# ALTERNATIVE FUELS FOR AVIATION. BEYOND ITAKA

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**Abstract.** The ITAKA project aimed to demonstrate the development of biojet in an economically, socially, and environmentally sustainable manner, improving the readiness of European technology and infrastructures. ITAKA has performed research and demonstration activities along the biojet value chain from production to its final use by the airlines in commercial operations, using conventional airport infrastructures and dedicated supply for testing flights.

Progress has been achieved for camelina and UCO as feedstocks, improving their readiness for Europe. At the refining phase, results show that there is potential to better adjust the parameters of the fuel to the needs of the aircraft. At aircraft-fuel systems level, tests on engine, APU and flights have provided information about performance and emissions, delivering interesting potential benefits as the reduction of frequency of maintenance or the mitigation of local pollutants.

Particularly relevant, ITAKA has provided the first worldwide demonstration of comingled use of biojet at an airport, providing key elements for the discussions about emissions trading, other than demonstrating the drop-in characteristics of the biojet and generating public awareness about the use of biojet at airports.

Interesting results have been gathered about the technical, operational and performance challenges and opportunities of using alternative fuels. Also, some gaps have been identified, especially related with the market situation that should be discussed to continue promoting the use of alternative fuels.

As a result, ITAKA outputs can be used by the scientific community as a basis for further research and for strategic decision making about alternative fuels for aviation agendas.

**Keywords: Biojet, alternative fuels, deployment, sustainability.**

## INTRODUCTION

The Initiative Towards sustAinable Kerosene for Aviation (ITAKA) is a collaborative project framed in the implementation of the European Union policies, implementation of European Industrial Bioenergy Initiative (EIBI) and specifically aims to contribute to the fulfilment of some of the short- term (2015) EU Advanced Biofuels Flight Path objectives.

The ITAKA project supports the development of aviation biofuels in an economically, socially, and environmentally sustainable manner, improving the readiness of existing technology and infrastructures. This has been achieved through a first of its kind collaborative project in the EU, which has developed a full value-chain in Europe to produce sustainable drop-in Hydroprocessed Esters and Fatty Acids at large scale.

The value chain was fully demonstrated by testing the use of the biojet fuel produced in existing logistic systems and in normal flight operations in the EU. ITAKA linked supply and demand by establishing a relationship under specific conditions between feedstock grower, biofuel producer, distributor and final user (airlines), encompassing the entire supply chain.

ITAKA links supply and demand by connecting the full value-chain: feedstock grower, biofuel producer, distributor and airlines.

ITAKA addressed challenges in two main areas:

- Development of commercial scale production and study implications of large-scale use.
- Research on sustainability, economic competitiveness and technology readiness.

The overall objective of ITAKA was to produce sustainable Synthetic Paraffinic Kerosene (SPK) at large scale in order to allow testing and demonstrating its use in existing logistic systems and in normal flight operations in Europe. The generated knowledge is aimed to identify and address barriers to innovation and commercial deployment.

Development and validation of biojet full value chain, starting from camelina oil provider to production plant, testing, blending, distributing and storing the fuel until the delivery to the end-user.

Sustainability, competitiveness and technology assessments have been performed, studying economic, social and regulatory implications of large-scale use.

Beyond these technological and research objectives, ITAKA is also contributes to the achievement of a further EU objective: the need to coordinate efforts and complementarities among European initiatives on sustainable aviation fuels, as highlighted during the Flight Path definition and identified in SWAFEA recommendations: "Setting up a knowledge and test capability network within the EU to provide an EU based fuel evaluation capability". ITAKA has been built aiming to engage key stakeholders and to make a first significant step in the establishment of such a European network; ITAKA is connected and collaborated with the main biojet fuel initiatives in Europe and worldwide.

## WORK PLAN

The ITAKA workplan covers all phases of the value chain for the implementation of the biofuels, from feedstock to final users:

1. Feedstocks: focused on camelina oil, this phase delivers adapted camelina varieties and crop protocols for its cultivation in Europe.

2. Energy: includes the production of biojet fuel, the innovations for the production in existing refineries, the assessment on waste oils and a model for the collection and elaboration of economic and financial data related to the refining technologies.

3. Logistics: this phase tackles all the issues regarding the delivery of the fuel, from the refinery to the final use, including the segregated distribution for specific tests but also the use in normal airports systems.

4. Aviation: this phase is focused in analyse the different effects and differences of the biojet fuel use in the aircraft fuel systems, but also to interact with the airlines to knowing their requests and needs regarding alternative fuels.

Finally, all these four blocks are integrated to improve the coordination and interfaces and also to assess the technological and sustainability performances.


Figure 1. Structure of the ITAKA work plan. The central element of the project is linking the different elements of the value chain for its integration under sustainability conditions.

**RESULTS**

All the experiences and research carried out have contributed to optimize the value chain performance in Europe. For clarity sake, the main results are showed in the Table 1.

Table 1. Main ITAKA results per value chain step

| Value chain step | Description of key result |
|---|---|
| Camelina oil production | • **4 camelina** large plantations deployed in Spain + 2 in Romania<br>• Selected and new camelina **varieties adapted** for Europe and with increased **oil content**<br>• Optimized camelina **growing protocols**<br>• new techniques for pre-processing **UCO** (Used cooking Oil) |
| Refining | • **Improved refining facilities** (new circulation line)<br>• Adapted **protocol** for in house **quality testing** |
| Logistics | • Better knowledge of the fuel logistics infrastructure: **different systems**, owners and operators and solutions for biojet, including new procedures for agreements and traceability.<br>• **1st worldwide use of biojet on an airport hydrant system** (Oslo airport) demonstrating normal use.<br>• **Blending accountability**: to be tracked based on chain of custody documentation on **mass-balance basis** for carbon trading and other mechanisms. |
| Aviation use | • **18 flights** AMS-AUA-BON [A330-200]: no detrimental effects on operation, similar or slightly better fuel consumption<br>• 2 APU tests for **pollutant emissions**: reduction in fuel flow, reduction in the SAE smoke number and possible reduction in PMs. No changes NOx or UHC.<br>• **80 flights** OSL-AMS [E190]: no detrimental effects on operation, similar or slightly better fuel consumption |
| Sustainability | • **GHG savings** estimated to achieve 60%, (66% as a standard value). EU RED RSB and RSB certification for the CCE camelina oil plantations.<br>• **Low ILUC risk assessment**: as camelina is produced in fallow land under rotation, no demand of additional land or substitution of crops.<br>• Several **sustainability checks**: RFS2 and SkyNRG sustainability board passed. |

## CONCLUSIONS

The main conclusions out from the ITAKA project are:

- There is potential for production of camelina oil as feedstock for sustainable biojet fuel in Europe, not enough to covering all the targets, but as a significant contributor.
- There are absolutely no negative effects from the use of the biojet in operations, including some main maintenance operations like in flight generated water drainage.
- The results indicate that greenhouse gases savings can go over 80% when using UCO and over 60% when using camelina oil as feedstock. While, some other pollutants like particulates (nvPMs) can be improved using synthetic fuels with a lower content in aromatics as the biojet.

Biojet production in the European Union faces some barriers and limitations, particularly regarding the market and the price gap, but it is technologically ready to produce and use biojet from the HEFA pathway.

## ACKNOWLEDGMENTS

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## REFERENCES

The detailed results summarized in this article can be found at *www.itaka-project.eu*.