Alternative aviation fuel: development prospects

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The Problem

$177.3 billion (global aviation fuel market in 2021) (Fortune Business Insights, 2022)

$654,8 billion (expected world market size by 2029) (Fortune Business Insights, 2022)

Annual increase in commercial airline fuel consumption (record level of **95 billion gallons in 2019**) (Statista, 2022)

IATA member airlines have adopted a resolution committing them to achieving net zero carbon emissions **by 2050** (IATA, 2021)

Sustainable aviation fuel (SAF) makes up less than **0.1%** of all jet fuel used (World Economic Forum, 2022)

SAF could provide about **65%** of the emissions reductions needed by aviation to achieve net-zero emissions **by 2050** (World Economic Forum, 2022)

Positive effects of using SAF: increased flight range (Daggett et al., 2007; Holladay, 2020), ⊓increased payload and fuel economy (Holladay, 2020; Detsios, 2023; Energy.gov, 2020), increasing flight availability and profitability of air carriers

Transformation of the aviation fuel market and significant increase in the use and production of SAF, despite the labor intensity of this process (Searle et al., 2019)

Research Objectives and Methodology

Aim: analysis of prospects for the development of alternative types of aviation fuel in the short and medium term

Research Objectives:

1) Study of approaches to determining sustainable aviation fuel;
2) Analysis of the current situation in the world in the field of transition to alternative energy sources;
3) Analysis of the limitations and drivers of this process.

Most studies examine specific areas of sustainable fuel development. Less attention has been paid to the development prospects of different fuel types and their comparison.

- Bibliometric analysis
- SWOT analysis
- Case studies of global initiatives at various levels (national, industry, corporate)
- Case studies of foresights on the prospects for the development of alternative aviation fuel

Key steps and results of the study

Bibliometric analysis

Promising areas of scientific research in the field of SAF have been identified

SWOT analysis

Key characteristics of SAF and development opportunities outlined

Analysis of government initiatives

Examples of the USA, Great Britain, EU, Japan are analyzed. The plans of leading states regarding the volumes of projected use of sustainable aviation fuel and the reduction of greenhouse gases were studied. Selected countries with the greatest plans to reduce greenhouse gas emissions and maximize the use of sustainable aviation fuel (Topsoe, 2022)

Analysis of industry documents

The plans of international associations involved in the development of aviation (ICAO, IATA, IRENA), as well as data from analytical and forecasting organizations (WEF, World Bank Group, KPMG) regarding the prospects of alternative fuels are analyzed.

Key steps and results of the study (continued)

Analysis of corporate forecasts

Obtaining more in-depth assessments and plans of key manufacturers (Boeing, Airbus, Embraer) and new players (ZeroAvia) in the foreign market, as well as Russian participants regarding the possibilities of transition to alternative energy

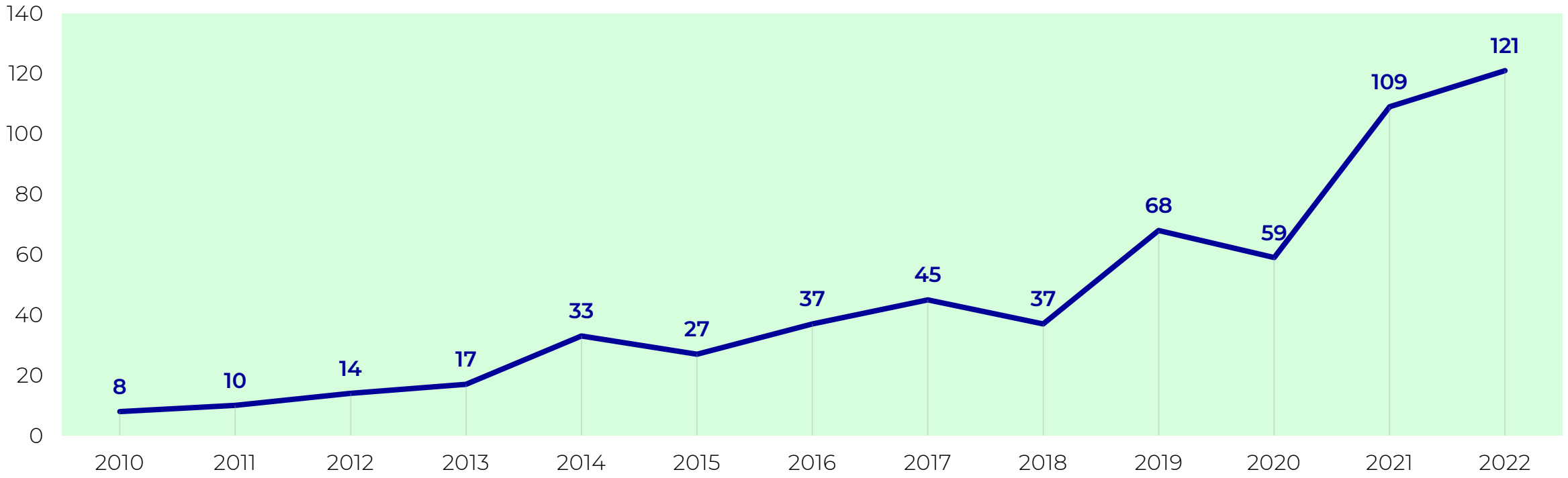
Overview of foresight studies

Identification of independent expert assessments regarding the future development of alternative types of aviation fuel. As examples, foresight studies were selected for regions leading in terms of targets for the use of sustainable aviation fuel (EU countries, the UK), as well as Brazil and Mexico, which are actively integrating into the global agenda for sustainable aviation fuel due to significant volumes of arable land that can be used in the production of biofuels

Bibliometric analysis

Growing attention to alternative types of aviation fuel in the world has led to interest in this topic in the research community

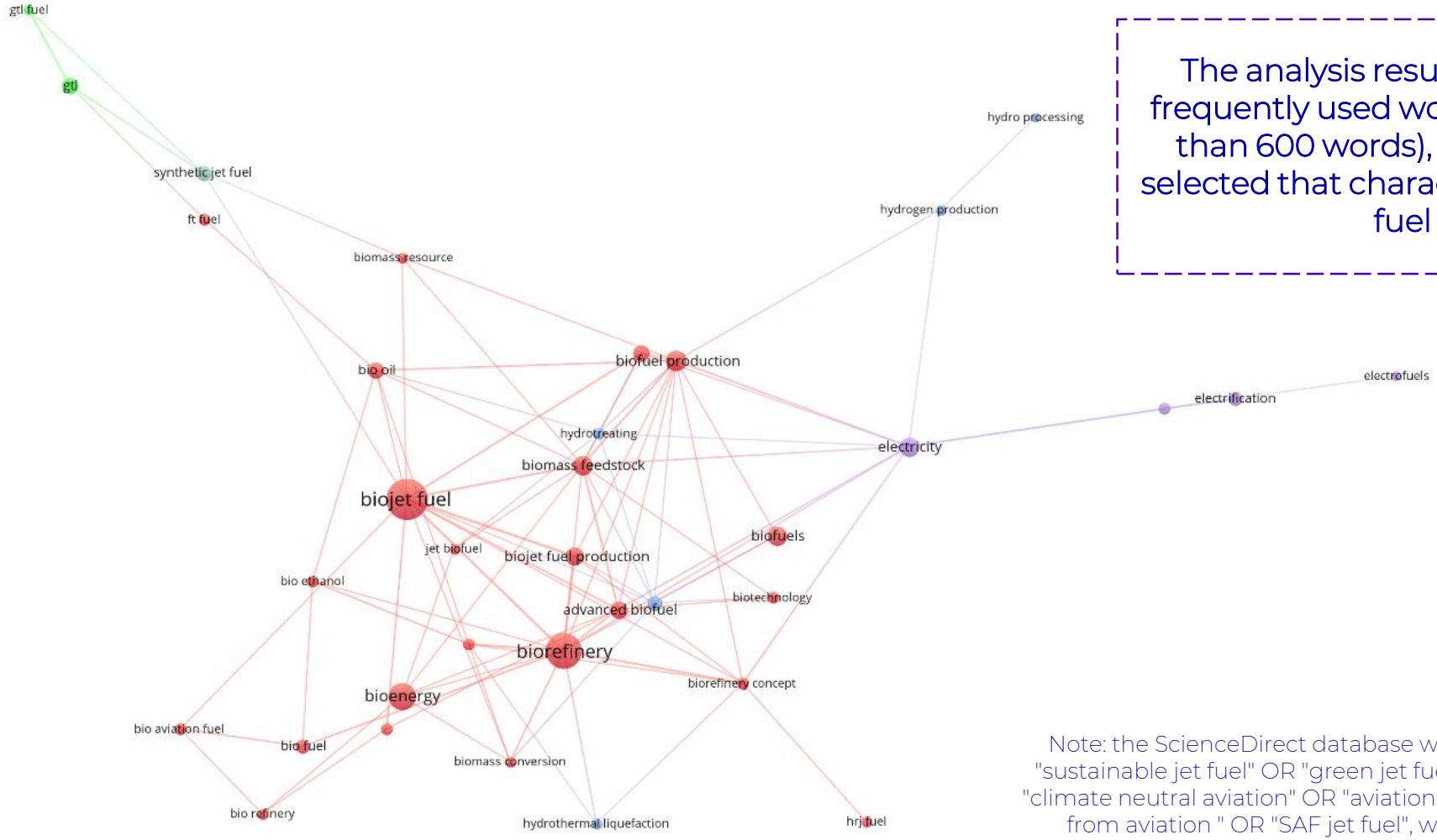
In recent years, there has been an increase in the number of publications on this topic (from 8 publications in 2010 to 109 and 121 in 2021 and 2022, respectively)



Search in ScienceDirect "alternative jet fuel" OR "sustainable jet fuel" OR "green jet fuel" OR "decarbonization of aviation" OR "climate neutral aviation" OR "aviation sustainability" OR "reducing emissions from aviation" OR "SAF jet fuel", 656 results

Semantic analysis

Four clusters have been identified that characterize alternative types of aviation fuel: biofuel, synthetic fuel, hydrogen, electricity



The analysis resulted in a list of the most frequently used words in publications (more than 600 words), from which words were selected that characterize alternative types of fuel (36 words).

Note: the ScienceDirect database was searched for "alternative jet fuel" OR "sustainable jet fuel" OR "green jet fuel" OR "decarbonization of aviation" OR "climate neutral aviation" OR "aviation sustainability" OR "reducing emissions from aviation " OR "SAF jet fuel", which returned 656 results. The received information was processed using VOSviwer.

VOSviewer

Research Agenda Analysis: Biofuels

Existing research in the field of biojet engines can be divided into the following areas: production methods, techno-economic and environmental analysis, etc. (Jie Yang, 2019)

Availability, sustainability and suitability of feedstocks to meet the growing demand for biofuels remains a challenge despite the existence of various production methods (Alherbawi, 2023)

When using biofuel, the engine has better energy efficiency by 18.2% compared to kerosene

The flow of costs for environmental damage, namely the environmental and economic parameter of the engine, decreases from 59.3 thousand US dollars per year to 39 thousand US dollars per year (Akdeniz et al., 2023)

Optimal mixing ratios of jet biofuel with conventional kerosene are modeled (Khalifa et al., 2022)

Research agenda analysis: other types of SAF

Regarding synthetic fuels, researchers (Pio et al., 2023) **note the need for large-scale deployment of PtL (power-to-liquid) plants for the production of alternative fuels and their subsequent use on the principles of a completely carbon-free cycle**

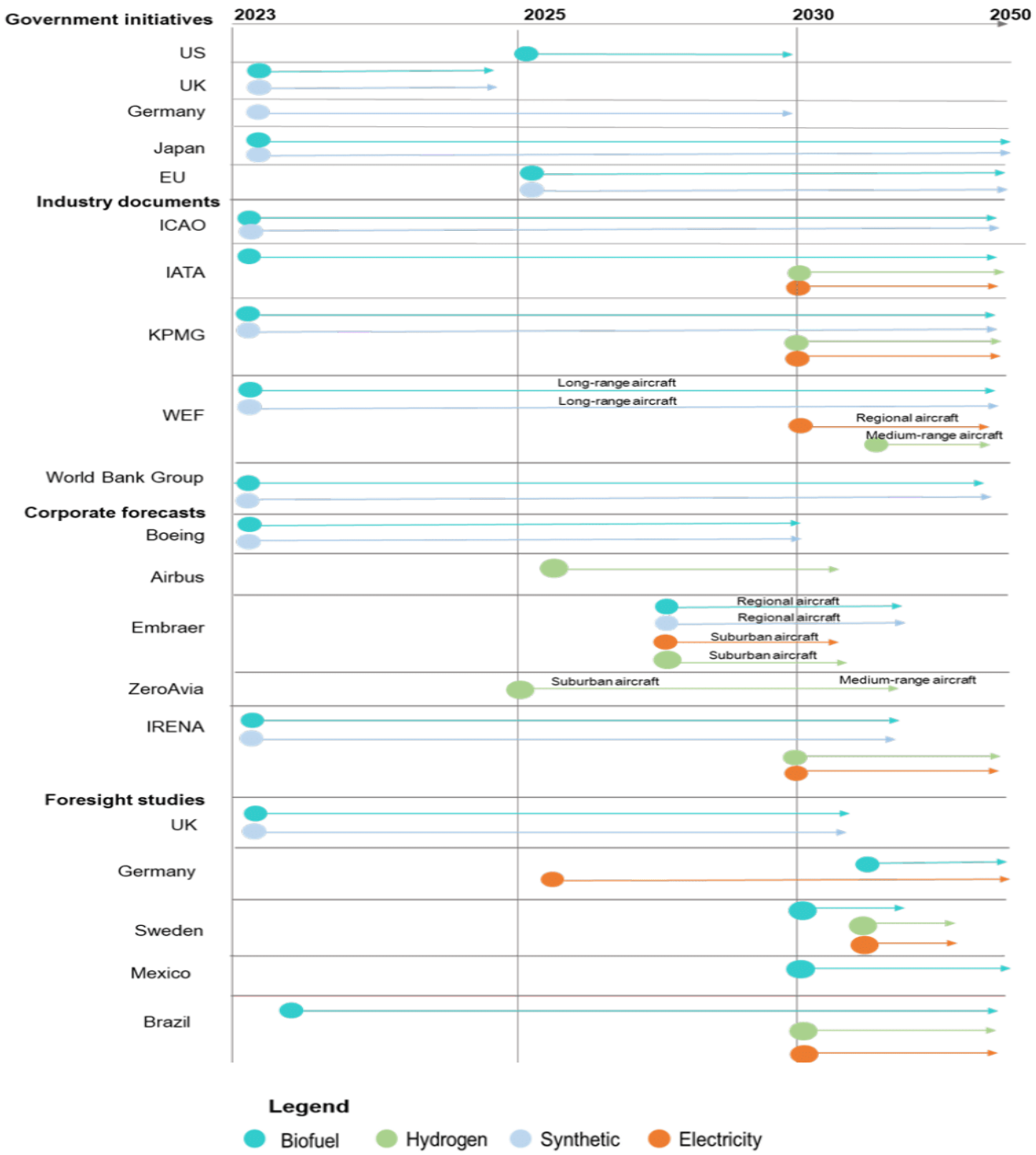
Opportunities to reduce aviation energy consumption using alternative fuels such as liquefied natural gas (LNG) and/or liquid hydrogen are being assessed (13-21% less environmental impact than traditional kerosene) (Mohideen et al., 2023)

Conclusions

Analysis of the research agenda indicates the relevance of the topic of biofuel, synthetic fuel, hydrogen as an alternative or “additive” to kerosene

Production methods are being studied and the efficiency of using such fuels is being assessed, but less common is research on the prospects for the development of sustainable aviation fuel in the short to medium term

Conclusions



Thank you!

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