# Research strategies for developing alternative fuels in aviation

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# Alternative fuel research in the EU

Since the late 1990's the EU has funded a number of consortia based studies focusing on the emergence of alternative fuels in civil aviation.

| Programme name | dates | focus |
|---|---|---|
| Aeronet | | |
| ECATS | 2005 – still here! | sustainability |
| Alfabird | 2008 – 2012 | suitability |
| SWAFEA | 2009 - 2012 | suitability, sustainability |
| ITAKA | 2012 - 2016 | logistics, sustainability, production |
| Forum AE | 2013 - 2017 | Emissions impact |

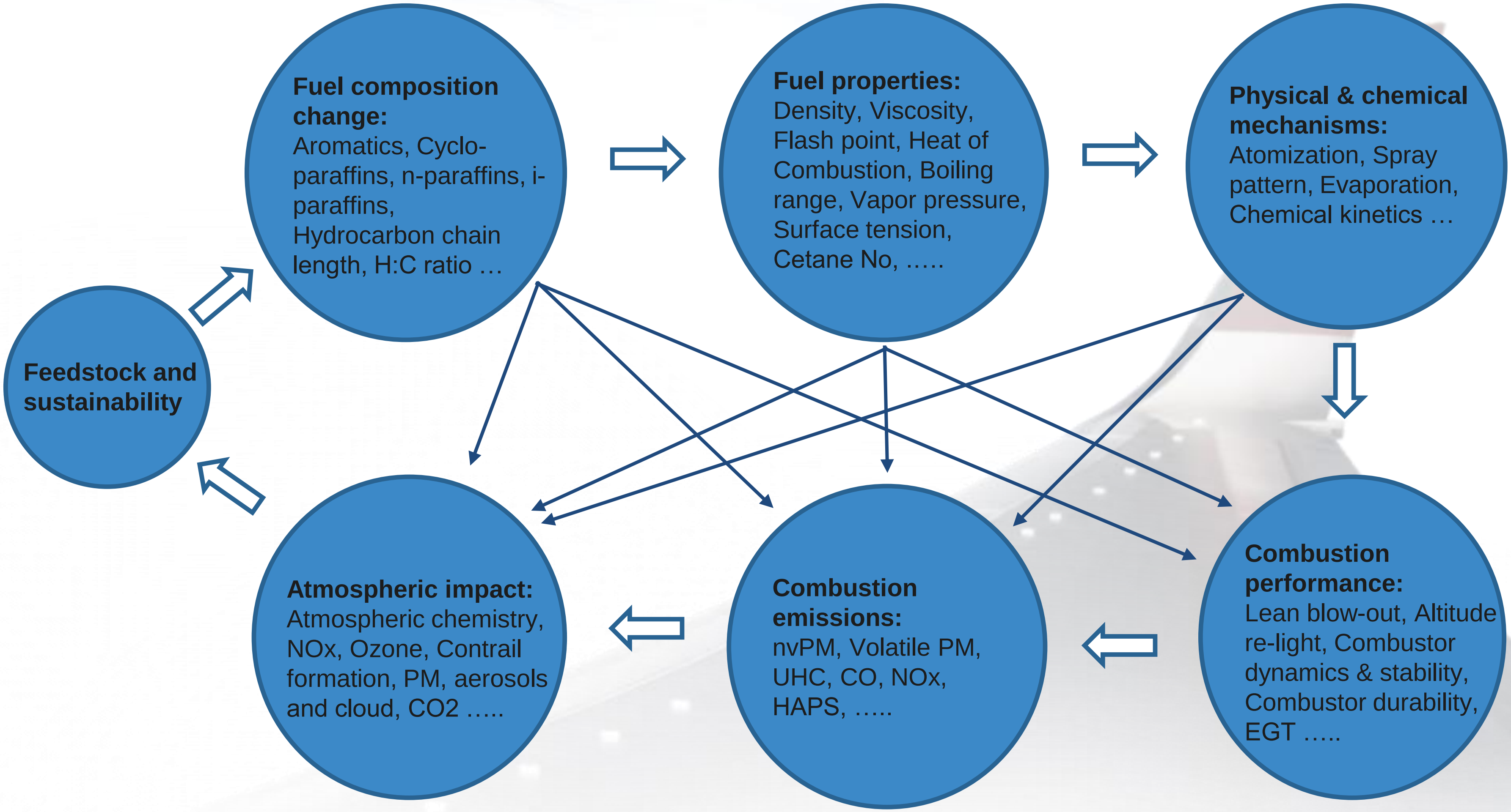
# Alternative fuels research & technology

- The **impact of alternative fuel** in aviation is more complex than it first appears.

- Even for **drop in fuels**, there are many inter-related structures, constraints and consequences.

- **Changes in fuel properties** can have far reaching impacts.

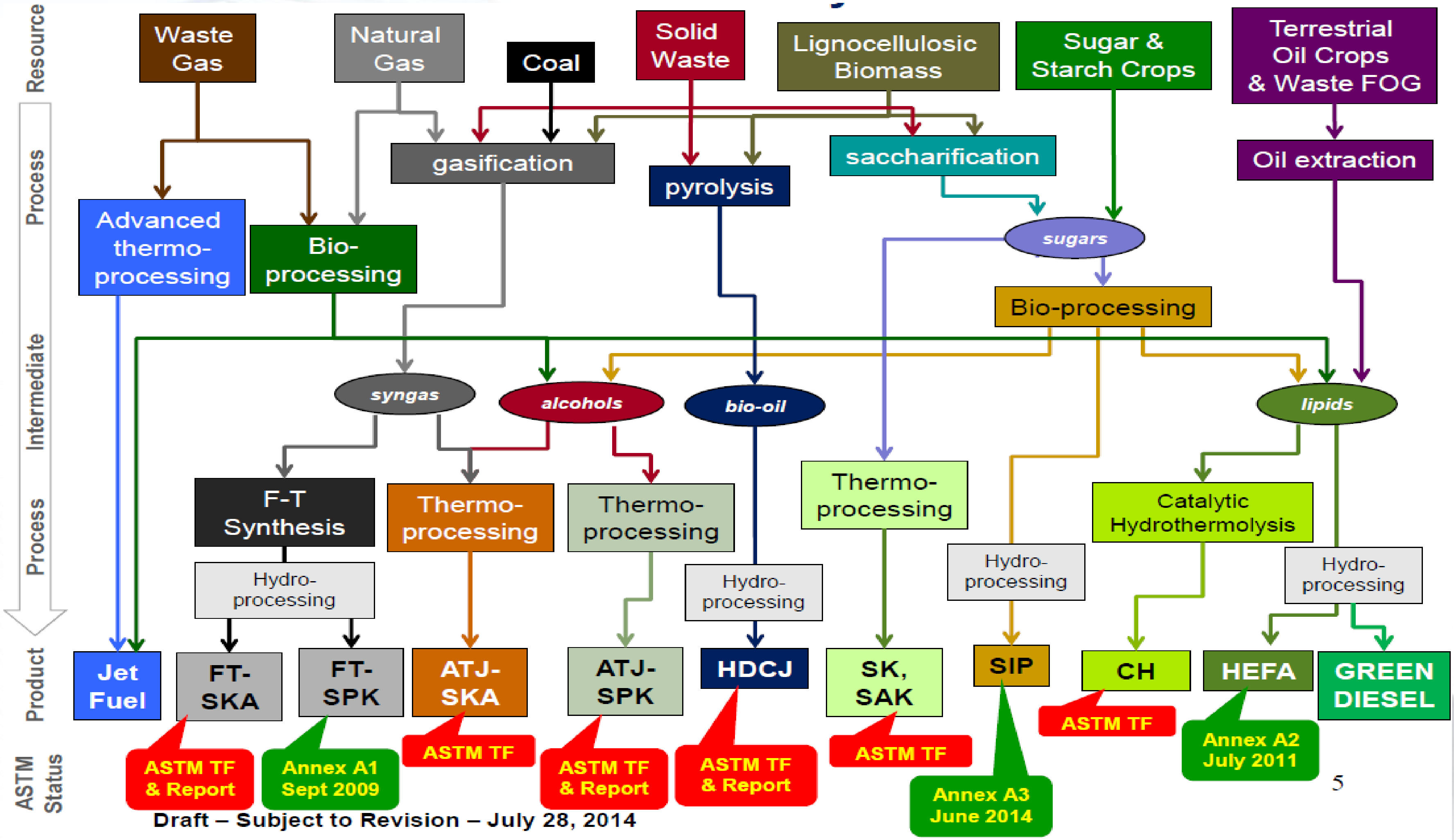
# The upstream / downstream impacts of alternative fuels



# Alternative fuels technology development

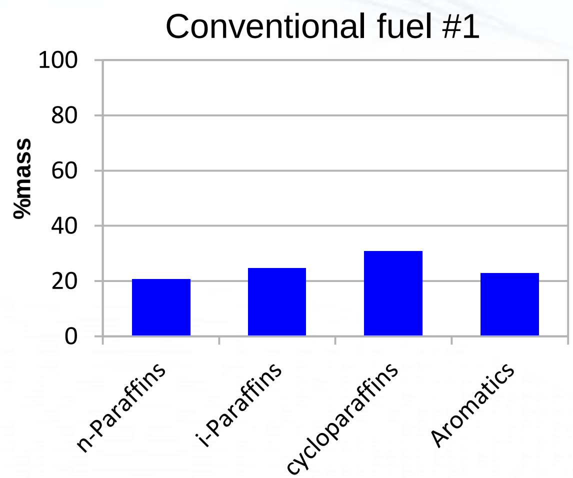
- A change in **fuel properties** will have consequences in area of endeavour elsewhere in the stream.
- **Sustainable alternative fuel pathways** have begun to emerge as a promising option to augment and diversify fuel supplies.
- **EU policy** is supportive of secure sustainable fuel supplies.
- Exactly how fuel will change in the future is **difficult to predict**,.... but the prediction that it will change seems dependable.
- Many new fuels may be **on their way**!

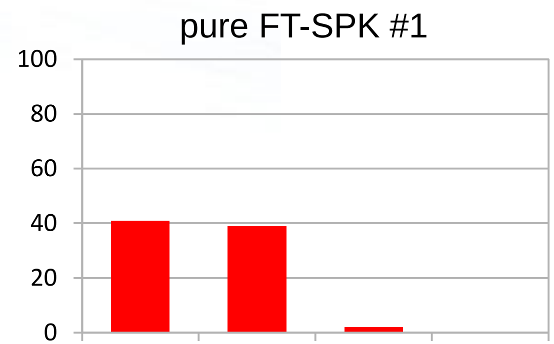
# Alternative fuels: new pathways and status

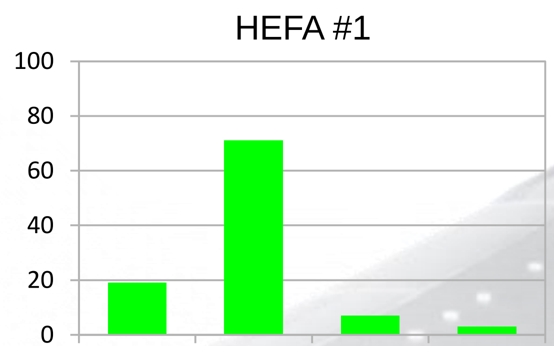


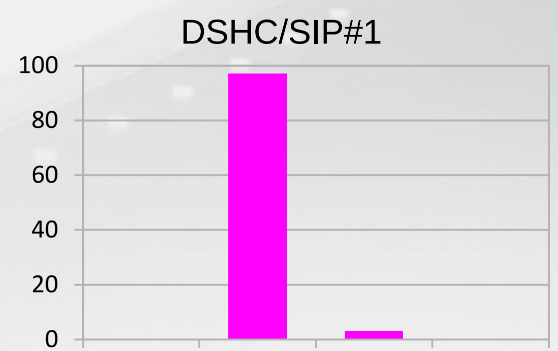

Source: Nate Brown 2015

# Alternative fuels: approved (in blends)




Source: FAA

- **FT-SPK: FT Synthetic Paraffinic Kerosene**
- **HEFA: Hydroprocessed Esters and Fatty Acids**
- **SIP: Synthesized Iso-Paraffins (formerly Direct Sugar to Hydrocarbons) – limited to 10% blends**

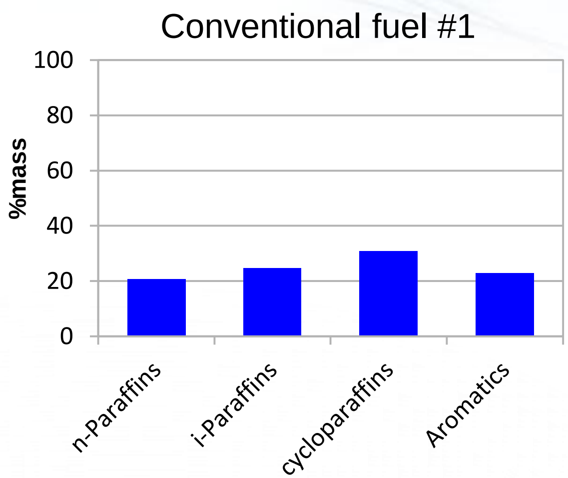
**Example of induced changes**

- **Reduced viscosity**
- **Lower density**
- **Increased vapour pressure**

- **Reduced PM mass and number**
- **Increase in EI(H2O)**
- **Decrease in EI(CO2)**

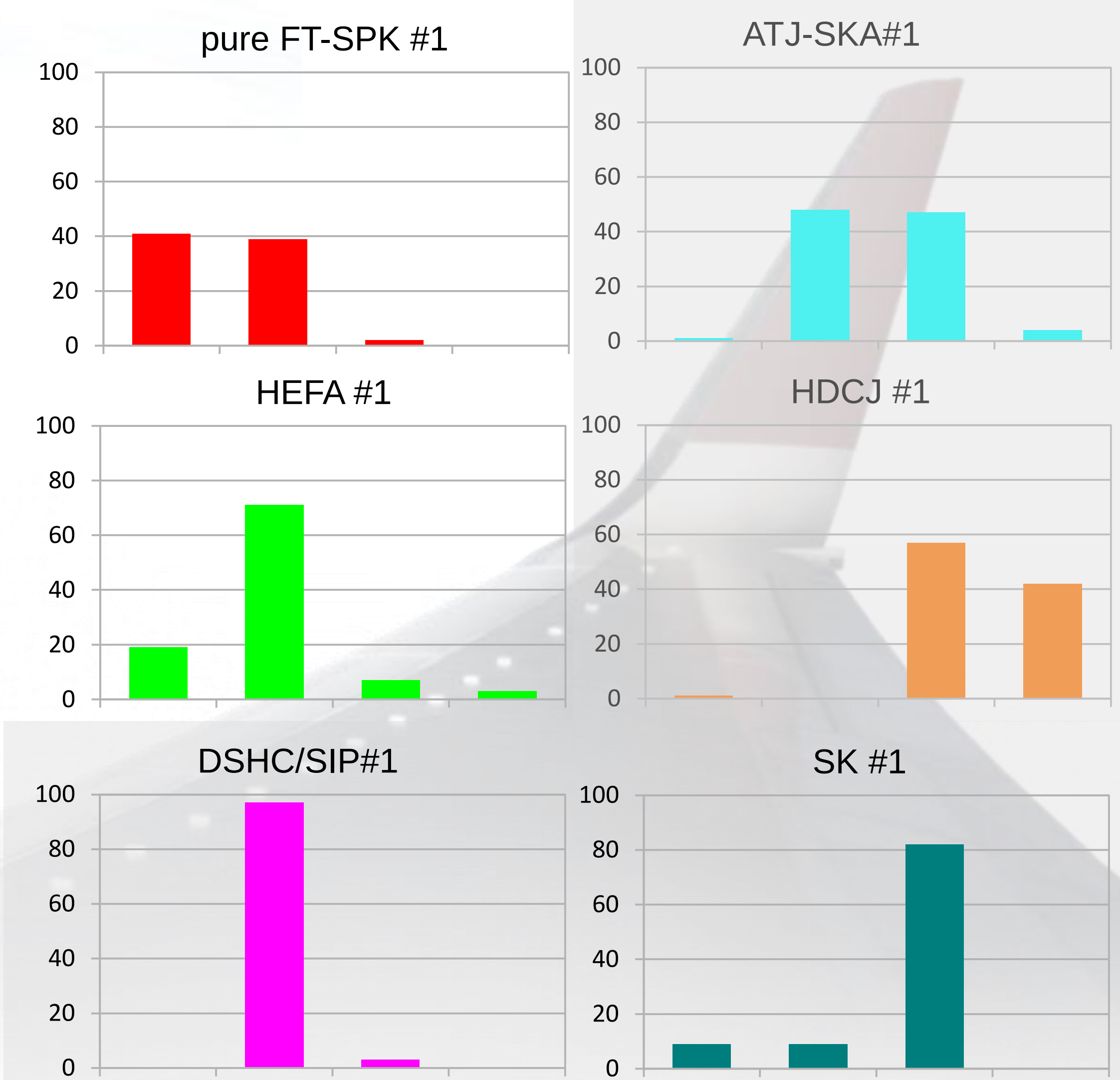
- **.....other currently uncharacterised impacts**

# Alternative fuels: changes to fuel composition




- **ATJ – Alcohol to Jet Synthesized Paraffinic Kerosene (also ATJ-SKA, containing aromatics)**
- **HDCJ – Hydroprocessed Depolymerized Cellulosic Jet (Pyrolysis amongst others)**
- **HDO-SK Hydrodeoxygenated Synthesized Kerosene**

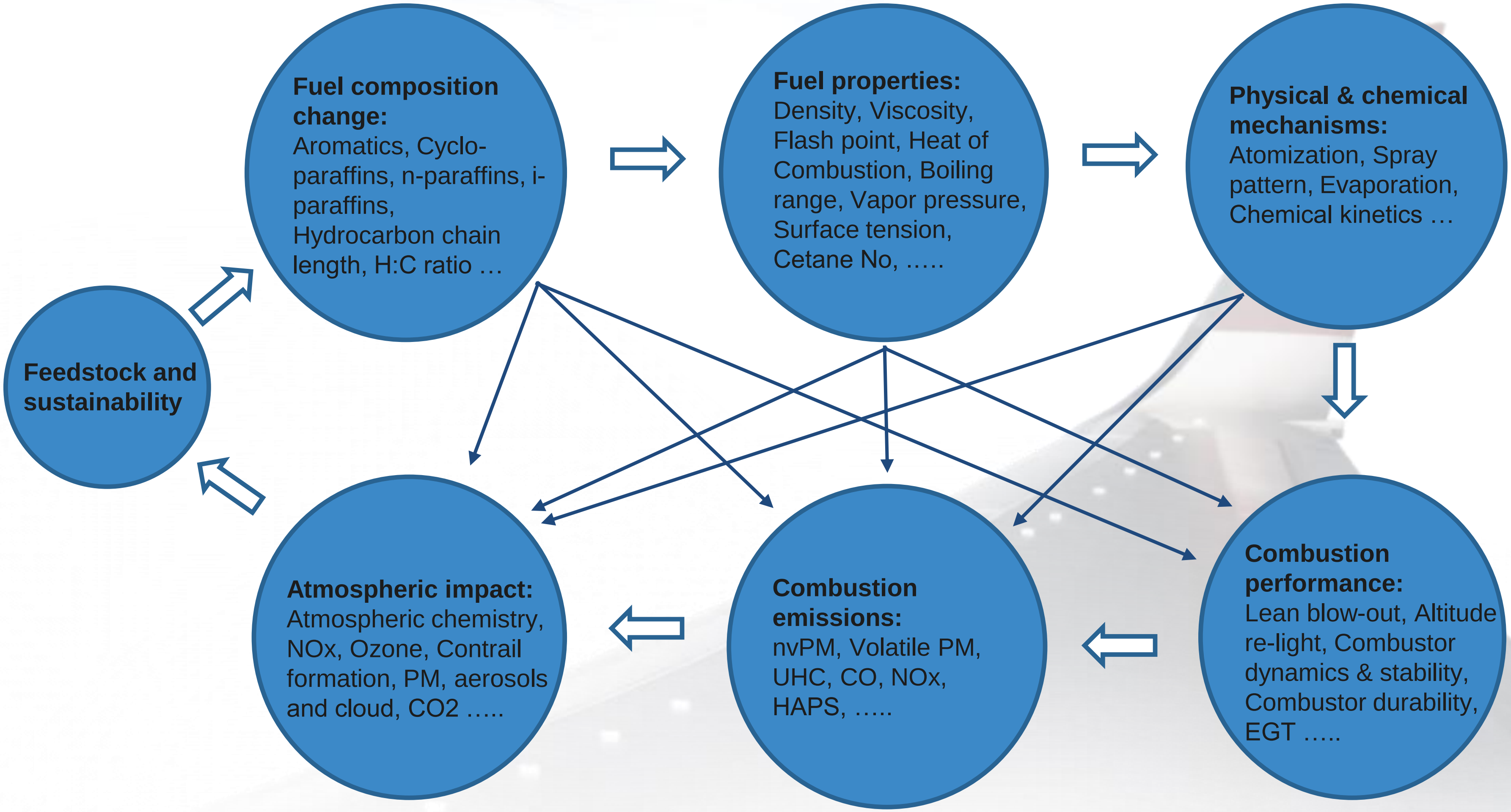
## What are the induced changes for these fuels?




Source: FAA

ECATS International Association

# The upstream / downstream impacts of alternative fuels (now with added complexity!)



# Alternative fuels research in the EU

- Aspects of alternative fuel research **are often disconnected** from their the corresponding upstream and downstream impacts.

  For example: Environmental or climate impact research is reactive to emission research when there is clearly an opportunity to proactively contribute to fuel chemistry and combustion research.

- There is a common thread, but alternative fuel research activities are only loosely coupled. There is no strategy to guide efforts, and no policy to link consequences.

Question:

If researchers **had a broader knowledge** of both upstream and downstream impacts of alternative fuels in aviation, could EU research be more effective?

# The need for more effective alternative fuel researcher training

- An EU coordinated action is needed to **train the next generation** of alternative fuel researchers.
- **Training structures** that traverse the disconnect between upstream and downstream impacts are essential. To be more effective research domains must become:
    - more informed and interdisciplinary,
    - more innovative with information feedback pathways,
    - more resilient, intersectoral, and EU wide,
    - supported by durable commercial involvement,
    - with cutting edge information exchange on new approaches,
    - Integrated with research activities elsewhere on the globe
    - and incorporating the latest findings in this emerging field.

# An alternative fuel researcher training network

- Such a coordinated action would **be best served by a network**, since the required skills and expertise are distributed across the EU.
- A **network tasked** with training the next generation of alternative fuel researchers would require:
  - ➢the ability to operate in close cooperation,
  - ➢enhanced communication and information exchange pathways,
  - ➢a wide breadth of competences,
  - ➢the ability to add value to existing research landscape.
- A network would facilitate the optimum **balance between** individual project requirements with cross cutting activities to preclude disconnected research definitions.

# What would a researcher gain from a network training model

- A better understanding of the **context and impact** of their research.
- Enhance the overall **coherence and effectiveness** of their work.
- Unique access to specialist training, different research environments and experienced researchers to aid skill development.
- Contact with **key stakeholders** and an exposure to the commercial environment through an industrial secondment program.
- Cross **boarder understanding** of different EU cultures to develop experience as a European players in alternative fuel research.
- Enhanced employability and career prospects **to help shape future** technology and policy development.
- The development of networks that will facilitate the communication of **best practice** well beyond the end of the training program.

# Concluding remarks

- The development of secure and sustainable alternative fuels is framed within Biofuel **Flightpath 2020** and EU aviation policy.
- A number of **alternative fuel pathways** have begun to emerge as a promising option to augment and diversify fuel supplies. However, the full impact of these fuels is unknown.
- A need to **better connect** the many aspects of alternative fuel research to their corresponding upstream and downstream impacts has been identified.
- An **EU wide network** has been proposed as a structure to most efficiently develop the necessary skills of researchers to address these issues and enhance the effectiveness of EU research.

# Thank you!

# Abstract

The aviation community in Europe aspires to develop an economic future that is sustainable in terms of fuel supply and with regards to climate impact. Sustainable alternative fuel pathways have begun to emerge as a promising option to augment and diversify fuel supplies whilst simultaneously reducing its environmental impact and emissions. It is this vision that is set out within the Biofuel Flightpath 2020 and EU aviation policy [1]. Research in this domain involves several different specialisms from fuel composition, chemical kinetics, combustion and propulsion, through to atmospheric chemistry and climate research. As a consequence, research is often disconnected across Europe and an integrated overview on how to best develop alternative fuels in aviation is often missing.

In this contribution we discuss a structure to traverse this gap: As a first objective we present a synopsis of state-of-the-art research covering key disciplines crucial for advancing the use of alternative fuels in aviation. As a second objective we present key open questions, and sketch pathways on how to overcome these challenges and advance research in this domain. In this context we introduce the idea of a network whose strengths reside in the breadth of competences from which it draws, supported by durable commercial involvement from across Europe, and cutting edge information exchange on new approaches, latest methods and recent findings in this emerging field. Concepts are introduced on how to best balance individual project requirements with cross cutting activities to preclude disconnected research definitions and promote integrated and efficient knowledge transfer. The paper will discuss identified research needs, visions for prospective research, and some of the strategic issues to be addressed in designing sustainable alternative fuel pathways into the future.