biofuels international

March/April 2024
Issue 2 • Volume 18

Capital investment

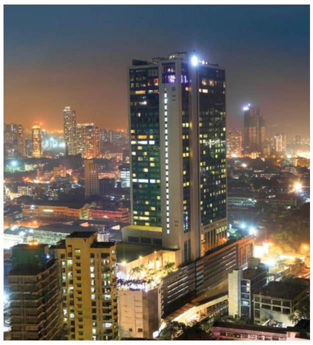
EU pushes ahead with new regulations

Innovative solutions

New technologies help drive growth in sector

Regional focus: Europe

contents



Front cover image: ©Krivinis
Image from bigstockphoto.com

biofuels international

Issue 2 Volume 18

March/April 2024

Woodcote Media Limited
Marshall House
124 Middleton Road, Morden,
Surrey SM4 6RW, UK
www.biofuels-news.com

ISSN 1754-2170

Biofuels International (ISSN No: 1754-2170, USPS No: 25611) is published six times a year by Woodcote Media Ltd, and distributed in the USA by Asendia USA, 701 Ashland Ave, Folcroft PA.

Periodicals postage paid at Philadelphia, PA and additional mailing offices.

POSTMASTER: send address changes to Woodcote Media Ltd 701 Ashland Ave, Folcroft PA 19032.

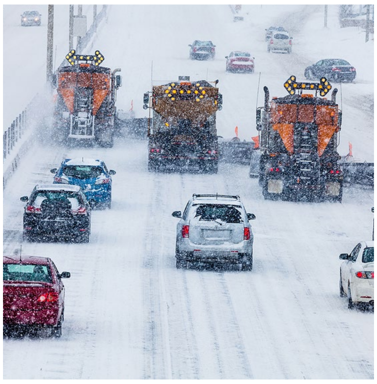
Biofuels Int
@biofuelsmag

Best performing tweet

588	10	15
impressions	retweets	likes

Tweet

The cities of #Ames, #Madison and #Washington #DC have utilised @optimuspgh for their #snowplows which are using 100% biodiesel (B100) as the decarbonisation solution for their heavy-duty fleets. https://biofuels-news.com/news/us-snowplows-run-on-biodiesel-to-beat-the-deep-freeze/



Top media Tweet Earned 233 impressions

Tweet

The @EU Commission has established the Union Database for Biofuels (UDB) which opened for online registration by biofuel operators. https://biofuels-news.com/news/union-database-for-biofuels-set-up-by-commission/

Why the adoption of biofuels is crucial if the world is to meet its decarbonisation goals

The adoption of biofuels stands as a pivotal strategy in the global endeavour to achieve net-zero carbon emissions.

With the latest global warming figures showing that the average monthly temperatures exceeded the 1.5˚C level for every month last year, the warning signs are there for everyone to see.

The transport sector, which is one of the biggest polluters, needs to decarbonise fast and the adoption of biofuels is one of the most efficient ways this can be achieved.

As nations across the world intensify efforts to combat climate change, transitioning to renewable energy sources becomes imperative.

Biofuels offer a promising solution in this quest for sustainability.

So why should this source of 'green energy' be adopted? We at *Biofuels International* have long been championing this fuel for at least the last decade when its development was still in its infancy.

Firstly, as we all know, biofuels present a viable alternative to fossil fuels, which remain the primary drivers of carbon emissions.

This reduction plays a crucial role in mitigating climate change and curbing the catastrophic impacts of global warming.

Moreover, the production and utilisation of biofuels can foster economic development and job creation, particularly in rural areas, it has been argued.

This economic stimulation bolsters local economies and enhances livelihoods, contributing to sustainable development goals.

Additionally, biofuels possess inherent versatility, capable of powering a wide array of vehicles and machinery.

From cars and trucks to aircraft and ships, biofuels can serve as a direct replacement for conventional fuels, enabling seamless integration into existing transportation infrastructure. This versatility facilitates the transition towards renewable energy across diverse sectors, accelerating progress towards net-zero emissions.

In conclusion, the adoption of biofuels represents a critical component of the global strategy to achieve net-zero carbon emissions.

As nations strive to build a sustainable future, embracing biofuels is essential in realising the vision of a decarbonised world.

Some of these issues will be debated at our Biofuels Conference and Exhibition that will take place on June 18-19 in Brussels. New this year will be our Sustainable Aviation Fuels Summit. We look forward to meeting up with everyone again. In the meantime, you can keep reading about this and more in our news online at biofuels-news.com.

Paul Warner
Editor

Connect with more than **17,000** members on *Biofuels International's* Linkedin page

Join more than **4,100** followers of *Biofuels International* at @biofuelsmag

Chevron idles biodiesel facilities as prices fall

Chevron has idled two biodiesel production facilities in the US Midwest – blaming poor market conditions.

The oil producer bought biodiesel maker Renewable Energy Group two years' ago to expand its renewable fuels production to 100,000 barrels per day by 2030.

The deal brought it 10 biodiesel plants and one renewable diesel facility.

However, Chevron has now idled plants in Ralston, Iowa and Madison, Wisconsin, that combined can process 50 million gallons per year of biodiesel.

Prices have slumped in recently months as supplies have grown and the value of renewable credits recently fell to a three-year low.

The price of a blend of 20% biodiesel fell in February to $3.45 (€3.20) per gallon of petroleum equivalent, from the peak of $4.80 (€4.40) per gallon in October 2022.

President Joe Biden's administration last year increased the amount of biofuels that oil refiners must blend into the nation's fuel mix over the next three years, but the plan includes lower mandates for corn-based ethanol than it had initially proposed which sent credit prices lower.

Producers of renewable diesel generate more renewable credits due to their lower carbon intensity score than biodiesel.

Velocys secures €37 million in growth capital

Velocys has begun a new chapter following the completion of a new deal on 18 January.

As part of the transaction, a new consortium of growth investors including Carbon Direct Capital, Lightrock, GenZero and Kibo Investments have infused Velocys with $40 million (€37 million) of growth capital.

The funds will be used to accelerate the delivery of Velocys' proprietary technology to customer projects while further building its technology leadership and scaling its production.

Velocys has also invested to scale its reactor facility in Plain City, Ohio.

Axiom Global Oil and Gas spearheads sustainability in alternative fuels

Helping to shape the future of biofuels

In a world increasingly focused on sustainability and renewable energy sources, Axiom Global Oil and Gas Trading DMCC has emerged as one of the leaders in the biofuel industry.

With a commitment to environmental responsibility and innovation, Axiom has achieved significant milestones and is poised for further growth and influence in the market.

Introduction to Axiom Global Oil and Gas

Founded with a vision to revolutionise the energy sector, Axiom Global Oil and Gas Trading DMCC has quickly established itself as one of the frontrunners in sustainable fuel solutions.

Headquartered in Dubai, Axiom operates at the nexus of innovation, technology and environmental stewardship.

The company's dedication to reducing carbon emissions and promoting renewable energy sources is evident in its recent achievements and ongoing initiatives.

ISCC Plus Certification: Setting the standard for sustainability

The company achieved a significant milestone last November by obtaining the ISCC Plus certification.

This prestigious certification is a testament to Axiom's unwavering commitment to sustainable practices and adherence to stringent environmental standards in the biofuel sector.

The certification serves as a benchmark for sustainability, validating its efforts to promote eco-friendly fuel alternatives and minimise its carbon footprint.

Pioneering VLSFO B24 supply with second generation biodiesel

In January, the company further solidified its commitment to sustainability with the launch of its inaugural supply of Very Low Sulphur Fuel Oil (VLSFO) B24.

This initiative involved blending second generation biodiesel derived from used cooking oil, sourced from a local plant in the UAE.

The biodiesel procured by Axiom adheres to EN 14214 standards, guaranteeing its quality and reliability. Rigorous qualitative testing was conducted to verify the Fatty Acid Methyl Ester (FAME) content of the final blend, ensuring compliance with industry regulations and standards.

Innovating with blockchain and digital solutions

The company is at the forefront of innovation, leveraging cutting-edge technology to enhance sustainability and efficiency in biofuel operations.

Collaborating with Circularise, a provider of blockchain-based solutions, Axiom is revolutionising the sustainability declaration process for ISCC Plus certification.

By utilising the power of blockchain technology, the company aims to streamline sustainability declarations, making the auditing process more efficient and transparent. This initiative not only enhances the integrity of certified data, but also reinforces its commitment to accountability and transparency in its operations.

Furthermore, Axiom is exploring the implementation of Electronic Bunker Delivery Notes (E-BDN) to digitise the bunkering process.

By digitising key operational processes, the firm seeks to enhance efficiency, reduce paperwork and minimise the environmental impact of its operations. Both the deployment of E-BDN and digital sustainability declarations are slated for implementation towards the end of the year, underscoring the company's commitment to innovation and technological advancement in the biofuel industry.

Outlook and challenges: Navigating regulatory landscapes

While regulatory developments such as the Carbon Intensity Indicator (CII) and the European Union Emissions Trading System (ETS) present promising opportunities for biofuels, significant challenges persist.

Despite the environmental benefits of biofuels, the bio-premium – the additional cost associated with biofuel production – currently outweighs that of traditional fossil fuels and EU ETS compliance.

This disparity poses financial hurdles for widespread adoption and market penetration of biofuels in the region.

Moreover, the near-term demand for biofuels in the region is largely driven by discretionary actors, such as environmentally conscious consumers and organisations.

While regulatory frameworks provide a supportive environment for biofuel adoption, market dynamics and consumer preferences play a crucial role in shaping demand patterns. Axiom recognises the importance of addressing these challenges through strategic partnerships, advocacy efforts and market development initiatives.

Expansion into the aviation industry: Commitment to sustainable aviation

The company's ambitions extend beyond traditional biofuel markets, with a strategic focus on the aviation industry.

Recognising the aviation sector's significant carbon footprint, Axiom is committed to providing sustainable aviation fuel solutions that reduce emissions and promote environmental stewardship.

As part of its expansion into the aviation industry, Axiom underwent the CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) audit, a crucial step towards obtaining certification.

Anticipated to receive certification shortly, Axiom is poised to become a trusted provider of sustainable aviation fuel, positioning the company as one of the leaders in the transition towards greener aviation practices.

By offering sustainable alternatives to conventional aviation fuels, Axiom aims to mitigate the environmental impact of air travel and contribute to global efforts to combat climate change.

> *"As the company navigates regulatory landscapes, addresses market challenges and expands into new frontiers such as the aviation industry, its commitment to sustainability remains unwavering"*

Conclusion

In conclusion, Axiom Global Oil and Gas Trading DMCC stands as a beacon of sustainability and innovation in the biofuel industry.

From achieving ISCC Plus certification to pioneering the supply of VLSFO B24 and embracing cutting-edge digital solutions, it is driving positive change and setting new standards for environmental responsibility in the energy sector.

As the company navigates regulatory landscapes, addresses market challenges and expands into new frontiers such as the aviation industry, its commitment to sustainability remains unwavering.

With a steadfast dedication to innovation, integrity and environmental stewardship, Axiom is poised to shape the future of biofuels and contribute to a cleaner, greener planet for generations to come.

The company's headquarters is located in Dubai, UAE

For more information:
Visit: axiomglobaltrading.com

Gregor Schaub, associate division director for biodiesel at BDI-BioEnergy International, discusses future areas of application for waste oil-based feedstock and the necessity of selecting the suitable technology


Cargill's biodiesel plant

What fits the process

Traditionally vegetable oils of different quality and refined stages were used for first generation biodiesel and HVO (hydrotreated vegetable oil) production.

The business and its growth was supported by governmental measurements and subsidies.

These measurements were stopped in most cases as new incentives were created, increasingly for waste-based feedstock only called advanced feedstock.

These changes were logically part of the development of overall carbon reduction that came into focus.

Even though technologies to process advanced feedstock have been available for many years, the main focus has only recently shifted to waste-based feedstocks due to political decisions.

Political situation

The current political landscape and the expected future development has led to the conclusion that the industry has a greater interest in increasing the use of waste-based raw materials for biofuel production.

These incentives include the Renewable Energy Directive (RED III) in Europe and measures like the carbon intensity score in the US.

The RED III directive sets a common target for the share of renewable energy consumption of 42.5% by 2030 and encourages member states to further increase this share by 2.5% by the same year.

In summary, advanced feedstock types will be pushed further into the market by national politics or tax incentives.

When biodiesel producers shift to waste-based material as feedstock, the first choice is often used cooking oil (UCO).

The main reason is that UCO's feedstock parameters are close enough to that of vegetable oil.

The result is that there are no, or only minimal changes, to the processes involved.

To incorporate low-quality waste oils as feedstock, significant alterations to the current process are necessary, leading to increased investment requirements. In certain instances, a completely fresh process design will be essential, which could involve retrofit units such as additional washing steps or distillation, the establishment of a parallel production line, or the creation of an entirely new standalone production process.

Technology

Yet, for producers of renewable diesel and sustainable aviation fuel (SAF), progress in utilising waste-based feedstock is advancing at a slower pace due to the diverse array of impurities present in the feedstock, posing challenges for downstream processing.

Typically, processes involving hydration (such as HVO and SAF) necessitate higher feedstock purity requirements because the catalysts utilised in these processes are sensitive to common catalyst poisons like phosphorus and metals.

Therefore, the typical input specification for HVO or SAF process plants are quite restrictive when compared with biodiesel production facilities.

Well-known technologies for HVO have limits in phosphors in the single digit ppm range as well as for metals group one and two.

In addition, existing facilities for co-processing might not fulfil corrosion protection necessities, which also strictly limits chlorides and acid values in the feedstock.

For biodiesel production, these parameters in waste-based feedstock are not that crucial because most of the production plants are equipped with a final purification step – a biodiesel distillation unit.

In this unit, the problematic impurities end up in the distillation bottom and not in the distilled product.

A general overview of the different kinds of feedstock are listed here.

Apart from UCO, the most common feedstock is animal fat or waste and residue streams from palm oil production.

Feedstock types, which are rarer on the market include trap greases from oil separation systems and acids oils from soap stock splitting processes from large-scale vegetable oil refining.

Generally, these types of feedstock can be categorised into different qualities, listed below from typically favourable to typically inferior.

Argent's biodiesel plant

Each feedstock is accompanied by its most crucial and characteristic parameter, which is discussed briefly, regardless of its intended use in biodiesel or SAF production.

Feedstock types

UCO is a common advanced feedstock for renewable fuel producers, as already discussed.

Relevant feedstock parameters include, for example, free fatty acids (FFA), water content and solid impurities.

The typical range of FFA in "classic" UCO spans from 0.5% to 5%. The water content varies between 0.2 to 2% and solids from 0.1 to 3%.

Furthermore, a high polymerised triglycerides content is expected – up to 10% – from the deep frying process.

Since UCO can be a complex mix of vegetable oils and animal fats, typical contents like phosphorous can be up to 50 ppm. Metal content, sodium chloride and other cooking ingredients in UCO can be on the high side.

Animal fat has a range of between 5 to 45% FFA depending on the source and time of storage.

The longer the storage time the higher the degradation of the fat, which also increases the sulphur content drastically.

Additionally, a significant concern with animal fat is the presence of polymer-type plastics such as polyethylene. The polyethylene often comes from the ear tags of livestock. In addition, the phosphorus content can be very high, but in most cases this is not a critical factor as it comes from the bone meal, which can be separated by a washing step.

Residues and byproducts from the palm oil industry like palm oil mill effluent (POME) and palm fatty acid distillate (PFAD) are also listed as feedstock for fuel production.

Offering a range of typical feedstock parameters would not be feasible due to the significant fluctuations in the various parameters of POME.

Water content, metal, sulphur and other parameters can vary a lot depending on origin and storage conditions of the sourced material.

However, a typical parameter for POME is the FFA content – 50% and above. However, even with this parameter, unexpected qualities (FFA < 25%) have recently appeared on the market.

PFAD is usually a clean high FFA feedstock and has little fluctuation in the quality parameters, but it is likely to be priced higher when compared with POME.

Greases are known by various names and classifications, including yellow, brown, black, and trap grease.

For instance, yellow grease is often synonymous with UCO. Generally, these greases comprise a blend of other waste oils and fats, residues sourced from various

A range of biodiesel types

origins such as fat separation in wastewater systems.

Due to their diverse sources, they tend to have high levels of moisture, impurities, and insoluble substances (MIU), and the triglycerides within the fats and oils can undergo significant chemical degradation. These characteristics collectively render greases as low-quality feedstock, often lacking reliable availability in substantial quantities.

Acid oils are derived from soap stock, a byproduct of large-scale vegetable oil production, particularly from the degumming process.

To recover the oil residue from soap stock, a process known as soap stock splitting is employed, often involving the addition of sulfuric acid.

These acid oils are characterised by high levels of FFA reaching up to 90%, and phosphorus levels as high as 2000 ppm, concentrated from the vegetable oil refining process.

Despite the daunting parameters associated with even the high-quality waste oils mentioned earlier, numerous state-of-the-art technologies exist for converting such waste oils into valuable biofuel products.

Among these technologies are the BDI RepCAT process, which produces biodiesel, and the BDI Advanced PreTreatment, which prepares the feedstock for subsequent use in SAF production through co-processing or hydration.

Purification

As described above, the pre-requirements for feedstock used in SAF and HVO production are very strict.

A multistage purification process is necessary to prepare the waste oils for their use in this sector.

One example for such a purification process is BDI's Advanced PreTreatment unit.

This consists of multiple washing steps combined with a feedstock drying unit, adsorption and filtration processes.

The process reliably reduces selected parameters like MIU, sulphur, phosphorus, chlorides and metals.

The effort and associated cost of cleaning the feedstock increases in proportion to the level of impurities, which are typically more abundant in low-quality feedstock such as animal fat, greases, and acid oils.

This limitation narrows down the range of economically feasible feedstock qualities that can be cleaned up for SAF and HVO production.

Essentially, all types of feedstock listed above are suitable for the BDI RepCAT process.

From the producer's perspective, the preferred feedstock will be of lower quality, which implies a lower asking price for the feedstock and, thus, higher margins when selling biodiesel as a product.

The technology was specifically developed to process materials with a high proportion of free fatty acids (up to 99% FFA) and is insensitive to typical impurities.

The design of the RepCAT technology makes it a robust choice when producers aim for the lowest quality of feedstock, like acids oils.

"The current political landscape and the expected future development has led to the conclusion that the industry has a greater interest in increasing the use of waste-based raw materials for biofuel production"

A Tricanter Pretreatment plant

The main process steps of the RepCAT plant are a pre-purification step followed by a two-stage continuous trans-esterification process under higher temperature and pressure conditions.

As a final production step, the biodiesel and glycerin are distilled in an optimised distillation column.

The products are biodiesel according the required norm (ASTM or EN14214) and is an absolutely salt-free glycerin of distilled quality.

The bottom product of the distillation, which contains the heterogenic catalyst, is partly recycled to the upstream process.

This step gives the technology its name – RepCAT – repeatable catalyst.

Conclusion

As political pressure for advanced feedstock and biofuels overall is increasing, so does the general demand for bio-based feedstock.

This leads to the conclusion that in the near future all feedstock qualities – whether good or bad – will be a valuable addition to the global feedstock mix for renewable fuel production.

Due to the disproportionate demand for SAF and HVO, coupled with the increased effort required for thorough feedstock purification, higher-quality feedstock such as virgin vegetable oil, UCO, and others will be largely absorbed by this market.

Consequently, biodiesel producers will primarily have access to lower-quality feedstock types that are generally unsuitable for SAF/HVO production. This evolving landscape in the feedstock market places added pressure on biodiesel producers to adapt their processes, integrate new lines with appropriate technologies, and maintain profitability while striving to regain a competitive edge. ●

For more information:
Visit: bdi-bioenergy.com

BioSFerA reveals key results from a ground-breaking approach for advanced biofuel production

A success story

BioSFerA is a research and innovation project that aims to develop a cost-effective production method of sustainable aviation and maritime fuels by combining different technologies.

The project, funded by the European Union's Horizon 2020 (Grant Agreement number 8842089), started in 2020 and it will finish in March.

The main aim of the concept is to produce advanced biofuels by means of hydrotreatment of microbial lipids (triglycerides, TAG).

The partners include the Centre for Research and Technology Hellas (CERTH), Q8 Research, Technical Research Centre of Finland Ltd (VTT), Fundación CARTIF, Bio Base Europe Pilot Plant (BBEPP), Spanish National Research Council (CSIC), RINA Consulting, SUMITOMO SHI FW, National Technical University of Athens (NTUA), Environment Park and the FinCo Fuel Group.

While the hydrotreatment process is similar to conventional HVO production, the BioSFerA project proposes an innovative and low-carbon process based on feedstock conversion of biogenic residues and waste that is by gasified into syngas.

Following on from this, the syngas is converted by two industrial fermentation steps to microbial lipids as illustrated in Figure 1.

The project received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement number 884208

After four years from the start of the project, BioSFerA is now able to share the most significant results and conclusions of its advanced ways of producing drop-in liquid biofuels using high TRL and diversified technologies that specifically contribute to the process.

The results

The art of industrial fermentation, for instance, is determined by the ability to select the right micro-organisms and to develop the right shape to make the highest possible yield of required molecules from the feedstock under specific conditions.

The big advantage of industrial fermentation is that the conversion is executed by the micro-organisms at ambient temperature, what may result in lower energy demand compared to conventional, often thermic, processes.

In case of, for example, syngas-fermentation to acetate there is another big advantage – syngas for a Fischer Tropsch (FT) process must be ultrapure, where industrial fermentation can handle more impurities and contaminants.

It has a significant impact on the pretreatment cost of the feedstock.

Different lab scale fermentation trials have been performed alongside the project by determining exhaustively the role of some of the main parameters influencing the fermentation performance, such as media, pH, syngas composition, pressure and duration on the maximisation of acetate/acetic acid and lipids at the syngas and acetate fermentation, respectively.

A proof-of-concept for continuous fermentation with cell-recycle using anaerobic bacteria was established in a 10 litre gas fermentation bioreactor. This allowed for the production of a sterile acetic acid stream with concentration of around 30 g/l, and reaching productivities up to 0.42 g/l/h, which are acceptable yields.

As for the second fermentation for the production of TAGs from acetate, the use of a genetically modified version of the oleaginous yeast *Y. lipolytica* together with the optimisation of key process parameters (mainly pH, dissolved oxygen content and nitrogen feeding) in one litre and seven litre bioreactors resulted in high biomass production and lipid titer (21 g/l).

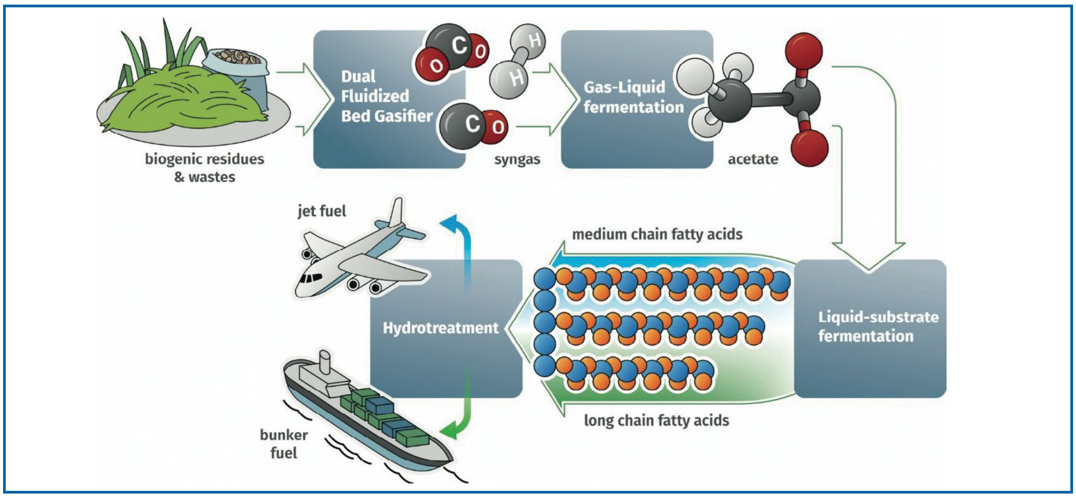
The profile of microbial TAGs produced was based on C16 and C18 fatty acids (30%:70%, respectively).

C16 and C18 fatty acids are commonly found in plant fats, where C16 is typically the formula for palm oil and C18 fatty acids are found in nuts.

This is a mix of lipids suitable for drop-in biofuel (HVO) production.

One of the project highlights was undoubtedly the successful pilot campaign in VTT's premises (Biorrukki site).

For the first time, a biomass fired gasification unit was successfully coupled with BBEPP's mobile unit and real biomass derived syngas was



BioSFerA technical scheme as referred to in Figure 1 converted into acetic acid (AA) via gas fermentation for almost 1.5 months in total.

The syngas fermentation process involved the growth of *Moorella thermoacetica,* an acetogenic bacterium capable of producing AA alongside growing biomass.

The lab-scale development of the syngas fermentation process was utilised as a starting point to bring the technology to TRL5.

Two different biomass feedstock were used, bark and straw.

Different gas cleaning configuration schemes were tested. *M. thermoacetica* exhibited strong resilience towards syngas contaminants, being able to grow and produce AA regardless of the gas cleaning strategy.

Larger scale

The process settings which resulted from the lab-scale process optimisation experiments were verified and applied at a larger scale.

The liquid fermentation technology was successfully upscaled at TRL5 where *Yarrowia lipolytica* was employed for the TAGs production in a 15 m^3 fermenter, resulting in 116 kg TAG.

All the performed fermentation runs at pilot scale were successfully executed. No contamination and no major process issues occurred.

This showed the robustness of the process and the scale-up potential of the *Y. lipolytica* fermentation for TAG production.

CERTH, with the assistance of KPRT, carried out the hydrotreatment tests for the jet and marine diesel fuel production on both TRL3 and TRL5.

Different catalytic systems were studied and the optimum hydrotreatment operating conditions that led to high diesel and jet yields were selected for the TRL5.

As the large scale production is still ongoing (24 January, 2024) and the quality assessment has not

finished, more than 120 litres of advanced biofuels with promising characteristics for use as drop-in in aviation and maritime have been produced.

Taking into account any available experimental/pilot data, but also implementing the necessary upscaling considerations, an appropriate process model for the commercial BioSFerA replication has been developed.

The configuration for the integrated commercial concept was elected with the aim of technical viability as well as the greatest possible performance/cost balance.

Full-scale (200 MWth) simulations were performed, the corresponding Process Flowsheet Diagram (PFD) was generated, an appropriate industrial layout was provided, and the overall process heat and mass balances were calculated.

The energetic fuel efficiency (fraction of the chemical energy in the initial feedstock that is transferred to the final fuels) of the plant was calculated at 35.6% whereas the carbon utilisation (fraction of carbon in initial feedstock that is converted to the final fuels) was estimated at 25.4%.

The performed benchmarking of the BioSFerA pathway with other established Biomass-to-Liquid (BtL) technologies such as FT and Alcohol-to-Jet (AtJ) in terms of performance revealed that the BioSFerA concept could be fully competitive.

The theoretically favourable position of BioSFerA lies in its ability to reach decent efficiency levels by avoiding the strict specification of FT that usually requires costly and energy-demanding equipment, or the several unit operations of the AtJ route that raises the total production costs.

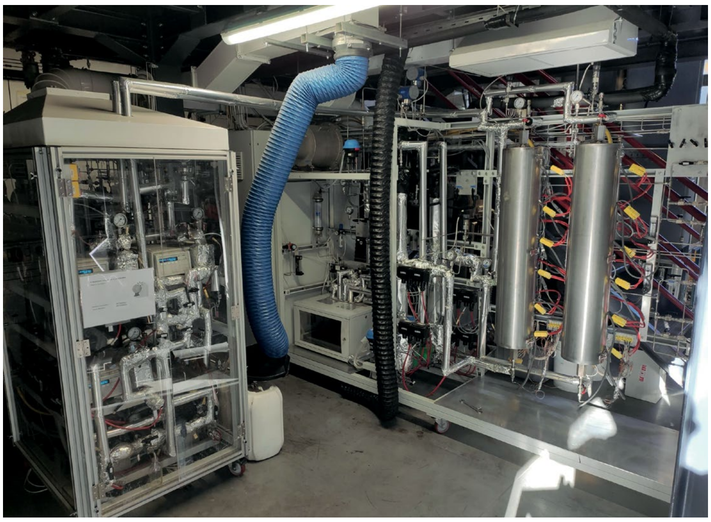
Value for money

The preliminary techno-economic evaluation of the concept implies sustainability and financial competitiveness compared to already certified BtL technologies that also target advanced feedstock (FT, AtJ).

Even though the capital costs for the suggested concept were expected to be even lower, the estimated baseline minimum selling prices of €1.83/l for jet fuel and €1.71/l for diesel (marine fuel) can be considered in the competitive price range for advanced biofuels.

Similar to other technologies that target advanced feedstock, capital investment and feedstock costs seem to be the main cost-drivers of the BioSFerA process as well.

Thus, favourable financial terms expressed in reduced



capital costs or potential involvement of cheap feedstock (for example, biogenic wastes) can lead to fuel production costs close to €1/l.

An additional business scenario was investigated, assuming the hydrotreatment of the purified TAGs (microbial oil) in an existing refinery.

The rationale was to avoid the investment cost of a part that can be entirely carried out in an ordinary refinery, thus exploiting the large existing refining infrastructure and experience. A microbial oil production of cost €1.32/l was calculated for that case.

The environmental assessment through LCA modelling revealed that the GHG emissions of a BioSFerA-type biorefinery are between 15.5-47.4 $gCO2_{eq}$/MJ_{fuel} depending on the grid electricity carbon footprint of the country that it is located in and the required pre-treatment of the selected feedstock.

It was found that the GHG emission savings compared to conventional fossil production pathways can reach 86%, presenting a significant environmental improvement.

Last, but not least, the results also indicated that future electricity mixes, with higher renewable energy penetration, could play a significant role in the decrease of the overall GHG emissions related to the production of biofuels.

A health and safety evaluation risk assessment

was also conducted to identify the main issues associated with the process and also the main mitigation actions to reduce the identified risks.

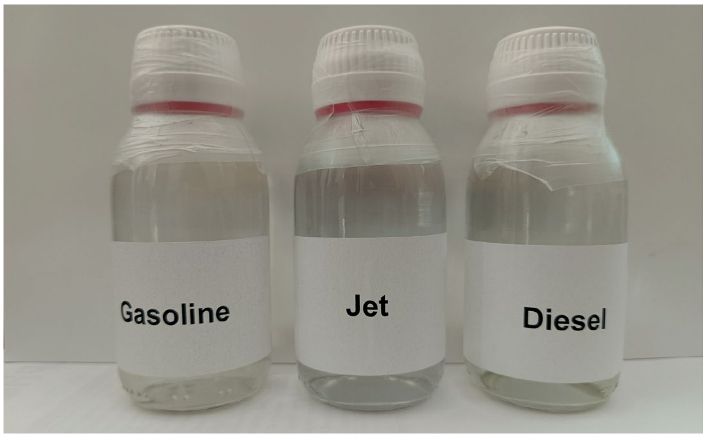
The BioSFerA project introduced, developed and tested at pilot scale an integrated thermochemical/biochemical route for aviation and maritime biofuel production.

The proof of concept throughout the BioSFerA value chain was also carried out.

The aim of the concept is the establishment of a competitive, new BtL technology based on mild operating temperatures, low pressures and generally reduced costs.

The beneficial environmental impact and the financial competitiveness of the concept were validated with appropriate LCA and techno-economic analyses, respectively.

An extended portfolio including verified process models, experimental/pilot results, identification of strong/weak aspects, and upscaling considerations was formed towards the potential scale-up of the technology.



Samples of the produced fuels

The legacy of the project includes the following points:

- Six different types of biogenic feedstock (forest/bark residues, olive/vineyard pruning, wheat straw, sunflower husk) were successfully gasified, ensuring the feedstock flexibility of the concept.
- The operability of the biological synthesis was successfully tested under various real bio-syngas purities, further reducing the cost related to gas cleaning requirements.
- Further advances in strains optimisation can lead to higher acetic acid and TAGs productivities/concentrations and subsequently efficiency improvement of the double-stage fermentation process as well as reduced capital costs (smaller required number of bio-reactors). The biological synthesis optimisation in terms of performance and cost is a key identified aspect towards the scale-up of the technology.
- The hydrotreatment tests verified that the produced BioSFerA microbial oil is an appropriate feedstock for upgrade into drop-in advanced biofuels, compatible with the existing refining infrastructure. ●

For more information:
Visit: biosfera-project.eu

Transport and coupling of mobile gas fermentation unit with the biomass gasification pilot plant