Analysis of green jet fuel production in Europe

Why the EU can and should increase e-kerosene targets in ReFuelEU

November 2022 (**updated study***)

Summary

Aircraft rely solely on fossil jet fuel to operate, leading to disastrous consequences for the planet and a dependency on imports from conflictual third countries. Sustainable aviation fuels (SAF) offer a promising alternative that will help reduce aviation's emissions. There are many types of SAFs. Renewable e-kerosene, a synthetic fuel made of CO_2 (e.g. captured from the atmosphere) and green hydrogen, is the most sustainable SAF and holds one of the keys to aviation's decarbonization. But e-kerosene production will need to be greatly increased to make a difference.

The EU has proposed to increase the amount of SAFs used in aircraft departing from the bloc through its ReFuelEU proposal. The ReFuelEU text includes a sub-target for synthetic aviation fuels, like e-kerosene, which constitutes a great opportunity to foster e-kerosene production in Europe. However, the sub-target proposal of 0.7% by 2030 made by the European Commission and followed by the Council's General Approach in June 2022 is too low to have an incentivising effect on the market. Even though a flexibility clause was discussed to allow voluntary member states to increase their national e-kerosene blending targets, an important opportunity for ambitious emission reduction and higher European energy autonomy was missed.

In this updated study*, we quantify the total e-kerosene production plans in Europe as of November 2022. Since the first version of this study, some predictions have changed. Our updated analysis shows that there is planned production for 0.025 Mt of e-kerosene in Europe by 2025, produced by 12 companies, meeting the 0.02 Mt needed for the 2025 target proposed by the European Parliament. In our initial assessment, there were plans for 0.16 Mt to be produced by 10 companies in 2025. The change of production outlook occurred as one project was cancelled (80.000 t) and another one (60.000 t) was postponed by one year, but four other projects became public in the meantime, partly with quantified targets. This shows that stronger political signals are highly needed to facilitate market ramp-up: the more we delay the e-kerosene sub-target, the more investors and companies risk delaying production. On the other hand, in the space of the four months since the last study there are now also 10 more companies (28 in total) planning for e-kerosene production in 2030, capable of producing a total of 1.85 Mt (up from our 1.83 Mt projection in June 2022). This shows that there is a strong willingness for the expansion of e-kerosene production capacities in the industry. This willingness for expansion needs to be nurtured by ambitious blending mandates, since it is highly dependent on favourable investment

conditions, and therefore policy signals. Seven further companies were also added as they made their production intentions public.

T&E, therefore, recommends

- An e-kerosene blending mandate of at least 2% (1.00Mt) in 2030.
- In line with the Parliament's proposal, an e-kerosene blending mandate of at least 0.04% (0.02 Mt) for 2025.
- E-kerosene needs to be produced with renewable electricity and preferably with carbon sourced from direct air capture.
- The synthetic fuel sub-target should also include renewable electricity and green hydrogen for direct use in aircraft. These will be used by novel propulsion technologies that will soon enter the market, such as electric, fuel cell, or hydrogen-powered aircraft.

The market development of e-kerosene bears great industrial potential for Europe's green job market and know-how and should therefore not be neglected.

*This study was first published in June 2022. The figures have been updated to reflect the latest available figures.

1. E-kerosene blending mandates as part of ReFuelEU Aviation

In July 2021, the European Commission's (EC) ReFuelEU Aviation proposal introduced blending mandates for sustainable aviation fuels (SAF) and sub-quotas for e-kerosene. Following this, the European Parliament adopted its position on the file with more ambitious targets (see Table 1). The EC proposed an e-kerosene blending mandate of 0.7% by 2030, increasing to 28% in 2050, but failed to include any e-kerosene target for 2025. This is where the European Parliament's position goes further by requiring a 0.04% sub-target already in 2025 and a 2% target by 2030 to ensure ReFuelEU Aviation encourages the production of e-kerosene in Europe and sets aviation on a pathway to zero emissions by 2050. In this analysis, we show how these sub-targets for e-kerosene currently proposed can be revised, based on the current planned e-kerosene production.

Proposed SAF and e-kerosene blending mandates in aviation fuel

SAF	2025	2030
European Commission	2%	5%
Council of the EU	2%	6%
European Parliament	2%	6%
SAF includes advanced biofuels and e-kerosene		

E-kerosene	2025	2030
European Commission	-	0.7% | 0.35 Mt
Council of the EU	-	0.7% | 0.35 Mt with flexibility to increase up to 1% | 0.5 Mt
European Parliament	0.04% | 0.02 Mt	2% |1 Mt
Availability (study)	**0.05%/demand | 0.025 Mt**	**3.69%/demand | 1.85 Mt**
T&E recommendation	0.04% | 0.02 Mt	2% | 1 Mt
Assumed total demand	48 Mt	50 Mt

Table 1: Proposed SAF and e-kerosene shares in aviation fuel

The ReFuelEU proposal is currently being discussed in the trilogue process between the European Parliament, the Council of the EU, and the European Commission. An ambitious compromise is needed to ensure ReFuelEU Aviation will be a success for the decarbonisation of the aviation sector.

INFO BOX: E-kerosene produced sustainably

While **demand reduction** and **energy efficiency** are important steps to reduce aviation's climate impact, e-kerosene is an important technological solution that will help reduce the remaining emissions according to T&E's Roadmap to decarbonise European aviation by 2050[1].

Synthesised from hydrogen and CO_2-molecules, using **green electricity**, the life cycle of e-kerosene can be near carbon-neutral. In order to be as sustainable as possible, **direct air capture (DAC)** should be the preferred pathway to obtain the carbon fraction for this fuel. This way, the production process will not rely on (fossil) combustion technologies as it would in the case of point source-capture (PS)[2].

Only e-kerosene produced with direct air capture (DAC) can be scaled up to the amounts needed, as biogenic resources are finite (e.g., biogas is not abundantly available). Additionally, biogenic resources are usually already used for other purposes. As it might be easier and cheaper to use biogenic resources for e-kerosene production in pilot plants and during testing phases, it needs to be legislated that only DAC will be allowed in the mid-term for large-scale production. We must not create a new problem while trying to solve an old one.

In addition, the **electricity used for the production process needs to be additional**. The producer needs to guarantee that it obtains additional green electricity certificates or uses its own green electricity production installations. More efficient technology alternatives exist for other transport modes, such as electrification for road transport. Therefore, renewable hydrogen and additional renewable electricity for the creation of synthetic fuels should be channelled towards aviation and e-kerosene, given the fact that aviation is considered a sector that is harder to decarbonise than the road sector.

The main advantage of e-kerosene is that it is more scalable than **biofuels**. Advanced biofuels, sourced from **waste** and **residues,** can play their part in renewable jet fuels but cannot be scaled in line with aviation's needs. They are available only as much as their primary product is manufactured. Biofuels from used cooking oil (UCO) or animal fats should only be used in very

[1] See also the briefing: T&E. (2021). *What role for Direct Air Capture (DAC) in e-kerosene. Why DAC holds one of the keys to sustainable aviation*. Retrieved from https://www.transportenvironment.org/wp-content/uploads/2021/08/DAC-briefing-e4tech-report.docx-3.pdf

[2] For more details: T&E. (2021). *Aviation's CO_2: use it or bury it? How can aviation end or extend the fossil fuel era*. Retrieved from https://www.transportenvironment.org/discover/aviations-co2-use-it-or-bury-it/

limited quantities, as both already have alternative use cases. More information about the sustainable production of e-kerosene can be found in our FAQ[3].

2. The market is ready to scale up the production of e-kerosene

This study analysed the projected production capacity of e-kerosene in Europe in order to assess whether the ReFuelEU e-kerosene mandate is set at the right level. If it is too low or too high, it will not incentivise manufacturers to ramp up production sustainably.

2.1 Commitments to produce e-kerosene go higher than proposed mandates

We have analysed 28 e-kerosene producers' plans in order to assess their expected e-kerosene production capacity by 2030. Four additional companies have planned to produce e-kerosene but did not specify their production capacity, so are not included in our quantification. More information on the companies and the data sources can be found in the Annex.

The key findings are that:

- Currently, the EC proposal suggests a mandate of 0.7% for 2030, which translates to 0.35 Mt[4] of e-kerosene.
- Table 2 shows that the total production capacity of the companies analysed adds up to 0.025 Mt (produced by 12 companies) as early as 2025 and 1.85 Mt in 2030 (produced by at least 28 companies).
- This translates to 0.05% of the EU's jet fuel demand in 2025. For 2030, there is planned production for 1.85 Mt of e-kerosene to cover 3.69% of the EU's jet fuel demand, saving about 5 Mt of CO_2, or what is emitted by 30,000 transatlantic flights[5].
- The majority of companies (19 out of 28) use a biogenic carbon source (sometimes in combination with point source or direct air capture). While it is understandable that biogenic carbon sources are currently used, this should only be temporary for the starting phase. In the long run, direct air capture should be used as this is the only way to scale e-kerosene production sustainably.

---

[3] See also: T&E. (2022). *FAQ: the what and how of e-kerosene. Why the aviation sector needs e-kerosene, and how to deploy it sustainably.* Retrieved from https://www.transportenvironment.org/discover/faq-what-and-how-e-kerosene/

[4] We assume a total jet fuel demand of 48 Mt in 2025 and 50 Mt in 2030, see also: T&E. (2022). *Roadmap to Climate Neutral Aviation in Europe*. Retrieved from https://www.transportenvironment.org/discover/2050roadmap/, p. 16ff.

[5] The emissions savings are calculated using 85% of GHG savings for e-kerosene compared to fossil kerosene. As data about the commercial production of e-kerosene are not easily available, the average between the legally required minimum GHG savings for RFNBOs (70%) and the maximum (100%) is used as a proxy. Emissions from a typical transatlantic flight are calculated as an average of emissions from flights between Europe and North America, using AIS data from PlaneFinder (2019) and the Eurocontrol CO_2 calculator.

- Companies are continuously making new announcements about their e-kerosene production plans, as funding requests get approved or testing phases have been successful. We, therefore, expect more announcements in the years to come.
- Conversations with companies reveal that their production targets (and the willingness of funders to invest) are highly dependent on the politically set blending mandates. Higher mandates increase the willingness of funders to invest and therefore create a better financial situation for companies to invest and scale production. Companies also state that their production targets and the choice of location highly depends on the financial incentives. Funding schemes are a big factor in choosing the production site.

E-kerosene production potential in Europe by 2025 and 2030

	2025	2030
Total kerosene demand estimated, without demand management	48 Mt	50 Mt
Total pledged e-kerosene production capacity	0.025 Mt	1.85 Mt
% of total kerosene demand covered by e-kerosene availability	0.05%	3.69%

TRANSPORT & ENVIRONMENT transportenvironment.org

Table 2: E-kerosene production potential in Europe by 2025 and 2030

2.2 EC's blending proposal is too low to incentivise market ramp-up

T&E recommends a blending mandate of minimum 0.04% in 2025 to support the ramp-up of the e-kerosene market, which translates to 0.02 Mt of e-kerosene. As highlighted in Table 2 **in 2025, we estimate that manufacturers will reach a production capacity of about 0.025 Mt.**

For 2030, T&E proposes a blending mandate of 2% which translates to 1.00 Mt of e-kerosene. We are confident that the market will be able to meet this target, as **companies already have production plans for 1.85 Mt of fuel by 2030** (and the amounts might still increase in the meantime).

The current European Commission proposal merely asks for 0.7% of e-kerosene in 2030. Compared to the overall amount of fuel expected to be produced, this amount is too low . It would not suffice to incentivise swifter and wider production uptake as it is far lower than what companies have already announced. **Figure 1** below shows the contrast between the ambition of the Commission proposal and the production forecast.

Forecasted e-kerosene production capacities in Europe

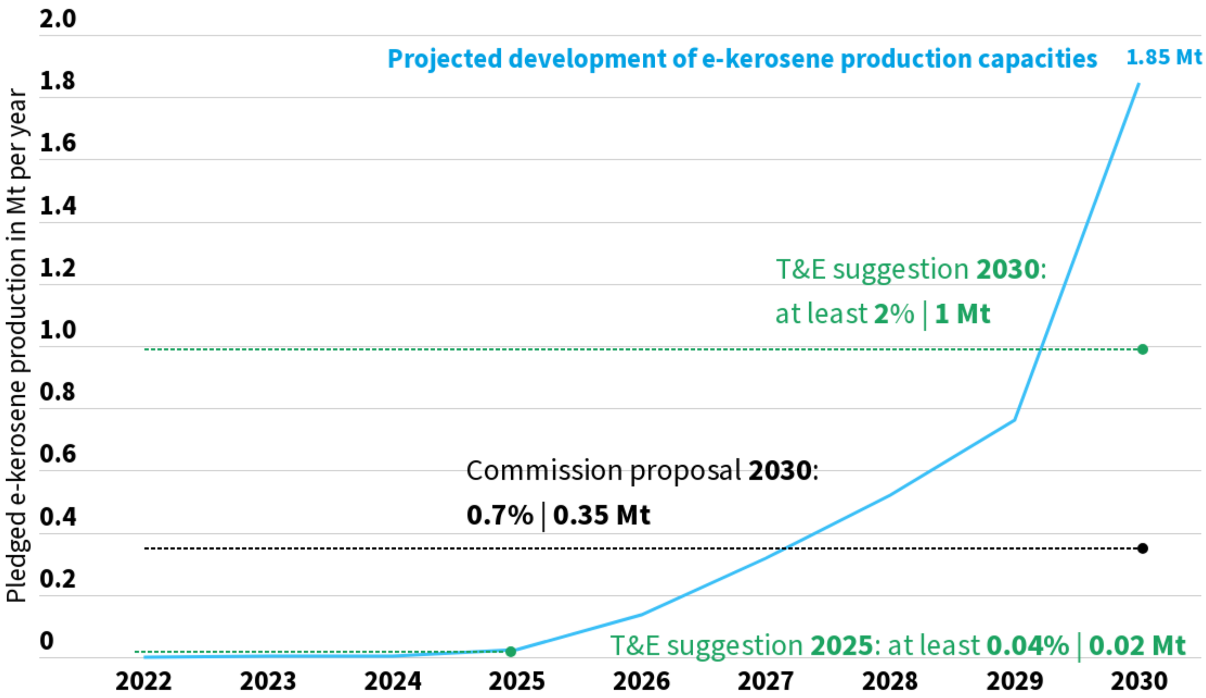

Figure 1: Forecasted e-kerosene production capacities in Europe with EC and T&E blending asks.

Looking at the graph, one can expect ambitious growth rates in the e-kerosene market. It can be expected that in time more companies will publish production targets, resulting in an even higher absolute amount of e-kerosene available in the market. It needs to be kept in mind that companies' outlooks are highly dependent on the political context. With favourable conditions, they are likely to increase their production goals. Additionally, newcomer companies will be encouraged to enter the industry as they see sufficient potential for market share in a non-saturated environment, provided that the blending mandates are sufficiently high.

2.3 E-kerosene production as an industrial opportunity for Europe

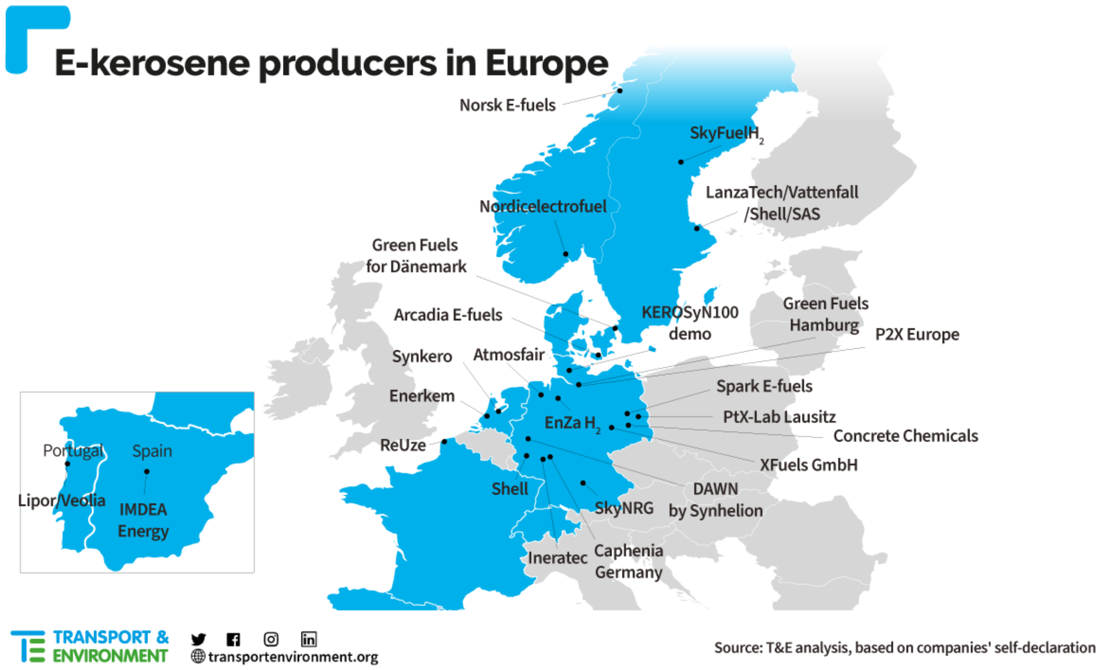

Figure 2: E-kerosene producers in Europe analysed in this study

As highlighted in Figure 2, most of the companies analysed are projected to produce e-kerosene in Europe in the next decade including in Germany, France, Portugal, the Netherlands, Sweden, and Norway.

The emergence of e-kerosene production companies is a great industrial opportunity for Europe that can be extended more widely. By fostering this sector, **Europe can establish itself as a leader in e-kerosene production**, paving the way for know-how and technology. According to the European Commission, **scaling e-kerosene production bears the opportunity to create 202,100 additional jobs by 2050**[6]. For example, the manufacturer EDL in Germany pledged to produce 50,000 t of e-kerosene starting in 2026 in the context of the project "HyKero". This will create roughly 100 jobs directly and indirectly lead to many more in the associated energy sector[7].

Even though the price of e-kerosene is not as competitive as untaxed fossil jet fuel at the moment, this is set to decrease as companies scale up production[8]. A study by ATAG for example estimates that e-kerosene costs will come down by 61% by 2050 (compared to 2025), as the cost of (green) hydrogen

[6] According to: European Commission. (2021). *Impact assessment / ReFuelEU Aviation - Sustainable Aviation Fuels*. Retrieved from https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12303-Nachhaltige-Flugzeugtreibstoffe-ReFuelEU-Aviation_de

[7] Kazooba, D. (2022, May 30th). EDL baut E-Kerosin-Großanlage bis 2026. Newsletter *Tagesspiegel Background Verkehr & Smart Mobility*.

[8] Mukhopadhaya, J., & Rutherford, D. (2022). Performance Analysis of Evolutionary Hydrogen-Powered Aircraft. *ICCT*. https://theicct.org/wp-content/uploads/2022/01/LH2-aircraft-white-paper-A4-v4.pdf

comes down and renewable electricity is more available[9]. Stronger carbon pricing signals through the EU's Emission Trading System (ETS) and a jet fuel tax can help accelerate this shift by ensuring that the price gap between fossil jet fuel and e-fuels is reduced as much as possible.

The bottom line is that there will be a growing amount of e-kerosene in the market. Companies have the capacity to produce but they need the right quotas to support them and a stable political horizon to convince investors of their long-term sustainability and profitability. An effective European e-kerosene mandate ensures the creation of a market for this product, which provides necessary reassurance to investors that the e-kerosene has a future in aviation's decarbonisation.

2.3. Looking forward: Hydrogen and electricity

The inclusion of renewable electricity and green hydrogen within the definition of synthetic aviation fuels in ReFuelEU will allow these energy sources to count "directly" towards the synthetic aviation fuels sub-mandate, thus creating incentives for technological innovation. Hydrogen and electricity will indeed soon be directly used by new "zero-emission" planes such as electric, fuel cells, and hydrogen-powered aircraft, so it is important that they are included in the ReFuelEU Regulation.

Moreover, these two energy sources are forecasted to provide a significant share of the EU's aviation energy demand in the coming decades. T&E's Aviation Decarbonisation Roadmap[10] estimates that European aviation will require 2.5 Mt of hydrogen for direct use in zero-emission aircraft by 2050, whereas A4E's Destination 2050 report[11] anticipates a hydrogen demand of 3.7 Mt. These projections represent 10 to 20% of aviation's energy consumption for 2050 and are consistent with global hydrogen demand projections for that year provided by ATAG's Waypoint 2050[12] (20% of aviation energy, 43 Mt), the ICCT's Hydrogen-Powered Aircraft White Paper[13] (18.7-94.6 Mt). As for electricity, ATAG's Waypoint 2050[14] estimates it will supply 2% of aviation's energy demand by 2050.

---

[9] ATAG. (2021). *Balancing growth in connectivity with a comprehensive global air transport response to the climate emergency: a vision of net-zero aviation by mid-century*. Retrieved from https://aviationbenefits.org/media/167417/w2050_v2021_27sept_full.pdf
[10] T&E. (2022). *Roadmap to Climate Neutral Aviation in Europe*. Retrieved from https://www.transportenvironment.org/discover/2050roadmap/
[11] NLR – Royal Netherlands Aerospace Centre. SEO Amsterdam Economics. (2021). Destination 2050. A Route to Net Zero European Aviation. Retrieved from https://www.destination2050.eu/wp-content/uploads/2021/03/Destination2050_Report.pdf
[12] ATAG. (2021). *Balancing growth in connectivity with a comprehensive global air transport response to the climate emergency: a vision of net-zero aviation by mid-century*. Retrieved from https://aviationbenefits.org/media/167417/w2050_v2021_27sept_full.pdf
[13] Mukhopadhaya, J., & Rutherford, D. (2022). Performance Analysis of Evolutionary Hydrogen-Powered Aircraft. *ICCT*. https://theicct.org/wp-content/uploads/2022/01/LH2-aircraft-white-paper-A4-v4.pdf
[14] ATAG. (2021). *Balancing growth in connectivity with a comprehensive global air transport response to the climate emergency: a vision of net-zero aviation by mid-century*. Retrieved from https://aviationbenefits.org/media/167417/w2050_v2021_27sept_full.pdf

Aviation's future demand for hydrogen and electricity will depend on technology development and aircraft uptake, but according to the average estimates above, we can expect an important part of the European aviation market to be fuelled by these two energy carriers. This would further support setting ambitious synthetic fuels sub-targets, especially after 2035, when the number of hydrogen planes in service is expected to grow rapidly.

3. Policy recommendations

1. European e-kerosene blending mandates should be set at a minimum of 0.04% (0.02 Mt) in 2025, thus introducing an interim target, and increasing to at least 2% for 2030 (1.00 Mt). Only mandates that are high enough can incentivise the market to grow. Flexibility should be given for national mandates to go beyond the European targets, but not at the expense of ambitious targets.
2. Electricity used for the e-kerosene production needs to be additional and the hydrogen needs to be green.
3. Direct Air Capture (DAC) CO_2 should be the preferred pathway to source the carbon needed for e-kerosene production and should have a dedicated scale-up target within ReFuelEU's synthetic fuel sub-target.
4. Renewable hydrogen and electricity for direct use in "zero-emission" aircraft should be included in the synthetic aviation fuel definition under the EU's ReFuelEU initiative.
5. Stronger carbon pricing signals should be adopted through a jet fuel tax and a revised EU carbon market rules (EU ETS) to improve the cost competitiveness of e-kerosene.

Further information

Matteo Mirolo
Aviation Policy Officer
Transport & Environment
matteo.mirolo@transportenvironment.org
Mobile: +32 (0)4 84 32 00 45

Annex: Methodology

We listed 28 companies that have announced their plans to produce e-kerosene. We analysed their production capacity based on the information available on their websites and through personal communication. For each company, we gathered the planned capacity and timeline, with a focus on 2025 and 2030. The e-kerosene total is evaluated by considering the share of e-kerosene for each company on the total production output of a plant. In case of doubt or uncertainties, we used the more conservative figures.

In order to assess the percentage of e-kerosene in the total share of aviation fuel demand in 2025 and 2030, we assumed a total jet fuel demand of 48 Mt in 2025 and 50 Mt in 2030, according to our Roadmap to Decarbonise European Aviation by 2050[15].

In Table 3 below, you can find an overview of the data sources used to assess expected e-kerosene production capacity and related assumptions. This list is not exhaustive so please contact us if you would like to be added.

Table 3:

E-kerosene production potential in Europe by 2025 and 2030

Company	Location	Country	2025 (t/y)	2030 (t/y)	Feedstock
Total			**25,240**	**1,846,590**	
Atmosfair	Werlte	Germany	400	400	Bio, DAC
Synkero	Amsterdam	Netherlands		50,000	Bio
Norsk e-Fuel	Mosjøen	Norway	7,500	225,000	DAC, PS
DAWN (Synhelion)	Jülich	Germany	265	463,889	DAC, bio, PS
Spark e-Fuels	Berlin	Germany	*	*	DAC, PS, bio
Ineratec	Frankfurt am Main	Germany	2,333	2,333	Bio
EnZaH2 (Caphenia, Oxxynova GmbH)	Steyerberg	Germany	1,080	1,080	Bio
Caphenia Germany	Frankfurt am Main	Germany	250	7,500	Bio
LanzaTech, Vattenfall, Shell, SAS	Forsmark	Sweden		50,000	PS
ReUze (Engie, Infinium)	Dunkirk	France		*	PS
Green Fuels for Denmark (Ørsted, SAS, Copenhagen Airports, A.P. Moller – Maersk, DFDS and DSV)	Copenhagen	Denmark	*	250,000	PS
Arcadia e-Fuels	Vordingborg	Denmark		325,000	DAC, bio
Nordicelectrofuel (Aker Solutions, Nordic Blue Crude NBC, P2X Europe)	Herøya	Norway	3,212	168,237	PS
KEROSyN100demo (Universiät Bremen, Chemieanlagenbau Chemnitz, DLR, IKEM, Raffinerie Heide GmbH, TU Bergakademie Freiburg)	Heide	Germany		550	Bio
PtX-Lab Lausitz	Lusatia	Germany		*10,000*	DAC, bio
HyKero (XFuels GmbH)	Böhlen-Lippendorf	Germany		50,000	Bio
SkyNRG Germany	Mergelstetten	Germany		25,000	PS

[15] see also: T&E. (2022). *Roadmap to Climate Neutral Aviation in Europe*. Retrieved from https://www.transportenvironment.org/discover/2050roadmap/, p. 16ff.

Concrete Chemicals (CEMEX, SASOL ecoFT, ENERTRAG)	Rüdersdorf	Germany		17,500	PS
SkyFuelH2 (Uniper, SASOL)	Långsele	Sweden		80,000	Bio
Lipor, Veolia, P2X Europe	Porto	Portugal		*	Bio
Enerkem, Port of Rotterdam, Shell	Rotterdam	The Netherlands		*	Bio
Green Fuels Hamburg (Uniper, Sasol EcoFT, Siemens Energy, Airbus)	Hamburg	Germany		10,000	Bio
St1, Vattenfall		Sweden		*	
Next Gate by P2X-Europe GmbH & Co. KG (Ineratec, Hansen and Rosenthal-Group, Mabanaft-Group)	Hamburg	Germany	100	100	Bio
P2X Portugal (Navigator Company, HR, Mabanaft)		Portugal	10,000	10,000	Bio
IMDEA Energy (Synhelion)		Spain	*	°	
Arcadia e-Fuels UK		United Kingdom		*	Bio
Arcadia e-Fuels USA	Texas	USA		*	Bio

Legend Table 3

* : Plant is announced to be in operation but specific data on production capacity is not available or cannot be published

Italic: Numbers in italic refer to capacities announced without a specific timeline

° : Pilot plant only, so unlikely that it will still produce

DAC - direct air capture; **PS** - point source capture (e.g., cement factory); **bio** - biogenic carbon source (e.g., wood wastes, biogas-plant)

Company*	**Data source(s)**
Atmosfair	Atmosfair: Erste Anlage zur Produktion von CO_2-neutralem synthetischen Kerosin im Emsland. (2021, October 4). *Airportzentrale.de*. Retrieved June 1, 2022, from https://www.airportzentrale.de/atmosfair-erste-anlage-zur-produktion-von-co2-neutralem-synthetischen-kerosin-im-emsland/72650/; Eröffnung E-Kerosin Anlage im Video. (2021, October 3rd). *Atmosfair.de*. Retrieved June 1, 2022, from https://www.atmosfair.de/de/ab-10-45-uhr-livestream-eroeffnung-e-kerosin-anlage/; telephone call, e-mails
Synkero	Synkero. (n. d.). *Futureproof Aviation*. Retrieved from https://synkero.com/wp-content/uploads/2021/06/Synkero-White-Paper.pdf; e-mails
Norsk e-Fuel	Accelerating the transition to renewable aviation. Making it possible to fly with a greener conscience. (n. d.). *Norsk- e-Fuel.com*. Retrieved June 1, 2022

	from https://www.norsk-e-fuel.com/; webinar contribution: Karl Hauptmeier (01.03.2022). *Norsk e-Fuel. Paving the way to renewable aviation*. At: T&E. (March 1, 2022). *Acting now for the zero-emission planes and ships of tomorrow*, online.; Our technology. Our technology can change the aviation industry. (n. d.). *Norsk-e-fuel.com*. Retrieved June 1, 2022, from https://www.norsk-e-fuel.com/technology; e-mails
Synhelion	Press kit. Our roadmap (n. d.). *Synhelion.com*. Retrieved September 22, 2022, from https://synhelion.com/press-kit#our-roadmap; We turn sunlight into fuel. And move the world toward net-zero. (n. d.). *Synhelion.com*. Retrieved June 1, 2020, from https://synhelion.com/; webinar contribution: Carmen Murer (01.03.2022). *Synhelion.solar fuels*. At: T&E. (March 1, 2022). *Acting now for the zero-emission planes and ships of tomorrow*, online.; e-mails, telephone calls
Spark e-Fuels	Our Vision. (n. d.). *Sparkefuels.com*. Retrieved June 1, 2022, from https://www.sparkefuels.com/; webinar contribution: Arno Zimmermann. *Spark e-Fuels*. At: T&E (March 1, 2022). *Acting now for the zero-emission planes and ships of tomorrow*, online.; e-mails, telephone call
Ineratec	Visit with German Chancellor Olaf Scholz (2022, August 9). *Ineratec.de*. Retrieved September 22, 2022, from https://ineratec.de/en/visit-with-german-chancellor-olaf-scholz/; Welcome to Ineratec. (n. d.). *Ineratec.de*. Retrieved June 1, 2022, from https://ineratec.de/en/home/; webinar contribution: Philipp Engelkamp. *Ineratec GmbH. Innovative Chemical Reactor Technologies*. At: T&E (March 1, 2022). *Acting now for the zero-emission planes and ships of tomorrow*, online.; e-mails
Caphenia (EnZaH2)	CAPHENIA produziert E-Fuels in Niedersachsen. (n. d.). *caphenia.tech*. https://caphenia.tech/caphenia-produziert-e-fuels-in-niedersachsen/; e-mails
Caphenia Germany	CO2-neutrale Kraftstoffe - neu gedacht. *CHEManager*. Retrieved June 1, 2022, from https://app.hubspot.com/documents/7517685/view/83735036?accessId=d93ae2, e-mails
LanzaTech	SAS, Vattenfall, Shell and LanzaTech to explore synthetic sustainable aviation fuel production. (2021, November 3). *sasgroup.net*. Retrieved June 1, 2022, from https://www.sasgroup.net/newsroom/press-releases/2021/sas-vattenfall-shell-and-lanzatech-to-explore-synthetic-sustainable-aviation-fuel-production/; e-mails
Engie	ENGIE aims to produce synthetic kerosene in France. (2021, February 4). *innovation.engie.com*. Retrieved June 1, 2022, from https://innovation.engie.com/en/news/news/new-energies/engie-aims-to-produce-synthetic-kerosene-in-france/24654; e-mails

Green Fuels for Denmark (Orsted)	Fact sheet. Delivering the sustainable fuels of the future. (n. d.). *Orsted.com*. Retrieved September 22, 2022 from https://presscloud.com/file/33/330870924970883/Fact_sheet.pdf; Green Fuels for Denmark receives IPCEI status. (2022, July 15). *Orsted.com*. Retrieved September 22, 2022, from https://orsted.com/en/media/newsroom/news/2022/07/20220715544411; Leading Danish companies join forces on an ambitious sustainable fuel project. (2020, May 26). *orsted.com*. Retrieved June 1, 2022, from https://orsted.com/en/media/newsroom/news/2020/05/485023045545315; e-mails
Arcadia e-Fuels	Producing the world's future fuels to protect our environment and power our world. (n. d.). *arcadiafuels.com*. Retrieved June 1, 2022, from https://www.arcadiaefuels.com/home; e-mails
Nordicelectrofuel	Company Announcements. (n. d.). *Nordicelectrofuel.no*. Retrieved June 1, 2022, from https://nordicelectrofuel.no/company-announcements/; Nordic Electrofuel og Eramet Norway inngår avtale om CO2 fra ovnsgass for nytt klimanøytralt grønt drivstoff. (October 26, 2021). *kommunikasjon.ntb.no*. Retrieved June 1, 2022, from https://kommunikasjon.ntb.no/pressemelding/nordic-electrofuel-og-eramet-norway-inngar-avtale-om-co2-fra-ovnsgass-for-nytt-klimanoytralt-gront-drivstoff?publisherId=17847958&releaseId=17918741; e-mails
KEROSyN100demo	KEROSyN100. Die Defossilisierung der Luftfahrt. (n. d.). *kerosyn100.de*. Retrieved June 1, 2022, from https://www.kerosyn100.de/; e-mails
Shell	Shell will synthetisches Kerosin in Rheinland Raffinierie produzieren. (2021, February 26). *shell.de*. Retrieved June 1, 2022, from https://www.shell.de/ueber-uns/newsroom/pressemitteilungen-2021/shell-will-synthetisches-kerosin-in-rheinland-raffinerie-produzieren.html; e-mails
PtX-Lab Lausitz	PtX Lab Lausitz. (n. d.). *Ptxlablausitz.de*. Retrieved June 1, 2022, from https://ptxlablausitz.de/; e-mails; workshop participation
HyKero	PtX Technologies and plants for a CO2-free future of the air transport. (2022, August 22). *EDL Pörner Gruppe*. Presentation at Achema conference 2022, Frankfurt a. M. by Michael Haid. Weg frei für Wasserstoff-Großprojekte. (2021, June 15). *Edl.poerner.de*. Retrieved September 22, 2022, from https://www.edl.poerner.de/news-edl/edl-pressemeldung/news/weg-frei-fuer-wasserstoff-grossprojekte/?tx_news_pi1%255Bcontroller%255D=News&tx_news_pi1%255Baction%255D=detail&cHash=77971c551249c4c9392370ec96288caf; Grünes Fliegen mit PtL-Kerosin aus Sachsen bald Wirklichkeit. (2022, April 22). *Edl.poerner.de*. Retrieved June 1, 2022, from https://www.edl.poerner.de/news-edl/edl-pressemeldung/news/edl-ptl-kerosin-hykero/?tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Baction%5D=detail&cHash=d469fddcd79758ac7713c51b4ec61e89;

	Germany's EDL plans EUR 700m green kerosene plant near Leipzig. (April 28, 2022). Retrieved June 1, 2022, from https://renewablesnow.com/news/germanys-edl-plans-eur-700m-green-kerosene-plant-near-leipzig-782556/; Newsletter Tagesspiegel Background Verkehr & Smart Mobility, 30.05.2022;
SkyNRG Germany	Baden-Württemberg fördert die Studie zur Herstellung und zum Einsatz von synthetischem Kerosin auf Basis erneuerbarer Energien. (2022, February 17). *schwenk.de*. Retrieved June 1, 2022, from https://www.schwenk.de/baden-wuerttemberg-foerdert-die-studie-zur-herstellung-und-zum-einsatz-von-synthetischem-kerosin-auf-basis-erneuerbarer-energien; e-mail
CEMEX/SASOL/ENERTRAG	CEMEX, Sasol and ENERTRAG join forces to produce SAF from green hydrogen and CO2. (2022, April 20). *aviacionline.com*. Retrieved June 1, 2022, from https://www.aviacionline.com/2022/04/cemex-sasol-and-enertrag-join-forces-to-produce-saf-from-green-hydrogen-and-co2/
SkyFuelH2 (Uniper/SASOL)	SASOL ECOFT and Sweden's Uniper partner to produce sustainable aviation fuel through SkyFuelH_2. (2022, April 28). *sasol.com*. Retrieved June 1, 2022, from https://www.sasol.com/media-centre/media-releases/sasol-ecoft-and-sweden-s-uniper-partner-produce-sustainable-aviation
Lipor/Veolia	Cutting-edge Power-to-Liquid project transforms municipal waste-derived CO2 into sustainable aviation fuels (SAF) in Portugal. (2022, February 17). *veolia.com*. Retrieved June 1, 2022, from https://www.veolia.com/en/our-media/newsroom/press-releases/power-liquid-project-transforms-municipal-waste-waste-derived-CO2-portugal
Enerkem	Facilities & Projects. (n. d.). Enerkem.com. Retrieved June 1, 2022, from https://enerkem.com/company/facilities-projects/