



## Industrial scale demonstration biorefinery for lignin-based aviation fuels

### Project overview

Aviation is one of the fastest growing transport sectors and this trend will continue in the coming years. Currently, petroleum derived liquid fuels are the main energy carrier in the aviation sector. Due to different environmental and economic concerns there is a need for the sustainable supply of aviation fuels.

Bioenergy will play a key role in the EU's long term energy strategy for all applications, especially in the transport sector. The supply of feedstock and biofuel conversion technologies which are currently deployed already provide a significant contribution, but diversification of feedstock and advanced technologies will be necessary for further development. The aviation industry considers biofuels to be one of the primary means to reduce the carbon footprint of the industry. In this context, the BIOREFLY project will develop and build the first industrial pre-commercial lignin to jet fuel facility in Italy.

The combined production of a high annual volume of cellulosic ethanol and lignin-based jet fuel through sustainable and innovative technologies will be the first step towards biofuel commercialisation and market deployment.

BIOREFLY is co-funded by the European Commission in the 7th Framework Programme (Project No. FP7-612747).



### BIOREFLY Objectives

- Optimisation of feedstock supply chains for the collection of lignin-rich residues
- Scale up of innovative lignin to fuel technology
- 2<sup>nd</sup> generation industrial pre-commercial facility for jet fuel production and process optimisation
- Bio jet fuel test programme and utilisation in aviation sector
- Integrated assessment of environmental and economic sustainability

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## Alternative aviation fuels

The aviation sector is recognised as a significant user of fossil fuels. Rapid growth of aviation emissions is due to the increase of air traffic volumes for both passenger and freight, with aviation usually having the highest energy and GHG intensity of all transport modes.

Compared to other transport sectors, aviation has less potential for switching to lower carbon footprint fuels due to special fuel requirements. In terms of renewable energies, several airlines have already implemented test flights using various biofuel blends, however standards to allow larger biofuel blend fractions in conventional aviation fuels are currently under development. Sustainable alternative fuels are one of the most promising routes to achieve reductions in aviation's CO<sub>2</sub> emissions and the only appropriate replacement for fossil kerosene since there is no alternative for liquid fuels for the next decades to come.



The BIOREFLY project will accelerate the development of high-efficiency renewable energy production technologies by providing the best processing and engineering strategies to produce bio jet fuel. The use of lignin-rich residues from biorefineries will guarantee the efficient utilisation of energy crops and agricultural residues. In this way the project will deliver a rapid breakthrough in the aviation sector.

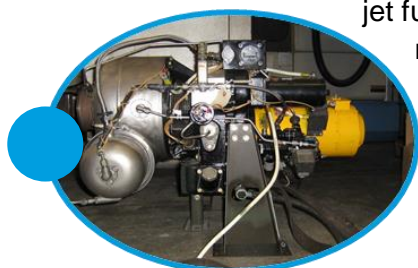
## Research and innovation

Lignocellulosic-to-jet fuel production at large scale has not been proven yet to be economically feasible, although significant potential exists. Research on second generation biofuels technology has been carried out mainly for bioethanol and at laboratory or pilot scale. Research goals of BIOREFLY project are linked to the construction and operation of a pilot plant based on second generation technology. BIOREFLY will carry out the following research activities:

- Validate process technology improvements achieved during demonstration operations and realize the scale-up to commercial plants
- Incorporate all component designs into an integrated and techno-economic sustainable process packages
- Confirm economic viability of process design
- Ensure that environmental, safety, health and security requirements are fully incorporated into project design and execution and can be implemented for plant construction in different locations worldwide



The BIOREFLY project will focus on demonstrating the thermo-chemical conversion of lignin to jet fuel in an integrated industrial demo scale plant, including innovative, tailor made and cost-effective downstream processes.



## Plant engineering

Within the BIOREFLY project a feasibility study for a 2,000 ton/y jet fuel plant in Italy will be prepared, followed by the permitting and construction phases. In addition, the supply of lignin-rich residues to the jet fuel plant will be established.

The main steps of plant engineering are to determine necessary design criteria for the plant (process parameters, equipment dimensioning, heat loss and heat recovery, water cycles etc.) and identify characteristics of the lignin co-product obtained from the second generation Biochemtex-Beta PROESA® technology in order to establish the overall design of the conversion reactors.



In the BIOREFLY project, design modifications will be evaluated and adopted in the engineering phase in order to minimize the scale-up risk and reach a shorter time-to-market for the technology. A sustainable approach for the selection of conversion technologies is novel and innovative processes that can be performed with equipment used in established industrial processes.

## Production plant

The goal of the BIOREFLY project is the construction of a 2,000 ton/y bio jet fuel plant. It will use lignin cake obtained from the conversion of both dedicated energy crops and agro residues in the second generation bioethanol production biorefinery in Italy. Even if the plant will have a quite small size comparing to the big commercial plants, it will be a prove of concept for the next scale-up to a full commercial scale.



The BIOREFLY plant will produce a fuel that respects Jet A / Jet A-1 specifications. This biofuel will serve for testing in turbines, aircraft engines and demonstration flights.

## Testing and product utilisation

A detailed testing scenario for large turbine engine systems and components will be established. The tests will support the ASTM certification process and provide relevant data on blends. In addition, demonstration flights will be scheduled, provided that the necessary evaluations comply with the required standards and involved authorities and OEMs (Original Equipment Manufacturers) issue temporary permits.



## Sustainability

Different criteria will be evaluated to demonstrate the sustainability of the BIOREFLY bio jet fuel value chain. This will be done in combination with the second generation Biochemtex-Beta PROESA® technology, by taking into account technological, economic and social aspects. In addition, the most sustainable biofuel pathways and the most efficient strategies will be identified to establish a competitive biofuel able to substitute large amounts of fossil fuels and replace first generation biofuels in the aviation sector.



## Dissemination

BIOREFLY activities and results will be disseminated among stakeholders and the public. An important part of the dissemination activities is exchange between RTD experts and stakeholders as well as synergies with other EU projects and European initiatives.

BIOREFLY dissemination activities include:

- Project website: [www.biorefly.eu](http://www.biorefly.eu)
- Newsletters and other publications
- 2 international BIOREFLY conferences
- Public events on the production of bio jet fuel at the production site
- Aircraft demonstration flights with bio jet fuel

## The BIOREFLY partnership

### Biochemtex Italia (Coordination)

Biochemtex, the engineering company of the M&G group, is a global organization that specializes in delivering innovative and value-added project solutions and technologies in renewable energy, green chemistry and biofuels sectors. Biochemtex is a true global company with operations in key centres throughout the world. Environmental protection is a priority for the conservation of natural resources and the health of our planet. Biochemtex recognizes its responsibility as a global company and is fully committed to reducing the environmental impact of the industrial activities of the developed projects.

All the recent and future investments in Research and Development have been mostly related to biofuels and biochemicals taking into account the complex matrix of different aspects for a complete economic and environmental sustainability. Since 2008, Biochemtex has developed several innovative technologies for the production of advanced biofuels and biochemicals from lignocellulosic feedstock. These processes have been validated on pilot and demonstration industrial scale.



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### ETH Zürich, Switzerland

ETH Zürich is a leading international university for technology and natural sciences. It is well known for its excellent education, groundbreaking fundamental research and for implementing its results directly into practice. Founded in 1855, today it offers an inspiring working environment to researchers and a comprehensive education to students. ETH has more than 17,000 students from approximately 80 countries, 3,700 of whom are doctoral candidates. More than 400 professors teach and conduct research in the areas of engineering, architecture, mathematics, natural sciences, system-oriented sciences, management and social sciences. ETH regularly ranks as one of the best universities in the world. 21 Nobel Laureates have studied, taught or conducted research at ETH Zürich, underlining the excellent reputation of the institute. Transferring its knowledge to the private sector and society is one of ETH primary concerns. It has succeeded in this, as borne out by the 80 new patent applications each year and some 240 spin-off companies that were created out of the institute between 1996 and 2011. ETH Zürich helps to find long-term solutions to global challenges. The focal points of its research include energy supply, risk management, developing the cities of the future, global food security and human health.



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## KLM, Netherlands

The Air France KLM Group (AFKL), to which KLM (KL) belongs, is at the forefront of the European airline industry and sets the standards for quality, innovation and sustainability. AFKL employees work to provide innovative products for the customers and a safe, efficient, service-oriented operations with a proactive focus on sustainability. KLM strives to achieve profitable growth that contributes to both its own corporate aims and to economic and social development. AFKL works to create sustainable growth at Schiphol and Charles de Gaulle, to gain access to any market that will increase the quality of its network and to maintain a level playing field for all industry players. It also works to ensure a balance between the company's interests and those of the people living and working close to the airport. AFKL wants to be the customers' first choice, to be an attractive employer and, a company that grows profitably for its shareholders. With smart partnerships, AFKL offers global access through its extensive network. Sustainable alternative fuels are essential in achieving AFKL's ambitions as well as for the aviation industry as a whole. Sustainable biofuels development is a priority for AFKL, whose strategy is to explore the entire value chain from research to commercialization.



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## RE-CORD, Italy

The RE-CORD consortium, founded in 2010 under the initiative of CREAR (University of Florence) develops scientific and technological research in the field of renewable energies and in particular bioenergy. RE-CORD is a no-profit independent research body, which merges competences and resources in the field of basic and applied research, engineering, and sustainable land planning and development. Founding members of RE-CORD are the University of Florence (CREAR), Pianvallico SpA, and Spike Renewables Ltd.



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RE-CORD and CREAR members participate to International Networks in Bioenergy (IEA Task 39 - Liquid Biofuels), as well as support the Commission, ministries, regions and local actors in carrying out assessment studies or evaluating and monitoring projects.

RE-CORD is member of the ITAKA consortium (Initiative Towards Sustainable Kerosene for Aviation), an EU-FP7 initiative aiming to contribute to the EU's 'Biofuel Flight Path Initiative' annual production target of 2 Mtons of biofuel for aviation by 2020. ITAKA aims at producing sustainable renewable aviation fuel and testing its use in existing logistic systems and in normal flight operations in Europe. The project will also link supply and demand by establishing relationships among feedstock growers and producers, biofuel producers, distributors, and airlines.

## SkyNRG, Netherlands

SkyNRG is the global market leader for sustainable jet fuel, having supplied more than 20 airlines worldwide. It is SkyNRG's mission to supply aviation with sustainable jet fuel. We source, blend and distribute the fuel. We guarantee sustainability throughout the supply chain and we help with co-funding the premium. In long term we focus on developing regional supply chains (SkyNRG BioPorts) that offer a real sustainable and affordable alternative to fossil fuels.

SkyNRG is a member of the Roundtable on Sustainable Biomaterials (RSB) and is advised by its independent Sustainability Board consisting of leading NGOs such as the Dutch Wing of the World Wide Fund for Nature (WWF-NL). SkyNRG was launched following the KLM biofuel test flight in November 2009. Founding partners are KLM, Argos Oil and Spring Associates.

SkyNRG has a proven track record. Besides KLM the company supplied leading airlines such as AirFrance, Finnair, Thomson, Alaska Airlines, Etihad, Qantas, All Nippon Airways, Thai Airways and Lan Chile.



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## WIP Renewable Energies, Germany

WIP Renewable Energies is a private company founded in 1968. The multi-disciplinary, international staff team of WIP involves more than 30 employees. WIP has been active in the fields of renewable energy technologies (solar, PV, wind, biomass, hydro) for over four decades, providing a range of technical expert and non-technical services to both industrial and public sector clients at the international level.

WIP's mission is to bridge the gap between research and implementation of renewable energy systems. It has a long record of performing outstanding activities in close co-operation with the European Commission, national entities (e.g. in Germany, The Netherlands, Tanzania) and international organisations such as the international Energy Agency (IEA). It has conducted analytical research work following an interdisciplinary approach by tackling energy issues in their economic, legal and social framework conditions.

WIP Renewable Energies is member of the CORE-JetFuel (Coordinating research and innovation of sustainable jet and other sustainable aviation fuels) consortium supporting the European Commission in its dynamic and informed implementation of research and innovation projects in the field of sustainable alternative fuels for aviation. The project evaluates the research and innovation "landscape" in order to develop and implement a strategy for sharing information, for coordinating initiatives, projects and results and to identify needs in research, standardisation, innovation and deployment, as well as policy measures at European level.



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