CORE-JetFuel

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

WP3: International Expert and Stakeholder Exchange

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Information submitted on behalf of CORE-JetFuel

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

D3.3: Minutes of telephone conference of stakeholder working group 3

SUBMITTED VERSION 1.0

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Work Package: 3
Work Package Leader: WIP

PROJECT PARTNERS

FNR – Fachagentur Nachwachsende Rohstoffe e.V., Germany

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

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Coordination and support action - FP7 – 605716

Working Group 3: Technical Compatibility, Certification and Deployment

Telephone conference 4 April 2016
10:00 – 12:00 (CET)

TELCO MINUTES

Telco Objectives: Discussion on ASTM Qualification of bio-jet fuels & relationships and prediction of detailed characterization/standard properties

Background

At present, the ASTM process is a long, time consuming and costly process.

Moreover, currently there are several routes for synthetic jet fuels, 3 yet approved, and a lot of pathways under approval procedure (probably not all successfully conducted to their final term of qualification).

The ASTM D7566-14c for synthetic jet fuel is quite complicated with one appendix for each SPK, HEFA and SIP route, even if the chemical structure is quite similar (especially for SPK and HEFA). For future pathways, such as Green Diesel / High Freezing Point (HFP) HEFA, as well as ATJ/Iso BuOH route by GEVO producing C12 and C16 isoP, ARA+ Chevron CH[1] producing jet fuel with aromatics (Readijet^{TM}), many annexes need to be approved, even if the chemical structures and properties are not very much different.

Several projects on French level (CAER followed by MOCCASSIN) or European level such as a currently proposed project with the objective of modelling jet fuel standard properties (such as freezing and cold behavior (i.e. viscosity at -20°C), thermal stability, oxidation stability, compatibility with elastomers) with the chemical structure in order to be able (or to try) to predict these standard properties and the behavior of synthetic jet fuel alone or blended with fossil jet fuel. This understanding will be very interesting for example for Green Diesel / HFP HEFA with its major concern related to cold properties, when blended at a few % up to 5-10%, depending on the cold flow properties of the biodiesel (summer, winter, artic quality).

In the mid/long term (it will take time to perform studies and change business as usual habits) a new approach based on the fact that similar chemical structures will give similar standard properties used in commercial transaction and quality insurance as well as in specification, promises to be more fruitful and efficient and could help to get a better understanding of the effect of the fine chemical structure on the final jet fuel blend, especially for main issues such as cold flow properties behavior, oxidation and thermal stability or compatibility with materials (i.e. elastomers).

If relatively detailed measurements of the chemical structure of the biojet fuel (e.g. modern analytical techniques such as 2D GC, NMR, IR) are possible, it will be easier to predict, at least at tendency level, the standard qualities of the products.

Such kinds of measurements are the aim of process development at IFPEN (but not only) since more than 20 years. In the long term it should be possible to get a pretty good prediction or even an excellent prediction (refer to Cetane prediction by NIR for example) of the quality of the final product even during early development at lab level.

The following guiding questions will structure the conference call.

Discussion & Questions:

Relationship detailed analyses / properties of usage

- Do you think that there still remains a lot to do to be able to predict usage properties in synthetic jet fuel and synthetic + fossil jet fuel blends from detailed chemical analysis and to be able to get a better comprehensive approach, i.e. in order to shorten routes development (detailed analyses only need very small quantity of product), to optimize specification limit (i.e. minimum level of aromatics or “solvent” components in jet fuel to avoid leakage in seal gaskets)?

- If yes, what should be the properties to be studied:

[1] Process now called Biofuels Iso-Conversion or BIC for Catalytic Hydrothermolysis followed by an Iso-Conversion (hydro-treatment CLG)

- Cold flow properties
- Oxidation stability
- Thermal stability
- Compatibility with elastomers
- Effect of impurities (not found in fossil fuel) at a very low level such as metal

Certification is currently a long and expensive process:

- Should it be possible to gather processes producing very similar chemical structures (such as FT and HEFA SPK) in order to decrease the number of qualification procedures or not?
- How can we solve or decrease/shorten this cost/time barrier, providing that safety issues shall remain at the same high level?
- What are good approaches and feedback to minimize cost and time (i.e. feedback from the SIP qualification)?
- How to maintain the high degree of safety obtained with current ASTM qualification and to be able to foresee potential troubles from new synthetic jet fuels (i.e. effect of new contaminants even at ppm level, blending rules for cold flow properties, stability) using more comprehensive characterization?
- Could comprehensive detailed analyses and a better understanding of the relation between properties of usage and chemical characterization help, and to what extent?
- Should the EU dedicate more resources to this aspect (currently Europe is very dependent on the ASTM procedure)?

Telephone Conference Minutes

The telephone conference was opened by Rainer Janssen, WIP Renewable Energies, and Johannes Michel, FNR, CORE-JetFuel Coordinator.

As leader of the CORE-JetFuel Stakeholder Working Group 3 on Technical Compatibility, Certification and Deployment, Alain Quignard, IFPEN acted as moderator of this telephone conference and gave a presentation providing background information and guiding questions. This presentation is attached as Annex 2 to these telco minutes.

1 Alternative Jet Fuel Pathways – Status of ASTM D7566 certification

Until today the following four pathways are certified:

- FT-SPK certified in 2009 (Annex A1 to ASTM D7566)
- HEFA-SPK certified in 2011 (Annex A2 to ASTM D7566)
- DSHC (Direct-Sugar-to-HydroCarbon), renamed Synthetic Iso-Paraffins (SIP) in June 2014 (Annex A3 to ASTM D7566)
- Synthesized Kerosene with Aromatics derived by Alkylation of Light Aromatics from Non-petroleum Sources. Last changes approved on November 1st 2015 (Annex A4 to ASTM D7566). Pathway supported by Sasol.1

ATJ-SPK GEVO

Furthermore, **certification of the ATJ-SPK pathway developed by GEVO was completed on 15th April 2016** (refer to recent news). Thereby, blending levels of up to 30% in conventional jet fuel will be allowed due to issues with the electrical conductivity and the distillation curve at higher blends.

Discussion related to AtJ 30% blend – why?

- *Electrical conductivity*, 30% is too much / a max. 20% should be better (G. Gauthier)
- *Distillation curve*: GEVO kerosene is made of iso-C12 and iso-C16 from IBuOH oligomerization after dehydration with a non-continuous distillation curves, as for fossil jet fuel or FT & HEFA SPK and may behave as a mixture of pure chemical products when blending with fossil fuels. 30% could be too much.

ATJ-SPK will be the 5th annex of D7566.

Biofuels ISOCONVERSION (BIC) process by ARA (Applied Research Associate) / CLG (Chevron Lummus Global)

In the coming months further turbine tests (on CFM 56) in cooperation with Lufthansa on particulate and pollutant emissions are scheduled by ARA.

Certification of the Biofuels Iso-Conversion (BIC) process developed by ARA is not expected very soon (2017?).

Green Diesel / High Freezing Point (HFP) HEFA

With respect to the pathway Green Diesel / High Freezing Point (HFP) HEFA no recent news are available and a number of issues still needs to be resolved.

According to Nicolas Jeuland, Boeing is working a lot on this pathway. Nevertheless, there are limits to its use. The research report is under preparation. There is industry interest in this pathway using existing or projected HVO units producing biodiesel (e.g. by Boeing) and research projects are currently performed.

- Specifically, the allowable blending ratio is not clear yet and could be as low as 1-2% (especially in summer time operation).
- Due to low blends the impact of this fuel on GHG emission reductions may be limited.
- Cold flow properties of HFP HEFA could hinder compliance with requirements of the aviation industry and thus prevent market introduction.
- Today, no robust models exist to calculate allowable blending levels, at least at the level of cold flow properties.
- Steady dedicated supply of Green Diesel would be needed to ensure compliance with specifications. Consistent quality of the produced fuel is of crucial importance. Because of the poor cold flow quality (related to jet fuel requirement) of HFP HEFA there are two solutions when blending significant quantities of synthetic fuel with fossil jet fuels: to choose a low freezing point fossil jet fuel base, if available, or to decrease the constraint on final Jet A/A1 fuel.
- So significant difficulties exist with respect to potential blending of “any kind” of HFP HEFA with “any kind” of fossil jet fuel.
- The (chemical) properties of HFP HEFA depend on both the feedstock used and the conversion process.
- This route could work well with a dedicated supply of low freezing point fossil jet and dedicated supply of renewable HEFA diesel but what about insurance quality (refer to overall later discussion on the subject).
- The future research report (N. Jeuland) will permit to check if all the properties, especially cold flow properties, are complying with the specification in ”true refining life”.
- **The certification date is not known today, but probably not before early or mid-2017,** as confirmed from a very recent mail from Mark Rumizen from FAA: “Regarding Green Diesel /HFP HEFA, the data report (called a “research report” at ASTM) has not yet been submitted to the ASTM team for review. Once it is submitted, it will take six months to a year to review the data and ballot the addition of Green Diesel to D7566”.

2 Discussion on opportunities to enhance the ASTM D4054 certification process

Opportunities to reduce costs and time of certification process

It was agreed that **a lot of R&D efforts are still needed and** compulsory (N. Jeuland) **to understand the properties of alternative jet fuel blends based on detailed chemical analysis,** at qualitative level first (molecule identification) and finally at quantitative level (Patrick Leclerq). The analysis of chemical properties has qualitative aspects with respect to the identification of specific molecules as well as quantitative aspects aiming at a reasonably precise prediction of properties.

There is also a lack of knowledge on some fossil fuels types. If European and North America fuels quality and analyses are quite well known through survey for example, this is not necessary the case for less known jet fuels such as Chinese or Russian ones. **There is probably a lack of knowledge on these fossil fuels.**

It should be the aim of such analysis of the alternative jet fuel to identify the most critical aspects of the certification process (i.e. red/green light for specific parameters).

Thus, fuel analysis is a good means to SUPPORT the certification process, but shall NOT REPLACE the certification process. Such support may serve to reduce costs and time needed for the certification 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 requirement for aircraft.

Furthermore, it was highlighted that some properties (cold flow such as freezing point or viscosity, as well as thermal or oxidation stability) of blended fuels are "non-additional" and may not be easily calculated from the ratio and properties of the blending components. The efforts have to be focused on such properties and also on combustion properties (Patrick Leclerc).

How to maintain a high degree of safety with alternative jet fuels?

It was discussed whether the ASTM certification of alternative fuels is sufficient to always guarantee safety of operations. ASTM certification is a robust process to guarantee than the new fuel will comply with all requirements related to compatibility, quality, safety…. (Ross Walker). Important concerns were raised with respect to the logistics of alternative fuels which may have a negative impact on the quality assurance of blended fuels.

The current certification process does not cover potential problems originating from logistics aspects and the presence of new players, and the ASTM certification process may need to be adjusted.

Opportunities to improve certification process

It was agreed upon that the ASTM certification process to include a new Annex for each certified pathway shall be retained (Nicolas Jeuland).

Certification of chemical properties instead of pathways is not considered easier.

It is thus important to separate research on the chemical structure of fuels (RTD efforts supporting certification) from the certification process itself.

Furthermore, experiences gathered on the certification of alternative jet fuels 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,** as done in the SIP pathway. Currently iso-paraffinics are quite well known from the first certification efforts and this knowledge can help to reduce time for new biojet fuels certification based on this chemical structure.

In that sense, a good understanding/modeling of relationship between chemical analyses and final fuels requirements is very important and can help to flag a red / green light on some of the relevant properties (NIcolas Jeuland, Patrick Leclercq).

Major cost factors within the certification process are the high costs for the construction of demonstration facilities able to produce sufficient quantities of fuels for engine testing. The reduction of fuel quantity requirements is however seen critical as tests performed on smaller engines may not lead to trustworthy results acceptable to engine manufacturers. Not all the engines have exactly the same behavior with fuels. For example testing a small turbine, such as an APU unit, is not enough to extrapolate to the aircraft propulsion engines. It is not only a matter of fuel combustion in a turbine, but there are differences among engines, such as for example the impact of contaminants, and a Turbomeca engine will not necessary exactly behave as a Snecma engine. It is thus mandatory to perform test on true propulsion engines too. Furthermore, the construction of (rather large) demonstration facilities is a necessary step towards market introduction anyways, as large-scale (beyond pilot) production of a fuel at consistent quality needs to be proven before commercialization.

It was stated that certification costs are not regarded as "show-stopper" for the development of alternative aviation fuels.

One of the key elements (Nicolas Jeuland) **is contaminants with a lack of understanding of their effects and there is a need for research in this area**. But this is not a question of certification but a question of quality insurance and to be able to check that the production is performed in a good way.

3 Specific recommendations to the European Commission

It was highlighted that focus should be placed on the identification of specific activities (including R&D programs) to be implemented on EU level in order to support the ASTM D5054 certification process of new pathways for alternative jet fuels. For this, feedback from industry representatives is needed.

The following **specific topics** were identified where support on EU level for RTD projects would be needed:

- Understanding of the impact of contaminants of alternative jet fuels on fuel properties and materials.
- Understanding and trying to model complex chemical and physical phenomena such as thermal and oxidation stability of fuel bases as well as on the final commercial blend.
- Understanding of the impact (on fuel properties, contaminants, etc.) of using new feedstock (e.g. algae) for the production of already certified jet fuels (e.g. HEFA).
- Quality assurance of the full supply chain (including logistics aspects) of alternative jet fuels, as well as blends with fossil jet fuel, especially for the jet fuel on which we have not so many analytical data and survey (i.e. Chinese or Russia).
- Inclusion of full chain quality assurance in the certification process.
- Understanding and modeling existing fossil fuel refined in Russia and China.
- What about the possible evolution of fossil jet fuel and blends with renewable jet fuels with lower sulfur and aromatic content?
- Impact of new jet fuel structure on dielectric constant.

4 Annex 1: Telco Participants

Alain Quignard (Moderator)	IFPEN
Rainer Janssen (Facilitator)	WIP Renewable Energies
Adam Fallon	AIRBUS
Frederic Eychenne	AIRBUS
Isabelle Lombaert-Valot	AIRBUS
Ross Walker	AIRBUS
Gerard Gauthier	SNECMA
Nora Lamharess	SNECMA
Laurie Starck	IFPEN
Mickael Sicard	ONERA
Philippe Novelli	ONERA
Nicolas Jeuland	SAFRAN
Patrick LeClercq	DLR
Philippe Marchand	TOTAL
Sonia Khennache	TURBOMECA
Johannes Michel	FNR
Maria de la Rica Jiménez	SENASA
Dominik Rutz	WIP Renewable Energies

5 Annex 2: Background Presentation by Alain Quignard, IFPEN


CORE-JetFuel
Duration: Sep 2013 – Aug 2016
Budget: 2.000.000 €
6 Project Partners
Bauhaus Luftfahrt
Neue Wege.
SENASA
WIP
Energies nouvelles
FNR
Fachagentur Nachwachsende Rohstoffe e.V.
AIRBUS GROUP
Project coordinator
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General Objective
CORE-JetFuel will evaluate the research and innovation "landscape" in order to identify needs in research, standardization, innovation/deployment, and policy measures at European level, in liaison with relevant initiatives at international level.
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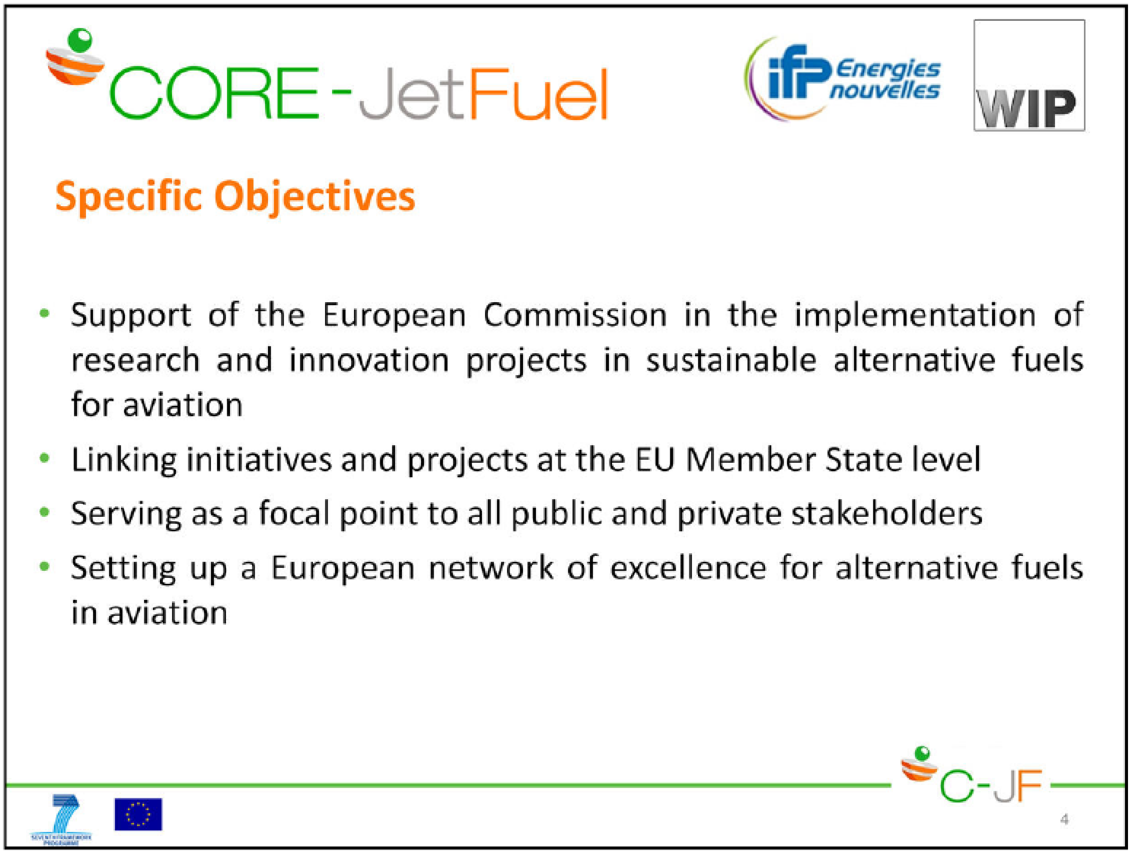
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WIP
Specific Objectives
• Support of the European Commission in the implementation of research and innovation projects in sustainable alternative fuels for aviation
• Linking initiatives and projects at the EU Member State level
• Serving as a focal point to all public and private stakeholders
• Setting up a European network of excellence for alternative fuels in aviation
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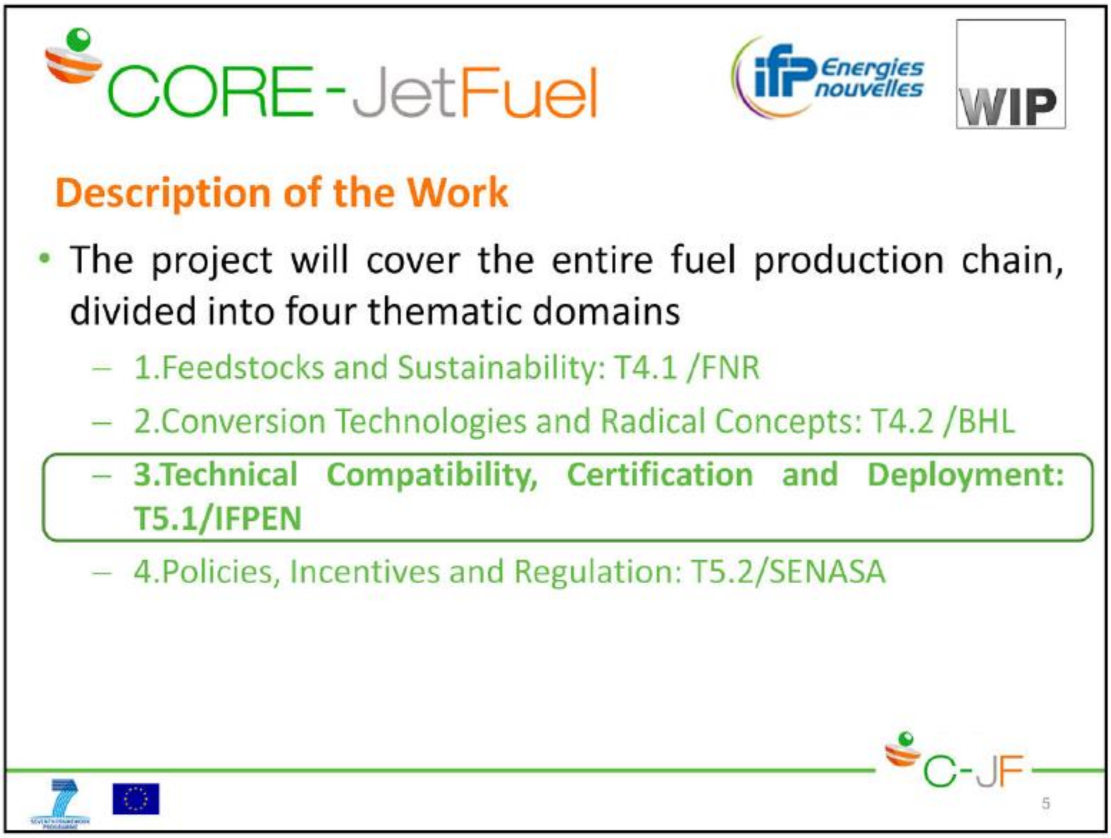
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Description of the Work
• The project will cover the entire fuel production chain, divided into four thematic domains
– 1.Feedstocks and Sustainability: T4.1 /FNR
– 2.Conversion Technologies and Radical Concepts: T4.2 /BHL
– 3.Technical Compatibility, Certification and Deployment: T5.1/IFPEN
– 4.Policies, Incentives and Regulation: T5.2/SENASA
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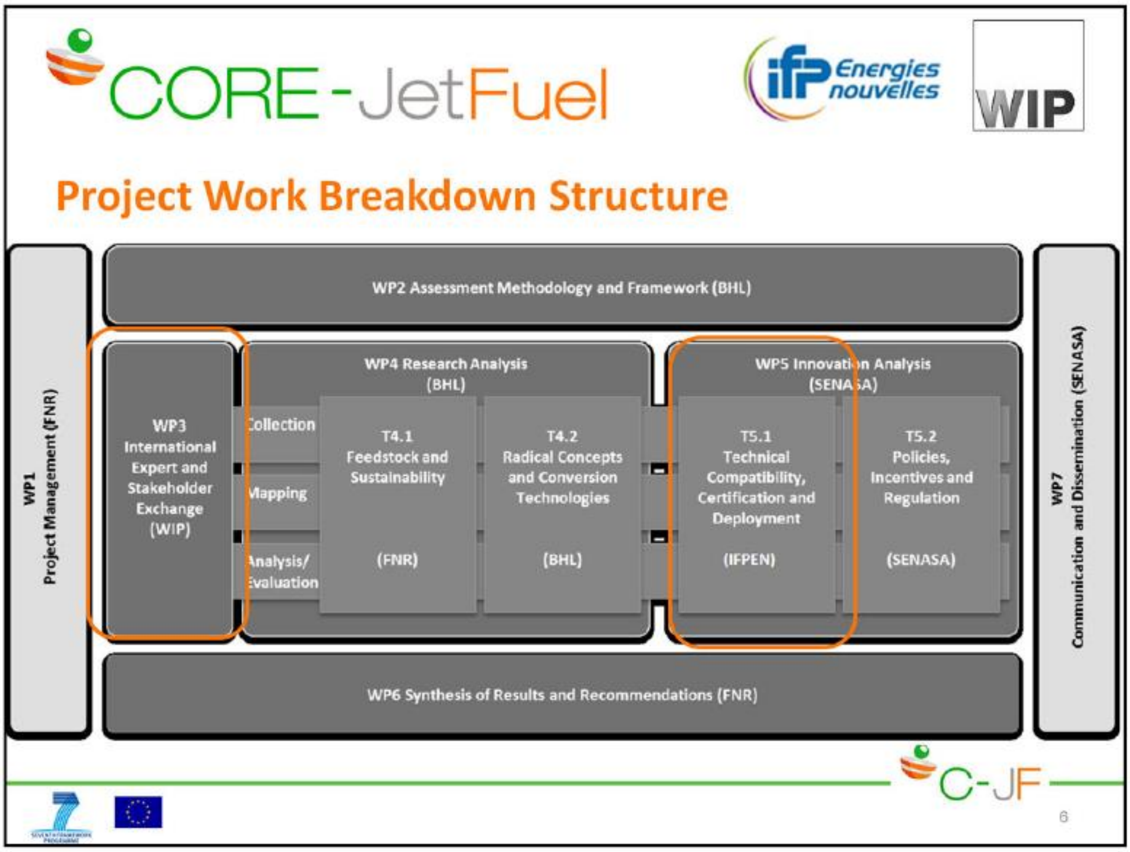
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WIP
Project Work Breakdown Structure
WP2 Assessment Methodology and Framework (BHL)
WP1 Project Management (FNR)
WP3 International Expert and Stakeholder Exchange (WIP)
WP4 Research Analysis (BHL)
Collection
Mapping
Analysis/ Evaluation
T4.1 Feedstock and Sustainability (FNR)
T4.2 Radical Concepts and Conversion Technologies (BHL)
WP5 Innovation Analysis (SENASA)
T5.1 Technical Compatibility, Certification and Deployment (IFPEN)
T5.2 Policies, Incentives and Regulation (SENASA)
WP7 Communication and Dissemination (SENASA)
WP6 Synthesis of Results and Recommendations (FNR)
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WP3 - Objectives
Ensure efficient involvement of international experts and stakeholders
Support of dissemination activities
Organization of workshops
Collection of information from experts and stakeholders
WP3 – Responsible: WIP
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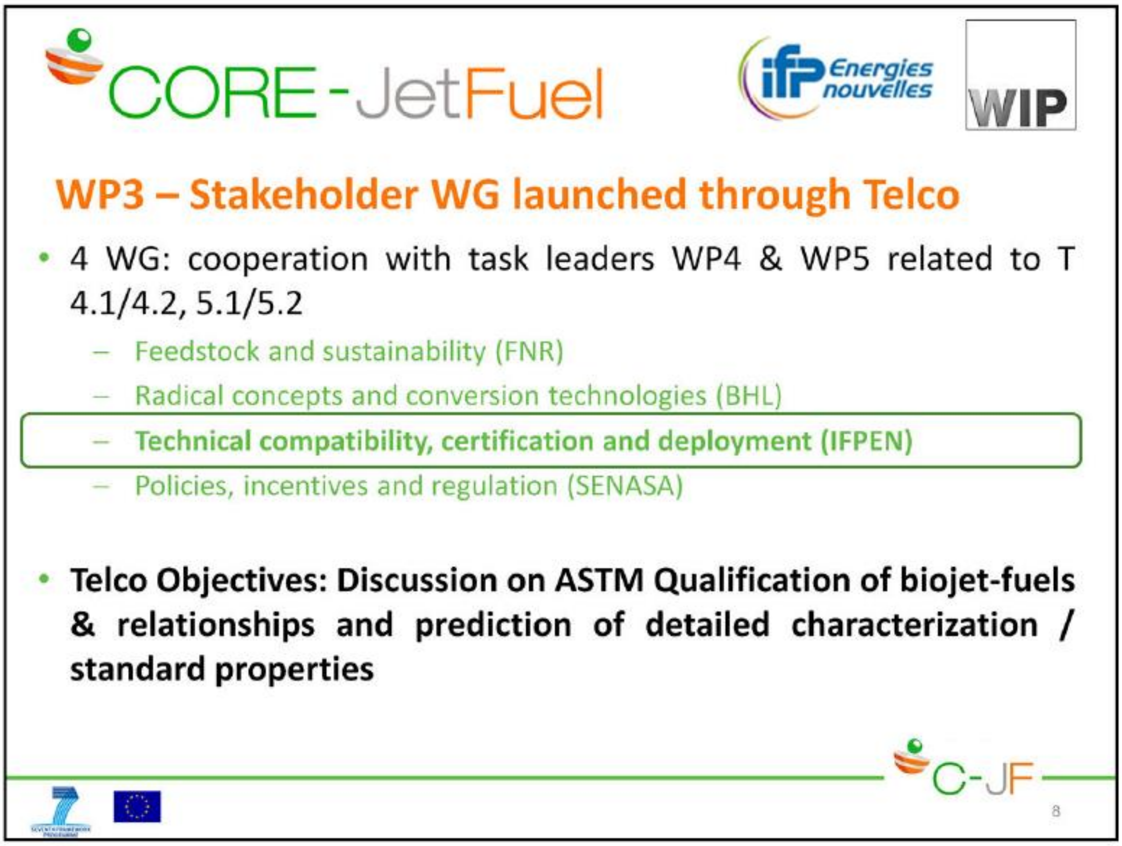
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WIP
WP3 – Stakeholder WG launched through Telco
• 4 WG: cooperation with task leaders WP4 & WP5 related to T 4.1/4.2, 5.1/5.2
– Feedstock and sustainability (FNR)
– Radical concepts and conversion technologies (BHL)
– Technical compatibility, certification and deployment (IFPEN)
– Policies, incentives and regulation (SENASA)
• Telco Objectives: Discussion on ASTM Qualification of biojet-fuels & relationships and prediction of detailed characterization / standard properties
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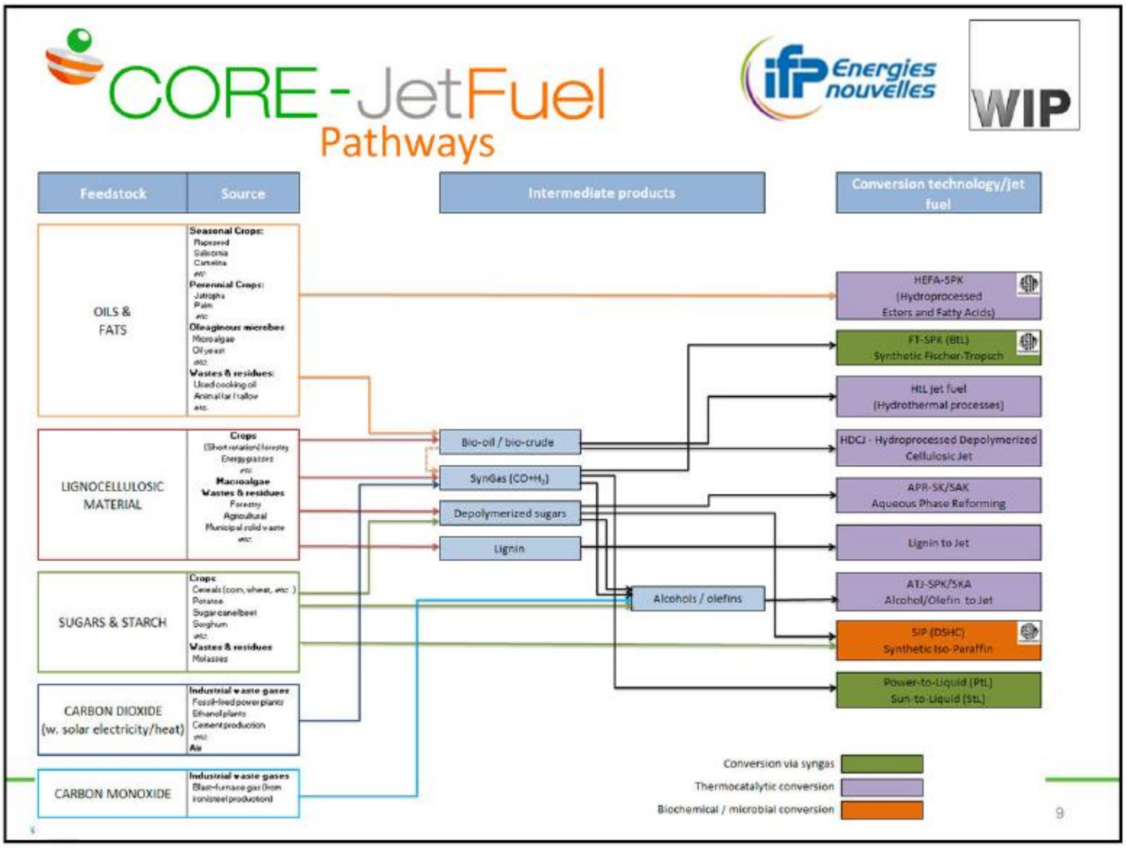
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Pathways
Energies nouvelles
WIP
Feedstock
Source
Intermediate products
Conversion technology/jet fuel
OILS & FATS
Seasonal Crops:
Rapeseed
Salicornia
Camelina
etc
Perennial Crops:
Jatropha
Palm
etc
Oleaginous microbes
Microalgae
Oil yeast
etc
Wastes & residues:
Used cooking oil
Animal fat / tallow
etc
LIGNOCELLULOSIC MATERIAL
Crops
(Short rotation) forestry
Energy grasses
etc
Macroalgae
Wastes & residues
Forestry
Agricultural
Municipal solid waste
etc
SUGARS & STARCH
Crops
Cereals (corn, wheat, etc)
Potatoe
Sugar cane/beet
Sorghum
etc
Wastes & residues
Molasses
CARBON DIOXIDE (w. solar electricity/heat)
Industrial waste gases
Fossil-fired power plants
Ethanol plants
Cement production
etc
Air
CARBON MONOXIDE
Industrial waste gases
Blast-furnace gas (from iron/steel production)
Bio-oil / bio-crude
SynGas (CO+H2)
Depolymerized sugars
Lignin
Alcohols / olefins
HEFA-SPK (Hydroprocessed Esters and Fatty Acids)
FT-SPK (BtL) Synthetic Fischer-Tropsch
HtL jet fuel (Hydrothermal processes)
HDCJ - Hydroprocessed Depolymerized Cellulosic Jet
APR-SK/SAK Aqueous Phase Reforming
Lignin to Jet
ATJ-SPK/SKA Alcohol/Olefin to Jet
SIP (DSHC) Synthetic Iso-Paraffin
Power-to-Liquid (PtL) Sun-to-Liquid (StL)
Conversion via syngas
Thermocatalytic conversion
Biochemical / microbial conversion
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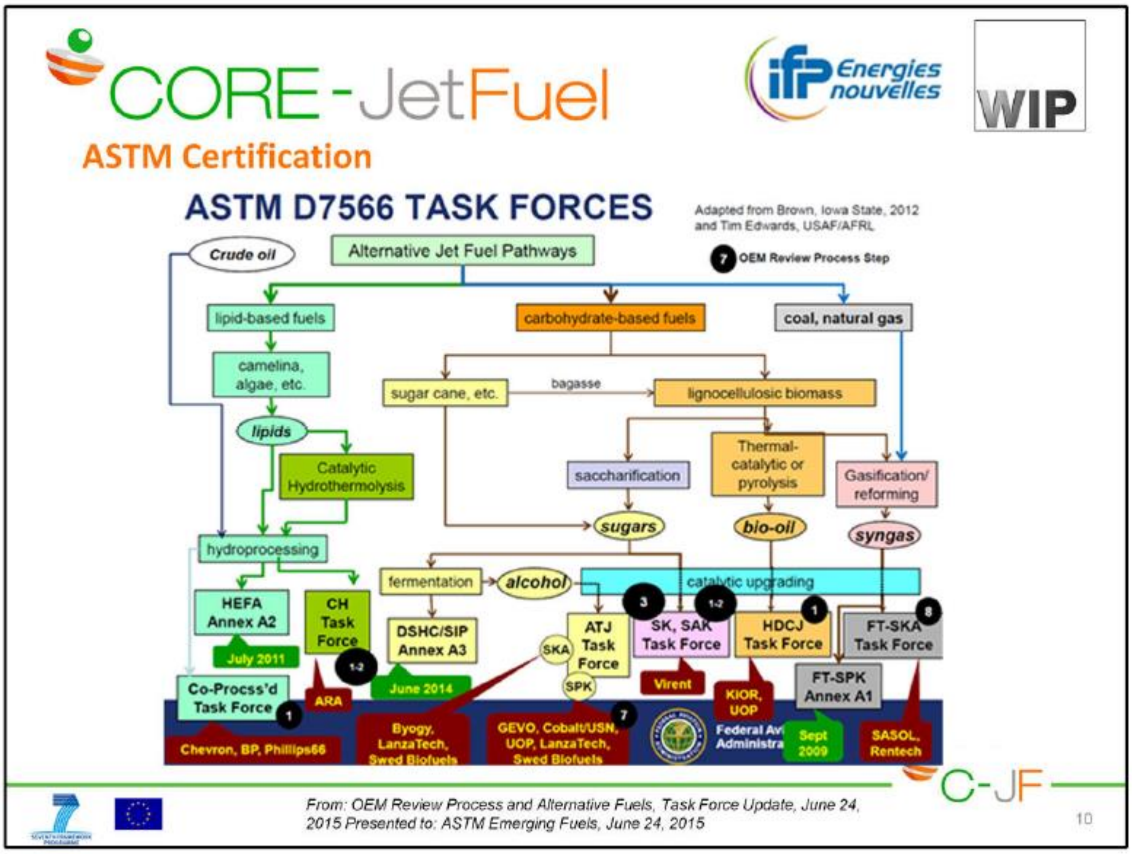

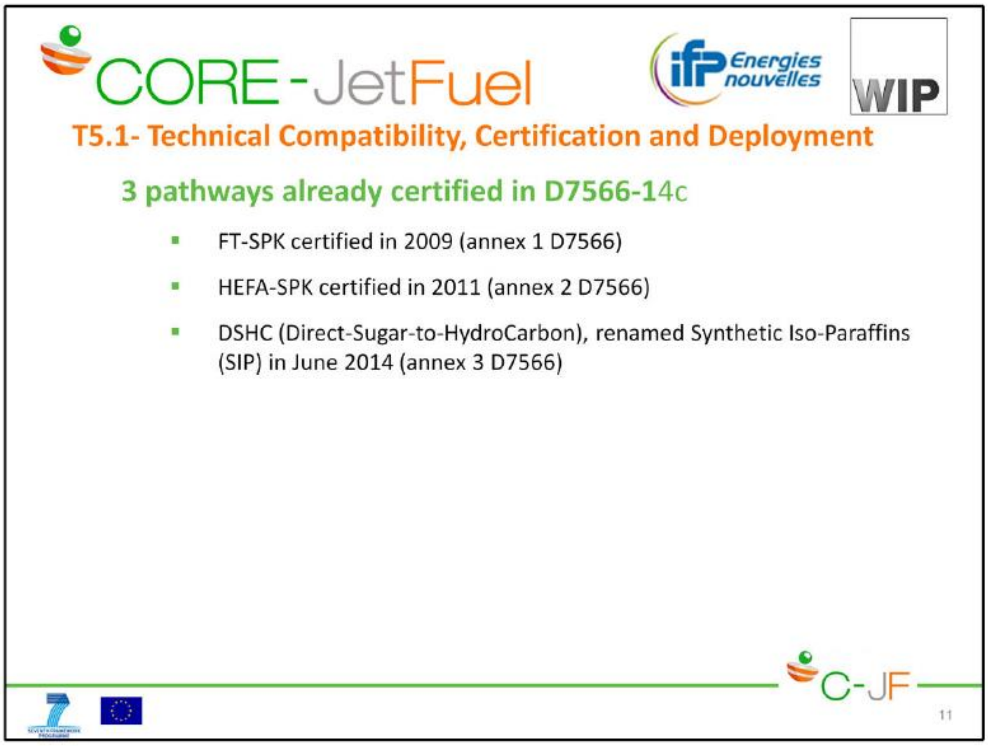

Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons

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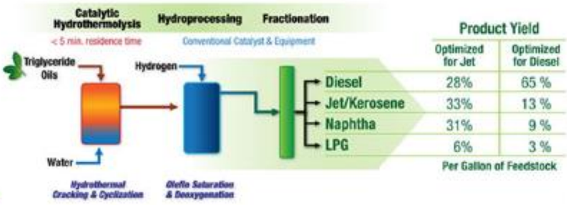
T5.1 - Technical Compatibility, Certification and Deployment

2-3 biojet fuels certified in D7566 in the short term ?

- **Biofuels ISCOCONVERSION (BIC) process: 1st step CHJ / Catalytic Hydrothermolysis / ARA, 2nd step Hydroprocessing / Chevron Lummus Global, producing 100% drop-in ReadiNaptha™, ReadiJet™ and ReadiDiesel™**
  - 150 000 gal. delivered (Feb 2016) for DLA [1]/US Navy certification contract (Military Spec.)
  - The biojet mainly consists in $C_{10}H_{22}$ to C_{14}-H_{30} HC chains, corresponding to a high flash point jet (Otan F-44 type), with properties similar to fossil jet (i.e. 10-20% aromatics)
  - D02 ASTM Dec. 2015 Studies completed, to be submitted to ASTM D02 ballot in order to submit a fourth annex to ASTM D7566 up to50% in jet A/A1 (certification end of 2016?)
  - Why 50% and not 100% ?

(1) Defense Logistic Agency



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- ReadiJet™

Specification Test	MIL-DTL-83133H Spec Requirement	ReadiJet™ from Camelina	ReadiJet™ from Carinata	Petroleum JP-8 Reference
Total Acid Number, mg KOH/g	≤0.015	0.011	0.012	0.003
Aromatics, vol %	≤25	24.2	16.8	18.8
Olefins, vol %	≤5	1.3	1.8	0.8
Heat of Combustion (m), MJ/kg	≥42.8	42.9	43.2	43.3
Hydrogen Content, % mass	≥13.4	13.3*	13.8	13.8
Smoke Point, mm	≥19	22	26	22
Thermal Stability @ 260°C:				
Tube Deposit Rating	≤3	1	1	1
Change in Pressure, mm Hg	≤25	0	0	2
Flash point, °C	≥38	48	46	51
Freeze Point, °C	≤-47	-54	-57	-51
Viscosity @ -20°C, cSt	≤8.0	3.9	3.5	4.9
Viscosity @ -40°C, cSt	≤12.0	7.4	6.5	9.9
Density, kg/L @ 15°C	0.775 - 0.840	0.818	0.802	0.804
Lubricity (BOCLE), wear scar mm	≤0.85	0.59	0.57	0.53

Analysis performed by DND-QETE and AFRL

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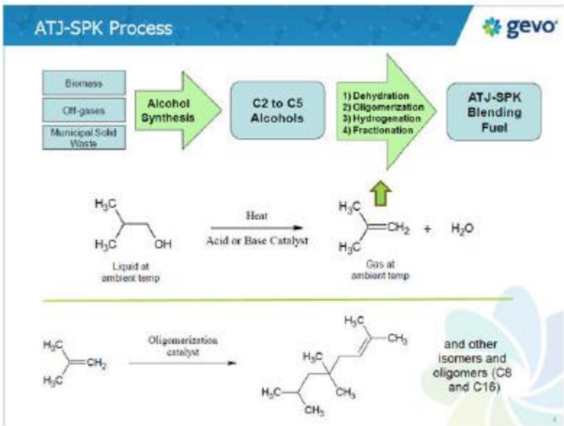
- Gevo ATJ SPK pathway



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T5.1 - Technical Compatibility, Certification and Deployment

2-3 biojet fuels certified in D7566-more in the short term ?

- **ATJ-SPK (IsoBuOH only) close to be certified in 2016?**
  - Gevo demo scale facility in Silsbee/Texas, being operating in continuous mode for the past 3 years with Over 100,000 gallons of ATJ-SPK blend produced
  - Gevo is preparing the shipment of ATJ to Alaska Airlines for this 1st flight
  - In June 2015, the ATJ-SPK data report was completed for specification data, fit for purpose testing, rig testing and engine testing and aircraft testing on jet from isobutanol (ASTM Step 7 level (on 9) for OEM engineering review)
  - The research report (ASTM D02 Dec. 2015) received 6 negative votes from US AF, US Army, USA Navy, DLA + Snecma, Airbus, still not approved, need complementary tests end 2015, but Gevo recently (March 28) announced that ASTM D02 and ASTM D02J have passed a concurrent ballot approving the revision of ASTM D7566, with final ASTM actions expected to be completed in early April??
  - Mainly C12-C16 isoparaffins ?
  - Gevo's ATJ would be eligible to be used for up to a 30 % blend in conventional jet fuel for commercial flights: Why 30% ?

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T5.1 - Technical Compatibility, Certification and Deployment

2-3 biojet fuels certified in D7566-more in the short term ?

- **Green Diesel / High Freezing Point (HFP) HEFA in 2016-2017 ?**
  - Interest: direct incorporation of biojet through direct integration in annexe ASTM D1655 (Jet A/A1) treated by ASTM D02.J0.01 SC, in place of D02.J0.06 for the other biojet fuels without a specific annexe in D 7566 and same limits as for fossil jet : JFTOT performed at 275°C and FAME lower than 50 mg/kg (100 mg/kg in future ?) / No specific investment using existing facilities
    - Possible production: REG, Neste, Diamond Green, ENI , UPM Bioverno ?, Total (2017), in Asia, Europe and USA, current world wide production > 2.0-2,5 Mt/y (800+ million gal), but dedicated to biodiesel
  - From ASTM D02 December 2015 meeting: a research report should be submitted to manufacturers (OEM) at the end of 2016. This report should be presented to ASTM D02 members in its next June meeting
  - % of HFP HEFA not clear
    - Boeing tested a 15% green D blend with the ecodemonstrator in 2014 (probably only using Winter grade diesel) and cold properties remains a main issue
    - Today probably 5% max (10-15% probably not achievable)
    - In summer time operation, may be not more than 1 to 2% ?

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ASTM Certification Highlights

- Pathways yet certified or closed to be certified
- Except for CHJ, all these routes are mainly iP based with a similar chemical structure !!

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T5.1 - Technical Compatibility, Certification and Deployment

→ **Certification of novel pathways in progress but, a lot (too many) of possible pathways considered:**

→ CH (ARA/CLG), ATJ-SPK (Gevo Isobutanol + Global Bioenergies isobutene ??), HDO-SAK (in progress with a blend 13% SAK/87% FT SPK recently tested in flight as well as a 17% SAK/HEFA SPK) and HDO SK (Shell/Virent), HDCJ (KiOR but bankrupcy in 2014) ???, HPO (Envergent/UOP but no recent news) ???, ATJ SKA (Lanza Tech) ???, ...

→ A lot of possible process providers, not necessary relevant in the long term (i.e. KiOR) with small a s well as large possible producers

→ ASTM D5054 qualification is a long (> 3 years: HEFA & FT SPK >5 years, but SIP=2 years!!) and costly procedure (may overpass US$ 10 millions)

→ ASTM D7566: a lot of annexes, one for each pathway ☹

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Panel Discussion

- **Relationship detailed analyses/ properties of usage**
  - Do you think that there still remain a lot to do to be able to predict usage properties in synthetic jet fuel and synthetic + fossil jet fuel blends from detailed chemical analysis and to be able to get a better comprehensive approach,
    - i.e. in order to shorten routes development (detailed analyses only needs very small quantity of product), to optimize specification limit (i.e. minimum level of aromatics or "solvent" components in jet fuel to avoid leakage in seal gaskets),….?
  - If yes, what should be the properties of usage to be studied:
    - Cold flow properties ?
    - Oxidation stability ?
    - Thermal stability
    - Compatibility with elastomer ?
    - Effect of impurities (not found in fossil fuel) at a very low level such as metal ?

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Panel Discussion

- **Certification is currently a long and expensive process**
  - Compatibility of HEFA-SPK or FT-SPK+SIP+fossil or SIP+AtJ+fossil jet fuels,.... with different fossil jet fuel qualities in the tanks due to refueling in different airports ? Is there a risk?
  - Should it be possible to gather processes producing very similar chemical structures (such as FT and HEFA SPK) in order to decrease the number of qualification procedure or not?
  - How can we solve or decrease/shorten this cost / time barrier, providing that safety issues shall remain at the same high level?
  - What are the good approach and feedback to minimize cost and time (i.e; feedback from the SIP qualification) ?
  - How to maintain the high degree of safety obtained with current ASTM qualification and to be able to foreseen potential troubles from new synthetic jet fuels (i.e. effect of new contaminants even at ppm level, blending rules for cold flow properties, stability,....) using more comprehensive characterization ?
  - Could a comprehensive detailed analyses and a better understanding of relation between properties of usage and chemical characterization help
  - To what extend ?
  - Could the EU dedicate more resources to this aspect (currently we are very dependent on the ASTM procedure)?

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THANK YOU!

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