sweden, jointly owned by Setra and Preem, Pyrocell was formed in 2018 based on the business concept of producing bio-oil from sawdust. Production at the ground-breaking plant – Sweden's first pyrolysis oil plant for biofuels – is now underway. Pyrocell's plant is located at the Setra Kastet sawmill in Gävle on Sweden's Baltic coast. It converts sawdust, a residual product in Setra's industrial process, into non-fossil pyrolysis oil. The pyrolysis oil is then processed further to make renewable diesel and petrol at Preem's refinery in Lysekil (Read more).

- September - Royal Dutch Shell plc (Shell) announced a final investment decision to build an 820,000-tonnes-a-year biofuels facility at the Shell Energy and Chemicals Park Rotterdam, the Netherlands, formerly known as the Pernis refinery. Once built, the facility will be among the biggest in Europe to produce sustainable aviation fuel (SAF) and renewable diesel made from waste (Read more).

- September - In Illinois, Honeywell announced the completion of a commercial refinery trial with Preem AB for co-processing of biomass-based pyrolysis oil in a fluidized catalytic cracking (FCC) unit. Utilizing UOP's proprietary bioliquid feed system with Optimix™ GF Feed Distributor, pyrolysis oil was successfully co-processed in the FCC at Preem's Lysekil refinery to produce partially renewable transportation fuel (Read more).

- September - In Louisiana, Kinder Morgan, Inc. is partnering with Neste to create a premier domestic raw material storage and logistics hub in the United States, supporting increased production of renewable diesel, sustainable aviation fuel and renewable feedstock for polymers and chemicals. Upon completion of the project, Kinder Morgan's Harvey, Louisiana facility will serve as the primary hub where Neste will store a variety of raw materials including, for example, the used cooking oil it collects from more than 40,000 restaurants across the United States (Read more).

- September - Neste has agreed to acquire 100% of Agri Trading, one of the largest independent renewable waste and residue fat and oil traders in the United States, and its affiliate entities. The transaction is subject to the completion of customary closing conditions and regulatory approval (Read more).

- September - Chevron aims to invest $600 million in two soybean crushing facilities owned by US agricultural commodities trader Bunge. The investment will result in a 50/50 joint venture, under the memorandum of understanding. US refiners have been ramping up their production of renewable fuels and are seeking to secure guaranteed access to vegetable oils, animal fats and used cooking oils, which some refiners say are already difficult to source (Read more).

- August - Marathon Petroleum Corp. announced progress with its renewable diesel projects during its second quarter earnings call. The company's renewable diesel facility in North Dakota has reached full capacity and conversion work is ongoing at its refinery in Martinez, California (Read more).

- August - In Ohio, Marathon Petroleum Corp. and ADM are forming a joint venture for the production of soybean oil to supply rapidly growing demand for renewable diesel fuel. The Spiritwood complex is expected to produce approximately 600 million pounds of refined soybean oil annually, enough feedstock for approximately 75 million gallons of renewable diesel per year (Read more).

- August - In Spain, Repsol has successfully completed the manufacture of the first batch of biojet produced from waste on the Spanish market at its Petronor Industrial Complex in Bilbao. This is a significant milestone in the production of fuels with a low carbon footprint. It represents a move forward in the decarbonization of fuels for air transport, a segment where electrification is not currently viable (Read more).

- August - In Indonesia, high palm oil prices are forcing the country to push back its B40 ambitions. Originally set for roll out in July from the current 30% blending level, the program has been delayed indefinitely but a senior energy ministry official did indicate it would be difficult to reach B40 in 2022. On August 12, Malaysian palm oil futures reached a record high of $1,089.35 and although they have fallen since then, they're still about 60% higher than last year (Read more).

- July - In Canada, Tidewater Midstream and Infrastructure Ltd. announced the creation of Tidewater Renewables Ltd. as a wholly owned subsidiary. Tidewater Renewables has been formed to become a multi-faceted, energy transition company focusing on the production of low carbon fuels. The creation of and the initial public offering of Tidewater Renewables is a result of a thorough evaluation of financing alternatives with the goal of funding Tidewater Renewables' portfolio of clean fuel projects while allowing Tidewater Midstream to continue to deleverage through 2021 (Read more).

- July - In Washington state, Boeing, SkyNRG and SkyNRG Americas announced a partnership focused on scaling the availability and use of sustainable aviation fuels (SAF) globally. Boeing will also invest in SkyNRG Americas' SAF production project, for which Alaska Airlines is a previously announced partner. Boeing, SkyNRG and SkyNRG Americas will work together to accelerate SAF development globally, focusing on scaling production capacity, building awareness and engaging stakeholders throughout the value chain, including airlines, governments and environmental organizations (Read more).

- July - Fulcrum BioEnergy Inc. announced that it has completed construction on the world's first commercial-scale plant converting household garbage into low-cost, zero-carbon transportation fuels. Through Fulcrum's revolutionary process, the Sierra BioFuels Plant located east of Reno, Nevada, will convert 175,000 tons of prepared municipal solid waste (MSW) into approximately 11 million gallons of zero-carbon syncrude annually, which will then be upgraded to transportation fuels such as sustainable aviation fuel, renewable diesel and renewable gasoline (Read more).

- July- Air bp, the international aviation fuel products and service supplier, announced its first sale of ISCC PLUS certified sustainable aviation fuel (SAF) in Spain, one of the largest global aviation markets. Air bp's key business aviation customer, NetJets Europe, became the first to purchase the fuel starting from the beginning of July (Read more).

Upcoming Meetings, Conferences & Webinars

Note: Due to ongoing coronavirus pandemic-related restrictions on travel and physical meetings, the dates of conferences and meetings may change. Please check websites for the latest status of these conferences and meetings.

January 2022

- International Conference on Advances in Biofuels Production, January 07-08, 2022, Singapore, Singapore
- International Conference on Advances in Biofuels and Biofuels Production, January 14-15, 2022, Zurich, Switzerland
- International Conference on Biorefineries and Biofuels Applications, January 14-15, 2022, Rome, Italy
- National Biodiesel Conference and Expo, January 17-20, 2022, Las Vegas, United States
- International Conference on Biofuels Production Technologies, January 21-22, 2022, London, United Kingdom
- Fuels of the Future 2022, Navigator for Sustainable Mobility!, January 24-28, 2022 — ONLINE
- International Conference on Recent Trends in Aviation Biofuels, January 28-29, 2022, Istanbul, Turkey
- International Conference on Microalgae-Based Biofuels, January 28-29, 2022, Sydney, Australia

February 2022

- International Conference on Applications of Aviation Biofuels, February 07-08, 2022, Melbourne, Australia
- International Conference on Biofuels for Internal Combustion Engine, February 07-08, 2022, Lisbon, Portugal
- International Conference on Biofuels and Biodiesel Production, February 15-16, 2022, Barcelona, Spain
- International Conference on Biomass Conversion and Biofuels, February 17-18, 2022, Paris, France
- National Ethanol Conference, February 21-23, 2022, New Orleans, United States

March 2022

- 13th Biofuels International Conference & Expo, March 15-16, 2022, Brussels, Belgium
- ABLC 2022, March 16-18, 2022, Washington, DC, United States
- International Conference on Sustainable Biofuels and Bioproducts, March 21-22, 2022, Dubai, United Arab Emirates
- International Conference on Advanced Biofuels, March 28-29, 2022, Paris, France

April 2022

- International Conference on Biofuel Production Technologies, April 07-08, 2022, Dubai, United Arab Emirates
- International Conference on Sustainable Biofuels and Current Problems, April 07-08, 2022, Athens, Greece
- International Conference on Biofuels and Biorefining Systems, April 07-08, 2022, Rome, Italy
- International Congress & Exhibition on Biomass: Fuel & Power — April 13-15, 2022 — Moscow, Russia
- International Conference on Thermochemical Conversion Science: Biomass & Municipal Solid Waste to RNG, Biofuels & Chemicals, April 19–21, 2022, Denver, United States
- International Conference on Microalgae-Based Biofuel Technologies, April 21-22, 2022, Boston, United States
- International Conference on Algal Biomass, Biofuels and Bioproducts, April 25-26, 2022, New York, United States

May 2022

- Symposium on Biomaterials, Fuels and Chemicals (SBFC), May 1-4, 2022, New Orleans, United States
- International Conference on Bioenergy, Biofuels and Biorefineries, May 05-06, 2022, Rome, Italy
- International Conference on Biofuels, Bioenergy and Bioeconomy, May 09-11, 2022, Vancouver, Canada
- EUBCE European Biomass Conference & Exhibition, May 9-12, 2022 — ONLINE
- International Conference on Biofuels Technologies, May 16-17, 2022, Amsterdam, Netherlands
- International Conference on Biofuels, Biomass and Wastes, May 16-17, 2022, Amsterdam, Netherlands

- International Conference on Advanced Biofuels, Biodiesel Engineering and Technologies, May 16-17, 2022, Paris, France
- Oleofuels 2022 Conference, May 18-19, 2022, Marseille, France
- International Conference on Biodiesel Engineering and Management (ICBEM), May 20-21, 2022, Vancouver, Canada
- International Conference on Sustainable Alternative Fuels and Biofuels Processing, May 26-27, 2022, Tokyo, Japan
- International Conference on Biofuels, Bioprocess and Biodiesel, May 26-27, 2022, London, United Kingdom
- International Conference on Biofuels and Biodiesel, May 26-27, 2022, Barcelona, Spain

Upcoming IEA Bioenergy Task 39 Meetings

IEA Bioenergy Task 39 is reviewing its plans for future meetings in light of the ongoing global COVID-19 pandemic affecting travel and in person gatherings. Task 39 will likely hold its next business meeting in a virtual or hybrid format in the first half of 2022. The expected focus of the meeting will be on the approved Program of Work and Task projects for the 2022-2024 triennium. More details will be provided in the next newsletter.

Please contact us for more detailed information about the Task's evolving plans for its future business meetings.