

What is it and why  
does it matter?



***SUSTAINABLE  
AVIATION FUEL***

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# **EXECUTIVE SUMMARY**

Flying has become an indispensable part of modern life. But as the aviation industry grows, so do its emissions. To meet climate targets, the aviation industry needs to become more sustainable. Significant advancements in alternative modes of travel, electric and hydrogen aircraft, and equipment optimization show that the industry is headed in the right direction. But, apart from flying less, most solutions to reduce emissions in aviation rely on future technology. To tackle the problem today, and in the future, Sustainable Aviation Fuels (SAFs) are key to making aviation more sustainable. Before we understand why we need SAF and how it can benefit you, we need to first understand what it is, and why it matters. Time to get onboard

# AVIATION

## A Hard-to-Abate Sector

Currently, the aviation industry is considered to be responsible for 2-3% of global manmade CO2 emissions. This number is expected to rise if steps are not taken to decarbonize this industry.

Solutions that work for road transport like electric or hydrogen engines are still years away from being available for aviation, especially for long-haul flights. Pair that with the fact that current engines that rely on liquid fuel have a lifespan of 20 to 30 years, and the result is a slow transition to battery-operated flights. Plus, it takes a lot of energy to get a plane in the air. Batteries are not as efficient in carrying energy as jet fuel is. Innovation is still needed to carry more than 50 passengers over long distances, sustainably.

This is where Sustainable Aviation Fuel (SAF) comes in. SAF acts as a “drop-in fuel”. A drop-in fuel is a fuel that can be mixed with fossil kerosene, more commonly known as fossil jet fuel, and used without having to change existing infrastructure and equipment. This means SAF, for all intents and purposes, matches fossil jet fuel’s technical requirements, while being a more sustainable alternative.

Because of this, SAF is widely recognized as one of the solutions to drastically reduce CO2 emissions in aviation from today onwards.



# SUSTAINABLE AVIATION FUEL

A Hard-to-Abate Sector

Sustainable Aviation Fuel is a liquid substitute for fossil jet fuels, produced from sustainable resources, instead of being refined from petroleum.

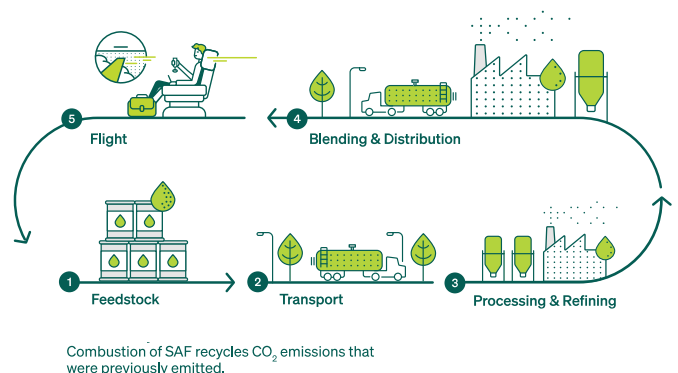
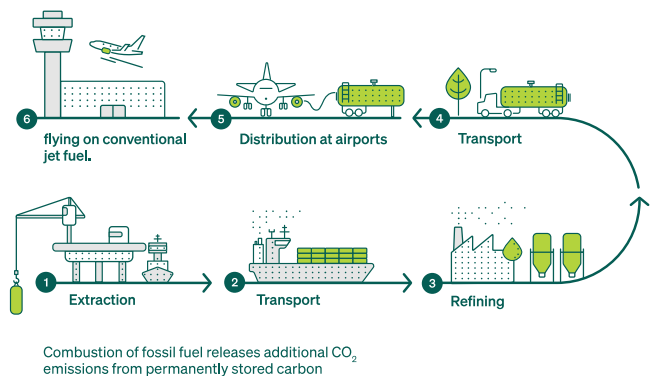
These sustainable resources, known as sustainable feedstocks, can be from biological sources such as waste oils, agricultural and forestry residues, or from non-biological origins, such as green hydrogen.

Since the first commercial flight operated by KLM in 2011, more than 350,000 flights took place on a mixture of SAF and fossil jet fuel.

SAF also does not emit sulfur-oxides (Sox) and allows the significant reduction of fine particles, which can cause negative health effects if exposure occurs. Latest research from NASA shows that it even reduces contrails, having a positive impact on the radiative forcing effects - an important feature of GHGs - of aviation.

*“Sustainable aviation fuels are safe, proven, and offer the greatest potential to reduce our industry’s carbon emissions in the near, medium, and long term. [...] Our industry will need a strong, reliable supply of SAF to address climate change and drive adoption[...].”*

— Boeing Chief Sustainability Officer  
**Chris Raymond**





# DECARBONIZING AVIATION

## A Comparisation

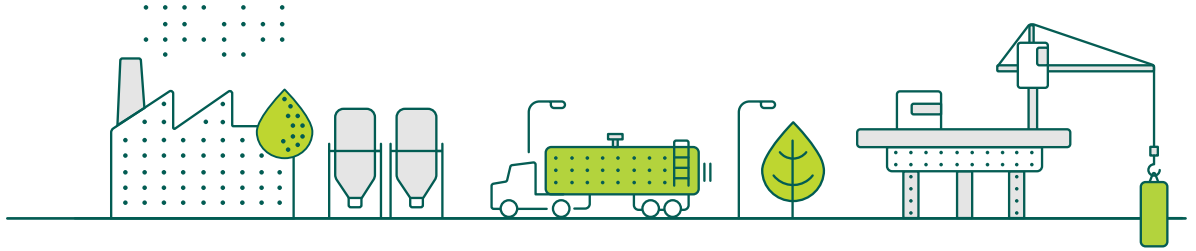
Sustainable aviation fuel carries many advantages when compared to other alternative energy sources for today’s aircraft. Even when pitting it up against the likes of hydrogen or electricity, it proves to be the best option to decarbonize aviation today.

With aircraft having a lifespan of 20 to 30 years, depending on the model, replacing a fleet with aircraft operating on an alternative energy source would not only be costly, but take many years to phase out. As a “drop-in” fuel, SAF can be directly mixed with fossil jet fuel in existing infrastructure, and used in aircraft without modification. Below, you can see the key technical characteristics that SAF meets in airplanes (✓) against other available fuel types, which do not (X).

Fuel Type	Same engine	Same aircraftE	nergy densityF	reeze point	Available today
Fossil Kerosene	✓	✓	✓	✓	✓
Sustainable Aviation Fuel	✓	✓	✓	✓	✓
Ethanol	X	X	X	X	✓
FAME	X	X	✓	X	✓
Electricity	X	✓	X	✓	✓
Hydrogen	X	X	✓	✓	✓
Nuclear	X	X	✓	✓	X

# HOW IT'S MADE

## SAF



There are many ways to make sustainable aviation fuel. Currently, there are 9 different certified SAF technology production pathways. This means there are 9 different technologies capable of producing SAF that meet strict technical requirements to be used in commercial aircraft. In addition to these 9 pathways, many more feedstock/technology combinations for SAF production are currently under development and in the process of getting ASTM certification. This ASTM certification provides international recognition for the SAF to be used in commercial aviation.

Each technological pathway differs vastly. They differ in feedstock, carbon reduction, sustainability, and whether they compete for other uses. Because of these differences, the percentage in which they can be blended with fossil kerosene can be as low as 10% to as high as 50%. Tests to fly commercial aircraft on 100% SAF are underway and showing promising results.

The different pathways can be broadly categorized under first-generation biofuel, sustainable aviation fuel: second-generation biofuel, sustainable aviation fuel: power-to-X.

A technology being certified does not mean that the fuel is also produced on a commercial scale. Currently, HEFA-based fuel is the only product that is commercially available today. HEFA refines fats, vegetable oils, waste oils, or greases into SAF through a process that uses hydrogen (hydrogenation). Out of the 9 certified technologies for commercial use, it has powered over 95% of all SAF flights to date.

Both the technology and feedstock affect how sustainable the SAF will be. But, with so many case-specific combinations possible, how do we ensure sustainability?

	Fossil kerosene	First-generation biofuel	SAF: second-generation biofuel	SAF: power-to-X
Feedstock	Fossil fuels: oil, coal, natural gas.	Rapeseed, sugar cane, corn, palm oil, soybeans.	Oil wastes such as cooking oil and other wastes such as solid or cellulosic.  Water plants like algae and soil plants like Jatropa.	Renewable energy from solar or wind.  Water.  CO2 captured from the air.
Carbon reduction	✗	✓	✓	✓
Sustainable	✗	✗	✓	✓
Sufficient raw material	✓	✗	✗	✓
No conflict of use	✓	✗	✗	✓



# ***ENSURING SUSTAINABLE SAF***

In the last years, we see both the introduction of SAF policies and mandates and a return to travel. This puts pressure from governments, individuals, and corporates on the aviation industry to become more sustainable. Along with this pressure, comes a renewed interest in sustainable aviation fuel. Airlines, airports, and corporates are announcing their commitment to fly on SAF. With more choices than ever on where to turn to, it is important to remember the most important quality of SAF: its sustainability. SkyNRG ensures the sustainability of its fuel, with an approach to sustainability that is much more than avoiding harmful impacts.

For SkyNRG, a sustainable feedstock must meet three requirements.

- First, higher-value applications such as living, food production, and high conservation areas should not be displaced.
- Second, the side effects of the SAF must also be far less negative than the usage of fossil fuel.
- Finally, food security, environment, and biodiversity cannot be sacrificed, and preferably, should even be enhanced.

Assuring sustainability is complex. This is why SkyNRG takes a 4-tiered approach on sustainability that emphasizes transparency with external accountability.

- Firstly, by being structurally advised by an independent Sustainability Board, consisting of leading

NGOs and scientists. They advise on all aspects related to social and environmental sustainability.

- Second, by certifying our operations by the Roundtable of Sustainable Biomaterials (RSB), a worldwide multi-stakeholder initiative concerned with ensuring the sustainability of sustainable biomaterials.
- Third, by tracking the latest developments and thinking through a global NGO network.
- And lastly, by becoming a certified B Corp, SkyNRG signals to the industry that SAF can become a force for good.

This way, we can assure that the SAF produced is socially and environmentally sustainable and traceable.



# **SAF'S MAIN CHALLENGES**

SAF still makes up less than 0.1% of all aviation fuel used. To successfully decarbonize the aviation industry, production capacity needs to increase drastically. There are positive signs that the SAF market is growing. New mandates, policies, subsidies, SAF-dedicated plants, announcements of SAF research projects, and programs designed to help airlines pay for SAFs are all exciting developments on the horizon. Add to this that corporates and governments are signaling the importance of SAF through substantial commitments, and it is becoming clear that SAF is the way to go. While SAF is no longer confronted with the challenge of creating demand, it is now facing and even greater one: assuring enough supply to meet it.



### **Challenge 1. Supply**

There is a very limited SAF production in the world. Scale is needed to meet global demand, stimulated by ambitious policy.

#### **Solution.**

Acknowledging this challenge exists is the first step towards stimulating the development of SAF-dedicated plants. Several SAF-dedicated plants have been announced in recent years. Some will build on pre-established technology, like SkyNRG's SAF production plant in Delfzijl. This SAF plant will rely on HEFA technology, which uses waste oils as its feedstock. Others, like Synker, will be a first-of-its-kind commercial scale synthetic SAF production plant, making SAF from the combination of CO<sub>2</sub> and green hydrogen, through the Power-to-Liquids (PtL) process. Government support and innovative SAF programs, such as SkyNRG's Board Now program, that go beyond providing SAF in the short term but focus on increasing production of SAF plants are key in overcoming this challenge.

### **Challenge 2. Policy**

Stable policy to support SAF market development is a cornerstone to help it grow. While some governments in Europe and the US are pioneering in their supporting of the SAF market, much still needs to be done. Current policies tend to push for other end markets, such as road fuels.

#### **Solution.**

Upcoming blend mandates will be the biggest driver in increasing SAF use. Currently, SAF production and use is limited because airlines can voluntarily choose to buy SAF or not. Thanks to recently-announced blending mandates, which put an obligation on the production and use of SAF, the sector is expected to take off further. 2021 has been a year of strong SAF policies, with Europe and the United States taking a leading role. On one side of the Atlantic, ReFuelEU is enabling a SAF market in Europe. On the other, the Sustainable Skies Act was proposed in the US, fueling a more sustainable future for aviation. Individual countries within Europe are also playing their part and introducing more ambitious national mandates. These national mandates or ambitions are expected to increase demand further compared to the European SAF mandate alone.

### Challenge 3. Price

The green premium is the additional cost of choosing for a sustainable option over an unsustainable one. Sustainable aviation fuel's green premium is then the additional cost of choosing SAF over fossil jet fuel, where the latter has a significantly longer carbon cycle. SAF's premium has reduced drastically since the first flight in 2009. But the remaining price gap could inhibit large-scale uptake of SAF.

### Solution.

Going beyond governmental incentives, customer programs, like SkyNRG's Fly on SAF solution for travel companies and airports, help co-fund the price gap over fossil jet fuel, allowing individuals to purchase SAF directly. SAF is more expensive than fossil jet fuel and therefore airlines will currently not buy SAF to completely replace its fossil jet fuel. When individuals and corporates step in to pay a part of this premium, to also reduce their own emissions from flying, SAF suddenly becomes much more attractive for the airlines. These solutions enable further uptake of SAF.



# REACH YOUR SUSTAINABILITY GOALS WITH SAF



SAF can be the way to reach your corporate climate targets. Airlines, corporates, OEM's, airports and travel companies – be it for business travel or freight – can all benefit from flying on SAF.

## **Airlines and OEM's**

The aviation industry is facing increasing pressure from governments, mandates, internationally recognized organizations such as IATA, and the public to transition to a more sustainable future. Net-zero targets in the industry are setting the deadline in 2050. To reach this goal, the aviation industry needs more than new technology and future innovations, it needs to start investing in sustainable solutions today.

## **How SAF can help you**

Sustainable aviation fuel provides a solution that can be implemented immediately to reduce emissions substantially, without modifying aircraft engines. SAF provides an in-sector solution and goes beyond reducing only carbon emissions. SAF tackles other polluting particles too, further reducing the environmental impact around airports.

Strong policy, corporate and individual SAF programs, and an increase in supply all help in reducing the price difference between fossil jet fuel and SAF. Cooperating with SkyNRG guarantees sustainability throughout the SAF supply chain; it also assures a knowledgeable SAF

partner, ready to facilitate the transition from fossil jet fuel to sustainable aviation fuel.

## **Airports and Travel Companies**

Travelers are growing more conscious of their carbon footprint day by day. This brings an increase in awareness from travelers about the negative environmental impact of flying. With travelers turning to eco-conscious choices, airports and travel companies that provide them these options set themselves apart.

## **How SAF can help you**

Providing SAF to your travelers can help mitigate concerns about their environmental footprint related to flying. By presenting your travelers with the opportunity to fly on sustainable aviation fuel during their booking process, they are given the chance to reduce their emissions directly. This way, your travelers now have the choice to go beyond offsets, empowering them to address their flight-related emissions in-sector. Airports and travel companies that give their travelers the agency to reduce their emissions through SAF, can benefit from this unique competitive advantage.

Solutions such as SkyNRG's Fly on SAF solution, provide a climate API that can be tailored to your branding and seamlessly integrated into your booking process. It's as quick and easy a process for airports and travel companies to implement into their existing services, as for their customers to purchase SAF.

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### **Corporates**

Corporates are going full steam ahead on sustainability. But, to achieve those ambitious net-zero targets, all emissions need to be addressed. Most corporates first focus on their Scope 1 emissions, those emitted directly, and Scope 2 emissions, emissions from purchased energy. For corporates that rely heavily on business travel or freight, these flight-related Scope 3 emissions can be sizeable. Options until now were limited, with many relying on carbon offsets to address them.

And while carbon offsets indirectly reduce a businesses' impact on the climate, it is still an out-of-sector solution that does not address these emissions directly.

### **How SAF can help you**

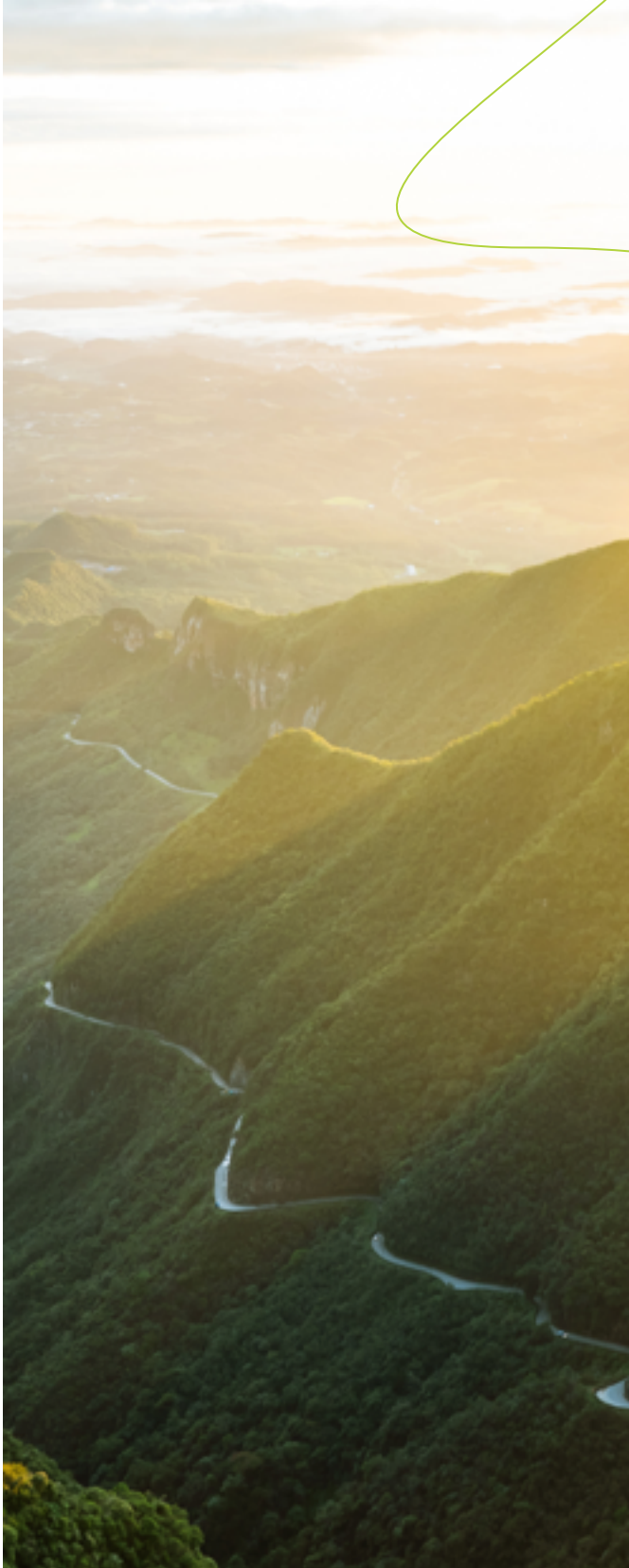
Sustainable aviation fuel provides corporates the opportunity to finally address their flight and freight-related emissions directly, in-sector. By making a commitment to flying on SAF through a corporate SAF program, such as SkyNRG's Board Now program, corporates take responsibility for their business travel and freight-related emissions.

Not only does joining a corporate SAF program help businesses get one step closer to achieving their net zero targets, but it helps the SAF market develop. On one hand, you help signal demand to investors and governments, validating the viability of developing future SAF production plants. On the other hand, SkyNRG's Board Now program focuses on more than just short-term SAF commitments, and is instead geared towards long-term commitments that help fund SAF production plants. Lastly, by helping to co-fund the green premium, corporates financially alleviate airlines, aiding in reaching mandated SAF targets. financially alleviate airlines, aiding in reaching mandated SAF targets.

Ultimately, flying on SAF shows a pioneering role in corporate sustainability.



# STRENGTH IN NUMBERS



SAF is not the only option to decarbonizing the aviation industry, but it is a very important piece of the puzzle. Flying less, further developing electric aircraft, investing in the infrastructure for international high-speed rails, and capping fossil fuels are all still needed to reduce aviation's carbon emissions.

What sustainable aviation fuel does provide, is a commercially proven, sustainable “drop-in” alternative to fossil jet fuel, that requires no modifications to infrastructure or aircraft engines, making it ready to use today. SAF supply needs to be scaled up significantly to meet growing demand and can only be done with the appropriate support from all parties. From airlines, to travel companies, to corporates, we need all hands on deck to effectively transition from fossil jet fuel to sustainable aviation fuel.

It's time to make SAF the new global standard, to keep our planet as we know it today.

About

# SKY NRG



Since 2009, SkyNRG has been building up SAF capacity and production for the industry to meet its 2050 net zero commitment.

SkyNRG has supplied SAF to over 40 airlines across the world and is now developing dedicated SAF production facilities to support the transition from fossil jet fuel to sustainable aviation fuel. SkyNRG does not compromise when it comes to sustainability; we are a globally recognized Certified B Corp™, our operations are certified by the Roundtable on Sustainable Biomaterials (RSB), and we are advised by an independent Sustainability Board, as well as a worldwide NGO network to ensure we make the right sustainability decisions across all of our operations. Learn more at [www.skynrg.com](http://www.skynrg.com).