Coordinating research and innovation in the field of sustainable alternative fuels for aviation

WP3: International Expert and Stakeholder Exchange

Due date:	31.10.2015
Actual submission date:	07.09.2016

Grant Agreement no.:	FP7-605716
Call identifier:	FP7-AAT-2013-RTD-1

Information submitted on behalf of CORE-JetFuel

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This project has received funding from the European Union's Seventh Programme for research technological development and demonstration under grant agreement No 605716

Coordinating research and innovation in the field of sustainable alternative fuels for aviation

D3.12: Report on final international conference

SUBMITTED VERSION 1.0

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Work Package: 3
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PROJECT PARTNERS

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BHL – Bauhaus Luftfahrt e.V., Germany

SENASA - Servicios y Estudios para la Navegación Aérea y la Seguridad Aeronáutica SA, Spain

IFPEN – IFP Energies Nouvelles, France

WIP- WIP Renewable Energies, Germany

AGI – Airbus Group Innovations

EXECUTIVE SUMMARY

On occasion of the EU Sustainable Energy Week (EUSEW) the CORE-JetFuel project organized its final international conference taking place in Brussels on 16th and 17th of June 2016.

The aim of this conference was to present outcomes and policy recommendations to representatives of the European Commission, industrial decision makers and other public and private stakeholders, as well as gathering final information for the elaboration of reports on recommendations. This event included discussion panels and feedback sessions to gather comments and suggestions from stakeholders, which are integrated in the final reporting and recommendations of the CORE-JetFuel project.

Apart from presentations by representatives of the European Commission and the FlightPath 2020 Initiative, the first conference day introduced a variety of national initiatives engaged in the field of alternative aviation fuels. The subsequent panel discussion addressed potential ways forward, for example centrally coordinating the initiatives at European level, focusing on stronger cooperation between them, but also with the industry. In general, the current low oil price is a major hindering factor in the large-scale deployment (and production) of alternative aviation fuels. Furthermore, instead of relying on large public support, smart ways to create self-sustaining business cases need to be developed.

In line with the project structure, the second conference day was organized in four different thematic sessions covering the entire production chain of alternative aviation fuels, ranging from suitable feedstocks and their sustainability, over conversion technologies, certification and deployment to political framework conditions. In each session, project results were presented by the CORE-JetFuel partners, subsequently to which an invited presentation supplementing the respective topics was held. In the four panel discussions of the day, the presented results as well as questions prepared by the CORE-JetFuel Consortium were discussed with the panelists and the auditorium.

This conference marked the successful final event of the CORE-JetFuel project, examples of the main conclusions drawn in the different panels are:

- Coordination on European level through the establishment of a joint platform is needed in order to move towards deployment of alternative aviation fuels (i.e. to “get things done”)
- Place quality over quantity and avoid targets or mandates potentially leading to unsustainable practices.
- Experiences on alternative jet fuel production need to be made instead of trying to find “perfect solutions”.
- For successful ASTM certification it is important to establish good cooperation with OEMs (Original Equipment Manufacturers), as air safety cannot be compromised.
- The existing price gap may be addressed by de-risking investment, appropriate credits for environmental benefits, and public money/investment.

TABLE OF CONTENT

Document Information

Project Title	CORE-JetFuel
Deliverable nature	R
Dissemination Level	PU
Start Date of the Project	01.09.2013
Duration	36 months
Contractual Delivery Date	31.10.2015
Actual Delivery Date	07.09.2016
Status	Submitted
Contractual	Yes
Version	1.0
Total Number of Pages	51
Work Package Number	3
Work Package Leader	WIP
Lead Beneficiary of Deliverable	WIP

LIST OF ABBREVIATIONS

C-JF	CORE-JetFuel - Coordinating research and innovation in the field of sustainable alternative fuels for aviation
ACARE	Advisory Council for Aviation Research and Innovation in Europe
AF	Advanced Fermentation
Aireg	Aviation Initiative for Renewable Energy in Germany e.V.
ASTM	American Society for Testing and Materials
AtJ	Alcohol-to-Jet
BtL	Biomass-to-Liquid
CAAFI	Commercial Aviation Alternative Fuel Initiative
CAEP	Committee on Aviation Environmental Protection
CAER	Carburants alternatifs pour l'aeronatuique
CapEx	Capital Expenditure
CCE	Camelina Company España
CO_2	Carbon Dioxide
CTRL	Conversion Technology Readiness Level
DG	Directorate General
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DSHC	Direct Sugar to Hydrocarbon
e.g.	for example
EC	European Commission
EIA	US Energy Information Administration
EIT	European Institute of Innovation and Technology
ENAC	Italian Civil Aviation Authority
EROI	Energy Return on Investment
ETS	European Trading Scheme
EUSEW	EU Sustainable Energy Week
FAA	Federal Aviation Administration

FAO	Food and Agriculture Association of the United Nations
FQD	Fuel Quality Directive
FSRL	Feedstock Readiness Level
FT	Fischer Tropsch
GHG	Greenhouse Gas
GMBM	Global Market-Based Measure
GREET	Greenhouse gases, Regulated Emissions, and Energy use in Transportation
HDCJ	Hydroprocessed Depolymerized Cellulosic Jet
HEFA	Hydroprocessed Esters and Fatty Acids
HFP	High Freezing Point
HVO	Hydrotreated Vegetable Oils
i.e.	it est
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
iLUC	Indirect Land Use Change
ISAFF	Italian Sustainable Aviation Fuel Forum
ITAKA	Initiative Towards sustAinable Kerosene for Aviation
KIC	Knowledge and Innovation Communities
LCA	Lifecycle Analysis
MAC	Minimum Abatement Costs
MCA	Multi-Criteria Approach
MEC	Maabjerg Energy Concept
MS	Member State
Mt/a	Million Tonnes per year
NGO	Non-governmental Organization
NISA	Nordic Initiative for Sustainable Aviation
NREL	National Renewable Energy Laboratory
OEM	Original Equipment Manufacturer

OpEx	Operational Expanditure
PM	Particulate Matter
PtL	Power-to-Liquid
R&D	Research and Development
R&I	Research and Innovation
RE	Renewable Energy
RED	Renewable Energy Directive
RFS	Renewable Fuel Standard
RHC	Renewable Heating & Cooling
RSB	Roundtable on Sustainable Biomaterials
RSPO	Roundtable on Sustainable Palm Oil
SAFF	Sustainable Aviation Fuels Forum
SAFUG	Sustainable Aviation Fuel Users Group
SAJF	Sustainable Alternative Jet Fuels
SDG	Sustainable Development Goals
SIP	Synthesized Iso-Paraffins
SKA	Synthetic Aromatic Kerosene
SPK	Synthetic Parrafinic Kerosene
SRC	Short Rotation Coppices
StL	Sun-to-Liquid
TRL	Technology Readiness Level
UCO	Used Cooking Oil
UCO	Used Cooking Oil
UN	United Nations
WtW	Well-to-Wake

Final International Conference

Sustainable Alternative Aviation Fuels – The Way Forward

16-17 June 2016 in Brussels

on the occasion of the EU Sustainable Energy Week (EUSEW) 2016

CONFERENCE SUMMARY

CORE-JetFuel is co-funded by the European Commission in the 7th Framework Programme (Project No. FP7-605716) – www.core-jetfuel.eu

1 Conference Background

This conference took place on occasion of the EU Sustainable Energy Week (EUSEW) and followed up on a series of successful CORE-JetFuel events, namely the Sustainable Aviation Fuels Forum (SAFF) on 20-22 October 2014 in Madrid, the CORE-JetFuel Workshops on 1 June 2015 in Vienna and the CORE-JetFuel Strategy Workshop in Berlin on 29 October 2015.

This event was organised in the framework of the project CORE-JetFuel (www.core-jetfuel.eu). The CORE-JetFuel project supports the EC in its dynamic and informed implementation of research and innovation projects in the field of sustainable alternative fuels for aviation. CORE-JetFuel addresses competent authorities, research institutions, feedstock and fuel producers, distributors, aircraft and engine manufactures, airlines and NGOs. The project is aimed to set up a European network of excellence for alternative fuels in aviation that brings together technical expertise from all across this complex thematic field and helps to coordinate R&D, as well as implementation efforts.

The aim of this conference was to present outcomes and policy recommendations to representatives of the European Commission, industrial decision makers and other public stakeholders, as well as gathering final information for the elaboration of reports on recommendations. This conference included discussion panels and feedback sessions to gather comments and suggestions from stakeholders, which will be integrated in the final reporting and recommendations of the CORE-JetFuel project.

Conference Organisation

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Conference Summary

Presentations: R. Janssen, D. Rutz, WIP Renewable Energies

Panel discussions: R. Janssen, D. Rutz, WIP Renewable Energies, J. Michel, FNR, A. Sizmann and A. Roth, Bauhaus Luftfahrt, A. Quignard, IFPEN, M. de la Rica Jiménez, SENASA

Conference Presentations

Presentations are available at the website: http://www.core-jetfuel.eu/nav/events4.aspx

CONFERENCE SUMMARY

DAY 1 – 16 JUNE 2016

2 Opening Session

The CORE-JetFuel Final International Conference "Sustainable Alternative Aviation Fuels – The Way Forward" in Brussels on 16-17 June 2016 was opened by **Rainer Janssen**, WIP Renewable Energies.

This CORE-JetFuel event is a follow-up on three successful CORE-JetFuel workshops, namely the Sustainable Aviation Fuels Forum (SAFF) in Madrid on 20-22 October 2014, the CORE-JetFuel Stakeholder Workshop "Sustainable Alternative Aviation Fuels - Innovative conversion technologies and deployment" in Vienna on 1 June 2015 and the CORE-JetFuel Strategy Workshop "Policies and Value Chains for Large-scale Deployment of Alternative Aviation Fuels" in Berlin on 29 October 2015.

Johannes Michel, coordinator of the CORE-JetFuel project, Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany presented an overview of activities and results of the project. Mr. Michel first introduced to the auditorium the main objectives of the project, namely to:

- Develop and implement a strategy for sharing information, for coordinating initiatives, projects and results,
- Identify needs in research, standardisation, innovation and policy measures at European level,
- Evaluate the research and innovation “landscape” with collection of the lessons learned in order to support decision makers in setting priorities for the European funding strategy.

The CORE-JetFuel working methodology consists of ***collection*** (information gathering), ***mapping*** of data and results from identified projects, as well as ***analysis/evaluation*** of gathered information and mapped projects/technology pathways. In order to evaluate the performance of the identified bio-jet production pathways, a multiple-criteria approach (MCA) is applied. This MCA makes up the three key (“high-level”) criteria of alternative aviation fuels, namely Suitability (e.g. “Drop-in” capability), Scalability (e.g. production potential), and Sustainability (e.g. GHG Emission reduction potential).

After presenting current project results with respect to the four thematic domains (feedstock & sustainability, conversion technologies, deployment & certification, policies & regulations), Mr. Michel highlighted the importance of stakeholder feedback within this conference in order to gather comments and suggestions from stakeholders, which will be integrated in the final reporting and recommendations of the CORE-JetFuel project.

An overview on renewable fuels for aviation was presented by **Remy Denos**, DG ENERGY, European Commission. Mr. Denos first stated the current very low level of achievement towards the target of 2 million tons (i.e. ~4% of current volumes) of biofuels blended with kerosene per year by 2020 introduced by the European Advanced Biofuel Flight Path Initiative.

In order to identify opportunities for the way forward towards enhanced deployment of alternative aviation fuels, a number of important questions need to be addressed, namely:

- How to establish a stable and sustainable framework for investments?
- How to finance the extra cost of renewable fuels?
- How to include biofuels for aviation in EU Member State legislation?
- How to overcome fragmentation in the EU?
- How to move from EU ETS to Global Market-Based Measures (GMBM)?
- How to deal with, guarantee and harmonize sustainability?
- How to establish logistics chains?
- How to improve the image of biofuels?

The present EU climate and energy policy with its ***targets for 2030*** (40% GHG emission reduction (compared to 1990, binding), 27% share of Renewable Energy (binding at EU level only, no sub-target for transport), 27% improvements in energy efficiency) may not be sufficient to establish a suitable framework for investments in advanced aviation fuels. Furthermore, most Member States are still focussing on road transport and future developments on alternative aviation fuels will most likely depend on action and leadership of a few Member States.

In comparison with the USA, activities on alternative aviation fuels are fragmented in Europe. US initiatives are jointly developed by the Federal Aviation Administration (FAA) and the Departments of Energy, Agriculture and Defense with the support of the Commercial Aviation Alternative Fuels Initiative (CAAFI). In Europe, however, the cooperation and coordination between different Directorate Generals of the European Commission is limited.

In the discussion following Mr. Denos's presentation it was emphasised that targets for alternative aviation fuels shall be realistic and not overly ambitious in order to learn from experiences in the road transport sector.

There was disagreement among conference participants about the "level of understanding" on ILUC effects. While it is obvious that ILUC effects exist for so-called first generation biofuels that may significantly reduce potential GHG benefits, the approach to exclude these types of feedstock may be too general. In order to embrace the complexity of biofuels production it was recommended to improve sustainability performance by rewarding good practices (that may then be replicated) in addition to further modelling initiatives to deepen the understanding of ILUC.

With respect to international harmonization of sustainability standards, which are urgently needed for the global aviation sector, it was stated that a sustainability framework is currently being developed in the framework of the International Civil Aviation Organization (ICAO).

2.1 European and National Initiatives on Alternative Aviation Fuels – The Way Forward

An overview of the European Flightpath Initiative was provided by **Alexander Zschocke**, Lufthansa Group. The initiative was jointly launched in 2010 by major stakeholders from the aviation and biofuels industry in cooperation with the European Commission in order to create functioning supply chains for biokerosene.

Activities of the European Flightpath are based on member representatives with personal experiences in biokerosene projects and mainly focus on information exchange and the initiation of research activities. The Flightpath thereby aims to identify and address obstacles to biokerosene production on topics such as feedstock supply, production capacity and post-production issues.

At time of initiation of the European Flightpath in 2010, the only certified biokerosene production pathway was the Fischer-Tropsch (FT) process. As FT processes were expected to remain the only biokerosene pathway for the foreseeable future, the 2011 Flightpath document strongly focussed on this technology.

However, the following years showed the emergence and certification of a number of other promising technologies (HEFA (Hydroprocessed Esters and Farry Acids) approved in 2011, SIP approved in 2014, FT with aromatics from coal approved in 2015 (fossil based fuel), Kerosene from iso-butanol (ATJ) approved in 2016) and several further technologies are currently in the certification pipeline. On the other hand, limited progress was achieved in the field of FT-based biokerosene production. The main reasons for the limited progress are large (and not fully resolved) challenges concerning biomass gasification as well as the high investment costs for production plants.

Therefore, all future planning on alternative aviation fuels needs to be 'technology neutral' (i.e. not exclusively focus on specific technology approaches).

With respect to feedstock supply the launch of the European Flightpath coincided with the start of the sustainability debate. Initially there was much hostility by NGOs towards biokerosene and public perception was shaped by food-vs-fuel concerns. Due to on-going discussions and concerns about ILUC, airlines moved to source non-food, low-ILUC feedstock as indicated in the so-called SAFUG (Sustainable Aviation Fuel Users Group) pledge (see: www.safug.org/safug-pledge/) and focus was placed on feedstock such as jatropha, camelina and pongamia, regarding the HEFA pathway. However, as yields of such crops in early development phases were often disappointing and considering that within the revised RED all oil crops are treated equally, airlines today have the tendency to move away from crops towards waste and other materials.

In conclusion, Mr. Zschocke underlined that solutions for aviation need to be fully integrated into the European energy and climate strategy until 2030. There has been increasing pressure on aviation to contribute to CO_2 reduction including the industry goal to reduce emissions by 2050 to 50% of 2005 figures. Thereby, CO_2 reduction by aviation has to take into account biokerosene as commercial aviation will certainly be dependent on liquid fuels beyond 2050.

The Nordic Initiative for Sustainable Aviation (NISA) was presented by **Martin Porsgaard**. NISA was established in 2014 as an active Nordic association working to promote and develop a more sustainable aviation industry, with a specific focus on alternative sustainable fuels for the aviation sector. NISA actors and dialogue partners are a number of airlines in the Nordic region as well as the largest airport owners in Denmark, Finland, Norway and Sweden. Aviation industry organizations in those countries, the respective aviation authorities and IATA, Boeing and Airbus are also active participants in the initiative.

The goal of NISA is to promote the framework and conditions for access to new fuels and to stimulate innovation and new green jobs, attracting solid investments and contributing to the region's position as a leader in global green growth. NISA's-specific activities at national, Nordic and international level in the coming years will focus on:

- Systematic overview of ongoing initiatives (feedstock, technologies, R&D, production);
- Overview of relevant actors: key stakeholders in the Nordics, supplemented with global inputs;
- Coordination and facilitation of initiatives and activities across countries, companies, researchers;
- Establishment of relevant partnerships;
- Customer requirements for biofuels in the Nordics;
- Logistics, transport and storage overview and recommendations;
- Regional focus for innovation in advanced sustainable biofuels for the aviation industry;
- Strategic input to decision makers at airports, industry and governments on alternative pathways that may be pursued to promote the development of competitive sustainable fuel;
- Economics and pricing;
- Assessment on barriers to advancing sustainable fuels in the Nordics.

Mr. Porsgaard presented an overview of the current status and future perspectives of alternative aviation fuels in Denmark, Finland, Sweden, Norway and Iceland. He underlined that aviation is considered as the most important polluter in Scandinavia (public perception).

Advantages within the Nordic region include the vast forest resource with a well-established industry and infrastructure, strong competencies and technical know-how with regards to utilization of forest biomass, strong competencies in fermentation and enzymatic technologies, existing commercial scale facilities for HEFA production, as well as the high willingness of airlines and airports to introduce biofuel in aviation.

However, current main challenges include the lack of congruent sustainability requirements, lack of political support, business barriers such as the high price gap between fossil and sustainable jet fuels and competing uses for (forestry) feedstock often leading to the production of other higher value products.

2.2 Panel on "European and National Initiatives on Alternative Aviation Fuels – The Way Forward" - Introduction

Moderation

- Rainer Janssen, WIP Renewable Energies

Panelists:

- Remy Denos, European Commission, DG Energy
- Martin Porsgaard, NISA, Denmark
- Sierk de Jong , SkyNRG, Netherlands (Bioport Holland Initiative)
- Manfred Aigner, Aviation Initiative for Renewable Energy in Germany (aireg) President
- Francesco Sepe, ENAC, Italian Representative
- Inmaculada Gomez Jimenez, SENASA, Bioqueroseno Initiative, Spain

Brief presentation of National Initiatives

This panel discussion was launched with a brief introduction of the panelists and the respective national initiatives. An overview of the EC perspective and NISA had already been presented by **Remy Denos** and **Martin Porsgaard** in the previous session and was therefore not repeated in the panel.

The **Spanish Bioqueroseno** initiative was represented by **Inmaculada Gomez Jimenez** from SENASA. This Spanish Initiative for the Production and Consumption of Bio-kerosene for Aviation is a national program, led by the Spanish government involving actors from the full value chain in a public-private partnership. The development of the initiative is foreseen in three stages:

- Feasibility Study (2010-2012): pre-analysis of the environmental, social and economic feasibility of the production chain and consumption of biokerosene.
- Demonstration (2012-2013): to develop the demonstration of the most promising processes in line with the results of the feasibility study, including feedstock scale-up, analysis of grain, oil and biokerosene transport and a biojet fuel demonstration plant.
- Implementation (2014 onwards): to develop the implementation and temporary scaling of the biokerosene production process.

The initiative is strongly involved in the implementation of the ITAKA project and provides a framework for information exchanges among National Authorities and stakeholders. It facilitates both synergies between industrial partners and connection with other international initiatives which aim at developing the production and consumption of bio–kerosene.

National initiatives in Italy in the field of alternative aviation fuels were represented by **Francesco Sepe** from the Italian Civil Aviation Authority (ENAC). Mr. Sepe stated that the **Italian Sustainable Aviation Fuel Forum (ISAFF)** is currently not active, mainly due to economic challenges faced by alternative aviation fuels and the lack of coherent political support on European and national level.

Presently the main Italian lead initiative in the field is the European FP7 project **BIOREFLY** (www.biorefly.eu) aiming at an industrial scale demonstration biorefinery on lignin-based aviation fuels by the industry player Biochemtex.

Manfred Aigner from DLR introduced the audience to the **Aviation Initiative for Renewable Energy in Germany e.V. (AIREG)**, an initiative set up 5 years ago by air carriers, airports, research institutions as well as the aviation industry and other partners. The headquarters are located in Berlin. The aim of AIREG is to promote the development and use of renewable liquid fuels in order to help achieve the carbon reduction targets of the aviation sector. AIREG is looking to replace 10% of the German jet fuel demand with sustainable, alternative aviation fuels by 2025.

Germany with its leadership position in research and technology is engaging in a large number of projects along the entire alternative jet fuel value chain. AIREG supports these activities through stakeholder involvement and public relations. Furthermore, Mr. Aigner emphasized that AIREG is not focused on national solutions, but open to global members. Internationally, AIREG is monitoring the **ICAO/CAEP** process towards a global market-based measure (GMBM) to reduce aviation's carbon emissions. These negotiations offer an important opportunity to stipulate alternative aviation fuels as a cornerstone of the industries' climate action.

The Dutch Initiative '**Bioport Holland'** was represented by **Sierk de Jong** from SkyNRG. Bioport Holland is a joint initiative of key stakeholders from the public and private domain in the Dutch aviation and biofuels industry: KLM, SkyNRG, Schiphol Airport, Neste Oil, Port of Rotterdam, the State Secretary of Infrastructure and the Environment and the Minister of Economic Affairs.

The initiative's stakeholders believe that the use of biofuels is the most important pathway for aviation to address the global challenge of climate change and achieve the sector's ambitious goals for greenhouse gas emissions reduction. In order to significantly increase the amounts of bio jet fuel available in the years ahead, the central objective is to create a sustainable biofuel market in the Netherlands and in Europe, and to set-up whole supply chains, which comply with strict environmental, economic and social sustainability criteria.

Thereby, the vision of 'Bioport Holland' focusses on the successful establishment of full sustainable supply chains for alternative aviation fuels, a significant expansion of the volume of produced fuels using sustainable feedstock supply, as well as an expansion of the technology portfolio for the production of alternative aviation fuels.

Introduction to the Panel Discussion

In order to kick-off the panel discussion **Rainer Janssen**, WIP Renewable Energies briefly presented the following guiding topics:

- Working towards common policy positions by EU Member States (MS) through coordination of national initiatives on alternative aviation fuels
- Identifying lessons learnt from existing successful national initiatives in EU MS
- Strengthening of partnerships among all relevant actors of the aviation sector (fuel producers, airports, airlines, aircraft producers, civil aviation authorities)
- Means to overcome the barrier of high fuel price for deployment

2.2.1 Panel Discussion on "European and National Initiatives on Alternative Aviation Fuels – The Way Forward"

Topic A: Coordination of national initiatives

Cesar Velarde

- Europe needs to learn from coordination efforts in the USA where initiatives are jointly developed by the Federal Aviation Administration (FAA) and the Departments of Energy, Agriculture and Defense with the support of the strong national platform CAAFI.

Inmaculada Gomez

- More coordination is currently needed on European level, as for instance the cooperation between the Spanish Bioqueroseno initiative with the European Flightpath is very limited.
- The future European Flightpath shall ensure the active involvement of national initiatives.

Francesco Sepe

- More coordination is needed among authorities (e.g. Civil Aviation Authorities) on European level.

Manfred Aigner

- The formation of a strong European "cooperation roof" is urgently needed. The existing Flightpath Initiative could be a good starting point.

Sierk de Jong

- Coordination on European level through the establishment of a joint platform is needed in order to move towards deployment of alternative aviation fuels (i.e. to "get things done").

Remy Denos

- A tender was recently launched to support coordination on European level (building upon the European Flightpath Initiative) over the next 4 years with a budget of 2.5 million EUR. The aim of this tender is to provide operational and strategic support to the core team of the Flightpath.
- Activities within this tender shall also assist to bring together MS in order to develop common positions in the field of alternative aviation fuels. At present, MS support for alternative aviation fuels is very limited.

Topic B: Lessons learnt from existing successful national initiatives

Manfred Aigner

- Within 5 years AIREG succeeded in establishing a strong network for the promotion of alternative aviation fuels. This experience shall be replicated on European level based on a group of active and engaged people from important stakeholders with good existing working relationships.

Sierk de Jong

- In the Netherlands renewable aviation fuels are allowed to contribute to the 10% target specified in the RED. According to a recent study this experience could be implemented in six other MS including Spain, Italy and Germany.

Martin Porsgaard

- Strong cooperation of the national initiatives with national authorities (as implemented within NISA) needs to be ensured.

Remy Denos

- Compared to the USA the political and strategic importance attributed to alternative aviation fuels in Europe is limited. This fact is indicated by the limited time and resources allocated to this topic within EC DGs and lack of support on MS level.

Robert Malina, MIT

- The present achievements and success of alternative aviation fuels were triggered by large public investments in order to kick-start industrial involvement and to create promising business cases. The establishment of initiatives such as CAAFI may strongly support the development of alternative aviation fuels, but it is not a sufficient pre-condition.

Maarten van Dijk, SkyNRG

- During the past 5 years a lot has been achieved on alternative aviation fuels in Europe. Focus needs to be placed on action based on good practice experiences through close cooperation between industry and (national) Governments.

Topic C: Strengthening partnerships

Martin Porsgaard

- Due to the large number of players involved the question of 'ownership' and responsibilities among different stakeholders needs to be addressed.

Manfred Aigner

- Long-term commitments of stakeholders from industry and Government are needed. Project level involvement of actors is not sufficient.

Topic D: Means to overcome the barrier of high fuel price for deployment

Manfred Aigner

- Due to the current low oil price, industry is facing high economic barriers despite their willingness to get involved in alternative aviation fuels. Governmental support is needed to overcome the current economic barriers.

James Beard, WWF

- Cooperation between international industry players is needed to account for potential benefits of alternative aviation fuels.

Inmaculada Gomez

- Due to the present economic situation it may be difficult to receive large public support for alternative aviation fuels. Clever ways to develop self-sustaining business cases need to be developed.
- Funds sourced by carbon taxes (e.g. 40 EUR/t) could be used to support deployment initiatives.

Remy Denos

- Experiences in other renewable energy sectors (e.g. wind, PV) show that technological learning can achieve cost parity with fossil energy options. Bold European energy policies are needed to reduce the large dependency on imported fossil fuels and the associated high energy import costs.

Maarten van Dijk, SkyNRG

- Renewable aviation fuels will remain to be more expensive (about 1 EUR/l) than fossil based fuels. However, societal benefits (e.g. through jobs, innovation, rural development) may be higher than the cost differential.

Sierk de Jong

- Even though cost reductions by technological learning may be limited, there are still opportunities to reduce costs within the full value chain.
- Means to stimulate alternative aviation fuels deployment include CAPEX loans, landing fees and public co-funding of production facilities.
- Regulatory measures to promote alternative aviation fuels need to be implemented on global level (such as activities by ICAO/CAEP).

DAY 2 – 17 JUNE 2016

3 Session 1 – Feedstock and Sustainability

In his introductory presentation for session 1 on "Feedstock and Sustainability" **Johannes Michel**, FNR presented outcomes and policy recommendations elaborated in the framework of the CORE-JetFuel project.

CORE-JetFuel activities in the field of feedstock and sustainability included the analysis & evaluation of the **European R&D portfolio** in feedstock production, the analysis of different types of feedstock with respect to their **sustainability** of cultivation and further processing (i.e. GHG balance, impact on local biodiversity, risk of inducing LUC/ILUC), the assessment of sustainable production potential in Europe, as well as an analysis and evaluation of **certification schemes.**

Assessed feedstock types included oils and fats (e.g. microalgae, UCO (Used Cooking Oils), camelina), lignocellulosic feedstock (e.g. SRC (Short Rotation Coppices), switchgrass), and wastes and residues from agriculture and forestry. For camelina, selected results show advantages with respect to cultivation on marginal land (low-ILUC), low irrigation and fertilizer requirements, high technical maturity of cultivation, and its suitability for well-established conversion technologies. Drawbacks exist regarding current low production potential. Advantages of SRC include their abundant availability, no competition with food production, and low fertilizer requirements whereas barriers exist due to high water requirements, low incentives for farmers and a comparatively low yield.

With respect to feedstock availability studies predict a very large geographical (theoretical) potential for microalgae (49 Mt/a) contrasting with the current low total production of 9.200 tons per year (food and feed). For agricultural residues a total production potential of 315 Mt/a (dry basis) is reported leading to a sustainable availability for biofuel production of 84.6 Mt/a. For forestry residues the total production potential of 67.59 Mt/a (dry basis) results in sustainable availability for biofuel production of 9.23 Mt/a.

In conclusion, the following recommendations were highlighted:

- Need for R&D projects that assess the **sustainable feedstock availability** in Europe and its **geographical distribution**
- Decrease **costs** of feedstock cultivation/production and logistics
- **Overall strategy** for feedstock prioritization between application sectors / make use of potential synergies
- Adopt **sustainability certification** schemes/standards to the regional character of feedstock production, avoid multiple certification

In the discussion after the introductory presentation the following issues were raised:

- SRC may lead to ILUC and competition with food production due to competition over land.
- Competing uses of (agricultural) residues exist for e.g. animal feed and heating, especially in developing countries.
- High GHG emission values calculated for microalgae result from high fertiliser and energy input requirements.

- Camelina may be used in intercropping schemes as well as on marginal and even degraded/polluted lands and thus create additional income for farmers and serve to improve the quality of soils (according to ITAKA results in Romania).
- Camelina business cases for farmers have been elaborated within the ITAKA project (for marginal, polluted as well as agricultural land).
- Oil yields for camelina show a large range in different regions. Improvements are still needed with respect to yield increases, agricultural practices and the development of business cases as camelina is still a rather "new" crop for farmers.
- The necessity of additional studies on feedstock potential was questioned due to the large number of existing studies.
- Strategies for feedstock prioritisation may be needed, however allowing sufficient flexibility for stakeholders and business cases.

Daphne Lorne from IFPEN, France gave an invited presentation on "Feedstock and sustainability for biojet deployment - A multi-criteria approach from CAER project". Activities are performed in the framework of the French 2011-2016 project "Alternative Fuels for AERonautics (CAER)" involving the technical partners CNRS, INRA, INRIA, IFPEN (project coordinator), TOTAL, AIRBUS Group Innovations, SAFRAN, AIR FRANCE, and DASSAULT.

The CAER project follows an integrated approach from biomass resource assessment and processing up to usage and fuel certification issues and includes economic and environmental assessment of biojet pathways, the biojet market potential regarding public policy constraint and competition on energy usage of resources.

Biojet production pathways investigated within CAER include vegetable and algae oil for HEFA production, sugarcane for SIP production, and lignocellulosic biomass for FT processes.

Economic assessments for biojet production from oils and fats revealed that vegetable oil accounts for more than 85% of HEFA production cost. Considerable price variability exists regarding type of crop and energy price index with waste oil feedstock leading to higher profitability, but limited availability. High potential may exist from algae/yeast oil, but production is still far from economic competitiveness. For FT biojet from lignocellulosic biomass feedstock costs (at 100 EUR/t DM) account for about 50% of the production costs.

In conclusion, Mrs Lorne stated that in a context of globalised environmental issues for the aviation sector, there is a need to build a global integrated approach in order to:

- Push biomass usages towards pathways with low alternative substitution
- Define more relevant geographic areas for biojet production (in terms of biomass availability/competitiveness)
- Define **specific sustainability criteria** shared by all producing/consuming countries to ensure equity between countries and stakeholders
- Define a harmonized certification scheme and **carbon accounting methodology**
- Define the right level of constraints (mandate, GHG reduction, …) at different time periods to ensure the **continuity of the biofuel market**

3.1 Panel on "Feedstock and Sustainability"

Moderation

- Johannes Michel, FNR

Panelists

- Nikita Pavlenko, ICCT, UK
- Olivier Dubois, Senior Natural Resources Officer & Leader Energy Team, Food and Agriculture Organization of the United Nations (FAO)
- Andreas Feige, Meo Carbon Solutions, ISCC, Germany
- Sergio Ugarte, SQ Consult, Netherlands
- Carlos Calvo Ambel, Transport & Environment (T&E), Belgium
- Rocio Diaz-Chavez, Imperial College, UK

Introduction to the Panel Discussion

In order to kick-off the panel discussion **Johannes Michel**, FNR briefly presented the following guiding topics:

- Are diversification of feedstock sources coupled with good agricultural practices sufficient for GHG reduction targets while safeguarding sustainability?
- Fundamental bottlenecks of sustainable feedstock availability in Europe?
- Are agricultural waste and residues an appropriate feedstock for biojet production?
- Measures to overcome logistical barriers of lignocellulose as a feedstock for biojet production?
- Possibilities to reduce costs in the beginning of the biojet supply chain?
- Market-based measures as an alternative to biojet?
- Possibilities to reduce certification costs?
- Harmonization/mutual recognition as a way of increasing market uptake of biojet.

3.1.1 Panel Discussion on "Feedstock and Sustainability"

Prior to the event and in order to pave the way for the panel discussion, the panellists were asked to provide Mr. Michel with a key statement with respect to one (or more) of the selected questions. These are:

- **Olivier Dubois:** *„Biofuels are not good or bad per se, it depends on how they are managed"*
- **Andreas Feige:** "*Demanding energy and GHG quota targets and sustainability certification under RED/FQD have been a success and opened up significant improvement potentials (technology and sustainability wise). However, there is still significant improvement potential for certification systems with respect to sustainability performance and cost (having in mind that certification costs are much below 0.1% of the biofuel price)"*
- **Rocio Diaz-Chavez:** *"We need to look at an integrated use of biomass for all sectors to ensure sustainable production and use in the different sectors"*
- **Nikita Pavlenko:** "*Avoid making the same mistakes as road sector—do it correctly on the first try. It is possible to mitigate GHG emissions from aviation by using biofuels, but it can only be done if the industry utilizes biomass sources that offer genuine GHG reductions"*
- **Sergio Ugarte:** *"Large scale deployment of biofuels for aviation will only be feasible when biofuels are produced meeting criteria fully compatible with the Sustainable Development Goals (SDG). Economics and GHG reductions are insufficient for the larger scale change the aviation sector would like to have"*
- **Carlos Calvo Ambel:** *"We should not be pushing to reach a significant percentage of aviation biofuels before outstanding issues are resolved. The potential impacts and the scalability are still problems to be clarified and we need to be brutally honest when analysing and modelling them. Otherwise, we might make the same mistakes we did in the road transport sector, where the cure was worse than the disease"*

After the introduction round and the key statements listed above, the panel discussion that focused on fundamental bottlenecks of sustainable feedstock availability in Europe as well as possibilities to reduce costs in the beginning of the biojet supply chain was launched.

Nikita Pavlenko

- Avoid mistakes that were made when biofuels were introduced in road transport.
- Take measures to maximise GHG benefits without ignoring indirect effects.
- Residues are usually dispersed and difficult to collect.
- Competing uses exist for residues and waste for applications in other sectors (e.g. road transport, heating and cooling, electricity, on-site farm uses), biomass supply will be directed to markets through price levels.
- In the future, it is likely that demand for biomass (from different sectors) will be larger than the (sustainable) supply. Therefore, strict sustainability criteria are needed that ensure sound agricultural practices and low ILUC.

Olivier Dubois

- Avoid oversimplification and generalisations with respect to feedstock for biofuels as there are no inherently good or bad biofuels.
- Biofuels from food crops are not always “bad”, on the other hand using residues or energy crops is not always “good”.
- Eliminating feedstock options is risky if based on modelling efforts (also due to underlying model assumptions).
- Use of the food crop sugarcane in Brazil for biofuels production triggered improvements of yields and agricultural practices and did not cause food-fuel conflicts.
- Palm oil is the highest yielding oil crop globally and 30% of palm oil is produced by smallholders. Promoting sustainable palm oil production may lead to increased yields and productivity.
- Schemes need to be introduced recognising and rewarding good practices.

Andreas Feige

- RED and FQD are successful examples promoting advances with respect to sustainability.
- First generation biofuels paved the way towards the development of advanced biofuels.
- The current European climate and energy policy for post-2020 may lead to national fragmentation and reduced momentum on sustainability issues.
- A large number of sustainability standards and certification systems are operative.
- Existing certification systems still have considerable improvement potential.
- Certification generally is not expensive, only accounting for approximately 0.1% of the costs. Cost barriers still exist for smallholders.
- Significant (technical) improvement potential exists for palm and soy feedstock.

Sergio Ugarte

- The development of sustainable biofuels shall be aligned with UN Sustainable Development Goals (SDG).
- Challenges exist for the aviation industry with matching environmental (GHG emission reductions) and economic (production costs) aspects of biofuels.
- Increased costs with respect to sustainability do not concern certification costs, but cost related to implementing good practices (i.e. ensuring sustainable production).
- The introduction of biofuels in the European road transport sector without suitable sustainability schemes in place leads to considerable reputation problems. The aviation sector shall therefore exclusively rely on sustainable biofuels.

Carlos Ambel

- Avoid pushing for increased biofuels production before important issues regarding sustainability are solved.
- Place quality over quantity and avoid targets or mandates potentially leading to unsustainable practices.
- Recent modelling efforts using the GLOBIOM model suggest that biofuels development lead to increased (rather than decreased) GHG emissions due to indirect effects.
- So-called first generation biofuels grown on agricultural land cause concerns in the light of population increase until 2050.
- Use of residues and waste in the aviation sector will face competing use options in other sectors.
- With the absence of taxes on aviation fuels options to incentivise alternative fuels are limited.

Rocio Diaz-Chavez

- Present main bottlenecks for alternative aviation fuels include the availability of sustainable feedstock and high associated costs for industry.
- Integrated strategies need to be developed for all biomass applications.
- Biomass will be one of the options for climate change mitigation towards achieving the 2°C goal.

4 Session 2 – Conversion Technologies and Holistic Assessment of Production Pathways

In their introductory presentation for Session 2 on “Conversion Technologies and Holistic Assessment of Production Pathways” **Arne Roth** and **Andreas Sizmann**, Bauhaus Luftfahrt presented outcomes and policy recommendations elaborated in the framework of the CORE-JetFuel project.

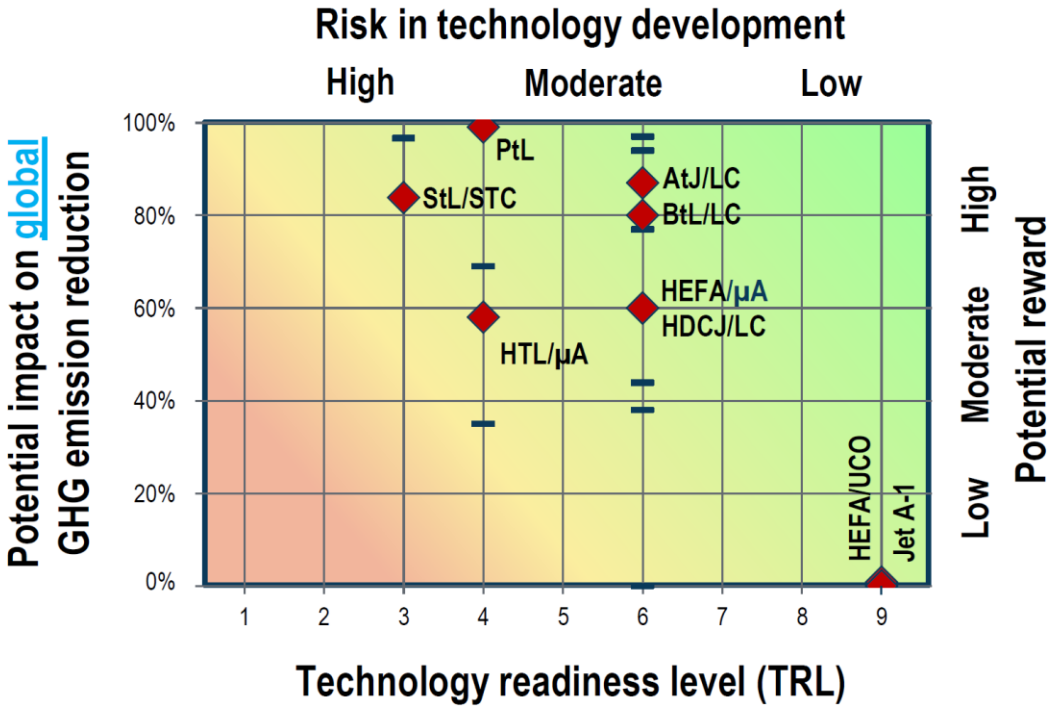
The objectives of the research analysis performed within CORE-JetFuel include technology assessments of the state-of-the-art and potentials of technology pathways for the production of alternative aviation fuels with respect to environmental, economic and technical performance parameters as well as a portfolio assessment on the impact and balance of the existing R&D portfolio at European level.

The technology assessment of alternative fuel technologies was guided by the following relevant questions and followed a multi-criteria approach with criteria and metrics as displayed in the table below:

- How much can we make?
- What is the potential environmental impact?
- How much would it cost?
- Drop-in capable or not?
- What is the current state of development (maturity)?

Criterion	Metric	
Technical maturity	Technology Readiness Level	TRL (1-9)
Feedstock production maturity	Feedstock Readiness Level	FSRL (1-9)
Conversion technology maturity	Conversion Technology Readiness Level	CTRL (1-9)
Technical compatibility	Maximum blending ratio	$r_{Blend,Max}$ [%]
Economic competitiveness	WtT production costs relative to spot price in 2013	γ [%]
***Global* substitution potential**	Production potential relative to demand in 2050	σ [%]
***European* substitution potential**	Production potential relative to demand in 2050	σ [%]
Specific GHG emissions reduction	Specific lifecycle GHG emissions relative to conventional jet	ε [%]

The following graph shows an evaluation of **risk and potential reward** for several technology pathways for the production of alternative aviation fuels. Thereby, risk in technology development is related (but not identical) to Technology Readiness Level (TRL) (x-axis) whereas an identified potential reward is given by the potential impact on global GHG emission reduction (calculated as product of specific emission reduction and global substitution potential) (y-axis).



The HEFA/UCO (Hydroprocessed Esters and Farry Acids / Used Cooking Oils) pathway is a mature technology that shows an excellent environmental performance (i.e. high specific emission reduction), however the availability of feedstock is limited. Several technologies such as AtJ/LC (Alcohol to Jet), BtL/LC (Biomass to Liquid), HEFA/µA, HDCJ/LC (Hydroprocessed Depolymerized Cellulosic Jet) are currently at TRL 6. Whereas AtJ/LC and BtL/LC pathways show a rather large global substitution potential, significant uncertainties exist today with respect to the performance and potential of algae based fuels (HEFA/µA). Power-to-Liquid (PtL) technologies are at lower TRL of about 4, but show a very large global substitution potential.

Overall, the following conclusions and recommendations from the CORE-JetFuel research analysis can be summarised.

- Most relevant performance indicators
  - GHG reduction potential: Product of carbon intensity and production potential
  - Costs of production as metric for potential economic competitiveness
  - Technical maturity as proxy for risk of development
- Balance of effort/funding dedicated to basic science and technology development
  - There is need for both technology development and basic science
  - Main objectives are: Balance in funding for basic science and technology development; Linking of basic science with technological innovations

- Overall portfolio analysis shows a 20/80 distribution between knowledge creation and product-oriented research
- Balance of risk and potential reward
    - Identify potential rewards for European energy supply security, competitive industries and socio-economic benefits
    - Identify high-reward options with balanced risk in the portfolio
    - Highest potential for European production and impact on GHG reduction: Lignocellulosic feedstock and renewable non-biogenic options (PtL, StL (Solar-to-Liquid))

The invited presentation by **Robert Malina**, MIT focused on production pathways for short- and long-term availability of alternative jet fuel and their performance perspective.

Mr. Malina presented WTW (Well-to-Wake) life cycle GHG emission data for a variety of alternative jet fuel (AJF) technologies (e.g. FT, HEFA, AF (Advanced Fermentation)) using different feedstock, highlighting that most AJF production pathways show improved GHG emission performance with respect to Jet A fuel if adverse LUC emissions can be avoided. It was reported that alternative jet fuels will be more expensive than the jet fuel price projected by the US Energy Information Administration (EIA) for 2020 of 2-4 US$ per gallon. Therefore, (public) support will be needed in order to facilitate market deployment of AJF.

Global AJF production scenarios for 2050 show an achievement range from 0-203 EJ (4.600 Mt), replacing up to 100% of 2050 jet fuel demand. In these scenarios emission reduction ranges from 0-63% compared to petroleum derived jet fuel usage. Within these scenarios, annual growth in AJF production out to 2050 needs to be in the order of recently observed growth of 5-15 Mt/yr in global biofuel production capacity to achieve between 10% and 20% emissions reduction by 2050. However, growth needs to significantly exceed historical global biofuel production growth rates for total GHG emission reductions of greater than 20%.

The following summary statements were made by Mr. Malina:

- There is a large alternative jet fuel potential whose usage could significantly reduce aviation GHG emissions.
- Aviation biofuels, on average, will remain more expensive than conventional jet fuel in the short- to medium-term, therefore, in order to get fuels into the market, policy incentives will be required.
- Very significant investment is necessary in order to achieve a substantial aviation biofuel market penetration: Annual capital investment similar to highest annual investment in road transportation biofuels for 10-20% emissions' reduction out to 2050
- Higher costs for aviation biofuels are justified from a societal perspective as long as environmental benefits compensate for the additional costs.

4.1 Panel on "Conversion Technologies and Holistic Assessment of Production Pathways"

Moderation

- Arne Roth and Andreas Sizmann, BHL

Panelists

- Roger Blokland, UOP – A Honeywell Company, Netherlands
- Sierk de Jong , SkyNRG and Utrecht University, Netherlands
- Robert Malina, MIT, USA
- Patrick Schmidt, Ludwig-Bölkow-Systemtechnik GmbH, Germany

Introduction to the Panel Discussion

In order to kick-off the panel discussion **Arne Roth and Andreas Sizmann**, BHL briefly presented the following guiding topics:

1. Technology monitoring and future potentials of alternative fuel production pathways

Well defined performance indicators are essential for technology monitoring and for quantification of technology potentials. In the domain of alternative fuels, such indicators are the state of development (TRL), economic competitiveness (cost of production) and *specific* GHG emissions (carbon intensity) as well as *total* GHG reduction potential. Further indicators of interest are, e.g. the energy return on investment (EROI) and the minimum GHG abatement costs (MAC).

➔ *Which performance indicators do you consider most relevant when evaluating and comparing conversion technologies and production pathways of renewable fuels?*

2. Balance of effort in basic science and technology development

In alternative fuels research, there is a need for both technology development and basic science. A certain balance in funding as well as the linking of basic science and technological innovation should be achieved.

In the long term, today's basic research might play an important role for the product-oriented research priorities of tomorrow. In the short term, the technology development effort should integrate existing knowledge to bring alternative fuels to the marketplace, clearly showing the importance of a well-balanced approach.

➔ *What are the priorities and key challenges in R&I activities, both in basic science (advancing our basic understanding) as well as in technology development for alternative fuels?*

➔ *What is the right balance of funding between basic and applied research? How should a well-balanced distribution of R&I efforts (in terms of relative allocation of resources, funding) between basic science and technology development be defined and achieved?*

➔ *How can we better link basic science and technological innovation, and integrate new knowledge in innovative solutions?*

3. Risk-and-reward correlation of technology development

Research and development come with some probability of success and failure and with potential benefits of incremental to substantial magnitude. Of particular interest is the *relation* of risk to potential rewards: If R&D funding is solely spent on easy-to-attain objectives ("low-hanging fruits"), the technology development will probably succeed, but scientific leadership and long-term technological innovation in a competitive environment is at stake. High-risk long-term R&D projects therefore have a place in pro-active aggressive innovation. In a well-balanced distribution of high and low-risk technologies, the magnitude of the acceptable risk (technical risk, commercial risk) will depend on the magnitude and quality of the potential reward (e.g. European socio-economic benefits, global climate impact).

➔ *Considering the risk of failure to reach technical maturity and economic competitiveness with certain production technologies, and potential rewards their development promises:*

- *Which technologies do you see as candidates in the "high reward / high risk" domain, i.e. yet uncertain to succeed technically and/or commercially but potentially very rewarding?*
- *Which technologies do you see as "low-hanging fruits" with sufficient benefits in the "low risk" domain?*
- *Are there any candidate technologies with both "low risk" and "high reward" expectations?*

4. Coordination of future R&I

There are certain needs for future research to better support fact-based decision making. For example, CORE-JetFuel has identified the need for a comprehensive and coherent analysis of realistic European energy/feedstock potentials.

➔ *Which gaps in the current research landscape do you see and which capabilities need to be developed to empower the EU to implement its alternative fuel strategy?*

4.1.1 Panel Discussion on "Conversion Technologies and Holistic Assessment of Production Pathways"

Patrick Schmidt

- In order to achieve the emission reductions of 90% by 2050 agreed upon at COP in Paris, most sectors (with the exception of the food sector) will need to reach zero emissions.
- With respect to alternative aviation fuels only PtL technologies based on renewable electricity offer opportunities to achieve zero emissions.
- Recent study indicates that high altitude emissions will be detrimental to achieving the 90% GHG emission reduction goal, focus thus needs to be placed also on electric and hybrid aviation technologies.
- Important sustainability criteria include water intensity and water use.

Sierk de Jong

- The performance indicators selected for the present analysis are reasonable.
- A publication on GHG performance of alternative aviation fuels has recently be elaborated by the project RENJET (Renewable Jet Fuel Supply Chain and Flight Operations) implemented within the EIT (European Institute of Innovation and Technology) Climate-KIC (Knowledge and Innovation Communities).
- It is difficult to identify no-regret options for technology pathways.
- Focus shall be placed on defining key conditions that make technologies work successfully.
- Both basic and applied research is needed, however, connections between both are important (i.e. guidance to basic research).
- Ideally, long term research activities shall lead towards technology demonstration and construction of (pre-) commercial facilities.

Roger Blokland

- AltAir has converted an existing refinery into a 40 million gallon per year (corresponding to a biofuel production of about 150 000 m^3/y or 120 kt/y) facility for the production of renewable diesel and jet fuel based on agricultural waste, fats and oils.
- An off-take agreement has been made by United Airlines to purchase up to 15 million gallons (57 000 m^3/y or 42.75 kt/y) of sustainable biofuel from AltAir Paramount over a three-year period.
- In addition to performing research on alternative jet fuels implementation and deployment initiatives need to be launched in order to learn by doing (including by trial and error).
- Experiences on alternative jet fuel production need to be made instead of trying to find “perfect solutions”.
- Supply chains need to be developed (e.g. using Camelina feedstock) in addition to technology development activities.
- Markets for alternative jet fuel need to be developed.

Robert Malina

- Indicators to assess sustainability of alternative jet fuels shall include air quality impacts (low sooth, sulphur free) and non-emission climate impacts (such as changes in albedo).
- Future developments shall aim at replacing the full barrel of fossil oil within integrated bio-refinery concepts. Focus needs to be placed on higher value markets.

5 Session 3 – Technical compatibility, Certification and Deployment

In his introductory presentation for session 3 on “Technical compatibility, Certification and Deployment” **Alain Quignard**, IFPEN presented outcomes and policy recommendations elaborated in the framework of the CORE-JetFuel project.

CORE-JetFuel activities in the field of technical compatibility, certification and deployment included an update of the current ASTM certification and deployment status and the collection of data in a database, the identification of the most promising pathways, and the elaboration of recommendations on actions to be taken by the EU in the future.

Until today, the following pathways for alternative aviation fuels have been certified under ASTM (D7566-16):

- **FT-SPK**: **2009** / **50%**
- **HEFA-SPK: 2011** / **50%**
- **SIP** (Renewable Synthesized Iso-Paraffinic (*SIP*) fuel from Hydroprocessed Fermented Sugars): **June 2014** / **10%**
- (FT) **SPK/A: FT-SPK + mono-aromatics** from alkylation of a benzene-rich cut (naphtha type) with light FT olefins: **Nov. 2015** / **50%**
- **ATJ-SPK** from **iBuOH** + dehydratation + oligomerization +HDT (Hydrotreatment): **April 2016**

For the following pathways certification is foreseen in the short term:

- Biofuel ISCOCONVERSION (BIC) process
- Green Diesel / High Freezing Point (HFP) HEFA in 2016-2017

For the following pathways certification is foreseen in the medium/long term:

- ATJ-SPK Global Bioenergies isobutene
- ATJ SKA (Lanza Tech) from industrial waste gas

Lastly, Mr. Quignard presented the following preliminary recommendations:

- Develop initiatives gathering the stakeholders
- Decrease industrial risk
- Improve production costs to favor investment decision & biojet implementation
- Improve the understanding of the properties of biojet-fuels
- ASTM D4054 process and opportunities to improve it
- Logistics and quality insurance
    - Understand the impact of contaminants of AJF on fuel properties and materials
    - Understand and trying to model complex chemical and physical phenomena such as thermal and oxidation stability of fuel bases & final commercial blend

- Understand the impact of using new feedstock on fuel properties, contaminants, for the production of already certified jet fuels; i.e. HEFA with microalgae
- Check quality assurance of the full supply chain & logistics of AFJF & blends with jetA/A1, especially for jet fuels with low data availability (i.e. jet fuels from China or Russia)
- Check full chain quality assurance in the certification process
- Study possible evolution of specifications for fossil jet fuels and blends with AJF (e.g. with respect to S and aromatics content)
- Study impact of AJF chemical structure on specific characteristics such as dielectric constant or water solubility (iso-paraffins, n-paraffins)

In his invited presentation **Erik Wormslev**, NIRAS, Denmark presented an overview of the objectives and activities of the Nordic Biofuels for Aviation Project. The main aim of the project is to investigate how sustainable jet fuel may contribute to GHG mitigation, to assess the commercial potential at a Nordic level, and to identify barriers and steps to take to remove these barriers. The final study report will be released in September 2016.

The following general characteristics of the Nordic market for alternative aviation fuels were highlighted. Feedstock availability mainly relates to wood and straw with Finland, Norway and Sweden enjoying an abundance of woody biomass (collective potential of 178-224 PJ). Straw is widely available in Denmark and Finland with a potential of around 37 PJ, roughly corresponding to the total energy demand for jet fuel in Denmark. Tall oil (limited availability) and black liquor is available in Finland and Sweden. Municipal waste provides a potential feedstock in the short run, but long transportation distances in Finland, Norway and Sweden limit the potential.

A number of established industry players are active in Nordic countries, namely:

- **Neste** (Finland) – Global frontrunner in aviation biofuels: The first of the few companies worldwide, capable of producing sustainable aviation fuels at a commercial scale, even at limited quantity currently; Capable of utilizing a range of feedstocks, incl. vegetable oils such as camelina, crude palm oil, UCO and waste.
- **Borregaard Biorefinery** (Norway): Biorefinery producing biochemicals, materials and fuels from wood; One of the world's largest producers of bioethanol.
- **Inbicon** (Denmark) – The world's 1st straw-based 2G refinery: Enzymatic hydrolysis break down straw to sugars; eliminates molasses as a by-product, in favor of higher feedstock-to-fuel conversion rates.
- **Maabjerg Energy Concept** (MEC) (Denmark) - Integrated technology concept: Large-scale bioethanol plant, combined with both biogas and CHP plants, allows for increased resource efficiency; utilization of by-products in the various processes helps to reduce costs.

In conclusion, Mr. Wormslev stated that as biofuels are highly susceptible to fluctuation in market prices, there is a need for political action to create market demand and decrease uncertainties. Yet, sustainable aviation fuels receive little political attention, compared to other forms of renewable energy. Very few explicit goals exist for aviation (outside of the industry's own targets) and incentive structures are skewed towards electricity production and land transport. Therefore, setting clear targets for the share of Renewable Energy (RE) in aviation could help create market demand and spur investments in sustainable aviation fuels production (e.g. blend-in mandates).

5.1 Panel on "Technical compatibility, Certification and Deployment"

Moderation

- Alain Quignard, IFPEN

Panelists

- Nicolas Jeuland, SAFRAN, France
- Philippe Marchand, TOTAL New Energies, France
- Graham Osborn, AIRBUS UK Filton
- Erik Wormslev, NIRAS, Denmark
- Carl Wolf, LanzaTech, USA

Introduction to the Panel Discussion

In order to kick-off the panel discussion **Alain Quignard**, IFPEN briefly presented the following guiding topics:

Developing initiatives gathering the stakeholders

Developing initiatives gathering the stakeholders related to a dedicated biojet-fuel pathway, such as the European ITAKA project or the French Lab'line initiative, to demonstrate the technical viability as well as assessing all the logistic issues (i.e. using the airport hydrant system) or the social acceptance by passengers of using biofuels. Such initiatives could be pushed forward by the EC in the future for new pathways.

Decreasing the industrial risk

Decreasing the industrial risk of producing biojet fuel within a highly moving world of fossil crude and fuel prices by securing the production through long term contracts with airlines or national defense/civil administration (such as done in the US) should be a key factor for the deployment of AJF.

Improving the production cost to favor investment decision and biojet implementation

The main driver explaining the higher or much higher cost of biojet-fuel v/s fossil fuel is the low fuel yield v/s feedstock, typically within the 5-15 wt% range. Any R&D study to reduce the carbon losses and to improve the final yield of biofuels is very important.

Improving the understanding of the properties of biojet-fuels

A lot of R&D efforts are still needed to understand the properties of AFJ blends based on detailed chemical analysis. It should be the aim of such analysis on AFJ to identify the most critical aspects of the certification process (i.e. red/green light for specific parameters). Furthermore, some properties (cold flow such as freezing point or viscosity, as well as thermal or oxidation stability) of blended fuels are “non-additive” and may not be easily calculated from the ratio and properties of the blending components. Efforts have to be focused on such properties and also on combustion properties.

ASTM D4054 qualification process and opportunities to improve the process

ASTM qualification of AFJ is a robust process to guarantee that the new fuel will comply with all requirements related to compatibility, quality, safety, etc. Including a new Annex for each certified pathway in ASTM D4054 qualification remains mandatory, especially for safety issues.

Fuel analysis is a good means to SUPPORT the qualification process, but shall NOT REPLACE the qualification process. It may serve to reduce costs and time needed for the qualification process, as well as to reduce the time for the overall development of a new pathway and to be able to judge in advance at a relatively low TRL how the new synthetic fuel may comply with final fuel requirements for aircraft.

Experiences gathered on the ASTM qualification of AFJ will make the certification of new pathways easier and faster. To make it as short and efficient as possible, as well as to reduce the cost, it is also important to focus in advance on the most critical issues for the certification and to take into account the feedback from previous certifications.

5.1.1 Panel Discussion on "Technical compatibility, Certification and Deployment"

Carl Wolf

- LanzaTech's process involves biological conversion of carbon to products through gas fermentation. Using microbes that grow on gases (rather than sugars, as in traditional fermentation), carbon-rich waste gases and residues are transformed into useful liquid commodities.
- ArcelorMittal, the world's leading steel and mining company, LanzaTech, and Primetals Technologies will construct Europe's first commercial scale production facility to create bioethanol from waste gases of the steelmaking process.
- De-risking of industrialization of alternative fuel pathways is necessary.
- Operations need to be implemented at large scale in order to proof concepts to partners.
- Partnerships with airlines, oil companies, and Government departments are important.
- Off-take agreements may serve to bring down production costs.
- Carbon taxes may be an option to promote competitiveness of new technologies.

Graham Osborn

- In order to clear alternative fuels and achieve ASTM certification of new fuels all equipment suppliers need to be involved; some suppliers may not be very interested in approving new fuels.
- ASTM certification processes may involve top secret materials and information.
- Overall, ASTM certification is a complicated process.
- AtJ pathway was cleared for 30/70% blends (not for 50/50% blends).
- Important properties for ASTM certification include boiling points and flash points.
- The adaption of engines or other technology components for the use of alternative fuels is not a suitable procedure. The present simple fuel systems shall not be changed. New fuels need to comply with the existing system.

Philippe Marchand

- Biojet fuels are part of TOTAL's ambition as energy conscious company.
- TOTAL aims at a leading (technology neutral) role within the field of biojet fuels promoting market creation for such fuels.
- In the short term the HEFA pathway (with flexible feedstock) will be dominating, TOTAL aims at producing HVO (Hydrotreated Vegetable Oils) in a former crude oil refinery in South France (La Mede near Marseille) by 2018 (Axens Vegan process).
- TOTAL partners with Amyris for the direct fermentation of sugars (from first generation and cellulosic sugars).
- For successful ASTM certification it is important to establish good cooperation with OEMs (Original Equipment Manufacturers), as air safety cannot be compromised.

- All OEM constraints and worries need to be taken into account, fast responses towards OEM concerns are necessary.
- Short ASTM certification processes of about two years are possible.

Nicolas Jeuland

- Biojet fuels need to fulfil all requirements; fuels need to be suitable for all applications.
- A long list of properties needs to be fulfilled to make aviation fuels fit for use.
- For safe operation of engines precise knowledge about fuel composition and properties is needed.
- Adaptation of engines for the use of alternative fuels is complicated, engines are constantly improved for existing fuels, but shall not be adapted for future fuels.
- Requirements by the ASTM certification process shall not be reduced.
- However, the ASTM process could be improved through e.g. better knowledge of fuel chemistry.
- Future research (e.g. within the Horizon 2020 programme) should support the understanding and potential impact of fuel properties.

Erik Wormslev

- Business cases for alternative aviation fuels need to be developed in order to facilitate technological learning.
- Research within Horizon 2020 should include activities on the production of hydrogen at lowest costs (for hydrotreatment).

6 Session 4 – Policies, Incentives and Regulation

In her introductory presentation for session 4 on “Policies, Incentives and Regulation” **Maria de la Rica**, SENASA presented outcomes and policy recommendations elaborated in the framework of the CORE-JetFuel project.

CORE-JetFuel activities in the field of policies, incentives and regulation included an analysis of the existing legislation and their impacts on the different regions as well as differences between different legislations (in particular EU RED and US RFS (Renewable Fuel Standard)), and recommendations on actions to be taken by the EU in the future.

Today, the following main barriers to biojet fuel uptake include:

- **Limited supply due to lack of production capacity**: Production capacity is mainly based on the HEFA route, lack of production facilities in Europe. HVO plants already exist or decided/under construction, but still mainly dedicated to biodiesel production.
- **High feedstock and production costs**: Production costs of biojet fuel are more expensive than the production costs for fossil kerosene. It is not realistic for airlines to unilaterally support these additional costs.
- **Lack of direct sectorial policy support**: Existing biofuel policy measures are geared towards the use of biofuel in road transport rather than in aviation. Currently the RED and the ETS together do not provide a sufficient incentive to bridge the cost gap between fossil and biojet fuels.
- **Concerns about sustainability**: Legislative frameworks and voluntary schemes aim at ensuring sustainable biofuels, but differ in scope and details of the sustainability criteria that they cover.

Potential policy measures to promote biojet fuels include regulatory measures, e.g. counting of bio jet fuels towards the obligation of fuel suppliers in MS (currently applied in the Netherlands), specific mandates for aviation biofuels, ICAO/CAEP Market-Based Measures (MBM), e.g. possible use of the revenue generated from the MBM system geared towards innovation in the aviation sector, non-regulatory actions, e.g. stimulation of innovation and projects in the supply chain, and voluntary initiatives, e.g. cooperation between major airports and airlines.

Presently, several policy and strategic issues still need to be solved. With respect to the competition of biofuels use in the aviation and other transport sectors, there is a lack of aviation-specific initiatives and objectives that take into account the very specific barriers of aviation (i.e. certification process). Competition for feedstock with other means of transport is both a main concern, but may also provide opportunities (e.g. processes developed for drop-in biojet fuel and biodiesel are similar). With respect to ILUC concerns and EU legislation it needs to be underlined that legal stability is a key factor for investment by the private sector.

Furthermore, concerns are expressed by airlines on the need of harmonized sustainability criteria. Today, no mutual recognition between sustainability criteria is required by different legislations (e.g. by EU RED and US RFS). In order to ensure public support for alternative aviation fuels, effective sustainability assurance is crucial. This is especially important if biofuels are to account for emissions reductions in a Global MBM scheme.

With respect to addressing existing economic barriers, a first step would be to establish additional financial support and incentive schemes. Investment needs to be de-risked, since it is currently unattractive for investors to create value chains in Europe. For this, financing

options need to be considered such as first mover/early adopter grants, off-take agreements facilitated by national administrations, and access to loan guarantees.

In conclusion, Mrs. De la Rica stated that no single policy option will individually accelerate deployment but rather a combination of different measures. Measures that could destabilize the market should be avoided, in particular any production/consumption objective should be established with caution and previous impact analysis. There is a need to have clear objectives (in terms of volume of production) including specific transport objectives for post 2020.

6.1 Panel on "Policies, Incentives and Regulation"

Moderation

- Maria de la Rica, SENASA

Panelists

- Hoang Vu Duc, European Commission, DG MOVE
- César Velarde, Senior Aviation and Environment Expert, ICAO Project Coordinator
- Thomas Roetger, International Air Transport Association (IATA)
- Robert Malina, MIT, USA

Introduction to the Panel Discussion

In order to kick-off the panel discussion **Maria de la Rica**, SENASA briefly presented the following guiding topics:

- Price gap is, among other factors, one of the main barriers for deployment. If the strategy in the EU is to increase the deployment and the level of use of alternative fuels, what policy options do you consider more interesting to help closing such a gap?
- What can we learn from the experience in other countries/regions on the policies for the promotion of alternative fuels?
- The establishment of Public-Private-Partnerships is seen as one of the key instruments to create small local value chains and learn about the barriers to

overcome. An example of this kind of partnership is the cooperation between major airports, airlines, and national administrations. This is important to establish small-scale/regional value chains that could later on evolve towards a higher level of use. What good practices could be implemented in this regard? Can we learn from previous experiences?

- Currently, the policy status in alternative fuels in Europe is under transition, with the objective of moving towards renewable fuels that minimize land use change. This will require an update of the objectives set in the Biofuels Flight Path and therefore the continuation of the stakeholder collaboration. What should be the priority when setting up such objectives and goals?
- The GMBM ICAO discussion includes the consideration of biofuels use as a possible way of reducing emissions for the regulated parties. What should be the European position in this regard? Should Europe have a stronger and common position in this negotiation? What should the European position be for the near future regarding aviation alternative fuels in the international discussions? How can market distortion be prevented in a GMBM when biofuels are unequally available in airports around the world?
- Can the current low oil prices have an influence on the inertia of the initiatives currently going on in Europe? What measures should be taken to keep the current initiatives ongoing?
- Stakeholders have generally agreed that a stable policy framework that creates market stability along with the appropriate institutional support is fundamental to incentivize investments. How can this positive atmosphere for investment be created in Europe? What additional steps are needed in this regard?

6.1.1 Panel Discussion on "Policies, Incentives and Deployment"

Thomas Roetger

- There exists a large willingness of airlines to support alternative aviation fuels as part of aviation's sustainability strategy, which helps to ensure public support for the growth of the aviation sector.
- The initiative in Indonesia is an interesting lab case for market deployment of alternative aviation fuels.
- The price gap may be addressed by incentivizing production leading to a reduction of costs along economies of scale and learning curves.
- Airlines fear market distortions caused by e.g. mandates applicable specifically to aviation and/or certain regions. Regulations covering the entire transport or oil products sector allow for a much easier sharing of additional costs
- Counting alternative aviation fuels towards the obligation of fuel suppliers in MS (as done in the Netherlands) is a viable option.

Cesar Velarde

- There are opportunities to learn from the alternative aviation fuel initiative in Indonesia setting a mandate of 2% biofuels blend in 2016 and 5% in 2025.
- Within its objective to decarbonize transport the Indonesian Government has launched a clear policy action to develop biofuels for aviation. The aviation sector is fully included in the national bioenergy policy.

- Preliminary assessments by IATA of the 2% mandate by the Indonesia government, supported by IATA, show no larger impact on travel demand and a small impact on ticket prices.
- Aviation can be a driver for sustainable development as it is a market with higher sustainability constraints. A strong sustainability framework needs to be established.
- Palm oil feedstock used in the road sector is RSPO certified. The aviation sector may be an off-taker for highly sustainable palm oil.
- In Indonesia FAO is promoting the adoption of sustainability schemes by smallholders.
- Until today, incentives for alternative aviation fuels are not sufficient. Aviation fuels should be included in mandates and target, a level playing field with road transport need to be established.

Hoang Vu Duc

- Alternative aviation fuels are a complicated topic at European level due to the involvement of many DGs (DG ENERGX, DG MOVE, DG Environment, DG Climate).
- Most suitable instruments for deployment of alternative aviation fuels still need to be found.
- Setting mandates is regarded as ”last option” to decarbonize sectors.

Robert Malina

- An aspirational goal for alternative aviation fuels of 100 million gallons[1] (380,000m^3 or approximately 285, 000 t) by 2018 seems feasible due to existing successful industry initiatives.
- Government support for first-of-a-kind plants is needed.
- De-risking of investment by smart Government incentives is important (e.g. loan guarantees).
- Off-take agreements are important means to de-risk investments.
- The existing price gap may be addressed by de-risking investment, appropriate credits for environmental benefits, and public money/investment.
- Developments on alternative aviation fuels will not happen without preference over other applications due to much stricter standards (i.e. level playing field is not sufficient).
- Societal discussions will need to take place with respect to short- and long-term benefits of biomass use in different sectors (e.g. RHC (Renewable Heating & Cooling), electricity, road transport, aviation etc.).

Audience

- After 2020 no sectoral targets are foreseen within RED, allocation of targets to sectors is done on MS level.
- Existing uncertainty with respect to the policy and regulatory framework post 2020 is a main barrier for investment. Discussions between the EC and MS on post-2020 framework are necessary.

[1] In California Altair is producing 42 million gallons/year since March 2016, including 15 million gallons/year HEFA biojet fuel

- Sustainability requirements need to be the same for all application sectors.

7 Conference Conclusions

The aim of this conference was to present outcomes and policy recommendations to representatives of the European Commission, industrial decision makers and other public stakeholders, as well as gathering the final information for the elaboration of reports on recommendations. The following main conclusions may be drawn from the conference discussion panels.

European and National Initiatives on Alternative Aviation Fuels

- Strong national initiatives are needed to promote alternative aviation fuels. At present, Member State support for alternative aviation fuels is almost not existent.
- In the Netherlands renewable aviation fuels are allowed to contribute to the 10% target specified in the RED. According to a recent study this experience could be implemented in six other Member States including Spain, Italy and Germany.
- Coordination on European level through the establishment of a joint platform is needed in order to move towards deployment of alternative aviation fuels (i.e. to “get things done”).
- Europe needs to learn from coordination efforts in the USA where initiatives are jointly developed by the Federal Aviation Administration (FAA) and the Departments of Energy, Agriculture and Defense with the support of the strong national platform CAAFI (Commercial Aviation Alternative Fuels Initiative).
- The present achievements and success of alternative aviation fuels in the USA were triggered by large public investments in order to kick-start industrial involvement and to create promising business cases.

Feedstock and Sustainability

- The introduction of biofuels in the European road transport sector without suitable sustainability schemes in place lead to considerable reputation problems. The aviation sector shall therefore exclusively rely on sustainable biofuels.
- Place quality over quantity and avoid targets or mandates potentially leading to unsustainable practices.
- RED and FQD are successful examples promoting advances with respect to sustainability.
- The current European climate and energy policy for post-2020 may lead to national fragmentation and reduced momentum on sustainability issues.
- Avoid oversimplification and generalisations with respect to feedstock for biofuels as there are no inherently good or bad biofuels.
- Schemes need to be introduced recognising and rewarding good practices.
- Certification generally is not expensive accounting for about 0.05-0.10% of the costs. Cost barriers still exist for smallholders.
- Increased costs with respect to sustainability do not concern certification costs, but cost related to implementing good practices (i.e. ensuring sustainable production).

Conversion Technologies and Holistic Assessment of Production Pathways

- Both basic and applied research is needed, however connections between both are important (i.e. guidance to basic research).
- Ideally, long term research activities shall lead towards technology demonstration and construction of (pre-) commercial facilities.
- In addition to performing research on alternative jet fuels implementation and deployment initiatives need to be launched in order to learn by doing (including by trial and error).
- Experiences on alternative jet fuel production need to be made instead of trying to find “perfect solutions”.
- Supply chains need to be developed (e.g. using Camelina feedstock) in addition to technology development activities.
- With respect to alternative aviation fuels only PtL (Power to Liquid) technologies based on renewable electricity could offer opportunities to achieve zero emissions for the long term.
- Future developments shall aim at replacing the full barrel of fossil oil within integrated biorefinery concepts. Focus needs to be placed on higher value markets.

Technical compatibility, Certification and Deployment

- Requirements by the ASTM certification process shall not be reduced in order to ensure safety of operation.
- For safe operation of engines precise knowledge about fuel composition and properties is needed.
- For successful ASTM certification it is important to establish good cooperation with OEMs (Original Equipment Manufacturers), as air safety cannot be compromised.
- All OEM constraints and worries need to be taken into account, fast responses towards OEM concerns are necessary.
- De-risking of industrialization of alternative fuel pathways is necessary.
- Operations need to be implemented at large scale to proof concepts to partners.
- Partnerships with airlines, oil companies, and Governments are important.
- Off-take agreements may serve to bring down production costs.

Policies, Incentives and Regulation

- There exists a large willingness of airlines to support alternative aviation fuels as part of aviation’s sustainability strategy, which helps to ensure public support for the growth of the aviation sector.
- Airlines fear market distortions caused by e.g. mandates specifically to aviation and / or to certain regions. Regulations covering the entire transport or oil sector allow for a much easier sharing of additional costs.
- The existing price gap may be addressed by de-risking investment, appropriate credits for environmental benefits, and public money/investment.
- Developments on alternative aviation fuels will not happen without preference over other applications due to stricter standards (i.e. level playing field is not sufficient).
- Counting alternative aviation fuels towards the obligation of fuel suppliers in Member States (as done in the Netherlands) is a viable option.

8 Annex 1 - Conference Agenda

Conference Agenda
Thursday, 16 June 2016 (15:00-18:00)

14:00 *Registration*

15:00 **Welcome to the Workshop**

RAINER JANSSEN AND DOMINIK RUTZ, WIP RENEWABLE ENERGIES, GERMANY

15:10 **Introduction to CORE-JetFuel**

JOHANNES MICHEL, FNR, GERMANY

15:30 **The European Commission's Perspective**

REMY DENOS, EUROPEAN COMMISSION, DG ENERGY

European and National Initiatives on Alternative Aviation Fuels – The Way Forward

16:00 **The European Flightpath 2020 Initiative**

ALEXANDER ZSCHOCKE, LUFTHANSA AG, GERMANY

16:20 **The Nordic Initiative for Sustainable Aviation (NISA)**

MARTIN PORSGAARD, NISA, DENMARK

16:40 **Panel Discussion on European and National Initiatives on Alternative Aviation Fuels – The Way Forward**

MODERATION: RAINER JANSSEN, WIP RENEWABLE ENERGIES

PANELLISTS:

- REMY DENOS, EUROPEAN COMMISSION, DG ENERGY
- MARTIN PORSGAARD, NISA, DENMARK
- SIERK DE JONG , SKYNRG, NETHERLANDS (BIOPORT HOLLAND INITIATIVE)
- MANFRED AIGNER, AVIATION INITIATIVE FOR RENEWABLE ENERGY IN GERMANY (AIREG) PRESIDENT
- FRANCESCO SEPE, ENAC, ITALIAN REPRESENTATIVE
- INMACULADA GOMEZ JIMENEZ, SENASA, BIOQUEROSENO INITIATIVE, SPAIN

18:30 ***Evening Reception at Thon Hotel EU***

Conference Agenda
Friday, 17 June 2016 (09:00-17:00)

08:30 *Welcome Coffee*

09:00 **Welcome to the Workshop (Day 2)**

RAINER JANSSEN AND DOMINIK RUTZ, WIP RENEWABLE ENERGIES, GERMANY

Session 1 – Feedstock and Sustainability

09:10 **CORE-JetFuel Results – Feedstock and Sustainability**

JOHANNES MICHEL, FNR

09:40 **Invited Presentation: Feedstocks and sustainability for biojet deployment A multicriteria approach from CAER project**

DAPHNE LORNE, IFPEN, FRANCE

10:00 **Panel Discussion on Feedstock and Sustainability**

MODERATION: JOHANNES MICHEL, FNR

PANELLISTS:

- NIKITA PAVLENKO, ICCT, UK
- OLIVIER DUBOIS, SENIOR NATURAL RESOURCES OFFICER & LEADER ENERGY TEAM, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)
- ANDREAS FEIGE, MEO CARBON SOLUTIONS, ISCC, GERMANY
- SERGIO UGARTE, SQ CONSULT, NETHERLANDS
- CARLOS CALVO AMBEL, TRANSPORT & ENVIRONMENT (T&E), BELGIUM
- ROCIO DIAZ-CHAVEZ, IMPERIAL COLLEGE, UK

11:00 *Coffee break*

Session 2 – Conversion Technologies and Holistic Assessment of Production Pathways

11:20 **CORE-JetFuel Results – Conversion Technologies Holistic Assessment of Production Pathways**

ANDREAS SIZMANN AND ARNE ROTH, BHL, GERMANY

11:50 **Invited Presentation: Production pathways for short- and long-term availability of alternative jet fuel and their performance perspectives**

ROBERT MALINA, MIT, USA

12:10 **Panel Discussion on Conversion Technologies and Radical Concepts**

MODERATION: ARNE ROTH AND ANDREAS SIZMANN, BHL, GERMANY

PANELLISTS:

- ROGER BLOKLAND, UOP – A HONEYWELL COMPANY, NETHERLANDS
- SIERK DE JONG , SKYNRG AND UTRECHT UNIVERSITY, NETHERLANDS
- ROBERT MALINA, MIT, USA
- PATRICK SCHMIDT, LUDWIG-BÖLKOW-SYSTEMTECHNIK GMBH, GERMANY

13:00 *Lunch*

Session 3 – Technical compatibility, Certification and Deployment

14:00 **CORE-JetFuel Results – Technical compatibility, Certification and Deployment**

ALAIN QUIGNARD, IFPEN

14:30 **Invited Presentation: The Nordic Biofuel for Aviation Project**

ERIK WORMSLEV, NIRAS, DENMARK

14:50 **Panel Discussion on Technical compatibility, Certification and Deployment**

MODERATION: ALAIN QUIGNARD, IFPEN

PANELLISTS:

- NICOLAS JEULAND, SAFRAN, FRANCE
- PHILIPPE MARCHAND, TOTAL NEW ENERGIES, FRANCE
- GRAHAM OSBORN, AIRBUS UK FILTON
- ERIK WORMSLEV, NIRAS, DENMARK
- CARL WOLF, LANZATECH, USA

Session 4 – Policies, Incentives and Regulation

15:30 **CORE-JetFuel Results – Policies, Incentives and Regulation**

MARIA DE LA RICA JIMÉNEZ, SENASA

16:00 **Panel Discussion on Policies, Incentives and Regulation**

MODERATION: MARIA DE LA RICA JIMÉNEZ, SENASA

PANELLISTS:

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- HOANG VU DUC, EUROPEAN COMMISSION, DG MOVE
- CÉSAR VELARDE, SENIOR AVIATION AND ENVIRONMENT EXPERT, ICAO PROJECT COORDINATOR
- THOMAS ROETGER, INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)
- ROBERT MALINA, MIT, USA

17:00 *End of Conference*

8.1 Annex 2 – List of Conference Participants

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