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

Deliverable 6.5
Minutes of comments and amendments from the final conference

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CORE-JetFuel

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Submitted Version 1.0

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Work Package 6:	Synthesis of Results and Recommendations
Work Package Leader:	Fachagentur Nachwachsende Rohstoff e.V. (FNR)
Task 6.4:	Final international conference

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PROJECT PARTNERS

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BHL – Bauhaus Luftfahrt e.V., Germany

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INTRODUCTION

The final international CORE-JetFuel conference took place on 16th and 17th of June 2016 in Brussels on occasion of the EU Sustainable Energy Week (EUSEW).

Representatives from the European Commission, from the industry, from public organizations and from research institutes have come to listen to and discuss the final results of the CORE-JetFuel research project. Additionally, external experts had been invited to present their view on the outcomes of our coordination and support action as well as to take part in several panel discussions. Herein, the CORE-JetFuel partners received very valuable feedback and comments which will be described in detail in the following chapters.

A key comment during the session on 'European and national initiatives on alternative aviation fuels – the way forward' was the need for a better coordination of national initiatives on alternative aviation fuels as well as the identification of lessons learned from existing successful national initiatives.

In 'Session 1 – feedstock and sustainability' a major comment from the panel discussion referred to need for R&D projects devoted to the assessment of the sustainable feedstock potential in Europe combined with an overall strategy for feedstock prioritization between application sectors to enable potential synergies.

In 'Session 2 – conversion technologies and holistic assessment of production pathways' a key comment was that the highest potential for European production and impact on GHG emission reductions could come from lignocellulosic feedstock and renewable non-biogenic options, such as Power-to-Liquids (PtL). Further, there is a need for both, technology development and basic science, with high potential rewards in terms of European energy supply security, competitive industries and socio-economic benefits.

In 'Session 3 – technical compatibility, certification and deployment' common comments related to the need for decreasing industrial risk and improving production costs to favor investment decisions and biofuel implementations.

In 'Session 4 – policies, incentives and regulation' a key comment was to close the current price gap by direct or indirect government support for first-of-a-kind plants to increase production capacity and, thus, reduce production costs due to learning curve effects. Another key comment in this session concerned the achievement of a more holistic planning for biomass use (e.g. RHC (Renewable Heating & Cooling), electricity, road transport, aviation etc.).

TABLE OF CONTENT

LIST OF ABBREVIATIONS

Abbreviation / acronym	Description
ASTM	American Society for Testing and Materials
AIREG	Aviation Initiative for Renewable Energy in Germany e.V.
AJF	Alternative Jet Fuel
AtJ	Alcohol-to-Jet
CAAFI	Commercial Aviation Alternative Fuel Initiative
CAEP	Committee on Aviation Environmental Protection
CAPEX	Capital Expenditure
CHP	Combined Heat and Power
DG	Directorate General
EC	European Commission
EIT	European Institute of Innovation and Technology
EU	European Union
FAA	Federal Aviation Administration
FSRL	Feedstock Readiness Level
FT	Fischer-Tropsch
FQD	Fuel Quality Directive
GHG	Greenhouse Gas
HDT	Hydrotreatment
HEFA	Hydroprocessed Esters and Fatty Acids
HFP	High Freezing Point
HVO	Hydrotreated Vegetable Oils
IATA	International Air Transport Association
ILUC	Indirect Land Use Change
ISAFF	Italian Sustainable Aviation Fuel Forum
KIC	Knowledge and Innovation Communities
MBM	Market Based Measures
MIT	Massachusetts Institute of Technology
MS	Member States
NISA	Nordic Initiative for Sustainable Aviation
OEM	Original Equipment Manufacturer
PtL	Power-to-Liquid
RFS	Renewable Fuel Standard
RE	Renewable Energy
RED	Renewable Energy Directive
RENJET	Renewable Jet Fuel Supply Chain and Flight Operations
RHC	Renewable Heating & Cooling
RTD	Research and Technology Development
SDG	Sustainable Development Goals

SIP	Renewable Synthesized Iso-Paraffinic
SPK	Synthetic Paraffinic Kerosene
SRC	Short-rotation coppice
StL	Sunlight-to-Liquid
TRL	Technology Readiness Level
UCO	Used Cooking Oil
WWF	World Wildlife Fund

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

In this chapter, an overview of the current status and future perspectives of existing European and national initiatives on alternative aviation fuels is presented.

The ***European Flightpath 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.
All future planning on alternative aviation fuels needs to be 'technology neutral' (i.e. not exclusively focus on specific technology approaches). Furthermore, 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 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.

The ***Spanish Bioqueroseno 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 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.

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.
The Aviation Initiative for Renewable Energy in Germany e.V. (AIREG) is an initiative set up 5 years ago by air carriers, airports, research institutions as well as the aviation industry and other partners. 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.

The ***Dutch Initiative '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.

1.1 Agenda and participants of 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

1.2 Comments and amendments in the session on European and National Initiatives on Alternative Aviation Fuels – The Way Forward

This discussion session focused on the following topics:

- Working towards common policy positions by EU Member States (MS) through coordination of national initiatives on alternative aviation fuels
- Identifying lessons learned 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

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 http://www.faa.gov/ (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.
- On European as well as MS level until today there is no legislation for alternative fuels requiring alternative fuels developments and diffusion, including fiscal incentives.
- Due to the current low blending level of alternative fuels the current contribution of alternative fuels to environmental protection is limited.

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.

Francesco Sepe

- The production of alternative fuels in Europe is still low as research and development of alternative fuels have just started 7-8 years ago.

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

Francesco Sepe

- Today, increased investments (funds) are the only possibility to stimulate development of alternative fuels.

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).

2 Session 1 – Feedstock and Sustainability

The most important CORE-JetFuel activities in the field of "feedstock and sustainability" entail the assessment of a variety of different types of biogenic feedstock. The sustainability of feedstock cultivation and further processing is analyzed by applying a set of quantitative assessment criteria such as GHG balance and net energy ratio of feedstock production, but also qualitative indicators are applied e.g. the risk of indirect land use changes (ILUC) or the potential impact of feedstock production on local biodiversity. Taking into account the large demand for biogenic types of feedstock by the aviation industry for reaching its GHG emission reduction targets until 2050, the sustainable availability of said feedstocks in Europe as well as their sustainability certification are other crucial aspects of the project work conducted in this field.

Accordingly, the focus of Session 1 was placed on the sustainable availability of the feedstocks assessed in the course of the project. In addition and seeing as the beginning of bio-jet value chains accounts for the major share of the associated production costs, possibilities to decrease these costs were discussed with the invited experts. Before the panel was opened and the invited presentation was held, the results of the CORE-JetFuel assessment were presented.

While microalgae have a vast theoretical production potential, their cultivation is due to high fertilizer and energy requirements very GHG intensive. Algae production particularly in closed photobioreactors is additionally technically immature and very expensive. If microalgae are to become an economically and environmentally viable feedstock for the production of alternative aviation fuels, sufficiently scalable CO_2 sources for example from industry, a reduction of fertilizer as well as energy requirements will be crucial in order to reduce the price of cultivation and increase its sustainability.

Camelina is a promising feedstock for sustainable bio-jet production with a high GHG emission reduction potential of the end product bio-kerosene. Sustainability advantages of this terrestrial oil crop are its relatively low fertilizer and irrigation requirements, its adaptability to arid to semi-arid climatic conditions as well as the fact that the crop can be cultivated on marginal / degraded land in intercropping systems. However, the large range of oil yields in different regions of Europe and the currently uncertain production potential of camelina

hamper its large-scale utilization as a bio-jet feedstock. According to camelina experts participating in CORE-JetFuel's final conference, since camelina is a relatively new crop for farmers cultivating it improvements in oil yields as well as in overall production volume will be made.

Short rotation coppices (SRC) such as willow or poplar are an interesting feedstock for bio-jet production due to their fast-growing nature, low fertilizer requirements as well as a non-existent competition with food production. Negative traits of SRC include their high water requirements. In addition, particularly logistical challenges in collecting and transporting this type of feedstock may hamper its economic viability– at least with respect to large-scale plantations.

Waste and residues as a side product of wheat production, for example, have a series of sustainability advantages compared to those types of feedstocks that are cultivated and directly utilized for bioenergy applications. In particular the very high GHG emission reduction potential of fuels based on straw, its high availability and the low risk of inducing indirect land uses changes make it a preferred feedstock for the aviation industry. However, a strong competition exists with other bioenergy and biomaterial sectors where agricultural residues such as straw are well-established and utilized at industrial scale. Apart from industrial uses, straw also fulfills a series of on-site functions at farm level such as supplying soils with nutrients or functioning as animal bedding. Depending on indicators for calculating the sustainable removal rate of residues and their importance for soil (nutrient supply, erosion protection), the availability waste and residues can vary considerable, particularly in case of forestry residue material.

The presentation conclusively gave the following recommendations:

- 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 required for feedstock prioritization between application sectors / make use of potential synergies
- Adopt sustainability certification schemes and standards to the regional character of feedstock production, avoid multiple certification

2.1 Agenda and participants of Session 1 – Feedstock and Sustainability

09:10	CORE-JetFuel Results – Feedstock and Sustainability JOHANNES MICHEL, FNR
09:40	Invited Presentation: Feedstocks and sustainability for bio-jet deployment A multi-criteria 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

2.2 Comments and amendments in Session 1 – Feedstock and Sustainability

After the presentations the panelists were invited to share with the conference participants a key statement concerning one or more topics that have been selected by Mr. Michel for the panel discussion on feedstock and sustainability. 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

As mentioned above, the focus of the subsequent discussion was placed on potential measures to decrease the costs associated with the beginning of the bio-jet value chain, i.e. feedstock cultivation and further processing as well as on the sustainable availability of biogenic feedstock in Europe. The following paragraphs will not summarize the entire discussion held in the course of the panel since an exhaustive conference summary[1] is given in Deliverable 3.12, the "Report on the final international conference". Instead, statements made by the panelists (and the auditorium) that oppose or diverge from the presented results and recommendations will be highlighted. On the other hand, statements that underline the

[1] Cf.: http://www.core-jetfuel.eu/Shared%20Documents/CORE-JetFuel-Final-Conference_Aviation%20Fuels_Brussels_160616_Summary_Final.pdf

CORE-JetFuel findings in the area of feedstock and sustainability or have not been addressed properly in the project work will also be featured and marked as such.

With respect to decreasing the cost of feedstock production the panelists agreed that opposed to an often stated perception, sustainability certification is not a costly matter. In fact, less than 0.1% of the biofuel costs are attributable to certification. In order for fuel producers as well as banks and investors to assess the economic viability of a feedstock option, a metric comparable to Feedstock Readiness Level (FSRL) would be beneficial. An "Investment Readiness Level" would complement indicators / assessment criteria such as Technology Readiness Level and FSRL, as these are from an investor's point of view not sufficient for making an investment decision in a certain type of feedstock or fuel pathway. Although not further substantiated, some conference participants added that costs (for airlines) from being sustainable or producing sustainably are considerable. For the medium-term, a practical approach that was mentioned in the particular case of lignocellulosic biomass were decentralized initiatives with comparably small capital investment and the according smaller risk. Building large-scale facilities for the conversion of lignocellulose is from economic point of view not recommendable at the moment, but it is nevertheless important that these decentralized initiatives are linked and coordinated at larger scale. The same approach could theoretically also be applied to (agricultural) waste and residues, whose collection is also challenging as they are usually dispersed.

Concerning the sustainable availability of biomass in Europe and the need for more studies assessing it and its geographical distribution, respectively, some of the conference participants were of the opinion that additional assessments in this regard are not necessary because there is already sufficient literature available on that topic. Taking into account the competition for biomass across different application sectors, demand will most likely surpass the sustainably achievable supply. It is therefore essential to introduce strict sustainability criteria in order to ensure sound agricultural practices and minimize indirect land uses changes as a consequence of feedstock production. In general, the panelists agreed that feedstock availability and consequentially the availability of land as well as the accompanying sustainability issues are political issues that should be solved at that level. In this context the issue of prioritizing biomass sources across different sectors arose as well. It was recommended that instead of prioritizing single sectors, an integrated biomass policy including all application sectors should be implemented.

Another topic that was discussed vividly in the panel on feedstock and sustainability was the perception the broad public has of aviation as being unsustainable, which in turn evoked the aviation industry to focus on so-called advanced types of feedstocks in order to be a sustainability "front-runner". Particularly the mistakes that were made in the European road transport sector by not adhering to suitable sustainability schemes in the beginning, and consequentially leading to considerable reputation issues serves as an example for the aviation sector how not to approach the utilization of fuels based on biogenic sources, in particular so-called 1st generation feedstocks. This approach was, however, objected by some of the panelists who argued that the aviation sector should not eliminate any of the feedstock (and conversion) options currently available in order to reach its GHG emission reduction targets, and to account for the learning curve that will necessarily be noticeable in light of the relatively short time the industry is engaged in the utilization of bio-based fuels. The metaphor stated by one panelist, namely that "one has to learn how to walk first before being able to run" summarizes the issues outlined above quite nicely.

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

The tasks of the research analysis performed within CORE-JetFuel include the assessment of the state-of-the-art and potentials of production technologies 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:

- 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)?

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

- Most relevant performance indicators
  - Absolute 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, such as Power-to-Liquids (PtL)

The invited presentation by Robert Malina (MIT) focused on production pathways for short and long-term implementation of alternative jet fuel and their performance perspective. The central statements of the presentation were:

- 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 renewable jet fuels into the market, incentives or regulatory measures will be required.
- Large investment would be necessary 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.

3.1 Agenda and participants of 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

3.2 Comments and amendments in Session 2 – Conversion Technologies and Holistic Assessment of Production Pathways

In order to kick-off the panel discussion, Arne Roth and Andreas Sizmann (BHL) briefly presented the following guiding topics with closely related questions:

1. Technology monitoring and future potentials of alternative fuel production pathways
    a. *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
    a. *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?*
    b. *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?*
    c. *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
        i. *Considering the risk of failure to reach technical maturity and economic competitiveness with certain production technologies, and potential rewards their development promises:*

ii. *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?*

iii. *Which technologies do you see as "low-hanging fruits" with sufficient benefits in the "low risk" domain?*

iv. *Are there any candidate technologies with both "low risk" and "high reward" expectations?*

4. Coordination of future R&I
   a. *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?*

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 essentially zero emissions.
- With respect to alternative aviation fuels only, PtL technologies based on renewable electricity offer opportunities to achieve near-zero emissions.
- A recent study indicates that high-altitude emissions will be detrimental to achieving even 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 study on GHG performance of alternative aviation fuels has recently been elaborated in 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 should 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 should 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 m3/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 m3/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 soot, 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.

4 Session 3 – Technical compatibility, Certification and Deployment

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.

ASTM Certification

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

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 AJF & 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)

Objectives and activities of the Nordic Biofuels for Aviation Project (NIRAS)°

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).

4.1 Agenda and participants of 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

4.2 Comments and amendments in Session 3 – Technical compatibility, Certification and Deployment

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 AJF blends based on detailed chemical analysis. It should be the aim of such analysis on AJF 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 AJF 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 AJF 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.

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. Lanzatech is working with PNL for the downstream refining of olefins to hydrocarbons (oligomerization process). ASTM certification is not still completed.
- 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.
- A main challenge with biojet-fuel is the feedstock
- 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). HEFA flexiblility towards feedstock is a key issue because it makes it easy feedstock switch with availability, price,…
- TOTAL partners with Amyris for the direct fermentation of sugars (from first generation and cellulosic sugars).
- For successful and to shorten 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, if data are available on time and if everything is well scheduled.

Nicolas Jeuland

- Biojet fuels need to fulfill 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 and takes time, 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 should be improved through e.g. better knowledge of fuel chemistry and relationship with properties of usage, as well as to predict the interaction with fossil fuels, since biojet-fuels will be blended with fossil jet-fuels. This better knowledge could also be an access to get new fuels improving pollutant emissions.
- 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).
- It is important to develop at least a few biojet fuel in close cooperation with the oil industry and to try them.

5 Session 4 – Policies, Incentives and Regulation

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 order to give recommendations. The objective of the panel was to obtain an insight from the participants of what steps should be taken next in the policies field in order to incentivize aviation alternative fuel production at European level. Participants were chosen to represent a wide range of views, representing European and non-European views, Public Administration and industry as the final user of the product. This representation was complemented by the participation of the rest of the audience of the panel.

An introductory presentation was carried out on "Policies, Incentives and Regulation" where the outcomes and policy recommendations elaborated in the framework of the CORE-JetFuel where presented.

Some of the conclusions of this presentation included policy and strategic issues still need to be solved in order to achieve a higher level of deployment of aviation alternative fuels. With respect to the competition of biofuels use in the aviation and other transport sectors, it was identified that there currently 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). Regarding the ILUC consideration discussion, it was pointed out in the presentation that legislative stability is a must to de-risk investment and create confidence. The project work has also identified a need to consider harmonized sustainability criteria. Today, no mutual recognition exists between different legislations (e.g. by EU RED and US RFS) which is a barrier for commercialization. There is currently an ongoing discussion and work at ICAO level regarding aviation alternative fuel sustainability criteria which is very relevant in such proposal. In order to ensure public support for alternative aviation fuels, effective sustainability assurance and recognition is crucial. This is especially important if biofuels are to account for emissions reductions in a Global MBM scheme. Another conclusion of the presentation was related to addressing existing economic barriers, 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.

After the presentation, panel participants were invited to give their opinion regarding the following topics:

- 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?
- 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?

5.1 Agenda and participants of 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: • 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

5.2 Comments and amendments in Session 4 – Policies, Incentives and Regulation

To initiate the discussion, panelists where asked about the lessons that can be learnt from previous experiences in other world regions. Both Indonesian an US cases where mentioned in the discussion. In the case of the US, there is a current aspirational goal to replace 2% of domestic fossil aviation fuel consumption with alternative fuel. To achieve such goal several off-take agreements have been implemented. In the case of Indonesia, it was mentioned that there has been a big ambition to include bioenergy in the domestic policy action and to establish strong sustainability standards to palm oil production. Panelists commented that the case of Indonesia will be an interesting lab case for market deployment of alternative aviation fuels since it is a country that has an economy which very much depends on aviation transport. Future results of such policy should be followed up closely.

Regarding the existence of a large price gap between alternative fuels and conventional fuels, it was mentioned that it is an issue that should be addressed if there is a real interest in deployment. This should be carried out by incentivizing production that leads to a reduction of costs along learning curves. One example to close such gap could be direct or indirect government support for first-of-a-kind plants to increase production capacity which is currently low at European level. Loan guarantees or facilitating off-take agreements was also suggested by the panelists. Incentivizing production will eventually lead to a reduction of costs along learning curves facilitating deployment.

Panelists considered that developments on alternative aviation fuels will not happen without preference over other applications due to much stricter standards applicable for aviation fuels, meaning that currently, the level playing field is not sufficient compared to road transport. As a result, 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.), in order to achieve a more holistic planning for biomass use.

Regarding the establishment of mandates, there were different views in the room. While considered an effective way of achieving a specific option, mandates are not currently considered by the European institutions as a viable way forward. In addition, airlines fear that mandates could cause market distortions if they are applicable only to certain regions and in addition could put all the economic pressure on the airlines.

One of the worries expressed by panelists and assistants was the fact that there are no sectoral targets foreseen after 2020 within RED. Targets for specific sectors are only set at Member State level, meaning that different states in Europe may show a different levels interest in developing alternative fuels for the aviation sector. However, it is considered important to act at European level in order to have sufficient momentum to achieve significant deployment. Existing uncertainty with respect to the policy and regulatory framework post 2020 is considered a significant barrier for deployment. Discussions between the EC and MS on post-2020 framework for sustainable alternative fuels for aviation are necessary.

6 Summary of statements

The aim of the Final Conference was to present outcomes and concluded 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 statements 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 approach could be also implemented in six other Member States, including Spain, Italy and Germany.
- Coordination of national initiatives 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 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 production 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 near-zero emissions in the long run.
- 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 must not 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 help to bring down production costs.

Policies, Incentives and Regulation

- There exists a large willingness of airlines to support alternative aviation fuels in order to ensure public support for the growth of the aviation sector.
- Airlines fear market distortions caused by, e.g., mandates applicable only to certain regions. Additional costs should be shared by all sectors and players.
- 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.
- Counting alternative aviation fuels towards the obligation of fuel suppliers in Member States (as done in the Netherlands) is a viable option.

Annex A: Presentations

Contents of the following presentations:

- The European Flightpath 2020 Initiative
  ALEXANDER ZSCHOCKE, LUFTHANSA AG, GERMANY

- The Nordic Initiative for Sustainable Aviation (NISA)
  MARTIN PORSGAARD, NISA, DENMARK

- CORE-JetFuel Results – Feedstock and Sustainability
  JOHANNES MICHEL, FNR, GERMANY

- Invited Presentation: Feedstocks and sustainability for biojet deployment A multicriteria approach from CAER project
  DAPHNE LORNE, IFPEN, FRANCE

- CORE-JetFuel Results – Conversion Technologies Holistic Assessment of Production Pathways
  ANDREAS SIZMANN AND ARNE ROTH, BHL, GERMANY

- Invited Presentation: Production pathways for short- and long-term availability of alternative jet fuel and their performance perspectives
  ROBERT MALINA, MIT, USA

- CORE-JetFuel Results – Technical compatibility, Certification and Deployment
  ALAIN QUIGNARD, IFPEN, FRANCE

- Invited Presentation: The Nordic Biofuel for Aviation Project
  ERIK WORMSLEV, NIRAS, DENMARK

- CORE-JetFuel Results – Policies, Incentives and Regulation.
  MARÍA DE LA RICA, SENASA, SPAIN