Advanced Sustainable BIOfuels for Aviation

Deliverable D3.4:

RED II final status report

Consortium:

Acronym	Legal entity	Role
RE-CORD	CONSORZIO PER LA RICERCA E LA DIMOSTRAZIONE SULLE ENERGIE RINNOVABILI	CO
ENI	ENI S.p.A.	BEN
SKYNRG	SKYENERGY BV	BEN
CENER	FUNDACION CENER-CIEMAT	BEN
ETA	ETA – Energia, Trasporti, Agricoltura Srl	BEN
CCE	CAMELINA COMPANY ESPANA S.L.	BEN
JRC	JOINT RESEARCH CENTRE – EUROPEAN COMMISSION	BEN

CO…Coordinator, BEN…Beneficiary

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 789562.

General Information

Call identifier:	H2020-LCE-2017-RES-IA
GA Number:	789562
Topic:	LCE-20-2016-2017
Start date of project:	01/05/2018
Duration:	5 years (30/06/2023)
Work Package:	WP3 – Downstream logistics and USE
Type:	Deliverable
Number:	D3.4
Title:	RED II final status report
Due Date:	30/04/2022
Submission date:	06/05/2022
Reference Period:	30/04/2020 – 30/04/2022
Prepared by:	SkyNRG (Lead), CENER, RE-CORD
Responsible Person:	Oskar Meijerink
Dissemination Level:	Public

INTERNAL MONITORING & REVISION TABLE					
REV.	**DATE**	**DESCRIPTION**	**PAGES**	**CHECKED**	**APPROVED**
1	**05-03-2022**	**Draft**	**3**	**SKY**	
Draft	**27-04-2022**	**Draft**	**5**		
Final	**06-05-2022**	**Final**	**20**	**SKY**	

Document Type		
PRO	Technical/economic progress report (internal work package reports indicating work status)	
DEL	Technical reports identified as deliverables in the Description of Work	**X**
MoM	Minutes of Meeting	
MAN	Procedures and user manuals	
WOR	Working document, issued as preparatory documents to a Technical report	
INF	Information and Notes	

Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	
CON	Confidential, only for members of the Consortium	

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1 Introduction

Aviation accounts for a significant (>2%) contribution to global manmade emissions. Even though the sector has been hit hard over the past two years by the COVID-19 pandamic, we see rapid recovery in the sector and prospects of growth after 2024. This comes with significant pressure of increased emissions and challenges to decarbonize the aviation industry.

In 2020 we have covered the policy framework in Deliverable 3.3 as part of the Bio4A work. At the time the work focused on the transposition of the RED I as well as outlook to RED II implementation. This deliverable 3.4 focuses on the current status of policy implementation relevant to Sustainable Aviation Fuel uptake with a main focus on the newly suggested blending obligation as part of the Fit for 55 package.

This deliverable first reviews the status of policy development in the period 2020 – 2022. We will provide background to what has happened and concluding remarks on the impact of the Bio4A project set-up. As part of the Bio4A project, we have developed a market outlook which provides insights in which technologies are expected to fulfil the mandates, the market outlook from July 2021 will be included as part of this deliverable and we will reflect on the development since. Some concluding remarks will be provided on the necessary development of the mandates going forward.

2 SAF Policy framework

In the previous deliverable 3.3, published in 2020 we made a number of recommendations on policy development, specifically focused on developing strong policy/mandates for SAF uptake in the EU.

- *It is favoured that the mandate is announced some years (3-5) before it will be installed. This gives companies time to develop new production capacity and secure investments.*
- *Once this mandate is installed, investors need a policy framework of at least 10-15 years before they will have the confidence to step in*
- *Governments and the EU should provide (financial) support to develop the technology and feedstock portfolio to produce SAF. Currently, only one SAF technology pathway can be used on a commercial scale (this pathway is based on the Hydroprocessed Esters and Fatty Acids (HEFA) technology). As this technology cannot process feedstocks on the Annex IX – A list, there is a mismatch between push for advanced fuels and technology readiness of the feedstock technology combinations to produce the fuels. The technologies used to produce SAF need to be diversified in order to broaden the feedstock base. It should be prevented that more pressure on the waste oil market is created through the deployment of only HEFA facilities. It can also be seen as an opportunity to initiate sustainable waste, residue and cover cropping projects, which could improve environmental and social conditions.*
- *Last but not least, in order to ensure the functioning of an EU wide blend mandate, it is important to impose a cost of non-compliance which is higher than the cost of compliance. Otherwise, the obligated party of the blend-mandate will simply refuse to produce or buy renewable fuels for the aviation sector.*

In this section we will review what has happened since, and in the final concluding remarks we will reflect on those previous recommendation and come up with updated suggestions based on the current status of policy development.

2.1 Update on policy status 2020 - 2022

Since the last RED II status report published in 2020, the aviation industry has seen a very turbulent period of total shut-down and slow recovery due to the COVID-19 pandemic. Since early 2022 recovery has started to show significant progress especially in the US and EU, aviation quickly builds to pre-covid size again. Even though the world of aviation faces new stability challenges with the war in Ukraine there is consensus that aviation builds back to pre-covid numbers. Over the course of this downturn, momentum on SAF policy has seen a very different development and has picked up significantly.

With the presentation of the Fit for 55 package, the EU Commission in July 2021 proposed various pieces of legislation that directly or indirectly impact SAFs:

- ReFuelEU
- RED II revision
- Energy Taxation Directive
- EU ETS

In this section we will highlight the most significant elements from each of these bodies of legislation.

2.1.1 ReFuelEU

ReFuelEU is a proposed piece of legislation that would develop an EU wide blending mandate for Sustainable Aviation Fuels. This regulation (ReFuelEU) proposes a clear trajectory for the introduction of bio-based SAFs and synthetic aviation fuels from 2025 to 2050. With that, the EU is the first jurisdiction to provide long term investment certainty for SAFs, one of the requirements consistently demanded and suggested by the industry. We will further detail the blending requirement percentages and impact on the SAF industry in the market outlook presented in chapter 4.

In parallel to the blending mandate, ReFuelEU also proposes anti-tankering measures to avoid the competitive distortion that could result from increased jet fuel prices over time. With SAF being a more expensive alternative to fossil jet fuel, the mandate could have an effect where airlines flying into the EU bring more fossil kerosene than necessary, potentially worsening the emissions instead of improving them. This measure should avoid this and make sure EU airlines are protected against overseas competition effects.

The blending requirement is imposed on fuel suppliers. These will have to physically supply all Union airports with the defined blend of SAF, in a similar fashion as we have seen in the RED II transposition for road transport. During the early years of the mandate, this could create very inefficient supply-chains as blending needs to take place throughout all airports and with all supply chains, while facing a situation where SAF volume is still scarce. Therefore, a transitional period applies until 2030 in which suppliers can take an average of all SAF supplied to EU airports, and work on a so-called mass balancing basis.

There are non-compliance penalties suggested that will apply to the fuel suppliers and airlines:

- Fuel suppliers will have a cost of non-compliance of 2x the difference between SAF and fossil kerosene – it's still unclear how the cost of SAF will be determined when its not a commoditized market yet, even though this administrative issue might solve itself with a growing market.
- Aircraft operators face a penalty of 2x the price of fossil jet fuel – even though this might not be enough to overcome the price difference, this is covered through the cost of non-compliance on the fuel supplier. The penalty on airlines is mostly created to avoid the tankering problem as discussed above.

As of May 2022, discussions in the EU Parliament are in full force around the proposed legislative text under the ReFuelEU and several amendments are being proposed. Among the most debated topics is the height of the blending percentages and whether caps should be introduced for the blending of Annex IX Part B feedstocks to avoid the diversion of feedstock from the road sector to aviation.

2.1.2 RED II

As part of Fit for 55, a revision to the RED II was also proposed. In general, the share of renewable energy by weight was increased to 40% from 32% in 2030 across all end-use sectors. This target can be fulfilled through all sectors as long as the required sub-targets are met, discussed below. The need for the so-called aviation opt-in as part of the RED I and RED II legislation, discussed in D3.3 and recently in D5.4 became less apparent and needed for the long term due to the inclusion of the ReFuelEU package. Up to 2025 it will however play a significant role for the placement and uptake of SAF. Also, due to the increased overall target, there might be a need for the opt-in system to push for more SAF in the aviation sector, to avoid distortion effects due to the need to fulfil the total target with only road transport fuels.

For transport specifically, the RED II changed the renewable energy target from 14% (with various multipliers) to a greenhouse gas intensity target of -13% by 2030 compared to the fossil fuel baseline. This means that double counting for advanced fuels is removed as per the previous deliverable. Furthermore, advanced fuels will be credited on the basis of their GHG intensity. A multiplier for maritime and aviation fuels will remain to exists, and is set on 1.2x.

Sub-targets will be in place for:

- Advanced biofuels with 2.2% of final energy content in 2030
- Renewable fuels of non-biological origin (i.e., hydrogen, e-fuels) 2.6% of final energy content in 2030

This means that fuel suppliers need to ensure compliance with the overall GHG intensity target as well as the sub-targets. These sub-targets will trickle down into national legislation, either via

older provisions made via the Fuel Quality Directive or novel policy mechanisms based on GHG credits as proposed in Germany.

Aviation and maritime will be included into the scope of the RED. This means that the 5% blending mandate by 2030 under ReFuelEU will contribute to the overall RED II targets. Renewable energy will be counted towards the targets for the sector in which it is consumed, meaning that renewable power used to produce e-fuels is counted towards the transport targets and will therewith not fulfil the targets set to decarbonize the power sector itself, all this to avoid double counting and stimulate the development of more renewable energy.

Furthermore, a requirement is introduced that 50% of the hydrogen use in industry should be green hydrogen by 2030. This target can help develop the necessary infrastructure for hydrogen-based renewable fuels in aviation, as green hydrogen is a prerequisite and the most important feedstock for such power-based fuels.

Finally, a 70% GHG threshold for recycled carbon fuels was proposed. Further delegated acts on a methodology for the determination of GHG impacts for RCFs and RFNBOs is still expected in 2022, as well as a delegated act determining the renewability of RFNBOs. These delegated acts will have a large effect on the realistic and rapid realisation of the targets on the one hand and true long-term sustainability on the other.

All in all the RED II is sharpened and increased pressure on the entire transport industry. With limited availability of feedstock there is a strong rationale for technology diversification as well as further research into crop-based systems on degraded lands. The Bio4A project is in this light still very relevant. Inclusion of Camelina's cover-cropping system under RED II's Annex IX part A feedstocks could support the further uptake of SAF and other renewable fuels.

2.1.3 Energy Taxation Directive:

To better align taxes with the EU's climate targets, the EU aims to increase taxes for more polluting products. The Energy Taxation Directive stipulates a minimum increase of the kerosene tax from €0/GJ in 2023 to €10.75/GJ in 2033 by one-tenth per year. SAF is initially exempt from taxation until 2033, after which a relatively low tax of €0.15/GJ applies. This could play an increasingly important role to support SAF uptake.

2.1.4 EU ETS:

The EU aims to strengthen the EU ETS system by including more sectors, including aviation to a larger extend. This change obliges airlines to buy ETS credits for all the fossil jet fuel they uplift from 2027 onwards. Airlines do not have to surrender emission allowances for the portion of jet fuel that is SAF. At ETS prices as of May 2022 (€81/tCO2) that could save airlines ~€250/t SAF used. The combined taxation and EU ETS have a further pushing effect on the use of SAF beyond the mandated obligations that exist in the market.

2.2 Market assessment on ReFuelEU

As part of this deliverable and to inform the wider SAF community on policy development, SkyNRG has created a market outlook for Sustainable Aviation Fuel. This market outlook has the aim to translate the ReFuelEU targets into a model determining the actual SAF uptake per sub-target, this of the technologies feasible to fulfil the targets. Based on this exercise there are a number of clear recommendations that are still needed in addition to the ReFuelEU initiative and relevant to the Bio4A work:

- **Increased support for new conversion pathways**

To convert sustainable feedstocks beyond the existing waste oils and fats, feedstock diversification and pioneer facilities are likely to be associated with higher costs and risks. Industry and policy makers will need to work together to get adequate de-risking mechanisms in place to demonstrate these new technologies at scale. A flexible SAF strategy may prove useful in dealing with unexpected setbacks in hydrogen, capacity development or challenges in sustainable feedstock mobilization

- **Large-scale mobilization of sustainable feedstocks**

Given the feedstock volumes required, efficient supply chains need to be developed to unlock new sustainable, but currently underutilized, feedstocks within sustainable boundaries

- **Rapid renewable electricity deployment**

Renewable electricity is needed in vast amounts to decarbonize existing markets as well as to produce PtL SAF in a sustainable way. The scale-up of Power-to-Liquids SAF from 2030 onwards will cause an additional demand for renewable electricity and can incentivize novel supply. It is crucial that power is not diverted from other end-use sectors and that governments work towards increasing capacity targets for renewable energy in line with the additional demand for PtL SAF production. Moreover, investment in green hydrogen infrastructure is key to drive down the cost of hydrogen and attract investments into Power-to-Liquids.

3 Conclusions

Over the course of the Bio4A project, we have closely followed the policy development across both the Renewable Energy Directive (I and II) and the Fit for 55 packages. Looking back at the progress report D3.3. We can conclude that the recommendations restated in the introduction of this report are mostly met in the 2 years following.

Even though the impact of the Fit for 55 package will still depend on the way the final legislative text will come out of the Trilogue discussions. What is certain is that due to ReFuelEU, SAFs have received significant long term investment certainty due to blending percentages that steadily increase until 2050, adhering to the recommendations sketched in D3.3. A significant cost of non-compliance is also proposed which will follow the market prices, making sure there is true push for new capacity development.

In the market outlook we shared a view on how we expect the RED II and ReFuelEU packages will translate into actual SAF volume and development of technology. We expect HEFA to play a significant role, especially up to 2030 and as a baseload going forward. Future technologies able to convert cellulosic biomass (FT, AtJ) and CO_2 through the RFNBO pathway will cover large part of the growth in this industry afterwards.

We also see risks, with regards to the HEFA pathway, which is central in the Bio4A project. One potential risk for the HEFA route could be the introduction of a cap on Annex IX Part B feedstocks, limiting the amount of UCO and tallow feedstock that could be used for SAF. Even though the reasons for such a cap are understandable, avoiding distortion of the road transport markets. If a cap were introduced in the end, focus should be on finding a sizeable portion of Annex IX A feedstocks that could be used in the HEFA route. Alternatively, a potential outcome for the HEFA route could be the development of oil crops on abandoned and marginal lands that produce oily feedstocks, or oil-rich intermediate crops. It's of vital importance to avoid sustainability risks when dealing with crop-based systems and further research by the partners within Bio4A is needed to ensure this. On the medium term this would require inclusion of these feedstocks on the eligibility list of Annex IX Part A, which is an ongoing process, pending reviews.

As part of the Bio4A project, we will continue to include the learnings from the various policy activities from all partners into the market scaling strategy – of which the deliverable is due at the end of the project.

4 Appendix A – A market outlook for Sustainable Aviation Fuels.

SkyNRG

Summary Report

A Market Outlook on Sustainable Aviation Fuel

SkyNRG's Perspective on the ReFuelEU Aviation initiative Proposal

July 2021

FOREWORD

Maarten van Dijk
Managing Director
SkyNRG

Sustainable aviation fuel is essential to decarbonize the aviation industry.

At SkyNRG we have been pioneering voluntary markets for Sustainable Aviation Fuel for more than a decade, creating awareness and momentum among all relevant stakeholders. But to really scale SAF production capacity and market volumes, we have always realized the need for strong, stable, long-term policy. With the announcement of the ReFuelEU Aviation initiative, we see the first serious market-enabling framework emerging.

To understand the impact of this policy on the market, and on our own growth strategy as a consequence, we decided to take stock and analyze how the EU SAF blending mandate would affect the future of SAF. We have made an EU SAF supply/demand forecast scenario, building on market data, peer-reviewed literature, think-tank analyses, industry scenarios (and a bit of our own knowledge as well of course...).

Although we initially made this analysis for internal purposes, we decided to share our insights to enable other organizations to learn and potentially direct resources to growing the SAF industry. We know that the only way to scale up SAF successfully is by involving all stakeholders. And the only way to get people involved is by getting them informed.

And you can play your part too! We invite all stakeholders to engage in accelerating SAF production and uptake. Your ideas, considerations, insights and resources are valuable. The SAF industry needs them, so bring it on! In any case, we will monitor all SAF developments and update this analysis every 6 to 12 months. So stay tuned!

EXECUTIVE SUMMARY

On July 14th, 2021, the European Commission proposed a long-awaited blending mandate on sustainable aviation fuel (SAF). This marks a significant step towards reducing carbon emissions in the aviation sector.

- SkyNRG has assessed the following: the feasibility of meeting the targeted SAF volumes towards 2030, the requirements for capacity scale-up in the long term, and the various scenarios impacting the realization of this mandate.
- We conclude that up to 2030, supply can match demand, provided that currently announced production capacity materializes and either additional production capacity is developed or SAF is imported from outside the EU.
- To meet the targeted volumes in the short term, there will be a heavy reliance on waste oils as feedstock and both the HEFA and co-processing technology pathways.
- After 2030, technological developments are required to fulfill the mandated volumes up to 2050. Rapid deployment of new SAF technologies (e.g., Fischer-Tropsch, Alcohol to Jet, Power-to-Liquid), cellulosic feedstock mobilization, deployment of green hydrogen production capacity, and related renewable electricity scale-up are all needed to meet demand.
- It is unlikely Europe will be able to meet the targeted 2050 volumes without structural imports of SAF or intermediate products needed for EU production.
- There is a need for additional support structures to complement this mandate to de-risk new technologies, enable more ambitious voluntary commitments, and incentivize fuels with higher sustainability.
- All stakeholders need to play their part to engage and address the challenges ahead: governments, investors, industry, and individual and corporate travelers.
- *A Market Outlook on SAF - Summary Report* is a condensed version of a larger SAF supply/demand analysis performed by SkyNRG. The full analysis, *A Market Outlook on SAF - Background Analysis* is available on our website.

EU takes global leadership on climate action in aviation with SAF mandate

On July 14th, 2021, the European Commission (EC) proposed an EU-wide blending mandate on sustainable aviation fuel (SAF), as well as uplifting obligations for airlines.

The proposal was part of an ambitious set of legislative proposals – the "Fit for 55" package – and intended to reach an EU-wide GHG reduction target of 55% by 2030. The proposal includes a 2% blending obligation for SAF by 2025, increasing to 5% in 2030, 32% by 2040, and 63% in 2050, with a specific sub-mandate for Power-to-Liquid fuels. This sub-mandate, as a part of the broader SAF mandate, starts with 0.7% in 2030, 8% by 2040, and increases to 28% by 2050.

Preceding this proposal, several European countries already implemented or proposed a national blending mandate. Some of these national mandates are more ambitious than the recently proposed EU-wide mandate. If member states choose to keep these mandates, they could form a national mandate 'top-up' on the EU-wide mandated volumes. To meet both the EU-wide mandate and the additional volumes from national mandates, this would require 3.5 million metric tons (Mt) of SAF in 2030 and approximately 30 Mt in 2050[1].

The proposed EU-wide SAF mandate is a serious step towards accelerating the market for SAF and provides the necessary foundations for investment security in SAF. The EU is sending out a clear signal that it is taking a leading role on climate action in the aviation sector.

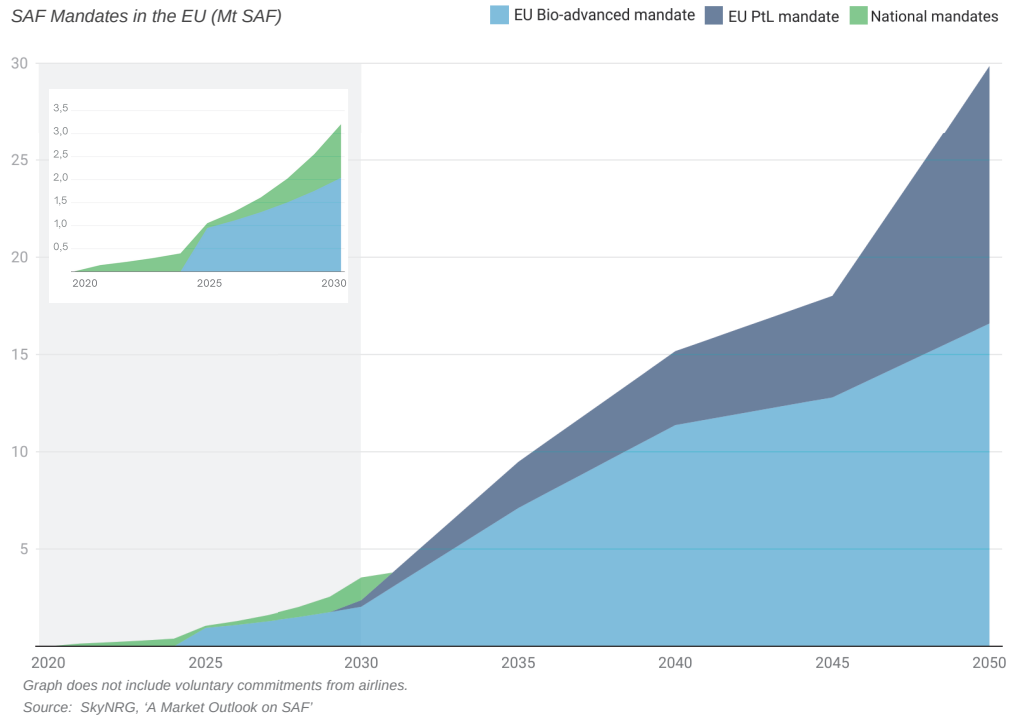


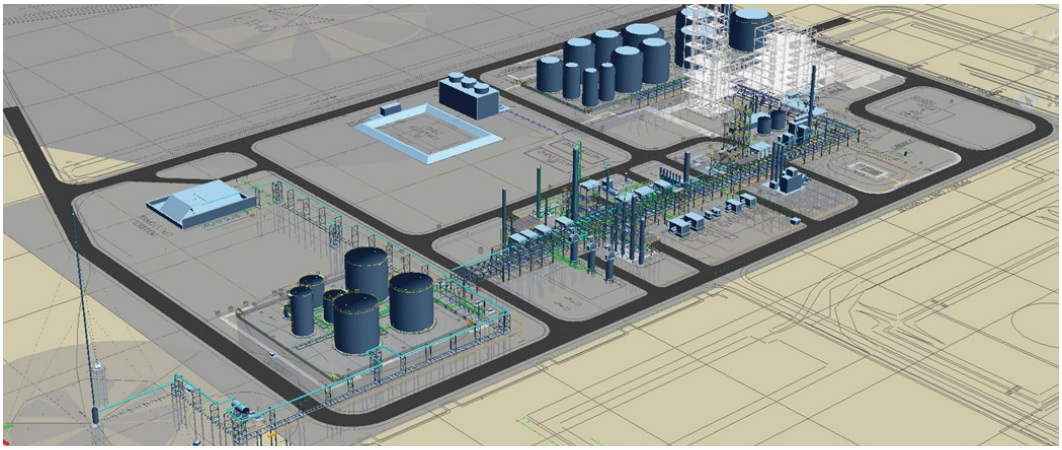
Figure 1. Mandated SAF demand in the EU

1. Assuming a post-Covid return of EU-27 jet fuel demand by 2024 to 2019 volumes and a stable demand of 47.4 Mt afterwards. Source: Eurostat

EU SAF blending mandate: is it feasible?

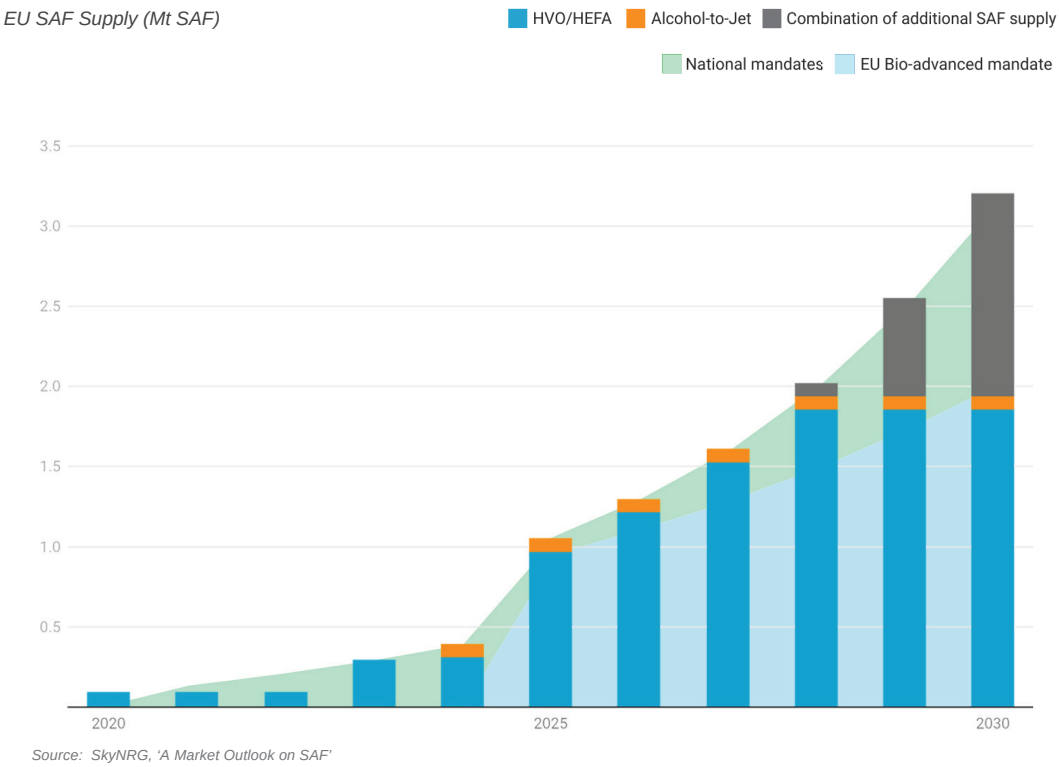
Global SAF production in 2020 accounted for <0.1% of the total jet fuel production in 2020, corresponding with approximately 0.1 million tons (Mt) of SAF. This raises questions about the feasibility of achieving the proposed blending targets and the impact of a mandate on renewable fuel market dynamics. As a global supplier and a leader in SAF, SkyNRG has assessed the feasibility of meeting the required SAF volumes towards 2030 and explored the requirements for capacity scale-up in the long term. With *A Market Outlook on SAF - Summary Report*, we present the results of this assessment and our perspective on these questions.

Up to 2030, supply can match demand, provided that plant announcements and capacity switches materialize



WWe have investigated short-term supply possibilities based on 75+ entries of existing renewable fuel capacity and global capacity announcements. We assessed each entry on its technical ability to produce SAF adhering to RED-II sustainability criteria, its theoretical maximum share of SAF in product output, and the likelihood of the announcement to materialize on time. We have also accounted for competition in the demand of sustainable feedstocks and fuels in other sectors, such as road transport. The difference between announced capacity and the mandated volume was determined. An assessment was made on the potential for RED-compliant imports from outside the EU and the requirement for additional announcements or 'capacity switches' from road fuel capacity to SAF until 2030. In the ReFuelEU Aviation Initiative Impact Assessment, a limited (3.2%) shift of waste lipid feedstocks used for fuel production in the road transport sector to aviation is foreseen. For more details on the methodology and assumptions, please refer to A Market Outlook on SAF – Background Analysis on the SkyNRG website.

Provided that all currently announced renewable fuel capacity will materialize, we consider it realistic that up until 2027, the mandated amount of SAF in the EU can be fulfilled with European-based SAF production. By 2030, however, there is a gap between announced capacity and the mandated volumes. This gap would be fulfilled with yet-to-be-announced SAF capacity, 'capacity switches' from announced renewable diesel production or by importing SAF from outside of the EU ("Combination of additional SAF supply" in Figure 2) and is projected to be around 1.2 Mt by 2030.



Source: SkyNRG, 'A Market Outlook on SAF'

Figure 2. EU SAF Supply until 2030

The majority of the announced plants until 2027 use HEFA technology and, to a lesser extent, co-processing. This makes it the dominant SAF production pathway up to 2030. Contrastingly, there are currently no commercial or demo scale facilities operational for SAF production using either the Alcohol-to-Jet (AtJ), Fischer-Tropsch (FT) or Power-to-Liquids (PtL) technology. Demonstration plants are, however, expected to come online in the coming years. These will be important proof points for further deployment of these technologies and further ramp-up of SAF production.

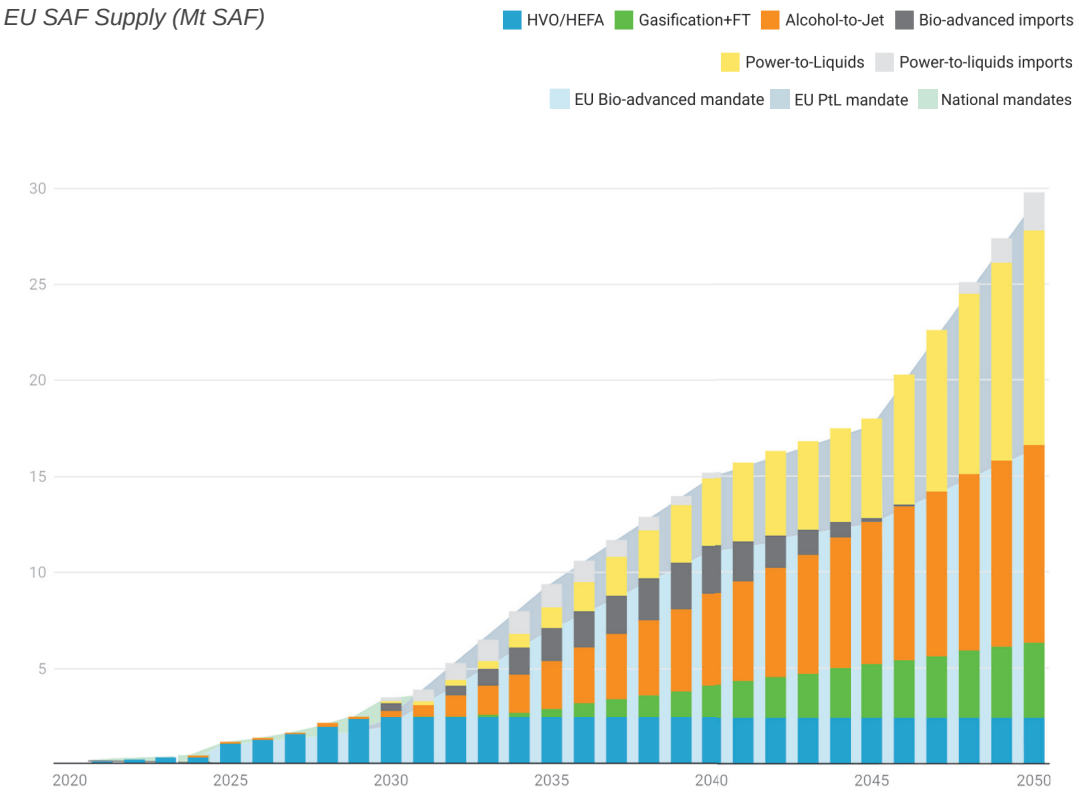
It is important to note that both the HEFA and the co-processing production pathways make use of waste oils and fats as feedstock. Due to a tight European market for these feedstocks[2], reliance on this route until 2030 implies a substantial increase of waste oils and fats imports, which carries sustainability risks[3]. This makes Europe heavily dependent on non-European countries in reaching the mandated volumes in the short term.

Rapid deployment of new technologies and feedstock mobilization required to supply mandated volumes post-2030

While 2030 targets set out by the proposed mandate seem feasible, post-2030 targets present a challenge. A significant step-change in growth rate can be observed after 2030, with mandated amounts of SAF quadrupling within the EU between 2030 and 2040. To assess the feasibility of meeting the mandated volumes post-2030, we built upon the analysis performed by the Energy Transition Coalition under the Clean Skies for Tomorrow Initiative[4]. Based on in-house experience and industry expert interviews, we adjusted certain assumptions related to feedstock availability, plant output and product slates. From here, we developed a projection that is more aligned with our assumptions

2. Greenea, 2021 (link)
3. Transport & Environment, 2021 (link)
4. ETC, 2020 (link)

on a realistic growth scenario, rather than maximized EU production potential. For detailed assumptions, please refer to *A Market Outlook on SAF - Background Analysis* on the SkyNRG website.



Source: SkyNRG, 'A Market Outlook on SAF' (analysis adapted from ETC, 'Guidelines for a Sustainable Aviation Fuel Blending Mandate in Europe', 2021)

Figure 3. EU SAF Supply until 2050

In total, approximately 300 SAF plants with an average SAF production capacity of around 100,000 tonnes per year will be needed by 2050 to fulfill the mandated demand. Only 15 plants are currently proposed and expected to be operational by 2027 based on announcements up to June 2021. In order to reach these 300 SAF plants, over 10 plants need to be built each year between 2027 and 2050.

In such a rapid EU scale-up scenario, we recognize that there will be a need for importing SAF or its required intermediates. Especially in the 2030-2040 period imports seem likely, due to the rapid year-on-year growth of the SAF mandate. Imports could materialize in the form of bio-advanced SAF and PtL SAF, or for the green H_2 and cellulosic ethanol intermediates as in some cases, it will be more cost-efficient to source feedstocks from outside the EU. Furthermore, for PtL SAF, it is not considered likely that large shares of the EU renewable power supply will be allocated to synthetic aviation fuel production. The currently modeled PtL SAF production would consume about 10% of the expected EU renewable power supply by 2050[5].

Due to constraints in the availability of renewable power for PtL SAF, most SAF produced in Europe is expected to come from bio-advanced pathways. SAF available from waste oils and fats is similarly restricted. This means the major share of bio-advanced SAF will have to come from cellulosic waste and residue streams in the long run, thus using conversion pathways such as Gasification combined with Fischer-Tropsch and Alcohol-to-Jet. Evidence suggests that the cellulosic feedstock base, made up of MSW, forestry residues and agricul-

5. Based on EU's Clean Planet for All 1.5 TECH scenario which assumes large-scale uptake of hydrogen and synthetic fuels across the economy, where total gross electricity generation is 6,800 TWh by 2050

tural residues, is significantly larger, although more research is needed to assess which share can be used sustainably. The high reliance on Bio-advanced pathways contrasts with other studies that have investigated SAF supply until 2050, which foresee a more dominant role for PtL SAF[6].

The size of the challenge depends on competing demand, technology development, feedstock supply, and sector growth

Four key drivers impact the realization of the targeted volumes and associated capacity scale-up, positively or negatively:

- **Competing demand for feedstocks and production capacity:** Rapid electrification of road transport may increase available biomass and production capacity for SAF production. Alternatively, new or increased biofuel/biomass demand from other sectors (road, marine, chemicals) may lead to higher biomass and production capacity pressure[7]. Similarly, SAF demand-side stimulation in other regions (e.g., the US) will increase demand for biomass and SAF volumes.

- **Aviation sector growth**: The current analysis assumes jet fuel demand will recover to pre-COVID levels in 2024 and remains constant after that. More pessimistic or optimistic growth assumptions impact the absolute mandated SAF volumes. In addition, rapid progress in the development of alternative aircraft, e.g. based on hydrogen or electric propulsion, and improved efficiency can curb jet fuel demand and reduce the SAF volumes needed to fulfill the mandate.

- **Technology development**: Failure to widely commercialize and deploy technologies able to convert cellulosic biomass or CO_2 to SAF will make it very challenging to reach mandated targets. Alternatively, technological breakthroughs in other areas, such as Power-to-Liquid technologies, may increase the scale-up rate of SAF capacity.

- **Feedstock availability and mobilization**: The stringency of sustainability constraints on feedstocks impact the available feedstock base. The scale-up rate of Bio-advanced SAF capacity also largely depends on the pace of mobilization of cellulosic feedstocks. Large-scale imports of hydrogen could impact the prevalence of PtL SAF in Europe.

We need the right set of enablers to achieve this ambition.

In our opinion, the ReFuel EU Aviation initiative targets are ambitious however achievable, with the right set of enablers in place:

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6. Studies which foresee a more dominant role for PtL SAF include: ETC (link), NLR - Destination 2050 (link), ICCT (link)
7. Current analysis is aligned with the European Commission's RED-II scenarios on electrification rate of road transport. Current analysis assumes a 14% renewable energy target for road transport and does not yet include suggested increase to a 13% reduction in GHG intensity (link).

- **Increased support for new conversion pathways** to convert sustainable feedstocks beyond just waste oils and fats, such as Alcohol-to-Jet, Fischer-Tropsch or Power-to-Liquids. Pioneer facilities are likely to be associated with higher costs and risks. Industry and policy makers will need to work together to get adequate de-risking mechanisms in place to demonstrate these new technologies at scale. A flexible SAF strategy may prove useful in dealing with unexpected setbacks in hydrogen capacity development or challenges in sustainable biomass mobilization

- **Large-scale mobilization of cellulosic feedstocks** through new supply chains. Given the feedstock volumes required, efficient supply chains need to be developed to unlock new sustainable, but currently underutilized, feedstocks within sustainable boundaries

- **Rapid renewable electricity deployment** is needed to produce Power-to-Liquids SAF in a sustainable way. The scale-up of Power-to-Liquids SAF from 2030 onwards will cause an additional demand for renewable electricity and can incentivize novel supply. It is crucial that power is not diverted from other end-use sectors and that governments work towards increasing capacity targets for renewable energy in line with the additional demand for PtL SAF production. Moreover, investment in green hydrogen infrastructure is key to drive down the cost of hydrogen and attract investments into Power-to-Liquids.

- **A solid, science-based sustainability framework** is key to guide this transition. This framework should provide long-term stability to establish a solid investment climate, while leaving room for improvement as our thinking on sustainable practices evolves. We welcome systems steering towards sustainable outcomes (e.g., greenhouse gas emission thresholds), as they provide clarity and enable policy flexibility. Even though the ReFuelEU Aviation Initiative relies on the RED II sustainability framework, we believe the Regulation provides an opportunity to consider the specific context of the aviation sector and promote fuels that are truly renewable and sustainable.

- **Corporate climate commitments** are important streams of revenue to bring new SAF capacity online. Corporates can take their emission reduction goals in their own hands by co-financing SAF volumes with airlines and accelerate the uptake of SAF. In this way, they can even finance SAF beyond what is mandated by policies.

We invite all stakeholders to engage in accelerating SAF production and uptake

We conducted this analysis to inform our business strategy. We chose to share these insights to enable other organizations to learn and potentially direct resources into growing the SAF industry. Our intention is to keep monitoring developments and update this analysis to provide our view on the state of the EU SAF market. We will issue an updated Market Outlook on SAF every six months. We would like to invite all stakeholders, inside and outside the SAF supply chain, to provide us with your viewpoint and explore how to join forces to scale the SAF industry and decarbonize aviation.

ABOUT SkyNRG

SkyNRG is the pioneer and a global leader in sustainable aviation fuel with the industry's most extensive dedicated sustainable aviation fuel team.

SkyNRG scales up SAF demand and supply globally. Having supplied over 30 airlines on almost all continents, it is SkyNRG's mission to make SAF the new global standard, driven by sustainable practices throughout the supply chain. To ensure SkyNRG makes the right decisions regarding the sustainability of its operations, projects and products, SkyNRG is structurally advised by an independent Sustainability Board, which includes representatives from WWF International, the European Climate Foundation, Solidaridad Network and the University of Groningen.

Also, SkyNRG's operations are certified by the Roundtable on Sustainable Biomaterials (RSB), the highest possible certification standard for sustainable fuels.

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