How Germany's PtL Roadmap for aviation fuel outlines its larger green plans

Industry Insight:
Clean Hydrogen

Sept 09

Aviation as an industry has suffered a massive blow due to the Covid-19 pandemic. With the restrictions on domestic and international travel and freight slowly opening up, the industry is inching back to normalcy. However, the recovery to pre-2019 levels could take a while from a decline of around 66% in air travel during 2020, compared to 2019. During the same period, various governments also aligned with the climate change mitigation goals listed under the UN Paris Climate Accord towards a net-zero carbon emissions economy. In the European Union (EU), the most recent major announcement comes from Germany, which has outlined its roadmap for the use of power-to-liquid (PtL) fuels for its aviation industry. How ambitious are these PtL roadmap goals? We find out:

Introduction

Although no singular classification standard exists, sustainable aviation fuels (SAF) can be broadly defined as aviation alternative fuels (AAF) which meet sustainability criteria. AAF can be obtained from sources other than petroleum, including coal, natural gas, biomass as well as hydrogenated fats and oils. The sustainability criteria for SAF has been defined by the carbon offsetting and reduction scheme for international aviation (CORSIA). For the European Union (EU), the criteria were defined first under the Renewable Energy Directive (RED) of 2009, which were further reinforced under RED II at the end of 2018, requiring to be transposed into national law of EU Member States by June 2021.

While CORSIA mandates that SAF should achieve life cycle emissions reductions of at least 10% compared to the fossil fuel baseline of 89 grams of CO_2 equivalent per megajoule (g C02e/MJ), RED II requires biofuels to achieve 65% reduction in emissions against a fossil fuel baseline of 94 g CO2e/MJ. However, despite their ecological benefits, SAF costs are between 2 to 8 times that of conventional aviation fuel.

At the same time, PtL fuels, also known as electro-fuels (e-fuels) and include synthetic kerosene, e-kerosene and synfuels, have drawn increased interest. These fuels are sourced from green hydrogen produced from electrolysis by renewable electricity, which is then combined with carbon obtained though carbon capture to yield a liquid hydrocarbon. PtL can achieve up to an 80% reduction in CO_2 emissions. It can be blended into conventional kerosene for use as aviation fuel and is hence called a drop-in fuel. PtL fuels are currently 3 to 6 times more expensive than conventional jet fuel. However, Germany's PtL Roadmap could create the demand necessary to decrease that gap.
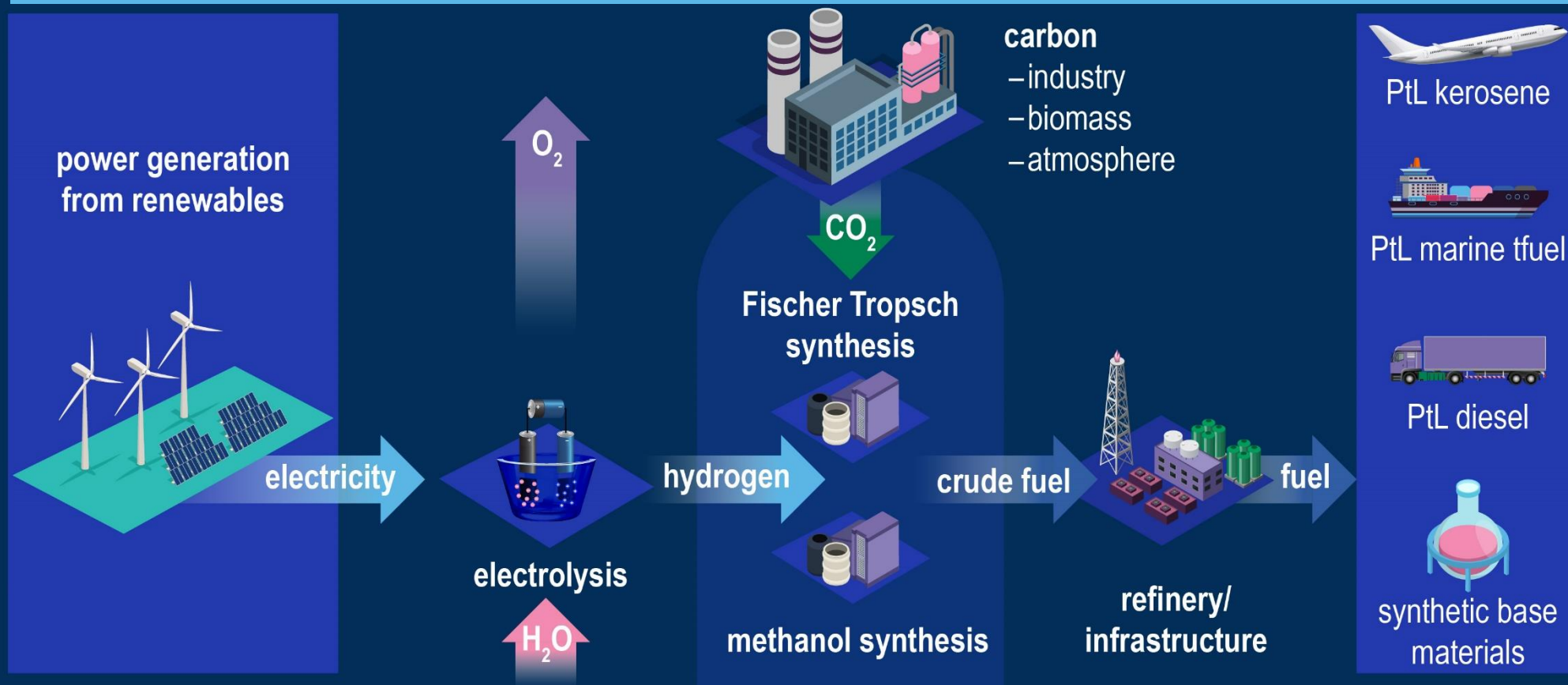
Sustainable aviation fuel (SAF)

There are various methods to produce SAF, including FT-SPK, HEFA-SPK, HFS-SIP, FT-SPK/A, ATJ-SPK and CHJ. The Fischer-Tropsch synthesis process, which creates FT-SPK – Fischer-Tropsch Synthetic Paraffinic Kerosene is widely regarded as one of the main methods to produce PtL fuel. It is even approved by the American Society for Testing Materials (ASTM). The process dates back to 1923, when chemists Franz Fischer and Hans Tropsch decided on this novel method to convert coal into a new synthetic fuel using gasification and synthesis of hydrogen and carbon feedstocks. Modern-day PtL production can be simplified as:

1 Renewable electricity powers electrolysers to produce green hydrogen

2 Climate-neutral CO2 obtained via processes including direct air carbon capture is converted into carbon feedstock

3 The carbon feedstock and green hydrogen are synthesised using Fischer-Tropsch into liquid hydrocarbons, which are then further converted into synthetic kerosene

Power-to-Liquid fuels

Global aviation industry and SAF snapshot

915 million tonnes
of CO2 emissions produced
by flights worldwide in 2019

12%
of all transport CO2 emissions can
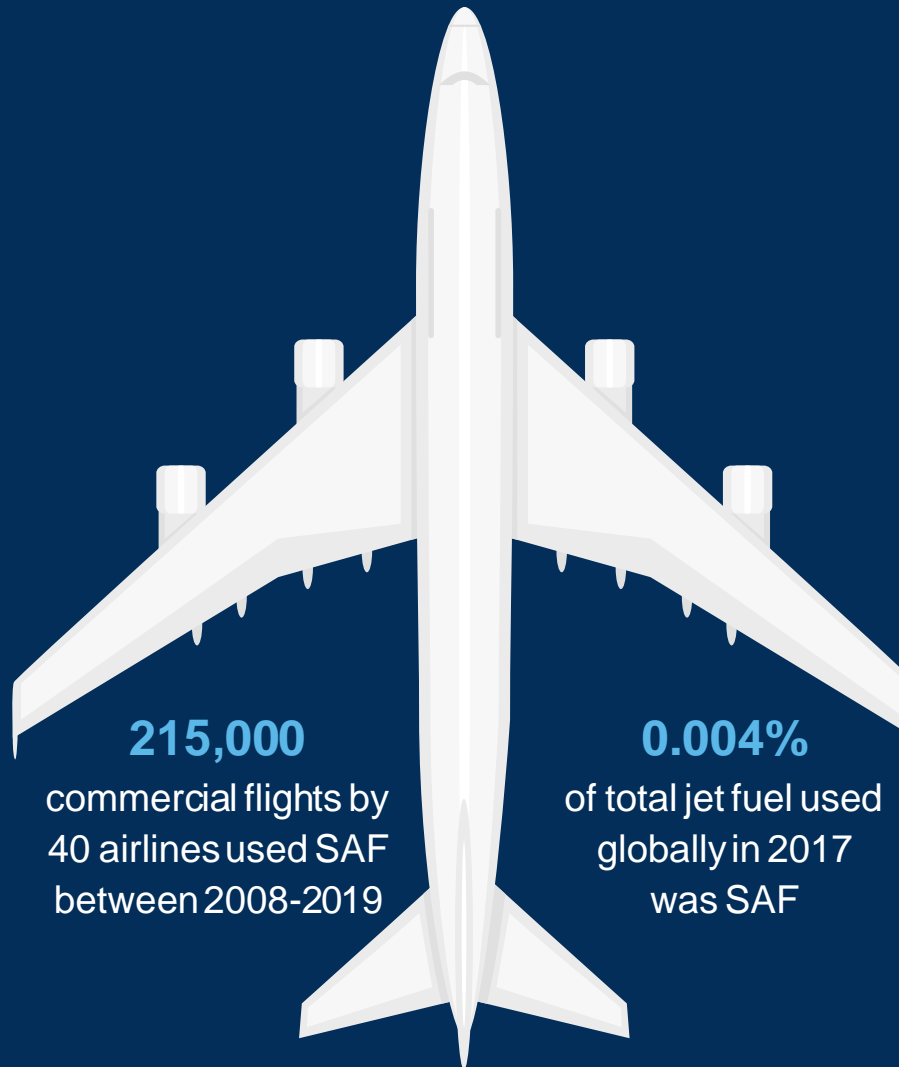be attributed to commercial aviation

5.5%
of global anthropogenic
warming before Covid-19
pandemic came from aviation

2.8%
of the total global greenhouse
gas (GHG) emissions come
from air transport

50%
of comparable emissions from
2005 levels is the aim for the
global aviation industry by 2050

215,000
commercial flights by
40 airlines used SAF
between 2008-2019

0.004%
of total jet fuel used
globally in 2017
was SAF

0.05%
of total jet fuel in EU flights
during 2017 was SAF

23.7%
is the share of fuel in airline
operating costs in 2019,
compared with 13% in 2001

6%
annual growth in global air traffic
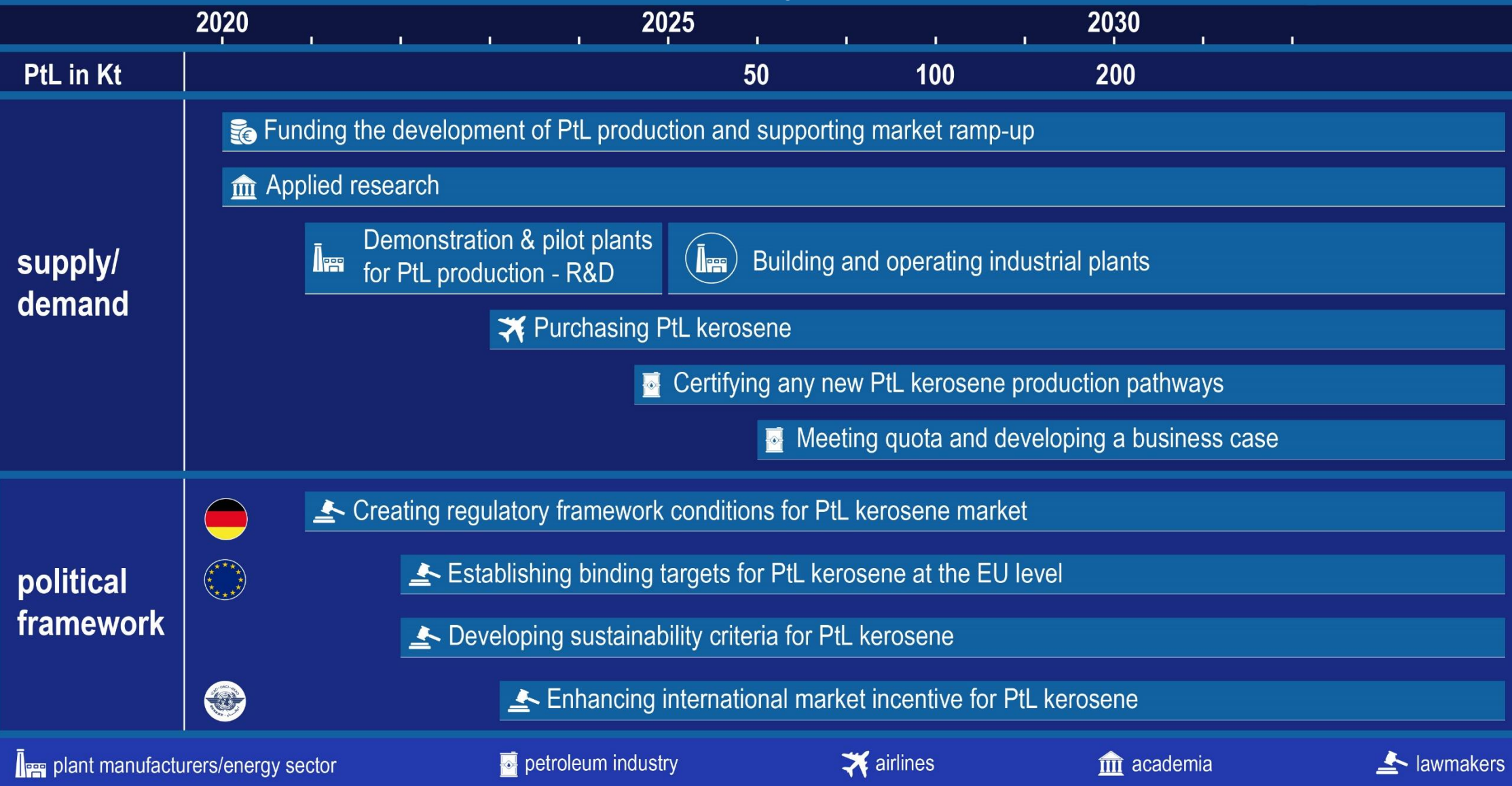for 5 years before the pandemic

12,000 tonnes
of bio aviation fuel produced in 2018

4.8 million tonnes
in sustainable fuel forward
purchase agreements existed at
the end of December 2019

Power-to-Liquid fuels

Source: Evalueserve Insights, BMVI, ATAG, EPRS

Timeline of Germany's PtL Roadmap

	2020		2025		2030	
PtL in Kt				50	100	200

supply/ demand

- 💰 Funding the development of PtL production and supporting market ramp-up
- 🏛 Applied research
- 🏭 Demonstration & pilot plants for PtL production - R&D
- 🏭 Building and operating industrial plants
- ✈ Purchasing PtL kerosene
- 🛢 Certifying any new PtL kerosene production pathways
- 🛢 Meeting quota and developing a business case

political framework

- 🇩🇪 ⚖ Creating regulatory framework conditions for PtL kerosene market
- 🇪🇺 ⚖ Establishing binding targets for PtL kerosene at the EU level
- ⚖ Developing sustainability criteria for PtL kerosene
- ⚖ Enhancing international market incentive for PtL kerosene

🏭 plant manufacturers/energy sector   🛢 petroleum industry   ✈ airlines   🏛 academia   ⚖ lawmakers

🛢 Power-to-Liquid fuels

Germany's projected PtL kerosene market ramp-up

200,000 tonnes

(kilo tonnes, kt) of annual PtL kerosene production for use in German air traffic by 2030, preceded by 100 kt in 2028, and 50 kt in 2026

50%

is the current feasible blend of synthetic kerosene into conventional jet fuel without any technological upgrades to aircraft
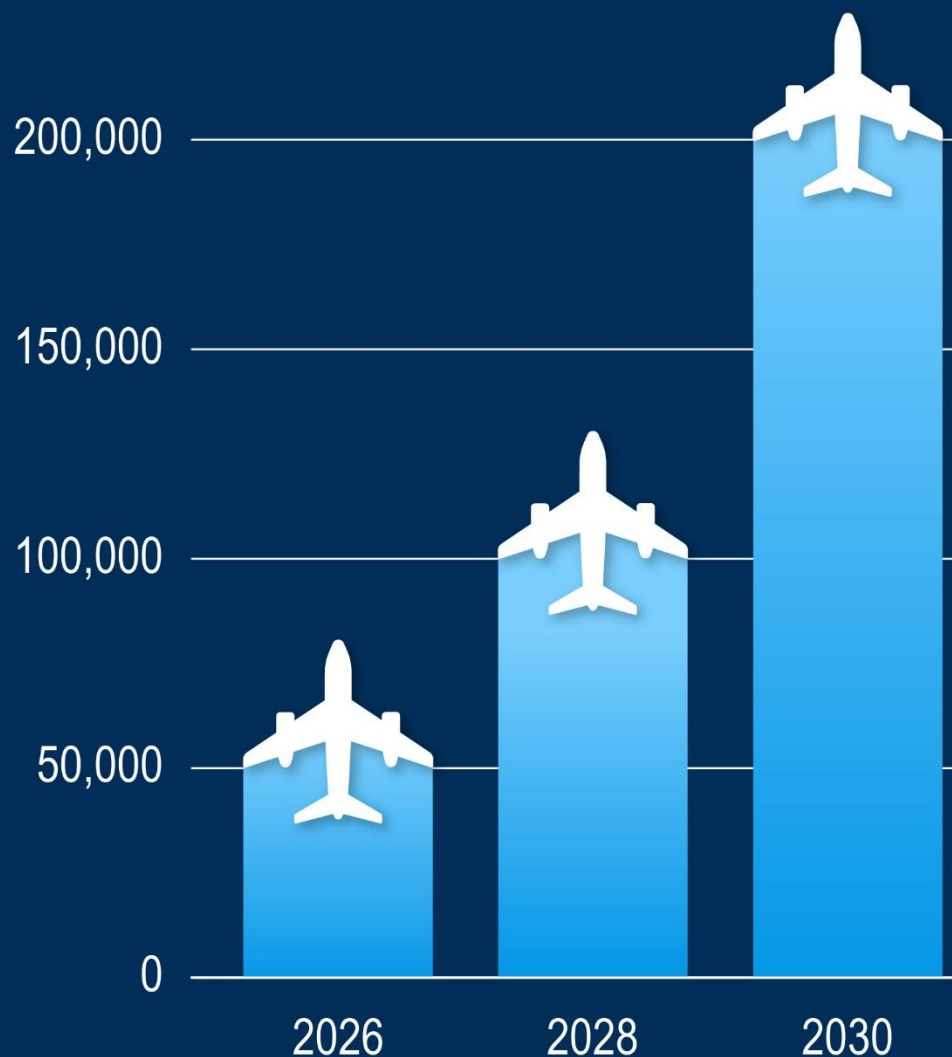
30%

of the current fuel requirement for domestic German air traffic is equivalent to the targeted PtL production in 2030

2%

PtL kerosene overall share of the projected kerosene sales in Germany in 2030, is what the target represents

PtL kerosene in tonnes

Year	PtL kerosene in tonnes
2026	~50,000
2028	~100,000
2030	~200,000

14%

minimum of the energy consumed in overall transport sector to come from renewable sources by 2030, according to RED II guidelines

42%

reduction in CO_2 emissions by entire transport sector by 2030, is the German Federal Government's aim

2

of the methods to make PtL, Fischer-Tropsch and alcohol-to-jet fuel (ATJ), are under consideration

50% to 70%

reduction in in-flight emissions of soot particles from an aircraft engine from using PtL kerosene

Power-to-Liquid fuels

Source: BMVI

⊕ Advantages

The PtL Roadmap agreed upon by the German Federal Government's Ministry of Transport and Digital Infrastructure (BMVI) and the German Aviation Association (BDL) which represents the country's aviation industry has a major point going for it in that it will have an immediate effect of the **CO2** emissions. As part of the process is carbon capture, which can be obtained via carbon capture from unavoidable CO2 sources such as bioenergy plants and industry, it can drastically cut down on the overall CO2 emissions. In addition, the other major component of the fuel is green hydrogen, also sustainably sourced from renewable electricity. This lends credence to the concept of emissions-free aviation.

⊖ Challenges

However, while the PtL fuels have their ecological edge and are technically proven, their manufacturing costs remain a major challenge. PtL **fuels cost** between 3 to 6 times more than conventional jet fuel. The reason behind this is PtL fuels not having been produced in quantities which can help them achieve the economies of scale. The Roadmap shows the way forward with a ramp-up that is help while also being economically sound.

Advantages and Challenges

⊕ Advantages

Industry players part of the agreement have also volunteered to set up plants for the manufacture of PtL kerosene. The fuel blend can be **transported** using existing infrastructure, from manufacturers and refuel warehouses at airports to the aircraft itself. There is also advocacy for using the Central European Pipeline System (CEPS) but that will require approval from all NATO members states.

Industry players involved are advocating for both Fischer-Tropsch synthesis as well as alcohol-based conversion routes as well as other production technologies so as to enable additional production pathways **without favouring** a specific technology.

Approval for new fuels used to take much longer, with the first ever such approval taking around 9 years and required thousands of tonnes of aviation fuel to be tested. ASTM and its European counterpart, DefStan, now have furthered their processes to require only a couple of years, with testing quantities being no more than a few hundred tonnes.

⊖ Challenges

The one big drawback is that PtL fuel production via the green hydrogen route can taxing on the **electric supply**. It takes as much as 4 times the input of renewable electricity to output one-part PtL kerosene. This, again, means that subsidised or incentivised **power purchase agreements** (PPAs) to the benefit of PtL producers will need be enacted to rapidly reach price parity, and only additional renewable energy will need to be used to ensure no bottlenecks to the existing power grid. The PPA and its related guarantees will only be formulated on the basis of conditions for **green power purchase** to be set by the European Commission by 2021-end.

The roadmap signees support revising of the state-initiated components in electricity prices outlined under Germany's National Hydrogen Mission, **seeking exemption** from surcharges on green hydrogen production by Germany's Renewable Energy Act. However, again, this will all depended on the upcoming **EU guidelines**. There could be concerns if the act is not framed in favour of the planned market ramp-up.

Advantages and Challenges

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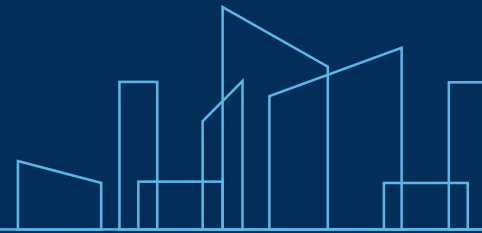
⊕ Advantages

However, to alleviate concerns over competing SAF types, Germany's policy does mention that they do no wish to focus on only a specific fuel type to keep competitiveness in check. In addition, more SAF options will only aid the growth of the alternative aviation fuels market, further enabling the market to mature by the time Germany's PtL fuels are introduced.

Being **early adopters** of this technology, Germany will have a big say in the sustainability standards for PtL fuels which are yet to uniformed and adopted globally. If this goes through, it will support not just their domestic market ramp-up but also in international one. Sustainability criteria under CORSIA is also set to get additional amendments by the end of CORSIA's pilot phase in 2023, giving Germany a leg-up in its formulation, as well as in that of the EU's RED II, which so far prescribes 70% emission reductions for electricity-based fuels.
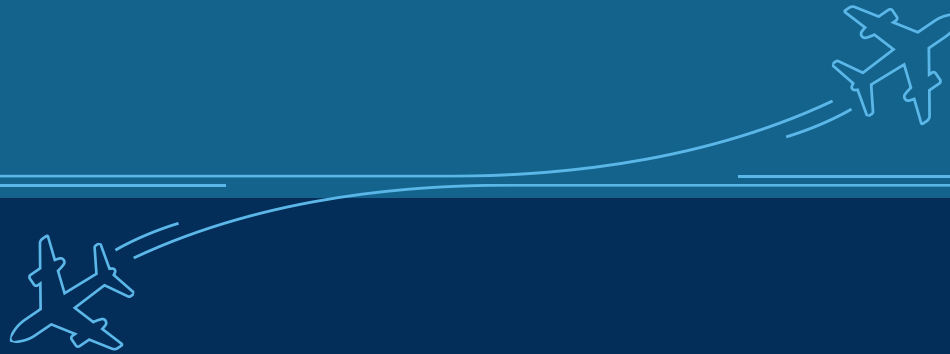
⊖ Challenges

There are **other SAF types**, including those generated from waste and residues including cooking oil, animal fat, vegetable oil, corn oil and fish fat as feedstock, which are already proven and for the Neste MY SAF. The growth of these and other alternative fuels such as those made from lignocellulosic feedstock, municipal solid waste, algae among others in the near future could hamper Germany's PtL plans.

The currently **permissible blend** of 50% PtL kerosene into conventional jet fuel requires no technological upgrades. However, if this blend is to exceed 50%, its impact on the propulsion system, and the refuelling infrastructure needs to be investigated. Subject to the test results, the propulsion and refuelling systems might need to undergo modification. This research will be key to answering which generations of existing aircraft fleets will be able to use the higher blend. This will have a bearing on the **next major expense** to airline operators, when time comes to upgrade their fleets.

Advantages and Challenges

Germany's PtL Roadmap harps on two major factors – the country's own National Hydrogen Mission, and on the potential for revisions to existing sustainability criteria in the EU and globally, as well as for setting up of sustainability standards that support its planned market ramp up. From current projections, Germany is planning ahead to the introduction of 50 kt of PtL kerosene for domestic air traffic in 2026, which is merely 0.5% of its total aviation fuel projections, then escalating gradually every two years, with 100 kt (1%) in 2028 and 200 kt (2%) in 2030, substantial but not overbearing. From this angle, the Roadmap does not seem over-ambitious.

However, this will only become clearer when governing bodies such as the European Commission, the ICAO, and their decarbonisation missions including CORSIA, RED II and the RefuelEU Aviation initiative support what Germany's aviation industry is advocating – the creation of framework conditions and standards that support PtL kerosene marketing through subsidies, incentives and a mandated sub-quota within their regulations for PtL kerosene.

How all this activity gets listed under the European Emissions Trading System (EU-ETS) will also weigh in on the success of the Roadmap. EU-ETS allows for carbon offset credits to be auctioned in place of outright biofuels purchase. Germany wants PtL kerosene credits to be included in the EU-ETS as GHG reduction credits if airlines buy more than the mandated quota of PtL. This will help them reach carbon neutrality sooner and also help push the National Hydrogen Mission.

We see Germany's PtL Roadmap as a smart move on the part of the government and industry to come together and make a strong foothold in the future of aviation and aviation fuel industries, while also benefitting local hydrogen project ramp-up and remaining influential in the standardisation of PtL kerosene across the globe.

Conclusion

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