Sustainable Fuels for Aviation

aireg

Aviation Initiative for
Renewable Energy in Germany e.V.

Introducing aireg: Vision and goals

aireg Aviation Initiative for Renewable Energy in Germany e.V.

- Founded in 2011 as an association of companies and organizations from industry, research, and science
- Availability and use of renewable energies in aviation in order to achieve the aviation industry's ambitious CO_2 reduction targets

What does aireg stand for?

Reliable regulatory framework

Consistent commitment to European regulation, in particular the SAF mandates of the ReFuelEU Aviation Regulation, as a key instrument for supporting the market ramp-up of sustainable aviation fuels (SAF).

Ambitious target achievement

Exceeding the specified SAF mandates for climate protection reasons and to actively support the ICAO's international climate targets in the area of sustainable aviation fuels.

Strengthening incentive systems

Further development and expansion of market-effective support and incentive mechanisms for the broader use of SAF in German and European aviation.

Reliable and sustainable value creation

Establishment of import structures for hydrogen derivatives to Germany in order to fulfill SAF mandates, while ensuring that a significant portion of industrial value creation remains in Germany—with the aim of securing technological leadership and strengthening national energy and supply sovereignty.

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58 Members

AIRBUS	AVIALLIANCE	Aviation Fuel Projects Consulting GmbH & Co. KG	Bauhaus Luftfahrt Neue Wege.	BOEING	bp	Die Senatorin für Wirtschaft, Häfen und Transformation – Freie Hansestadt Bremen	CAPHENIA Turning CO_2 into fuel	CONTINENTAL AEROSPACE TECHNOLOGIES	DEKRA
DEUTSCHE AIRCRAFT	LUFTHANSA GROUP	DHL Group	DLR	EDL PÖRNER GRUPPE	eFUEL	Emirates	ENERTRAG Eine Energie voraus	EY	ETERNAL POWER
FBB FLUGHAFEN BERLIN BRANDENBURG	Fraunhofer IBP	Greenlyte	GRIESEMANN GRUPPE	Hamburg Behörde für Wirtschaft und Innovation	HALTERMANN CARLESS	UHASSELT	HESSEN Hessisches Ministerium für Wirtschaft, Energie, Verkehr, Wohnen und ländlichen Raum	HIF	The Hong Kong Polytechnic University 香港理工大學 Department of Logistics and Maritime Studies
HORVÁTH	INERATEC	ISCC International Sustainability & Carbon Certification	IUE Institut für Umwelttechnik und Energiewirtschaft	JÜLICH Forschungszentrum	KIT Karlsruher Institut für Technologie	KITEDYNAMICS	MB Energy Our energy, your way.	McKinsey & Company	MTU Aero Engines
MUNICH AIRPORT	Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz	NESTE	OMV	PCK	PtX Lab LAUSITZ	BRAATHENS RENAVIA	ROLLS ROYCE	RWE	spark e-fuels
	Stricker & Weiken Hartkalksteinwerk Hemer	SYNTHECFUELS	TU Bergakademie Freiberg – Professur für Reaktionstechnik	Thorsten Luft Beratung für Treibstoffmanagement und Sustainable Aviation Fuels	TotalEnergies	uniper	WIWeB	ZAFFRA	

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Cooperation Agreements and Memberships

Cooperation Agreements

ASAFA | CAAFI – Fueling Solutions for Secure & Sustainable Aviation | en2x | H2 Business Alliance | Hamburg Aviation | impact on sustainable aviation

Memberships

European Climate Foundation | ICAO · OACI · ИКАО | RLCF Alliance

Strategy Paper

- Strategy paper published for ILA 2024 – Germany as a leading market for sustainable aviation fuels (SAF)
- aireg sees itself as a competence network and open transformation platform whose members can be classified into four subject areas (Aviation; Fuel Producers; Research, Development & Consulting; Policy) and develop new approaches and innovative concepts for achieving the ambitious usage targets for SAF

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Organizational Structure

Aviation Initiative for Renewable Energy in Germany e.V.

General Assembly

Executive Board

Six members of the Board

Advisory Council

Advisory Council members from science, industry and politics

Coordinating Committee

Consisting of the Executive Board and the chairs of the WGs

Auditors and Head Office

Our Executive Board

Siegfried Knecht
Chairman of the Board

Uwe Gaudig
Deputy Chairman of the Board

Prof. Dr.-Ing. Martin Kaltschmitt
Deputy Chairman of the Board

Melanie Form
Member of the Board
Managing Director

Prof. Dr.-Ing. Manfred Aigner
President for Science and Research

Prof. Dr. Jürgen Ringbeck
President for Industry and Aviation

Working Groups and Task Force

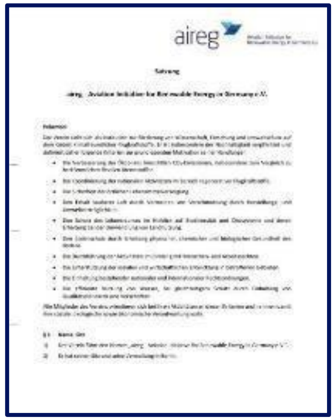
Resources and Technologies

Quality, Certification and Use

Sustainability

Task-Force Economy and Production

Our Statues



Working Groups and Task Force

Resources and Technology
Examine available feedstocks and production options for sustainable, renewable aviation fuels

Quality, Certification and Use
Practical use of sustainable, renewable aviation fuels and challenges of quality and certification

Sustainability
Considering all three pillars of sustainability – environment, social equity and economy – along the entire value chain

Task Force Economy and Production
Examination of economic aspects and potential production capacities of sustainable, regenerative aviation fuels

How does aireg work?

- **Network:** Our members cover the entire value chain for SAF. The office is happy to establish contacts for exchange purposes as needed.
- **airegNews:** Our weekly newsletter keeps our members up to date on everything related to SAF. Our SonderairegNews provides short-term information on current developments, such as draft legislation**.**
- **Events:** Biennial conference on SAF and participation in other high-profile industry gatherings (ILA, Aviation Evening, etc.)

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Climate Protection Plan of International Aviation in the face of major growth

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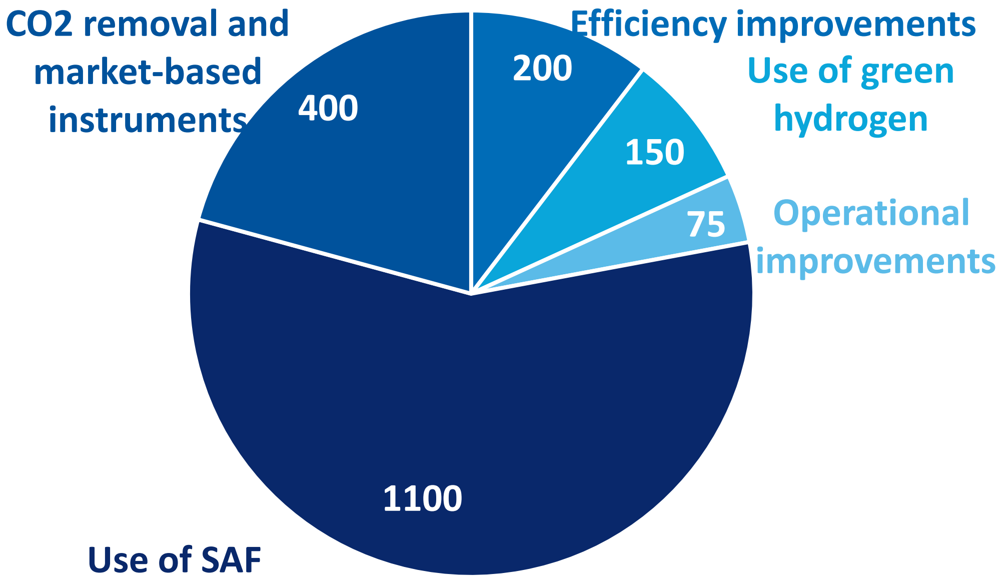
! Growth by 2050: ICAO expects revenue passenger kilometer (RPK) to double or even triple by 2050. !

→ At least doubling of the climate impact if no measures are taken.

IATA has developed a net-zero scenario for global aviation in 2050. Renewable energies (SAF and green hydrogen) contribute 65% to the total reduction in emissions.

- **Use of SAF (57%):** IATA expects SAF to account for 80%–90% of fuel used by 2050.
- **CO2 removal and market-based instruments (21%):** DAC and offsetting create negative emissions.
- **Efficiency improvements (10%):** Modern aircraft and engines require less energy for their flights.
- **Use of green hydrogen (8%):** Green hydrogen is used on short- and medium-haul flights.
- **Operational improvements (4%):** Efficiency gains through investments in operations and infrastructure

IATA'S NET-ZERO SCENARIO FOR 2050



*Emissions reduction in megatons

Source: IATA (2023): IATA Sustainability and Economics, ICAO LTAG SAF availability scenarios

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Emissions from the Combustion of Kerosene

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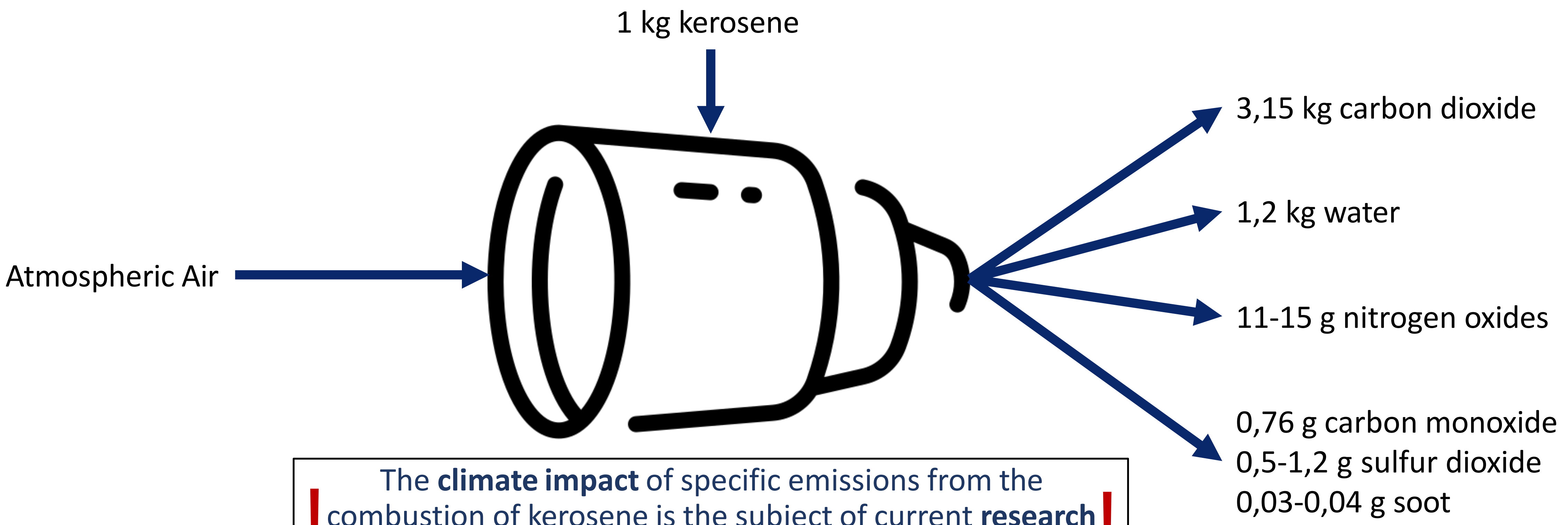

! The **climate impact** of specific emissions from the combustion of kerosene is the subject of current **research projects**, for example at the DLR. !

BAZL (2020): CO2-Emissionen des Luftverkehrs: Grundsätzliches und Zahlen.
Lee et al., Atmos. Environ., https://doi.org/10.1016/j.atmosenv.2020.117834,

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Why SAF to reduce Climate Impact?

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Lower GHG emissions

- Already up to 80% less GHG emissions with HEFA-SAF compared to fossil kerosene
- With electricity-based SAF potentially up to 100% CO_2 emission reduction

Reduction of non-CO_2 effects

- Result from the formation of soot particles and other climate-impacting substances
- SAF burns cleaner with reduced formation of particles

Lack of Alternatives

- Other climate-friendly propulsion systems (electric/ hydrogen) will be available from 2040 at the earliest
- Duration of market ramp-up very high due to long service life of aircraft

Drop-in solution

- No adaption of engines and tank infrastructure necessary
- Commercially available and in use today
- Already approved in admixtures up to 50%

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Overview of Approved SAF Options

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ASTM	Annex	Year of Approval	Process	Blending Limit	Possible Feedstocks
D7566	1	2009	FT-SPK	50 Vol.-%	flexible (biogen, fossil, synthetic, e.g. PtL or BtL)
D7566	2	2011	HEFA-SPK	50 Vol.-%	fats/oils (e.g. plant-based oils, used cooking oils)
D7566	3	2014	HFS-SIP	10 Vol.-%	sugar, starch, lignocellulose
D7566	4	2015	FT-SPK/A	50 Vol.-%	flexible (biogen, fossil, synthetic, e.g. PtL or BtL)
D7566	5	2016	ATJ-SPK	50 Vol.-%	sugar, starch, lignocellulose
D7566	6	2020	CH-SK	50 Vol.-%	fats/oils (e.g. plant-based oils, used cooking oils)
D7566	7	2020	HC-HEFA-SPK	10 Vol.-%	fats/oils (algae oil)
D7566	8	2023	ATJ-SKA	50 Vol.-%	sugar, starch
D1655	1	2018	Co-Processing (HEFA-SPK)	30 Vol.-%	fats/oils (e.g. plant-based oils, used cooking oils)
D1655	1	2020	Co-Processing (FT-SPK, FT-SPK/A)	5 Vol.-%	FT-biocrude (primary feedstocks see FT-SPK, FT-SPK/A)
D1655	1	2023	Co-Processing (of HEFA)	24 Vol.-% (Feedstock) 10 Vol.-% (Product)	hydroprocessed biomass

ATJ-SPK (Alcohol to Jet Synthetic Paraffinic Kerosene), **ATJ-SKA** (Alcohol to Jet Synthetic Paraffinic Kerosene with Aromatics), **CH-SK** (Catalytic Hydrothermolysis Synthesized Kerosene), **FT** (Fischer-Tropsch), **HC** (Hydrocarbons), **HEFA** (Hydroprocessed Esters and Fatty Acids), **HFS-SIP** (Hydroprocessed Fermented Sugars to Synthetic Isoparaffins), **PtL** (Power-to-Liquid), **SPK** (Synthetic Paraffinic Kerosene), **SPK/A** (Synthetic Paraffinic Kerosene with Aromatics)

In addition to **biogenic SAF** and **electricity-based SAF**, there is the option of combining these pathways. These SAF are called **hybrid SAF**.

Source: based on CAAFI (2025)

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Biogenic SAF Production Pathways

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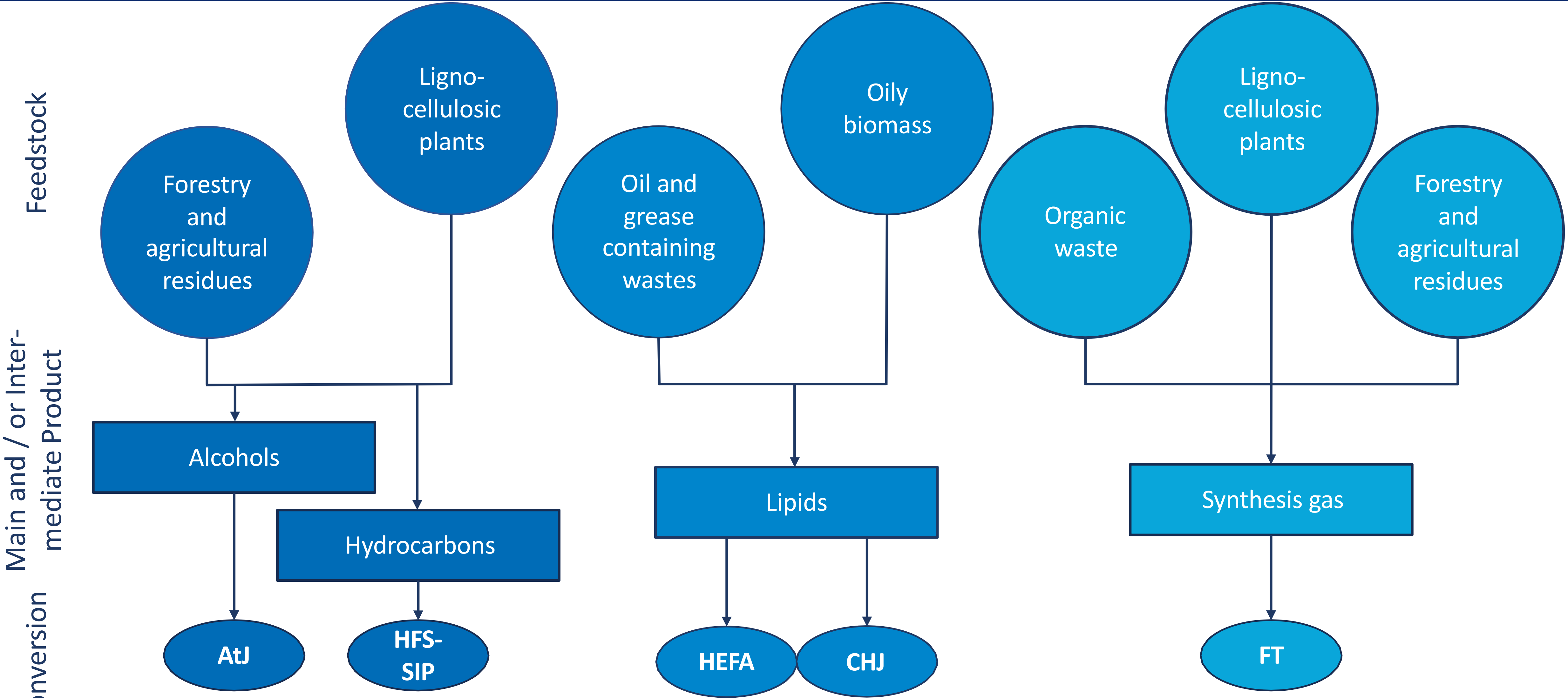

AtJ: Alcohol to Jet, **HFS-SIP**: Hydroprocessed Fermented Sugars to Synthetic Isoparaffins, **CHJ**: Catalyctic Hydrothermolysis Jet, **HEFA**: Hydroprocessed Esters and Fatty Acids, **FT**: Fischer-Tropsch

Source: Based on Thomson et al. 2020): Sustainable Aviation Fuels. The Best Solution to Large Sustainable Aircraft

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Electricity-based SAF – Power to Liquid (PtL)

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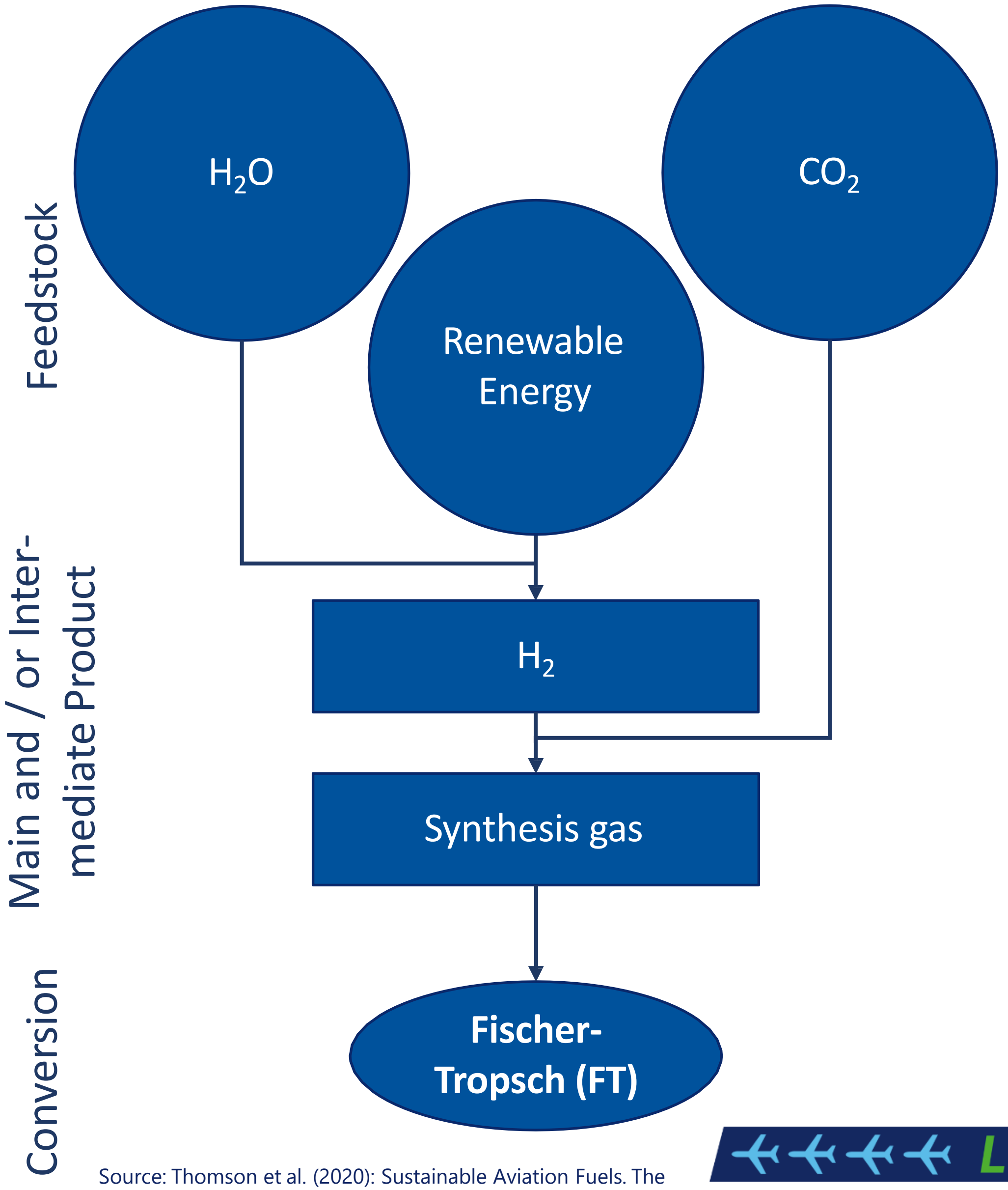
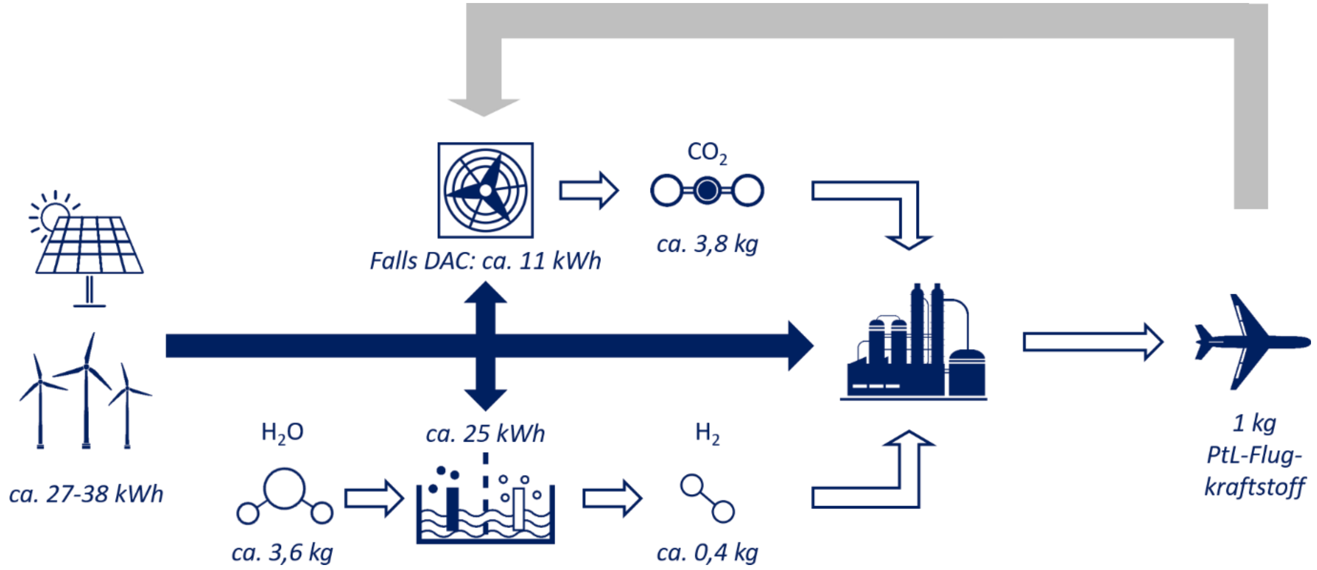


Source: Thomson et al. (2020): Sustainable Aviation Fuels. The Best Solution to Large Sustainable Aircraft

Quantitative overview of required feedstocks in the PtL production pathway:



Feedstock required to operate all domestic German flights with PtL:

- Demand of about 700,000 tons of kerosene (comparison year 2019).
- At least 19,000 GWh of renewable energy -> 750 to 2,500 wind turbines
- 280,000 tons of hydrogen ≙ 9 TWh hydrogen -> 10% of Germany's hydrogen demand in 2030 according to hydrogen strategy of the Federal Government of Germany
- 2.7 million tons of biogenic CO2 -> potential of CO2 capture of approx. 13 million tons from biogas, biomethane and bioethanol production in Germany

Source: aireg e.V. / TUHH (2023): Ptl Factsheet

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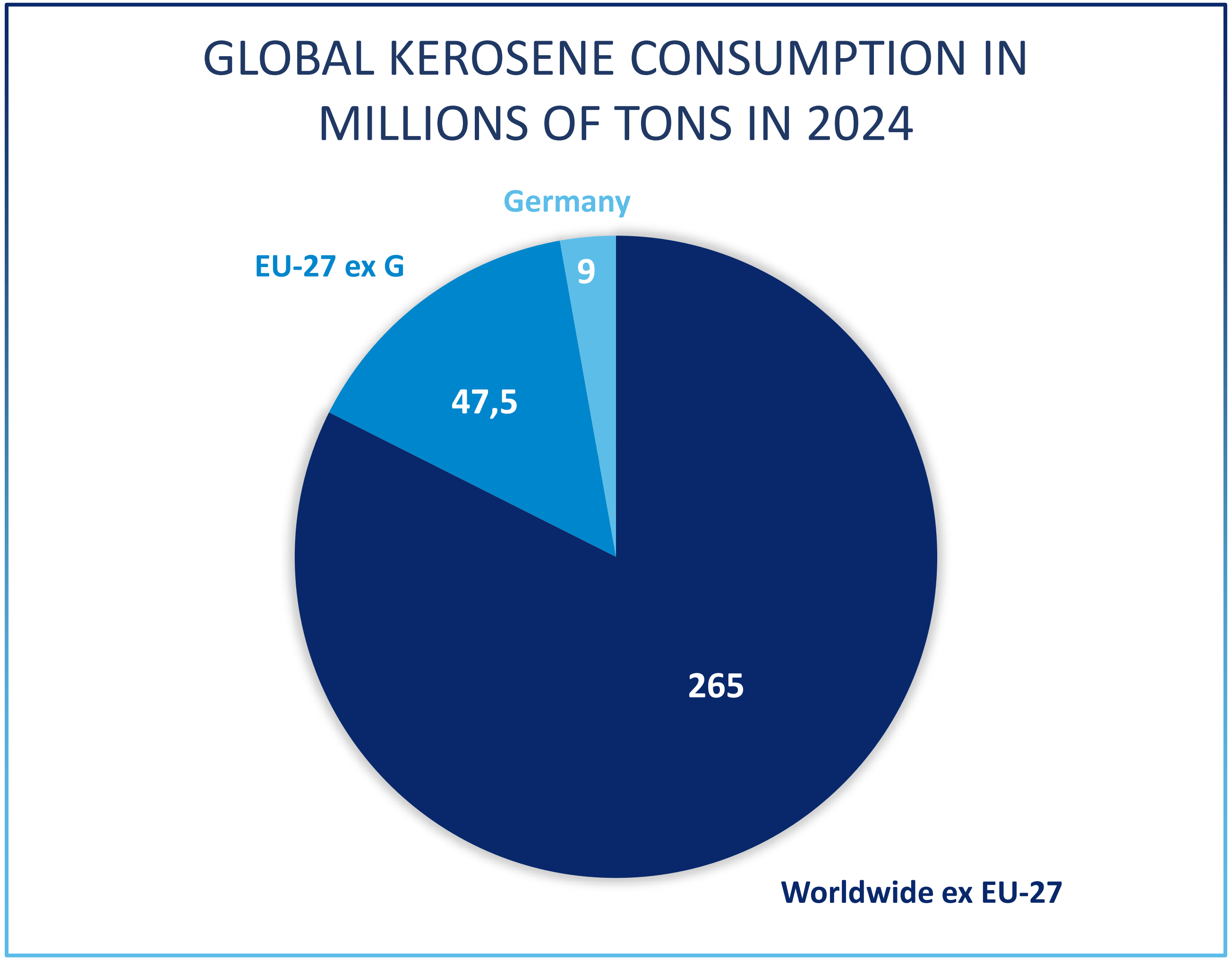
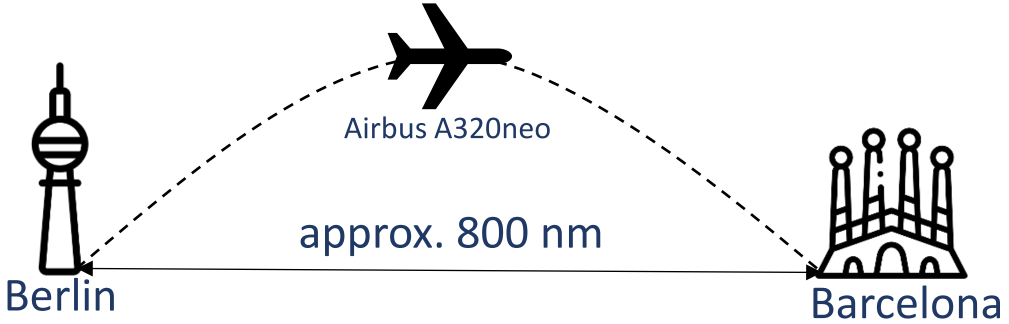
Kerosene Consumption



In 2024, German airlines achieved an average fuel consumption of 3.38 liters of kerosene per 100 passenger kilometers. To estimate the scale of individual flights, a number of realistic assumptions were made.

Realistic consumption: 40-55 tons kerosene



Realistic consumption: 5-7 tons kerosene

Sources: Statista - Weltweiter Treibstoffverbrauch aller kommerziellen Fluggesellschaften von 2004 bis 2025
EC – Supply and transformation of oil and petroleum products
BDL - Kerosinverbrauch der deutschen Fluggesellschaften sinkt auf durchschnittlich 3,38 Liter pro Passagier und 100 Kilometer

ReFuelEU Aviation

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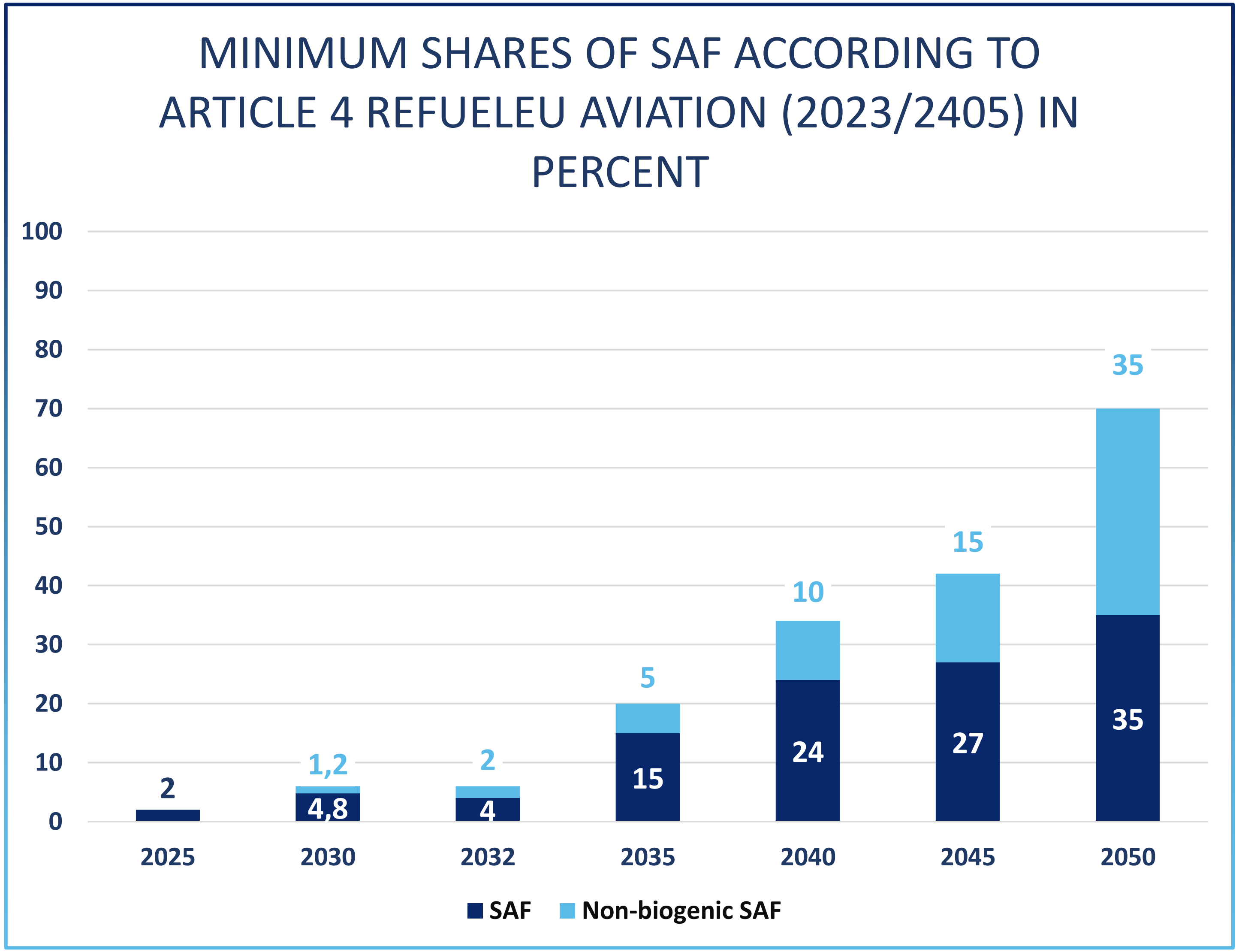
To stimulate the market ramp-up of SAF, the European Commission adopted the ReFuelEU Aviation regulation in 2023. Part of this initiative includes minimum quotas for distributors of aviation turbine fuel, which must be met from 2025 onwards. One percent corresponds to approximately 550,000 tons of aviation turbine fuel.



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Prices for SAF

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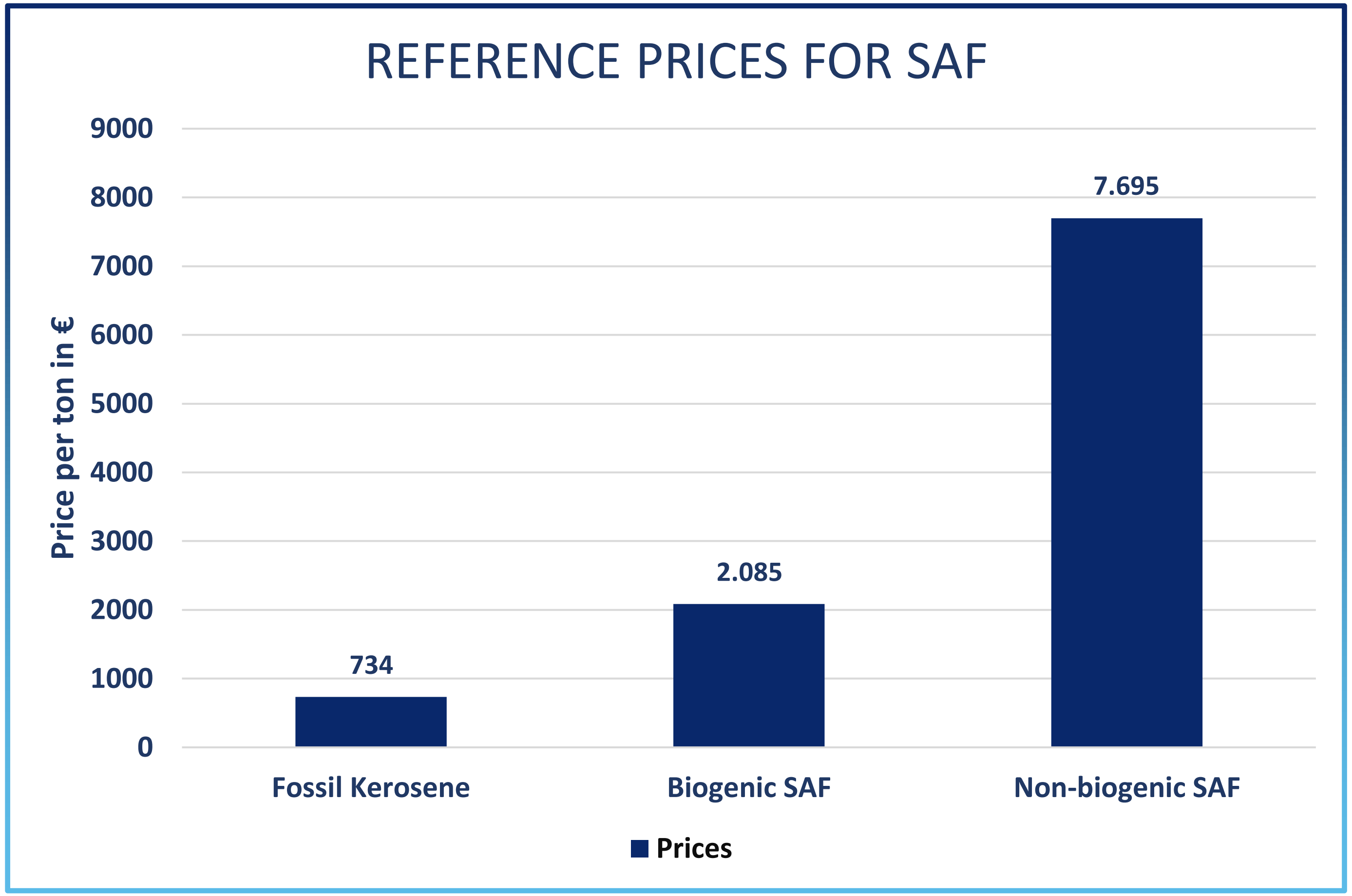
The reference prices (for SAF allowances/FEETS, among other things) are recorded annually in a report by EASA.



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Source: EASA – Aviation Fuels Reference Prices for ReFuelEU Aviation

Announced SAF volumes in 2030

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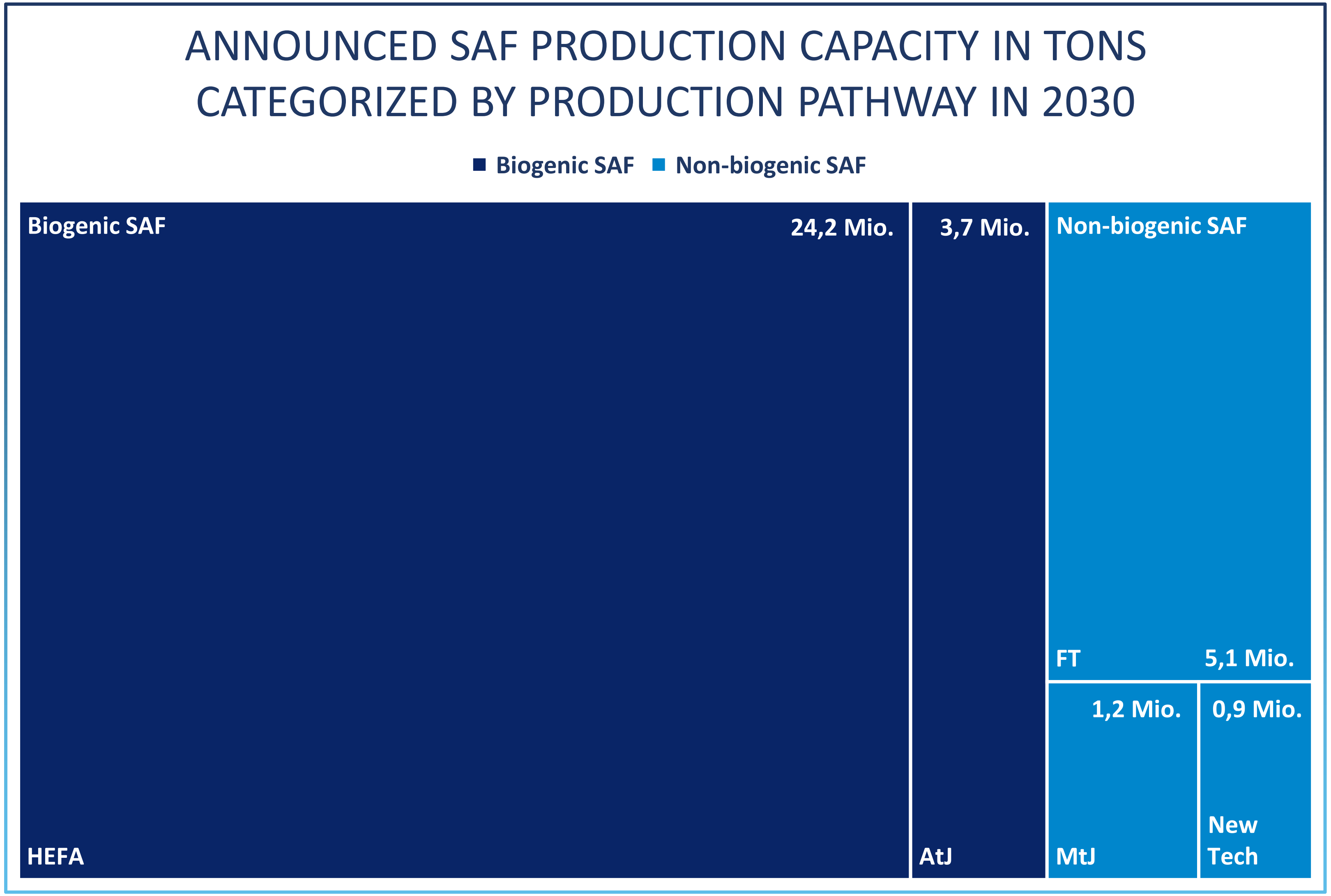
In its annually updated SAF Outlook, CENA Hessen examines the SAF production volumes announced worldwide, categorized here by production pathway.



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Source: CENA Hessen - SAF-Monitor

Selection of commitments: Climate protection in aviation in various countries outside the EU

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Country	2025	2026	2027	2028	2030	2040	2050
	2 %	2 %	2 %	2 % 0,2 % PtL	10 % 0,2 % PtL	22 % 2,5 % PtL	22 % 2,5 % PtL
	0 %	0 %	0 %	0 %	5 %*	5 %*	5 %*
	0 %	0 %	0 %	0 %	10 %	10 %	10 %
	0 %	0 %	0 %	0 %	1 % ab 2031	1 %	1 %
	0 %	0 %	0 %	0 %	10 %	10 %	10 %
	0 %	1 %	1 %	1 %	3 - 5 %	3 – 5 %	3 – 5 %
	0 %	0 %	1 %	2 %	5 %	5 %	5 %
	0 %	0 %	1 %	1 %	3 - 5 %	7 – 10 %	7 – 10 %
	0 %	0 %	0 %	0 %	0 %	0 %	50 %
	0 %	0 %	0 %	0 %	5 %	5 %	5 %
	0 %	0 %	1 %	1 %	2,5 %	12,5 %	30 %
	0 %	0 %	0 %	0 %	0 %	0 %	47 %

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Source: CENA Hessen - CENA SAF-Outlook 2025–2030 / own research

*Turkish fuel distributors must bring sufficient SAF onto the market to achieve a 5% reduction in emissions.

Thank you for your attention!

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