Criteria for atmosfair fairfuel

Label for green synthetic kerosene

Version 1.0, 03/2021

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Preface

This is the first version of the criteria for the atmosfair fairfuel label for green, synthetic kerosene, which was developed by atmosfair on the basis of a study commissioned by the ifeu Institute and coordinated with experts at the German Environment Agency (UBA). The label governs environmental and social criteria for the production of synthetic aviation fuel. It is set up in such a way that producers of e-kerosene can voluntarily be certified under an additional scheme according to the fairfuel criteria.

atmosfair reserves the right to make changes to the criteria since the production of synthetic hydrocarbons is only in the development phase.

atmosfair gGmbH

Berlin, March 2021

Summary

atmosfair fairfuel is a label for power-to-liquid (PtL) – e-kerosene for aviation. e-kerosene is refined from synthetic crude oil into Jet A1 fuel for commercial use. The crude oil is produced using electricity in synthesis processes from the raw materials CO_2 and water. e-kerosene can be used in the existing aviation infrastructure without having to modify either the infrastructure or the aircraft. This means that e-kerosene has the potential to solve aviation's CO_2 problem permanently and in enough time to meet the Paris climate targets. To harness this potential, the resolute use of PtL technology is needed to mitigate climate change – this is ensured by the atmosfair fairfuel standard.

What then remains are the non-CO_2 emissions from aviation, which contribute significantly to global warming and which are initially only reduced by e-kerosene, but not eliminated. Optimised flight routes[1] can help reduce these emissions in the long run but this is not covered by the fairfuel standard.

Target audience

The atmosfair fairfuel standard is a voluntary additional standard for all e-kerosene producers. The label shows the customer and consumer that extensive environmental and social criteria have been met during production.

Relationship to standards such as EU ETS and RED II

The fairfuel standard independently complements the existing legislative framework, e.g. the EU ETS and RED II, as well as their national versions. In some cases, the fairfuel standard and legislation address the same requirements, such as the additionality of electricity sources and the required reduction in greenhouse gas emissions. The fairfuel standard remains a voluntary additional standard, but its requirements go far beyond the legal framework mentioned above.

atmosfair fairfuel – label for e-kerosene

Criteria/ awarded by:	atmosfair
Form:	Voluntary additional standard
For:	e-kerosene producers
Audit:	TÜV or other technical auditor
Criteria:	Additional green electricity, non-fossil CO_2 sources, water, ESG for the Global South
Scope:	Validation of the plant, certification of the quantity and quality of the crude oil and e-kerosene

Restricted to aviation

Due to the large amount of energy required to produce PtL products and the initially low production volumes, the atmosfair fairfuel standard limits e-fuels to e-kerosene and its use in aviation (medium- and long-haul) as there is currently no alternative. atmosfair fairfuel may not be used on for cars and trucks.

Process for awarding the label

An audit of a fairfuel e-kerosene plant consists of a validation of the plant and the subsequent regular certification of the produced quantities by an independent auditor.

[1] To learn more about the impact of e-kerosene on the non-CO_2 effects of aviation and the importance for climate change mitigation, see the separate atmosfair paper "Sorgenfrei fliegen mit E-Kerosin?" (in German).

The e-kerosene producer is responsible for updating the registry; atmosfair issues the fairfuel certificates. The e-kerosene manufacturer can ultimately use these certificates to sell the product to customers in the aviation industry.

There are two variants of the label available, Gold and Silver. The Gold standard offers maximum climate change mitigation, while Silver keeps possible entry barriers low without endangering the sustainability of production.

The primary goal: decarbonisation of aviation

The atmosfair fairfuel criteria ensure that the potential greenhouse gas reductions offered by e-kerosene are maximised – through the use of non-fossil, mainly biological CO_2 sources similar to waste. e-kerosene plants certified under the fairfuel standard must also increasingly use *direct air capture (DAC)* systems to supply CO_2 so that they can become completely independent of all biogenic and waste sources in the long term. There are also requirements related to additionality and regionality for the renewable electricity sources used, which support the energy transition and do not compete with it.

CO_2

Reliable CO_2 sources are non-fossil and similar to waste. The sources are broken down into four categories (direct air capture, sustainable, partially sustainable, not sustainable). Filtering CO_2 from the air (*direct air capture, DAC*) is the best source in this process. How the sources are assessed also depends on the environmental impact of the upstream chain and excludes, for example, certain substrates in biogas plants, such as farmed biomass with maize. If climate-friendly alternatives are available, such as steel production with green hydrogen, coal-based steel production is out of the question as a source. The Silver standard of the fairfuel label, however, allows e.g. CO_2 from cement production as a temporary transitional solution.

If CO_2 from fossil sources is used, greenhouse gas emissions can be reduced by a maximum of 50% because the CO_2 is now used at least "twice" compared to the purely fossil status quo (see Figure 1). However, fossil CO_2 from the earth continues to be released into the atmosphere (see Figure 2), which will make it impossible to reach the climate targets. With DAC or biogenic CO_2, on the other hand, a CO_2 cycle can be achieved in the short term (Figure 3) as atmospheric CO_2 is extracted from the atmosphere by means of plants or technology and then processed to become e-kerosene. This is the only scenario where no fossil CO_2 is used for the production of e-kerosene and released into the atmosphere. The atmosfair fairfuel standard thus derives the fairfuel criteria from this scenario.

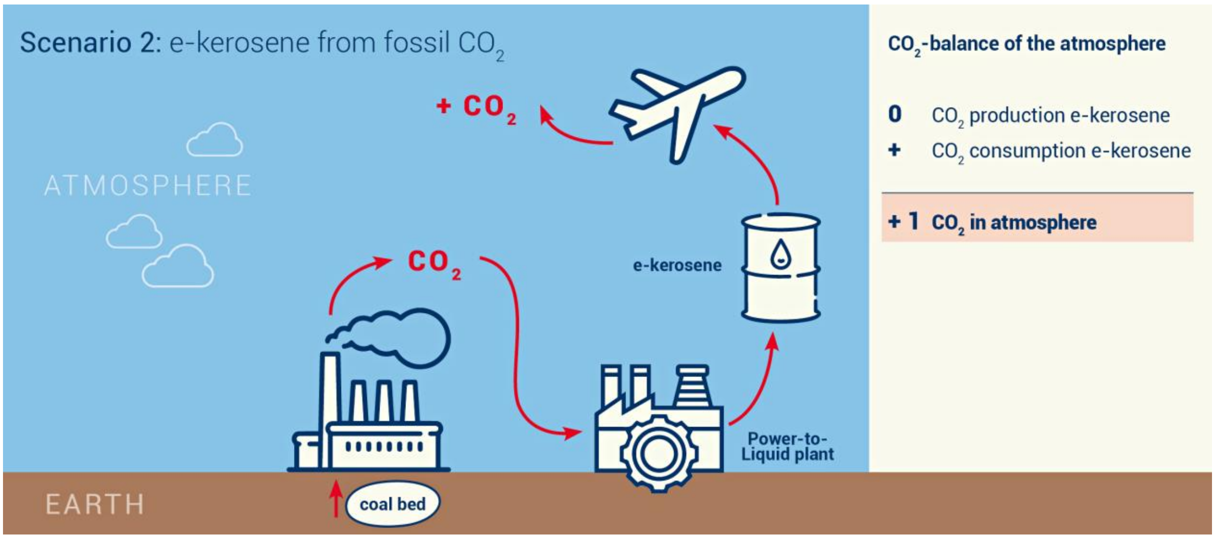

Figure 1: CO_2 emissions in the status quo.

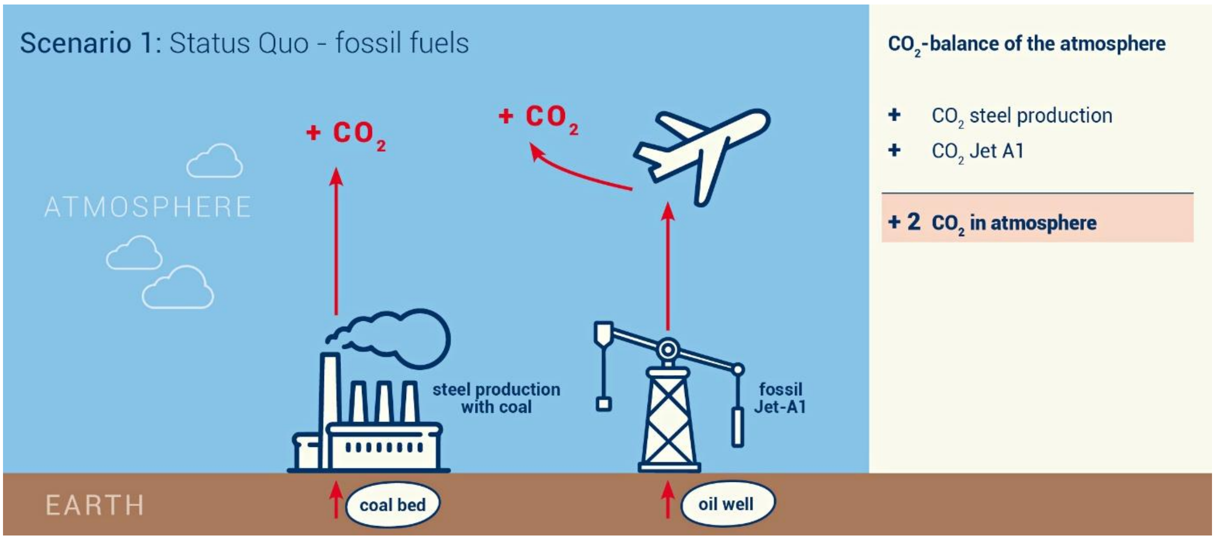

Figure 2: Fossil CO_2 emissions for e-kerosene from fossil sources – status quo reduced by a maximum of half.

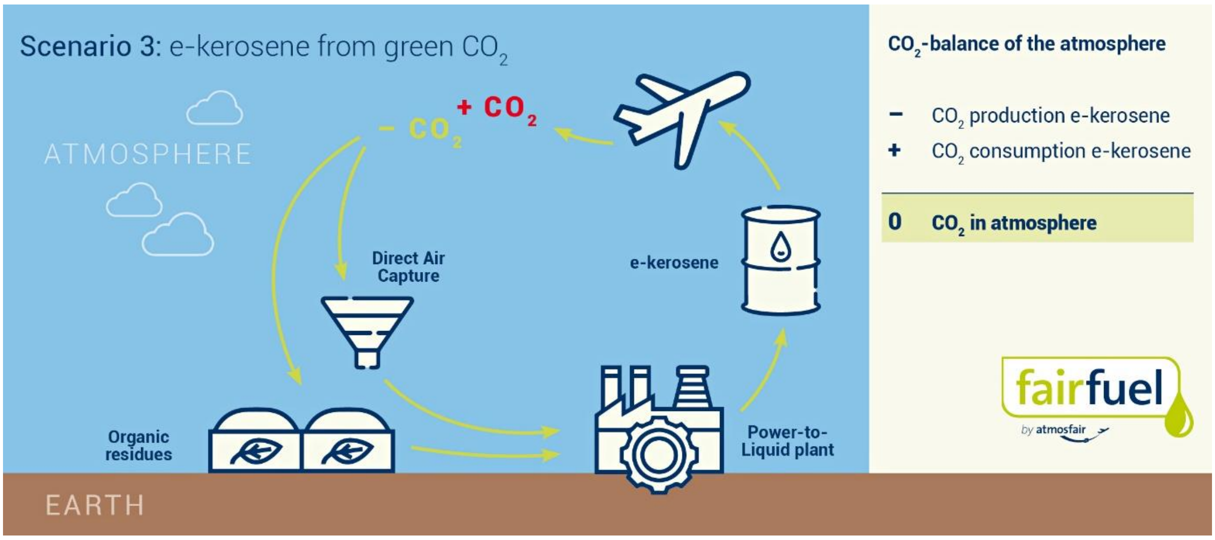

Figure 3: e-kerosene from green CO_2. Greenhouse gas neutrality possible.

Over time, the criteria will become stricter to ensure that the climate neutrality set forth in the Paris Agreement will be achieved in 2040 and the plants will only be allowed to operate with CO_2 from DAC starting in 2050.

Table 1: Permissible CO_2 sources

	In the first year of operation	2021 – 2024	2025 – 2030	2031 – 2035	2036 – 2040	2040 - 2045	2046 - 2050	From 2050
AAA DAC, min.	In planning phase	DAC-capable	1%	5%	10%*	25%*	50%*	100%*
A sustainable, min.	In planning phase	25%	35%	45%	65%	75%	50%	
B sustainable to a limited extent, max.	100%	75%	65%	50%	25%	0%	0%	0%
C not sustainable, max.	50% fossil**: 0%	25% fossil**: 0%	15% fossil**: 0%	0%	0%	0%	0%	0%
*Post-2035 DAC percentages subject to technical development and the development of the other CO_2 sources **fossil sources are category **C** (3) ff.								

Electricity

The electricity purchased for the PtL plant must not be at the expense of the energy transition and the Paris climate targets, with decarbonisation envisaged as part of the process This is why, for atmosfair fairfuel, electricity must not only be 100% renewable, but also "additional". This means

- Financial additionality, i.e. no subsidies such as those under the German Renewable Energies Act (Erneuerbare-Energien-Gesetz - EEG),
- Initiation additionality, i.e. the development of new electricity sources or the maintenance of unprofitable post-EEG plants, as well as
- Additionality through long-term direct power purchase agreements (PPAs) with e.g. the wind farm operators and ultimately regionality.

Regionality and system serviceability: The power sources must be located within 150 km of the PtL plant. In addition, the e-kerosene plant must be able to lower the power when controlled by the grid operator in order to reduce pressure on the grid if necessary.

For locations in non-EU countries, the PtL plant operator must provide electricity to the local population in addition to the e-kerosene plant, if required, at socially compatible prices.

Other criteria: Water and ESG

The fairfuel standard also includes criteria on water consumption and social aspects of PtL plant construction. This is particularly important for plants in non-European countries where there is considerable potential for renewable energy, and e-kerosene is likely to be produced at these locations as a result.

Water: In regions with water scarcity, the PtL plant operator must meet the plant's water needs through its own desalination plants and not from groundwater.

Social standard and governance criteria: atmosfair uses the ESG criteria of the European Investment Bank, as well as the Equator Principles for the implementation of social standards, occupational health and safety, preservation of cultural assets, and respect for the interests of disadvantaged groups.

Economic efficiency, feasibility, scalability

Although these criteria require increased effort from plant operators when it comes to planning, they do not automatically result in higher costs. On the contrary, in the long term the costs can be lower relative to other scenarios if the availability of CO_2 and electricity as the main resources in the fairfuel option also means becoming less dependent on external risk factors and being able to guarantee continuous plant operation.

The bottom line is that the fairfuel criteria can often be worthwhile financially speaking. In addition, the atmosfair Silver certificate keeps the entry barriers low. Overall, these criteria will not jeopardise the market ramp-up of PtL kerosene in the foreseeable future.

Sufficient CO_2 sources available for aviation

In addition to environmental standards, the sustainability of PtL also involves paying attention to the economic side. In addition to the costs already mentioned, it must be ensured that the CO_2 sources permitted by this standard are available in sufficient quantities.

As a result, atmosfair has calculated the CO_2 needed for PtL production for global air transport and compared this to the available quantities from sources in categories **A** and **B** (sustainable and partially sustainable) of this standard. It was shown that there are sufficient waste CO_2 sources available today worldwide, with a focus on waste biomass, to fully supply global aviation with sustainable PtL. The faster aviation grows in the future, the quicker we need to transition to direct air capture.

I. INTRODUCTION AND BACKGROUND

e-kerosene, produced from biogenic CO_2 and electricity from renewables, has the potential to solve the climate problem for the aviation sector. It can be used directly in today's fleet of commercial aircraft because it is suitable and approved for use as a kerosene alternative. Still, e-kerosene is not automatically "green". From a climate perspective, it is crucial that the energy used for production is renewable and the underlying CO_2 source is biogenic.

Atmospheric CO_2, captured via biogenic or technical processes, is the ideal raw material for the production of e-kerosene. The use of what are known as unavoidable fossil sources always results in the emission of fossil, terrestrial CO_2 into the atmosphere.

As renewable energy continues to be a highly contested commodity and an essential component in the energy transition, the electricity for e-kerosene will come from additional generation capacity, i.e. new plants built for e-kerosene production or through funding for old plants that would otherwise be taken off the grid.

The standard aims to firmly establish the use of CO_2 from the atmospheric cycle and additional, renewable electricity in the e-kerosene market.

1. *Target group and application of the fairfuel standard*

atmosfair fairfuel is a voluntary additional standard for all producers of synthetic kerosene. It is a label that essentially confirms the environmental quality of the product. The focus is on the requirements for the underlying raw materials of CO_2 and renewable energy, but also on broader environmental and social aspects.

atmosfair fairfuel certification should therefore be seen as complementary to government mechanisms for crediting CO_2 savings, such as the EU ETS or admixture quotas from RED II. Figuratively speaking, atmosfair fairfuel is the "organic label" for synthetic fuels.

Still, there are also overlaps between the EU framework and the atmosfair fairfuel criteria. The strict exclusion of non-fossil CO_2 sources in the fairfuel standard, for example, is the best possible starting position for achieving the reduction in greenhouse intensity of at least 70% compared to fossil fuels required by RED II. atmosfair's strict additionality and regionality requirements are also expected to cover all the criteria that the corresponding delegated act on electricity supply will contain.

2. *Restriction to aviation*

Fischer-Tropsch synthesis as well as electrolysis for hydrogen production, but also power-to-liquid processes, are energy-intensive processes in which a liquid fuel is produced as an energy source with high energy input instead of using the electricity directly for propulsion, This is why this form of synthetic hydrocarbons should generally be reserved for sectors where there is no better technological solution. This includes specifically all medium-haul flights and longer.

3. Compatibility with the 1.5°C climate target set in Paris

The IPCC's 6th Assessment Report of 2021 says that in order to prevent global warming of more than 1.5°C, there is a 66% probability that a total CO_2 budget of only 400 Gt CO_2 will remain from 2020 onwards. Annual global emissions of CO_2 are currently around 40 Gt (energy-related and direct industrial emissions from the production of cement and steel, for example).

This means that the CO_2 budget for the 1.5°C targets in a conservative scenario with unchanged emissions will be used up by around 2030, and the global economy would have to be fully decarbonised from that year onwards. This budget will be used up at a later point in time if the countries of the world lower their emissions sooner and it will be used up faster if it takes longer for them to lower their emissions.

In the status quo, both fossil point sources such as steel mills and fossil fuels emit CO_2 (Figure 1). The use of fossil CO_2 sources such as cement plants or the steel industry as raw materials for synthetic products achieves CO_2 reductions of no more than 50%. This is because if the CO_2 is extracted from a fossil source, it is only used "twice", but ultimately fossil CO_2 harmful to the climate ends up in the atmosphere (see Figure 2). While the question arises to what extent this is attributed to the synthetic product or the source, from a climate perspective a solution of this kind can never be carbon neutral. The situation is different when CO_2 is extracted directly from the air or biogenic CO_2 sources. These filter CO_2 from the atmosphere and absorb it in the short term (see Figure 3). Synthetic products from these sources are therefore ideally placed to bring about the complete decarbonisation necessary to meet the climate targets.

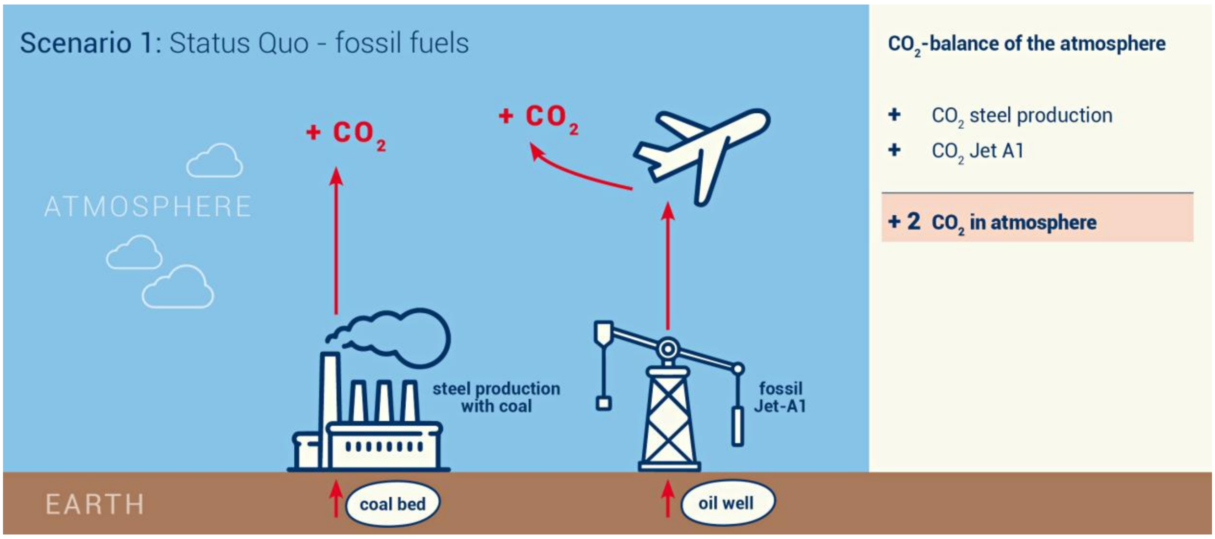

Figure 4: CO_2 emissions in the status quo.

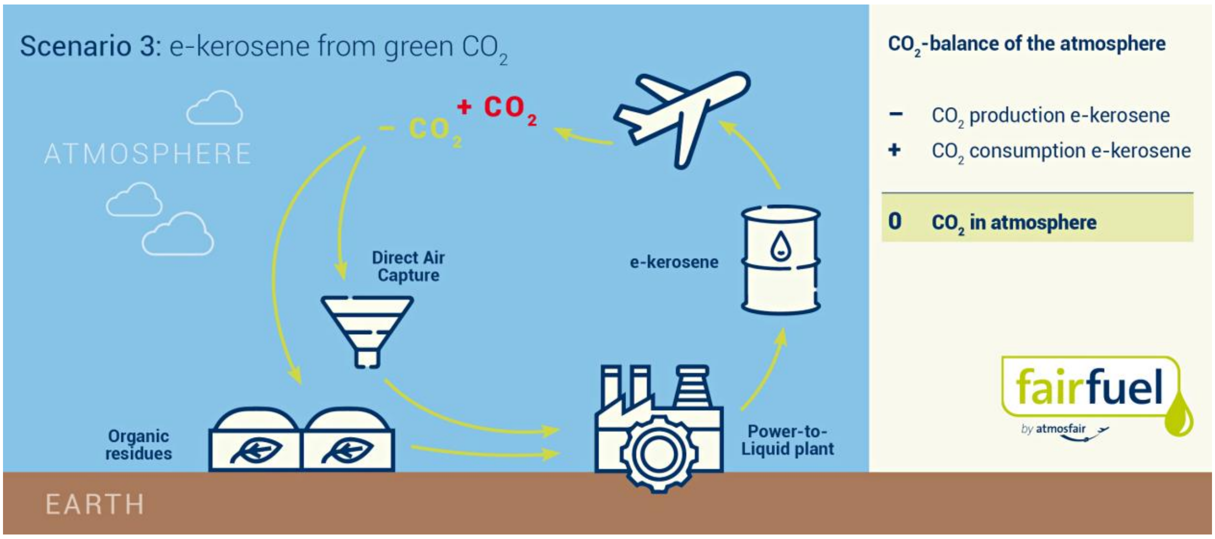

Figure 5: Fossil CO_2 emissions for e-kerosene from fossil sources – status quo cut by a maximum of half.

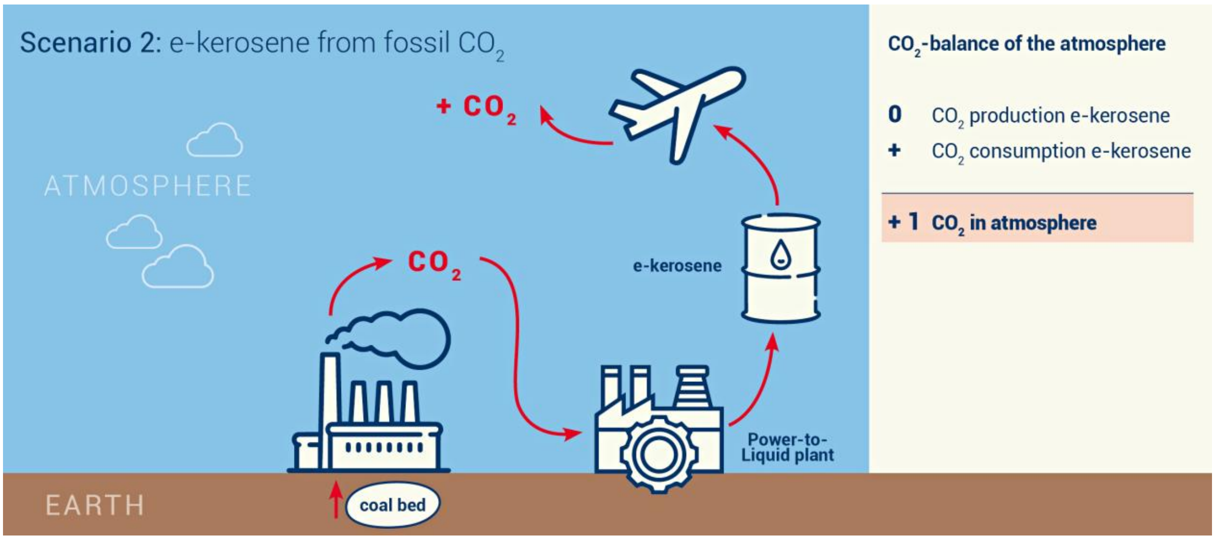

Figure 6: e-kerosene from green CO_2. Greenhouse gas neutrality possible.

The atmosfair fairfuel Gold standard therefore prescribes a strictly non-fossil CO_2 supply from 2031 onwards, the Silver standard from 2036. This makes the Gold standard compatible with the conservative development scenario described above for meeting the 1.5°C target, while the Silver standard only reaches these targets if countries lower their emissions before 2030.

In addition to the CO_2 and climate problem, the atmosfair fairfuel standard means solving potential resource challenges of supplying CO_2 for PtL production (including sustainable biomass, sustainable substrates for biogas plants) permanently and sustainably through total DAC supply from 2050 onwards.

4. Global sustainability systems

To evaluate the wide range of possible raw material sources and to give substance to the concept of sustainability, atmosfair commissioned a study from the ifeu Institute in 2019 with the aim of developing criteria from global sustainability systems, which we can use to assess the sustainability of a wide range of raw materials. To this end, atmosfair has specified the following global sustainability systems for the development of the criteria.

- UN SDG
- WBGU planetary guard rails
- planetary boundaries from Rockström et al. (2009) and Steffen et al. (2015)
- ISO standard for sustainability criteria and indicators for bioenergy
- Sustainability indicators of the *Global Bioenergy Partnership*

For the use of CO_2 from *direct air capture (DAC)*, we have developed a ramp-up scenario that envisages complete supply of CO_2 through DAC by 2050.

5. *Overarching principles for CO_2 and electricity*

The criteria of the atmosfair label are drawn from the highest-level approaches such as the guard rails of the German Advisory Council on Global Change (WBGU), the global boundaries as per Rockström et al., the UN SDGs as well as the Paris climate targets and environmental legislation. They are intended to ensure that atmosfair fairfuel is consistent with the Paris climate targets and, at the very minimum, no further direct or indirect environmental harm (such as competition for renewable electricity as a raw material), but rather further additional environmental and social benefits, especially for production in the Global South.

The certification of synthetic kerosene is based on criteria that apply to the resources used. In the following, we look in detail at the two main sources: CO_2 and electricity.

A. CO_2

The principles developed here for CO_2 sources ensure both a closed carbon cycle and a responsible approach to the environment.

i. **Exclusion of fossil sources:** This includes not only sources such as coal gasification, but also carbon capture from the waste gas of coal-fired power plants and similar sources. In this case, the carbon cycle would not be closed; the CO_2 emissions would merely be reused. This also further increases the concentration of CO_2 in the atmosphere.
ii. **Waste-like character of CO_2:** The CO_2 source should be similar to waste, i.e. that of an involuntarily produced waste material. This excludes CO_2 produced in industrial processing.
iii. **Environmental impacts of CO_2 production:** The process from which the CO_2 originates may not cause any other adverse environmental effects.
iv. **Avoiding lock-in effects:** We exclude sources that can be replaced by emission-free or lower-emission sources in order to prevent new economic and environmental opportunities from being created for them by including them as CO_2 sources in the PtL process.
v. **100% DAC from 2050 onwards:** This principle is necessary to ensure the global economy's is completely decarbonised in enough time. It is based on the assumption that by 2050 renewable energy will be available cost-effectively worldwide and will fully meet the energy needs of the global economy. This then justifies the energy-intensive DAC process from an energy standpoint, while it otherwise has no harmful environmental impacts or other negative effects that become almost unavoidable with other sources of CO_2 when large quantities are involved.

DAC and other sustainable CO_2 sources: not cost drivers

However, the CO_2 criteria and in particular the requirement to ramp up DAC as the main source of CO_2 for fairfuel is not only necessary from a climate perspective, but also feasible and sensible from an economic standpoint. With costs for DAC already forecast in the mid to low 3-digit euro range per tonne today, supplying all CO_2 from DAC only accounts for about 10% of the total costs of a PtL plant. In the atmosfair fairfuel ramp-up scenario described here, the total costs for DAC during the first decades are even in the low single-digit percentage range of the total costs. In exchange, the operator avoids the costs for other CO_2 sources, the long-term availability of which, however, poses a considerable risk to the economic viability of the PtL plant, especially at locations in areas with high political and economic instability. DAC, on the other hand, can be used virtually regardless of location and involves an independent source of CO_2 that is reliable in the long term.

The considerations mentioned above apply to an even greater extent to other CO_2 sources, which today cost even less than DAC. With this in mind, it becomes clear that fairfuel's criteria for CO_2 described here do not make a trade-off necessary between the economic viability of PtL plants and their environmental integrity.

B. Electricity

The electricity purchased for the PtL plant must not be at the expense of the energy transition and the Paris climate targets, with decarbonisation envisaged as part of the process. This is why, for atmosfair fairfuel, electricity not only has to be 100% renewable, but it must also meet the requirements for additionality.

i. **Financial additionality:** The electricity supply systems may not be subsidised by the government (EEG subsidy or comparable).
ii. **Initiation additionality:** atmosfair fairfuel requires the additional development of renewable electricity sources or the maintenance of existing plants with a generation capacity at least equal to the output of the production plants within 5 years after the start of PtL production. Keeping existing plants in operation makes an important contribution, particularly in countries like Germany, where the availability of renewable energy depends to a large extent on permits.
iii. **PPA additionality:** atmosfair requires the PPA-based purchase of the total amount of electricity generated by the power supply facilities. This takes the pressure off the electricity producers because the electricity generated by the electricity producer is guaranteed to be sold.
iv. **Regionality:** By keeping the power supply facility close to the grid and prohibiting the use of interconnectors, atmosfair ensures that additional grid expansion is kept to a minimum.

In addition, the criterion of system serviceability requires that the PtL production plant can be controlled to serve the grid. This means that the operator can power down the plant during times of peak demand to relieve pressure on the grid.

Current discourse on electricity: additionality - no public funding - regionality - simultaneity

In the current (2021) discussion about future quality criteria for electricity for PtL plants, the four criteria above are frequently mentioned in various forms, also at international level. The atmosfair criteria already reflect the basic ideas behind them.

The additionality of the electricity is represented by the atmosfair criteria as shown above. It is particularly important for countries like Germany that the criteria not only allow for new plants, but also the continued operation of post-EEG installations, a situation that is otherwise uncommon within the EU.

PtL plants should not be operated with publicly subsidised electricity because public funding should be reserved for the accelerated expansion of renewable energy sources in order to achieve a comprehensive supply of energy for the world's population by 2050. As an energy-intensive process, the synthetic production of kerosene may not slow down the necessary transformation of the world's energy systems, which should first provide people with this basic energy supply.

If the energy transition is seen from a systemic perspective, the regionality of electricity generation and PtL electricity demand is necessary in order to reduce pressure on the grids and be able to optimise use of fluctuating renewable electricity sources.

From a systemic point of view, simultaneous electricity generation and consumption would be preferable as a principle, but due to the limited potential to expand base-load capable renewable electricity generation in Germany (especially hydropower), it is currently not feasible and not compatible with the continuous operation of a PtL plant. Irregular operation of the PtL plant, which is based on the generation of fluctuating wind and solar power, is difficult to justify from an economic standpoint due to the resulting low level of use of the PtL plant with its high capital costs. In this case, atmosfair relies instead on the complete or surplus coverage with dedicated wind and solar installations covered by PPAs, for which further expansion is realistic. The production of PtL is thus not dependent on the scarce amount of renewable base load. atmosfair plans to include this in future revisions depending on the available state-of-the-art technology.

With the surplus coverage of the PtL plant capacity by the generation capacity of the renewable energy plants covered by PPAs stipulated in the fairfuel standards, this complete or surplus coverage of the electricity needs of the PtL plant in Germany is met with approx. 1,000 - 2,000 full load hours (solar or wind) with 8,600 hours of annual operation of the PtL plant with a factor of approx. 5 in total. For other countries, the surplus coverage factor is calculated based on the expected full load hours of the renewable energy sources used in relation to the 8,600 hours of operation of the PtL plant.

A regulation that governs the purchase of the electricity for the PtL plant using the amount of energy purchased (in kwh) instead of the generation capacity would in practice be difficult to reconcile with the requirement to meet the electricity needs under PPAs, since PPAs for renewable energy plants stipulate the mandatory purchase of the electricity that a plant generates at any time, whether the sun is shining, the wind is blowing or not. However, this PPA regulation makes sense and is necessary to achieve additionality because only through PPAs can electricity producers be sure to sell all their electricity.

6. *Other principles: Water, ESG, etc.*

In addition to sourcing the two essential raw materials, CO_2 and electricity, there are other principles that ensure the sustainable use of local resources.

Water

A PtL plant needs a significant amount of water, which can be critical in areas with high water scarcity. Consequently, it must also be ensured that the plant in this case does not harm or even decrease the water resources of local residents, for example through the construction of desalination plants.

Social and governance principles

Due to the more favourable electricity production conditions in the Global South, it is predestined as a plant location. With a project of this kind, it is imperative that project development protects the interests of the local community and also represents added value for the location.

7. Environmental integrity vs. economic viability and scalability?

Although the present criteria require increased effort from plant operators in planning, they do not automatically result in higher costs. On the contrary, in the long term the costs can be lower relative to other scenarios if the availability of CO_2 and electricity as the main resources in the fairfuel option also means becoming less dependent on external risk factors and being able to guarantee continuous plant operation. For example, supplying CO_2 with DAC plants on a large scale in the future will prevent potential conflicts of use with biomass. This idea is further developed in the following sections.

The bottom line is that the fairfuel criteria can often pay off. In addition, the atmosfair Silver certificate keeps the entry barriers low. Overall, these criteria will not jeopardise the market ramp-up of PtL kerosene in the foreseeable future.

Sufficient CO_2 sources available for air traffic

The sustainability of PtL requires paying attention to the economic side as well as the environmental standards. In addition to the costs already mentioned, it must be ensured that the CO_2 sources permitted by this standard are available in sufficient quantities.

As a result, atmosfair has calculated the CO_2 demand for PtL production for global air transport and compared this with the available quantities from sources in categories **A** and **B** (sustainable and partially sustainable) of this standard. It was shown that there are sufficient waste CO_2 sources available today worldwide, with a focus on waste biomass, to fully supply global aviation with sustainable PtL. The faster aviation grows in the future, the quicker we will need to transition to direct air capture as shown in Table 1.

II. Criteria

This part contains the atmosfair fairfuel criteria, which describe the requirements for the atmosfair fairfuel Gold label. The atmosfair fairfuel Silver section describes how these requirements are different for the atmosfair fairfuel Silver label.

The requirements for providing proof of compliance with the criteria can be found in the section Verification, the audit process is described in the Process section.

1. Principles

atmosfair fairfuel is a label for synthetically produced crude oil used and credited as aviation fuel that comply with these criteria for the entire production chain.

1.1 Use restricted to aviation only

atmosfair fairfuel may only be sold for civil, commercial aviation. This includes logistics companies, but only their aviation segment. This fuel is explicitly prohibited for use in road transport.

1.2 Not limited to a single technology

The label is non-technology-specific; the power-to-liquid (PtL) plant operator can produce the hydrocarbons along the currently available pathways, e.g. Fischer-Tropsch synthesis or (possibly in the future) the methanol route. Other routes are possible as long as they are approved by the ASTM for aviation.

1.3 Book&claim crediting, fairfuel certificates

The current volumes of synthetic crude oils that can be produced do not usually justify separate processing in a refinery, but require the crude oil to be processed into fuel in what is known as co-processing, where the refinery processes synthetic and conventional fossil crude oils together. Co-processing makes it necessary to credit the climate-friendly attribute of the synthetic crude oil to the paying customer (e.g. airlines) in accounting terms, since on leaving the refinery the fuels can no longer be physically separated into the different crude oils that came into the refinery Book&claim crediting is similar to the green electricity market with production certificates that certify the quantity and quality. This proof for customers (fairfuel certificates) can be certified by independent auditors at the end of the certification process for the respective quantity produced on the basis of these criteria.

1.4 Ban on double counting (crediting)

Double counting is not permitted. The applicant must ensure that intermediaries, e.g. service providers such as refineries or refuelling companies, do not already credit themselves for the CO_2 emission savings of fairfuel.

1.5 Exemptions, case-by-case assessment, further development

The criteria outlined here are an initial start for the relatively new field of synthetic kerosene production for aviation. atmosfair will continue to develop and adapt the criteria over time, incorporating developments from practical experience.

If plant operators cannot currently comply with individual criteria for certain reasons, they can still ask atmosfair to assess the plant. atmosfair can then decide on a case-by-case basis whether the arguments presented justify a temporary or permanent exemption from an environmental point of view.

2. CO_2 supply

1.1 Categories of permissible and impermissible CO_2 sources

Category **AAA**: Direct Air Capture, permitted

The PtL plant has to meet part of the CO_2 requirement through Direct Air Capture (DAC) modules. The scope is defined in Table 1.

Category **A**: unrestricted CO_2 sources

(2) Biogas (e.g. CO_2 biomethane upgrading by amine scrubbing): only Class A waste substrates may be used for the biogas plants, see *Substrate classes for biogas production*.
(3) Biomass: for more about permissible Class A biomass types, see *Substrate classes for biomass use*.
(4) Sewage sludge and biogas from municipal wastewater.
(5) Pulp&paper: only with an expert report as per *Proof of CO2 sources* (no net forest loss, no biodiversity degradation, depending on percentage recycled).
(6) Waste incineration with CCU (carbon capture and use), proportionately according to expert categorisation in Class A as per *Substrate classes for biomass use*.

Category **B**: CO_2 sources permitted to a limited extent

(1) Biogas (e.g. CO_2 biomethane upgrading by amine scrubbing): only Class B waste substrates may be used for the biogas plants, see *Substrate classes for biogas production*.
(2) Biomass: for more about permissible Class B biomass types, see *Substrate classes for biomass use*.
(3) Pulp&paper: only with expert report in accordance with *Proof of CO2 sources* (no net forest loss and no biodiversity degradation).
(4) Waste incineration with CCU (carbon capture and use), proportionately according to expert categorisation in Class B as per *Substrate classes for biomass use*.

Category **C**: non-sustainable CO_2 sources

(1) Biogas: Class C substrates, see *Substrate classes for biogas production*.
(2) Class C biomass types, *Substrate classes for biomass use*.
(3) Waste incineration with CCU, fossil, recyclable parts of waste using state-of-the-art technology according to expert categorisation.
(4) Cement plants
(5) All fossil sources (CCS at power plants, natural gas, etc.)
(6) Petroleum sector (refineries, etc.)
(7) Bioethanol production
(8) Steel, aluminium, glass and ceramic production

Upon request, atmosfair will consider sources or substrates not listed on a case-by-case basis. This is based on the principles from the section *Overarching principles for CO2 and electricity*.

1.2 Permissible percentages of the different CO_2 sources

Table 1 shows the composition of the permissible CO_2 categories for a given operating period.

The specified values are to be achieved at the beginning of the period except in the first ten years of operation. In this case, the values only have to be reached by the end of the first ten years of operation. At least 1/10 of the final value must be increased **(AAA** and **A**) or decreased**(B** and **C**) every year.

	In the first year of operation	2021 – 2024	2025 – 2030	2031 – 2035	2036 – 2040	2040 - 2045	2046 - 2050	From 2050
AAA DAC, min.	In planning phase	DAC-capable	1%	5%	10%*	25%*	50%*	100%*
A sustainable, min.	In planning phase	25%	35%	45%	65%	75%	50%	
B sustainable to a limited extent, max.	100%	75%	65%	50%	25%	0%	0%	0%
C not sustainable, max.	50% fossil**: 0%	25% fossil**: 0%	15% fossil**: 0%	0%	0%	0%	0%	0%
*Post-2035 DAC percentages subject to technical development and the development of the other CO_2 sources **fossil sources are category **C** (3) ff.								

Table 1 Requirements for CO_2 supply.

Example: If a PtL plant is commissioned in 2023, the restrictions in the first column apply in the first year. In 2033, the plant must operate with a minimum of 5% DAC CO_2, minimum of 45% CO_2 in Category **A**, maximum 50% CO_2 in Category **B** and without CO_2 in Category **C**. This means that from the second year onwards, at least 0.5% of the CO_2 from DAC and 4.5% (+45%/10) of the CO_2 from Category **A** and a maximum of 95% (-50%/10) from Category **B**, and a maximum of 90% (-100%/10) from Category **C** must be used.

3. Electricity supply

3.1 Principles

(1) One hundred percent of the electricity required to produce synthetic hydrocarbons must come from renewable energy sources that are not compensated under the German Renewable Energy Sources Act (EEG).
(2) In this context, the operator of the PtL plant must grant priority to wind and solar power (incl. *concentrated solar power*, CSP) over hydropower and biomass or biogas generation.
(3) The PtL plant operator secures access to electricity generation capacity. The quality of the capacity is divided into three components: (1) local PPA with special additionality requirements, (2) local PPA with basic additionality and (3) residual capacity.
The generation capacity of the first two components (via PPAs) must correspond to several times the total output of the PtL plant (see 3.2) and should only consist of wind/solar (individual cases can be approved via exemptions). The third component then supplies the electricity required by the PtL plant that the first two components, with their daily solar and wind fluctuations, cannot generate temporarily. The residual capacity (3) in this case is also preferably sourced by the PtL plant operator from wind and solar power, or alternatively from biomass or biogas power generation or hydropower.

3.2 Regionality and producer retention

The requirement for basic capacity according to item 3.1(3) is divided among the three supply components as follows.

(1) **Local PPAs + purchase additionality + initiation additionality, minimum factor 1**
(a) For this electricity component, the PtL plant operator must purchase electricity from power supply facilities within a radius of up to 150 km via PPAs[2]. The supply line to the PtL plant must not contain any interconnectors (cables that connect the electricity systems of neighbouring countries). The production capacity of the electricity supply plants must be at least equal to the total power of the PtL plant (minimum factor 1). The PPAs must stipulate that all electricity produced by the plants covered by the PPA is always purchased. A direct physical connection to the PtL plant is preferred, but not mandatory. If the PPA electricity is supplied via the grid or through a book&claim model, the associated guarantees of origin of the plants covered by the PPA must be invalidated. For example, a PtL plant with a total capacity of 4 MW must have at least one power supply facility with a production capacity of 4 MW that is covered by the PtL plant operator's PPA.
(b) The plants of this supply component must also satisfy the criteria listed in 3.3 (Extended additionality) .
(c) When the operating licence of the PtL plant is issued, a decision of the management body of the PtL plant operator must be available, which stipulates fulfilment of the supply component in accordance with (a) and (b). No later than two years after the PtL plant commences operation, the plant operator must submit a concept showing how the plant will guarantee the supply component. The supply systems must supply the PtL plant no later than 5 years after it was commissioned.

[2] The radius applies to PtL plants in Germany. For information about other countries, see 3.5.

(2) **Local PPAs + purchase additionality, minimum factor 4[3]:**

a) For this electricity component, the same rule applies as for the local PPAs with special additionality, except that here the production capacity of the electricity supply facilities must be at least four times[1] the total power of the PtL plant (see 3.2 (1) a).

b) The requirements for initiation additionality under 3.2 (1) b) do not apply.

c) The PtL plant operator must provide operational evidence of this supply component two years after approval.

(3) **Residual capacity:** The PtL plant operator can meet all electricity requirements of the PtL plant that are not covered by PPA supply a according to item 3.2 (1) or 3.2 (2) by procuring guarantees of origin. The financial additionality requirement in item (3.1 (1)) (No compensation under the Renewable Energy Sources Act (EEG)) remains in place for this component as well.

3.3 Extended additionality

Plants generating electricity from renewable energy sources that supply electricity to the PtL plant according to item 3.2 (1) still have to fulfil one of the following conditions:

(1) Initiation and operation
New wind or solar installations commissioned after the PtL plant has been put into operation by the PtL plant operator or a service provider he commissions, which are initiated, installed and operated by him [the operator]. Installations not subsidised within the scope of EEG tenders are eligible to apply for the label.

(2) Continued operation of post-EEG plants
Extended additionality can also be achieved through the continued operation of post-EEG plants. For this purpose, the PtL plant operator must prove that

a) the plants cannot be repowered (i.e. cannot be replaced by new plants subsidised under the German Renewable Energy Sources Act (EEG)) and the PPA with the electricity plant operator enables continued operation, or

b) the plant can be newly constructed or upgraded, but without EEG subsidies.

3.4 System serviceability

The PtL plant operator must upgrade his plant to provide services that serve the grid and have it certified no later than two years after commissioning (e.g. through regulation by external specialised load managers in a pre-defined scope and timeframe).

3.5 EU and non-EU foreign countries

When a plant is built within the EU, similar rules apply to guarantees of origin and the exclusion of subsidised plants, as well as supply components. The minimum factor for 3.2 (2) adjusts according to the hours of full capacity utilisation of renewable energies (wind and solar) in relation to the 8,600 full-time operating hours of the PtL plant.

[3] Here factor 4 only as an example for PtL plants in Germany. The minimum factor is calculated as the total hours of a year in relation to the full load hours of the renewable energy sources used at the location of the PtL plant minus the minimum factor from para 3.2, clause 1, so that the total fluctuating electricity produced from para 3.2, clauses 1 and 2 in average wind and solar years at least corresponds to the electricity consumption of the PtL plant.

The regionality of the power supply facilities must be checked and assessed on a case-by-case basis. The assessment basis is the infrastructure of the grid and the power supply facilities in the country of the PtL plant. It must be ensured that the PtL plant does not further exacerbate bottlenecks in the grids.

If an installation is erected in a non-EU country, the PtL plant operator is responsible for rural electrification, if applicable. If the last determined rural electrification rate (based on World Bank data) of the country where the plant is located is below 75% or if the Human Development Index (based on United Nations Development Programme data) of the country where the plant is located is below 55%, the PtL plant operator is required to construct additional power supply facilities. The electricity generated in these facilities must be made available to local residents at socially acceptable prices. The PtL plant operator must strive to ensure that the capacity of the power supply facilities corresponds to the total capacity of the PtL plant and to make an ambitious contribution to the development of renewable electricity supply in the country.

4. Water

Water scarcity for plants in non-EU countries is to be determined as a measure of *water stress* (SDG 6.4.2 freshwater withdrawal as a proportion of available freshwater resources, based on UN water data) over the past three years prior to submitting an application.

If there is a water shortage of more than 40% at the planned location, the water needed must be sourced, e.g. through seawater desalination, and not taken from freshwater reserves.

If there is water scarcity of more than 60% at the planned location, the water needed must be sourced, e.g. through seawater desalination, and an amount of desalinated water commensurate with the total investment must be made available to the public at socially acceptable prices.

5. Social standards and governance

The ESG criteria of the European Investment Bank and the *equator principles* apply for the implementation of minimum social standards, occupational safety, preservation of cultural assets and representation of interests in non-EU countries where plants are located. Compliance with the criteria is assessed by atmosfair on a case-by-case basis.

In particular, proof must be provided of compliance in the following areas for the construction and operation of the plant in accordance with the ESG criteria of the European Investment Bank:

5. Cultural heritage
6. Involuntary resettlement
7. Rights and interests of vulnerable groups
8. Labour standards
9. Occupational and public health, safety and security
10. Stakeholder engagement

Proof must be provided of compliance in the following areas for construction and operation of the plant in accordance with the *Equator Principles*:

5. Grievance mechanism
10. Reporting & transparency.

6. *atmosfair fairfuel Silver*

The following changes apply to the above-mentioned specifications (fairfuel Gold) for the atmosfair fairfuel Silver label.

6.1 CO_2 sources

(1) Change 1.1 Category **B**: Cement is permissible if an expert report is provided confirming that the cement plant uses an above-average percentage of alternative fuels (for example, used tyres, waste oil or sewage sludge) compared to the rest of the country (at least three other plants. If there are fewer than four plants in the country, plants in neighbouring countries must be taken into account) and meets its electricity needs with renewable energy sources.

(2) Change 1.2 Permissible percentages of CO_2 sources

	In the first year of operation	2021 – 2024	2025 – 2030	2031 – 2035	2036 – 2040	2040 - 2045	2046 - 2050	From 2050
AAA DAC, min.	-	-	DAC-capable	1%	5%	10%*	25%*	50%*
A sustainable, min.	-	-	-	In planning phase	20%	30%	50%	Max. 50%
B sustainable to a limited extent, max.	100%	100%	100%	100%	80%	50%	30%	0%
C not sustainable, max.	50% fossil**: 0%	30% fossil**: 0%	20% fossil**: 0%	10% fossil**: 0%	0%	0%	0%	0%

*Post-2035 DAC percentages subject to technical development.
fossil sources are category **C (3) ff.

Table 2 Dynamic CO_2 supply requirements for atmosfair fairfuel Silver.

6.2 Electricity supply

(1) Change in regional supply according to item 3.2 (1): does not apply.

(2) Change in supra-regional supply item 3.2 (2): The power plant must supply the PtL plant from the sixth year of operation.

7. *Book&claim crediting, CO_2 emissions reduction, certification for customers*

(1) The following applies to the amount of fairfuel (synthetic crude oil) produced: one tonne of synthetic crude oil produced and placed on the market is equivalent to one tonne of fairfuel. This impacts the climate less than fossil fuels.
(2) Owing to the reaction principle, the waxes (long-chain hydrocarbons) always present in the synthetic crude oil from Fischer-Tropsch synthesis must be completely processed into fuels by hydrocracking or other suitable processing methods, except for conversion-related residues (approx. C_5-C_{16}).

(3) If it is not possible to process the wax phases of the crude oil as described in (2), the PtL plant operator may still count the wax phase of the crude oil as fairfuel if the quantity of wax produced meets the criteria of this fairfuel standard and the wax is replaced on a mass basis by wax-free synthetically produced crude oil from other production sources. This crude oil from other production sources must then at least be produced without fossil CO_2, but does not need to meet any other criteria.

(4) Avoiding double counting: The operator of the PtL power supply facility must provide proof in the immediately upstream stage (CO_2 source) and downstream stage (refinery) of synthetic crude oil production that the relevant suppliers or customers do not credit themselves with the climate mitigation impact of the CO_2 used or the synthetic crude oil produced or sell it to other third parties.

(5) For book&claim sales, PtL plant operators can have a certificate issued by an independent technical auditor in accordance with these standards, confirming the amount of synthetic crude oil produced and the associated CO_2 reduction. The operator can market this certificate to his customers as proof of the amount of synthetic crude oil produced for the customer, the fuels placed on the market and the positive impact on climate change mitigation. The PtL plant operator is responsible for updating the necessary registries (verification of incoming and outgoing certificates to avoid double counting in appropriate registries) and for their transparent documentation and verification by independent third parties vis-à-vis his customers.

III. VERIFICATION

In this section, we list the documents to be provided by the applicant for the fairfuel label to validate the plant and verify the production of synthetic hydrocarbons for aviation.

1. *Proof of sales to aviation sector*

The operator undertakes to sell atmosfair fairfuel only to customers from civil, commercial aviation in an atmosfair fairfuel sales declaration. The sales declaration specifies the type of proof required for verification, e.g. reports of the applicant's financial auditor, marketing materials on websites, etc. as well as sanctions for non-compliance.

2. *Proof of CO_2 sources*

2.1 DAC use

Validation

(1) The PtL plant operator provides information on planning and DAC capability in the form of planning documents, in particular the installation plan, the overall flow diagram of the plant, and contracts of interest or purchase agreements with DAC module suppliers.

Certification

(2) The PtL plant operator provides the operating documentation (measurement data from a calibrated and protected flow sensor) as proof of the produced quantities.

2.2 Categories **A** and **B**

Validation

(1) The PtL plant operator presents the supply contracts with the CO_2 source operators as proof of quantities and qualities.

Certification

(2) Qualities: Proof of the actual qualities is provided by means of a suitable certification of the CO_2, which shows the quality of the CO_2, e.g. DENA or NABISY certification of a biogas plant or an expert report for wood. The expert report for wood must confirm that the wood used is at the end of the use cascade (material use – chip-based use – fibre-based use). For paper sources, it must be confirmed that the fresh fibre content is minimised using state-of-the-art technology. Proof of all fresh fibre sources must be provided and the fresh fibre may only originate from sustainably managed, ecologically compatible biodiverse and site-appropriate mixed forests. In addition, the expert report must confirm that the criteria in section *Social standards and governance* are also satisfied when wood is sourced.

(3) Quantities: The use of the CO_2 quantities is verified by the PtL plant operator via the production documents (measurement data from a flow sensor).

3. *Proof of electricity supply*

3.1 Principles

Validation

(1) The PtL plant operator submits the electricity supply contract as proof of the exclusive use of renewable energy.

3.2 Regionality and producer retention

Validation

(1) No later than the third year of operation, the PtL plant operator provides the PPA with the power supply facility for the supply component in accordance with I.3.2 (2). The PPA must stipulate that the electricity produced is purchased in full. The PPA may also be concluded between an energy trader of the PtL plant operator and the power supply facilities. In this case, the contract between the energy trader and the PtL plant operator must be provided.

(2) Also no later than the third year of operation, the PtL plant operator submits a concept for the planned fulfilment of the supply component in accordance with I.3.2 (1). In the sixth year of operation at the latest, the PtL plant operator submits the PPA with the power supply facility for this supply component together with operating documents (BImSchG permit, installation plan, lease documents if applicable) or proof of additionality confirmed by an expert report (see also 3.3).

Certification

(3) As soon as the power supply facility is in operation, the PtL plant operator provides the facility's production data.

(4) The PtL plant operator provides the electricity guarantees of origin, as well as the production profile of the power supply facilities and the load profile of the PtL plant.

3.3 Initiation additionality

(1) As proof of the new facilities, the PtL plant operator provides planning documents for the power supply facilities, in particular the approval notice and the installation plan.

(2) For post-EEG plants, the PtL plant operator explains why the site is not suitable for repowering and what measures it has taken to ensure additionality. Proof of additionality can be provided by, among other things:

- Long contract term of the PPA
- Risk allocation for the PtL plant operator (e.g. maintenance risk)
- Post-EEG conversion costs assumed by the PtL plant operator (retrofitting of the plants)
- Installations in areas not permitted under the EEG (for example solar installations in non-disadvantaged agricultural areas).

3.4 System serviceability

The system operator must provide evidence of certification of the control system to service the grid starting from the third year of operation.

4. *Proof of production quantity*

Validation

4.1 The PtL plant operator supplies proof of the agreement with the refinery by providing the purchase agreement [verified once].

4.2 The PtL plant operator provides proof in the form of written declarations by the suppliers of CO_2 and the purchaser of the crude oil (refinery) that they do not credit themselves for the CO_2 reductions achieved by the fairfuel.

Certification

4.3 The PtL plant operator provides proof of the delivered quantity of synthetic crude oil from the refinery. This also confirms the conversion of the synthetic crude oil to the refinery's final products.

4.4 If the PtL plant operator makes use of I 7.3 (separate use of wax phase), he must prove with suitable documents that the synthetic crude oil used was not produced with fossil CO_2, as well as the quantity produced by weighing (in kg). The plant operator must provide proof of the quantity of synthetic crude oil substituted by means of delivery receipts containing the quantity of crude oil in kg.

5. *Proof of water*

Validation

5.1 The plant operator provides the calculation of water scarcity at the location.

5.2 If necessary, the PtL plant operator provides planning documents for the desalination plant, in particular the purchase contract and the technical specifications, as well as technical data on the water requirements of the PtL plant.

5.3 If necessary, the PtL plant operator provides a concept on how local residents benefit from the desalinated water.

Certification

5.4 After commissioning, the PtL plant operator provides the operating documents (measurement data from a flow sensor) as proof of the desalinated water quantities.

6. *Proof of compliance with social standards and governance*

6.1 Compliance with social standards is assessed by atmosfair on a case-by-case basis. atmosfair compiles the required proof together with the PtL plant operator during the validation process.

6.2 The assessment may determine that the PtL plant operator needs to provide further proof for each certification.

IV. Process for awarding the label

The atmosfair fairfuel label is awarded in a two-step process: validation and certification. Validation is performed once to determine the suitability of the PtL plant and certification is the ex-post verification of production quantities of synthetic hydrocarbons.

Auditor

The label is designed as a certificate in TÜV Süd's portfolio of renewable energy certificates. The applicant may decide to use other certifiers. They would then be instructed by TÜV Süd for the audit steps. atmosfair does not charge applicants a fee to apply for the label.

1. *Validation*

Before the PtL plant operator can have production quantities certified, the plant must be validated. This includes an on-site inspection of the plant and serves to determine the basic suitability of the plant to produce synthetic hydrocarbons in compliance with the atmosfair fairfuel standard.

The areas to be audited are those mentioned in section Verification under the keyword Validation, as well as general criteria such as:

- Legal authorisation
- Operating licences
- Insurance policies

2. *Certification*

The operator of a successfully validated PtL plant can have produced quantities of synthetic hydrocarbons certified ex-post according to atmosfair fairfuel criteria, i.e. after production. The timing of certification is determined by the PtL plant operator. Any quantities produced in the last two years can be certified. After successful certification, the operator must submit the certification report to atmosfair within six months. atmosfair then certifies that the quantities produced are atmosfair fairfuel after checking the certification report.

The plant operator is free to have the general suitability of production quantities as fairfuel established before they are supplied to the refinery, i.e. to divide certification into two steps. The verification of compliance with the ban on double counting (crediting) and use as fuel is then demonstrated by the operator in a second step.

ANNEX: SUBSTRATE CLASSIFICATION FOR BIOGAS AND BIOMASS USE

This section contains the classification of substrates for biogas and biomass sources from which the CO_2 originates. It also provides a detailed breakdown of the individual substrates.

1. *Substrate classes for biogas production*

Biogas substrate list

Origin	Substrate	Category
Agriculture	Crop residues	A
	Fodder residues, mashed grain, spoiled silage	B
	Cereal straw	B
	Renewable raw materials (conventional)	C
	Renewable raw materials (organic farming)	B
	Liquid manure, dung	C
Landscape management	Green waste	A
Waste from food production, plant-based	(see below for exceptions)	A
	Rapeseed and sugar beet products	B
Waste from food production, animal-based	As a general rule	C
Food distribution	Food with expired best before date	A
	Defective batches (transport damage)	A
Municipal solid waste	Biowaste	A
	Sewage sludge	A
	Kitchen waste	A

Class A: sustainable, Class B: sustainable to a limited extent, Class C: non-sustainable

Upon request, atmosfair will consider substrates not listed on a case-by-case basis. This is based on the principles from the section *Overarching principles for CO2 and electricity*.

2. *Substrate classes for biomass use*

Substrate list biomass

Origin	Substrate	Category
Forestry	Wood residues only at the end of the use cascade (residues only after the upstream material, chip-based and fibre-based use) and only from forest use without biodiversity loss and without net forest loss, confirmed by expert report (see proof)	B
Agriculture	Cereal straw	B
Municipal waste	Sewage sludge	A
	Wood residues with expert report (see proof)	A-C
	Plastic (non-recyclable, end of life, e.g. from rivers) with expert report	A-C
Industrial waste	Wood residues only at the end of the use cascade (residues only after the upstream material, chip-based and fibre-based use) and only from forest use without biodiversity loss and without net forest loss, confirmed by expert report (see proof)	B
	Black liquor	A
	Animal meal	C
	Plastic (non-recyclable, end of life), depending on expert report	A-C
	Substitute fuels, according to expert report	A-C
	Sewage sludge	B

Class A: sustainable, Class B: sustainable to a limited extent, Class C: non-sustainable

Upon request, atmosfair will consider substrates not listed on a case-by-case basis. This is based on the principles from the section *Overarching principles for CO2 and electricity*.

3. Detailed list: classes of biogenic waste and residues

Origin	Type/substrate [a]	A	B	C
Agriculture	Crop residues	X		
	Fodder residues, mashed grain, spoiled silage		X	
	Cereal straw		X	
	Liquid manure, solid manure			X
	Energy crops, renewable raw materials			X
Landscape management	Wood waste, residual wood (end of use cascade) according to expert report		X	
	Roadside grass	X		
	Green cuttings from private and public garden and park maintenance	X		
Food, Plant-based	baking waste	X		
	spent grains (fresh/pressed)	X		
	Vegetables (rejected)	X		
	Vegetable trailings	X		
	Cereals (trailings)	X		
	Cereal vinasse	X		
	Cereal vinasse from alcohol production	X		
	Grain dust	X		
	Glycerine	X		
	Medicinal and spice plants (rejected)	X		
	Potato waste water from starch production	X		
	Potatoes (rejected)	X		
	Potatoes (mashed, medium starch content; not or no longer suitable for consumption)	X		
	Potato processing water from starch production	X		
	Potato pulp from starch production	X		
	Potato peels	X		
	Potato vinasse	X		
	Potato vinasse from alcohol production	X		
	Bran	X		
	Molasses from beet sugar production	X		
	Fruit and grape marc (fresh/untreated)	X		
	Small beet pieces from sugar processing	X		
	Rapeseed cake		X	
	Rapeseed meal		X	
	Sugar beet press cake from sugar production		X	

Origin	Type/substrate a)	A	B	C
	Sugar beet shavings		X	
Food, animal-based	Buttermilk fresh (not/no longer suitable for consumption)			X
	Casein			X
	Grease separator contents			X
	Flotation fats			X
	Flotation sludge			X
	Frying oil and fats			X
	Rennet whey			X
	Rennet whey fresh			X
	Guts (pork)			X
	Skimmed milk fresh			X
	Skimmed milk dry			X
	Milk (not or no longer suitable for consumption)			X
	Lactose			X
	Lactose molasses			X
	Lactose molasses low protein			X
	Ruminal contents			X
	Curd cheese (not or no longer suitable for consumption)			X
	Acid whey			X
	Acid whey fresh			X
	Animal blood			X
Other vegetable waste	Cut flowers (rejected)		X	
Other	Old bread	X		
Food	leftovers	X		
	Black liquor	X		
	Plastic (non-recyclable, end of life, e.g. from rivers), classified as A, B or C according to expert report	(X)	(X)	(X)
	Substitute fuels according to expert report			
	Sewage sludge, industrial		X	
	Sewage sludge, municipal	X		

Upon request, atmosfair will consider substrates not listed on a case-by-case basis. This is based on the principles from the section *Overarching principles for CO2 and electricity*.