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THE FRENCH AEROSPACE LAB

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Press Release

Onera-led SWAFEA study issues initial report at Toulouse conference
Aviation industry faces huge challenges in the use of alternative fuels, but expresses its commitment to following this path

Are alternative fuels the way forward for the aviation industry? Are they technically and economically viable? Are they acceptable from the standpoint of our environment and society as a whole? What are the investment priorities for R&D and deployment? These were just some of the main questions raised by the SWAFEA (Sustainable Way for Alternative Fuel and Energy in Aviation) conference held in Toulouse on February 9-10, 2011. Financed by the European Commission, SWAFEA is a 26-month study involving 18 partners[1] led by Onera, the French aerospace research center. Onera will submit its final report to the European Commission by the end of April 2011. The aim of this conference was to present initial results to all stakeholders in this sector, and to hold roundtable discussions on the key technical, environmental and economic issues. The main conclusion of this conference was that the aviation industry intends to go ahead with this ambitious program.

Proven compatibility between biofuels and today's aircraft engines

Today, two technologies are serious candidates for the short-term use of biofuels in aviation. The first, "biomass to liquid" (BtL), uses the Fischer-Tropsch process to convert any organic material, especially lignocellulosic plants, into a liquid fuel. The second is the hydroprocessing of vegetable oils, a process that involves eliminating the oxygen contained in these oils to convert them into a hydrocarbon. The fuels produced via these two processes may be mixed with conventional Jet A-1 fuel at a ratio of about 50-50. While the first process has been approved, the second is awaiting approval.

SWAFEA has studied other approaches, with the priority given to "drop in" fuels, i.e., those fully compatible with current systems. One possible solution is naphthenic compounds, which could be produced by the liquefaction of biomass.

Furthermore, since the quantity of biofuels available in the short run is limited, an initial deployment phase could be considered in which the biofuel accounts for only 20% of the total (instead of the targeted 50%). This lower content could also help relax several technical requirements, such as resistance to cold (-47°), and thus lower the cost of biofuel production. A specific standard will have to be defined in this case.

A real potential for reducing greenhouse gases

[1] Onera, Bauhaus Luftfahrt, German Aerospace Center (DLR), Altran, IFP, University of Sheffield, Airbus, Air France, CERFACS, CONCAWE, EADS-IW, Embraer, ERDYN, IATA, INERIS, INRA, Rolls-Royce (UK and Germany), Shell, Snecma.

Unlike fossil fuels, biofuels are made from plants. But these plants absorb carbon dioxide (CO2) during their growth. Without attaining perfect carbon neutrality over the entire life cycle, they will therefore significantly reduce releases of greenhouse gases (GHG).

The European directive on renewable energy stipulates that the transport sector should meet 10% of its energy needs with renewable sources by 2020. It therefore requires biofuels to offer a 60% reduction in greenhouse gases compared to fossil fuels, over their life cycle. This clearly shows how important it is to assess the overall impact of biofuels, from production to combustion.

SWAFEA's evaluations show that emissions throughout the entire life cycle of a biofuel are primarily related to growing biomass (fertilizers, diesel fuel for farm equipment, etc.). This implies that any introduction of biofuels, especially in aviation, demands particular attention to agricultural practices.

Another predominant factor is changes in land use. For instance, cutting down a forest and replacing the trees with annual plants would release a considerable quantity of greenhouse gases – to such an extent that it would take decades to offset the initial emissions. But the overall carbon budget may vary, and it may even become positive, depending on the plant initially grown, and its replacement.

While everybody agrees on the importance of evaluating biofuel emissions over the entire life cycle, several different evaluation methods can be used. The trends shown for a given crop are consistent, but the quantitative results may vary. In turn, this may cause problems in terms of complying with a regulation involving a quantitative threshold. However, it is hard to find a universally accepted method of analyzing the life cycle. What is important is to be transparent about the choices made, according to several experts, including the representative of the Roundtable for Sustainable Biofuels, an organization that has already drawn up environmental certification criteria.

The SWAFEA study also addresses the question of the atmospheric impact of biofuel combustion. Several tests have been carried out on engines using a 50% biofuel mixture, and they spotlight a decrease of 30 to 50% in soot emissions. In particular, soot leads to the formation of contrails. The preliminary results of the SWAFEA study show that the decrease in soot emissions would make contrails less opaque, and therefore decrease their impact on the climate. Furthermore, decreasing soot emissions improves air quality around airports.

Wanted: new sources of biomass and new conversion processes

The aviation sector wants to continue growing after 2020 without increasing CO2 releases. Initially, it could achieve this goal through economic measures such as carbon credits. But by 2050, some 52% of the biomass potentially available for non-food requirements would have to be converted into fuel to meet this goal, according to an evaluation by SWAFEA. This evaluation is based on current conversion processes and traditional biomass from farming, agricultural waste, forests, etc. The calculation takes into account the fact that only part of the biofuel produced would be useful for aircraft, with the remainder used on other types of transportation, such as cars.

Biomass production will have to be increased at a very sustained pace if we want to stabilize emissions from aircraft at their 2020 level starting in 2030 (assuming traffic growth of about 4% per year). Without new production channels, it is unlikely we will be able to meet this goal in 2030.

It is therefore important to develop new sources of biomass, as well as new conversion processes. The biomass to liquid (BtL) process offers a low conversion yield (about 25%), which means it is a net consumer of biomass, and we have to find other, more efficient processes. However, there are certain physiological limits.

Algae could be an interesting new source of biomass. In fact, some types of micro-algae may be used as raw material in the vegetable oil production process, without taking up arable land. However, it will undoubtedly take another dozen years before we can bring this process from the lab to the market, thus confirming the industrial potential of algae.

Multibillion euro investment needed to limit emissions to their 2020 level

If BtL technology is used, then some 400 billion euros would be needed, including 100 billion euros for the aviation sector alone. In Europe alone, we would have to build four new BtL production units every year from now to 2050.

Several economic scenarios were considered. The initial assumptions take into account the European Trading Scheme (ETS) CO2 exchange, and potential mandated quotas. It would take a long time to achieve a return on this investment, from 10 to 26 years.

What this means is that the development of biofuels for aviation will also have to depend on improving the cost-effectiveness of conversion processes. The cost of biomass production is also a decisive factor.

Proactive support policy needed

Are biofuels for aircraft the best way to use biomass? It will be up to our political leaders to answer this question. The SWAFEA study spotlights major difficulties in this regard, including the fact that other applications are in competition with aviation, including electrical power plants and the production of bioplastics.

However, the air transport sector does have some points in its favor. First, its requirement for liquid fuel is more critical than for other transport modes. Secondly, the public will undoubtedly have a hard time accepting the aviation industry as the only sector not to reduce its GHG.

If the aviation sector wants to significantly reduce CO2 emissions, it has to start deploying biofuels right now.

International partnerships are undoubtedly necessary. For example, the study suggests the creation of a European network of excellence in aircraft biofuels. The United States is open to partnerships, preferably building on existing links. Brazil, which has long been at the cutting edge for biofuels, is also open to partnerships – but makes no secret of the fact that many suitors are eyeing its industry.

Players in the sector now want a long-term, motivating policy. The study suggests mandatory quotas for the use of biofuels, at least to get things going. However, as underscored by the European Commission, the outlook revealed by SWAFEA still falls short of European objectives to reduce greenhouse gases by at least 80% by 2050. According to the study, we have to actively support different channels for research and innovation to accelerate progress.

In addition to this study, Onera has already been working for several years on different projects concerning the use of biofuels and other alternative fuels in aviation. For example, Onera participated in the Calin project (alternative fuels and innovative injection systems), which was completed in May 2010 and supported by Aerospace Valley. Examining a selection of alternative fuels, the Calin project studied the behavior of chosen fuels in relation to the baseline fuel, Jet A1.

Another project facet concerned the production of esters using a microbial channel. Starting with a substrate, microbial conversion results in fatty acids, which are then processed with enzymes to produce esters. This is a highly promising production process, because it does not compete with foods, and production yields are very good.

Teaming up with IFP Energies Nouvelles, Onera is also evaluating the physical and chemical properties of a mixture of Jet A1 with new biofuels. Key parameters are being studied, including the cold-resistance of these fuels, their thermal stability, and their compatibility with current aircraft engines.

At the European level, Onera is also involved in Alfa Bird (Alternative Fuels and Biofuels for Aircraft Development), a four-year project launched in July 2008. Complementing SWAFEA, this project focuses on the experimental characterization and physical modeling of alternative fuels, while also investigating environmental and economic aspects.

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About Onera

Onera is the leading aerospace and defense research organization in France. A public establishment created in 1946, it reports to the French Ministry of Defense. Onera has over 2,000 employees at eight major facilities, including 1,500 scientists, engineers and technicians, of which 220 are doctoral candidates and post-docs.
Building on its multidisciplinary expertise and a world-class fleet of test facilities, Onera works for both government and industry, spanning major corporations and small businesses. Onera deploys an innovative partnership-based approach to research, with five times more contract business per researcher than the average in France. In 2009, Onera had revenues of 210 million euros. Onera is a recognized source of innovative solutions, technical expertise and long-term design vision, paving the way for tomorrow's programs. Onera has contributed to some of today's most successful aerospace and defense programs, including the Ariane 5 launcher, Airbus jetliners, Eurocopter helicopters, the Rafale fighter and the Falcon 7X business jet.

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