GRANT AGREEMENT EASA.2015.FC21

Sustainable Aviation Fuel ‘Monitoring System’

An Agency of the European Union

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SUMMARY

Background and objective

This study has been performed under the Framework Contract EASA.2015.FC21: *Support on technical issues associated with Aviation Emissions*. In particular, it covers the implementation of the fifth Specific Contract (SC05) Task 3 on Sustainable Aviation Fuels.

The objective of this scoping study was to identify and recommend performance indicators (PI) related to the use of Sustainable Aviation Fuels (SAF) in Europe, as well as the associated aviation CO_2 emissions reductions achieved. Based on the identified PI, a proposal for a robust monitoring process was considered with the aim to report on progress towards European aviation & environment goals though future editions of the EASA European Aviation Environmental Report (EAER) and a possible fuel module in the EASA Environmental Portal.

Study process

The study has followed the following steps:

1) Identification of possible performance indicators by reviewing the current “state of the art” SAF indicators and consultation with key stakeholders.

2) Identification of regulatory reporting requirements, and other possible sources of datasets and information streams in the European context, with the potential to cover the data needs of the proposed performance indicators.

3) Examination of sustainability requirements applicable to SAF, and potential savings in greenhouse gas (GHG) emissions compared to fossil-based fuels.

4) Review of SAF use today and future expectations for SAF use within Europe.

5) Definition of a future monitoring and reporting process on SAF use in Europe and related recommendations to implement it.

Key industry stakeholders and individual experts have been consulted during the different steps of the study and have contributed to several peer-reviews during the drafting of this report.

Proposed Performance Indicators

From an analysis of data needed, and feedback from key stakeholders, the following Performance Indicators (PIs) are proposed:

SAF supply PIs:

- **Total SAF supply in the European Economic Area (EEA) (Mtoe)**
- **Share of SAF in gross final consumption of aviation fuels use – percentage (%)**

  - **SAF supply per EEA State (Mtoe)**
  - **SAF used by EEA operators and SAF used by non-EEA operators**

CO_2 emissions savings PIs:

  - **Greenhouse gases emissions savings from SAF use (supply) in EEA (t CO_2eq)**

The following additional PIs are identified as desirable and feasible, in case data are available:

- ✓ **Types of feedstock used**
- ✓ **Types of conversion technologies used (ASTM / Def Stan pathway)**
- ✓ **Percentage of SAFs supplied per type of technology (ASTM / Def Stan pathway)**

Key findings on current and future data sources

This study has concluded that **the existing European regulatory reporting mechanisms and data collection from Member States and industry operators, does not generate sufficient data streams to feed the identified PIs**.

The Fuel Quality Directive (FQD), and its implementing Directive 2015/652/EU, could be considered a good source of data for fuels and biofuels supplied in Europe and associated upstream GHG emissions savings in the short-term, but to be used as a SAF data stream source, a future change of scope to the FQD would be needed as for now aviation fuels (sustainable or not) are not part of its scope.

The information reported today by States under FQD has not yet been incorporated into centralized European databases. Nevertheless, Member States have established national databases which collect the required information and could easily include SAF supply if required.

The revised Renewable Energy Directive (RED II) establishes the development of a future Union Database that will collate all renewable energy information at a national level, and so this database will be an important means to support SAF use monitoring in Europe by EASA. The Union Database currently under development, may be the most robust data source once up and running in the medium term.

Aircraft operators report SAF use under the EU ETS, nevertheless, **EU ETS reporting has some limitations (indicated in Section 9.1.3.5, ETS reporting) which makes such data stream not sufficiently robust** to cover the identified SAF information needs.

Three circumstances generate information gaps or mismatches of information in the ETS reporting with respect to the total SAF supply data, and will do in future CORSIA reporting:

1) Non-European operators can report SAF use which has been supplied outside Europe.
2) Non-European operators can report abroad, SAF supplied in Europe.
3) European operators could not report under ETS/CORSIA SAF supplied in Europe.

Nevertheless, the above indicated data sources (FQD and Union Database) could be complemented by SAF use data reported by operators under the EU ETS and ICAO CORSIA.

SAF monitoring process recommendations

A 2-step approach as future SAF Use monitoring process is proposed:

1) Short-term (EAER 2022) SAF Monitoring process

An option by 2022 could be to request EC to consider a change of scope to the FQD to include aviation fuels (sustainable or not) as part of the Directive's scope for reporting purposes of Article 7a (GHG emissions reductions), and allow EASA access to data on SAF supplied.

If that is not possible by 2022, then, as it would not be expected to have a robust SAF supply or use data stream in Europe, it is proposed to perform an estimation based on surveys to industry stakeholders (from energy and aviation sectors) as well as Member State authorities.

The identification of States in which SAF could have been supplied can be done based on the identification of supply promotion policies and industry production plans made in this study.

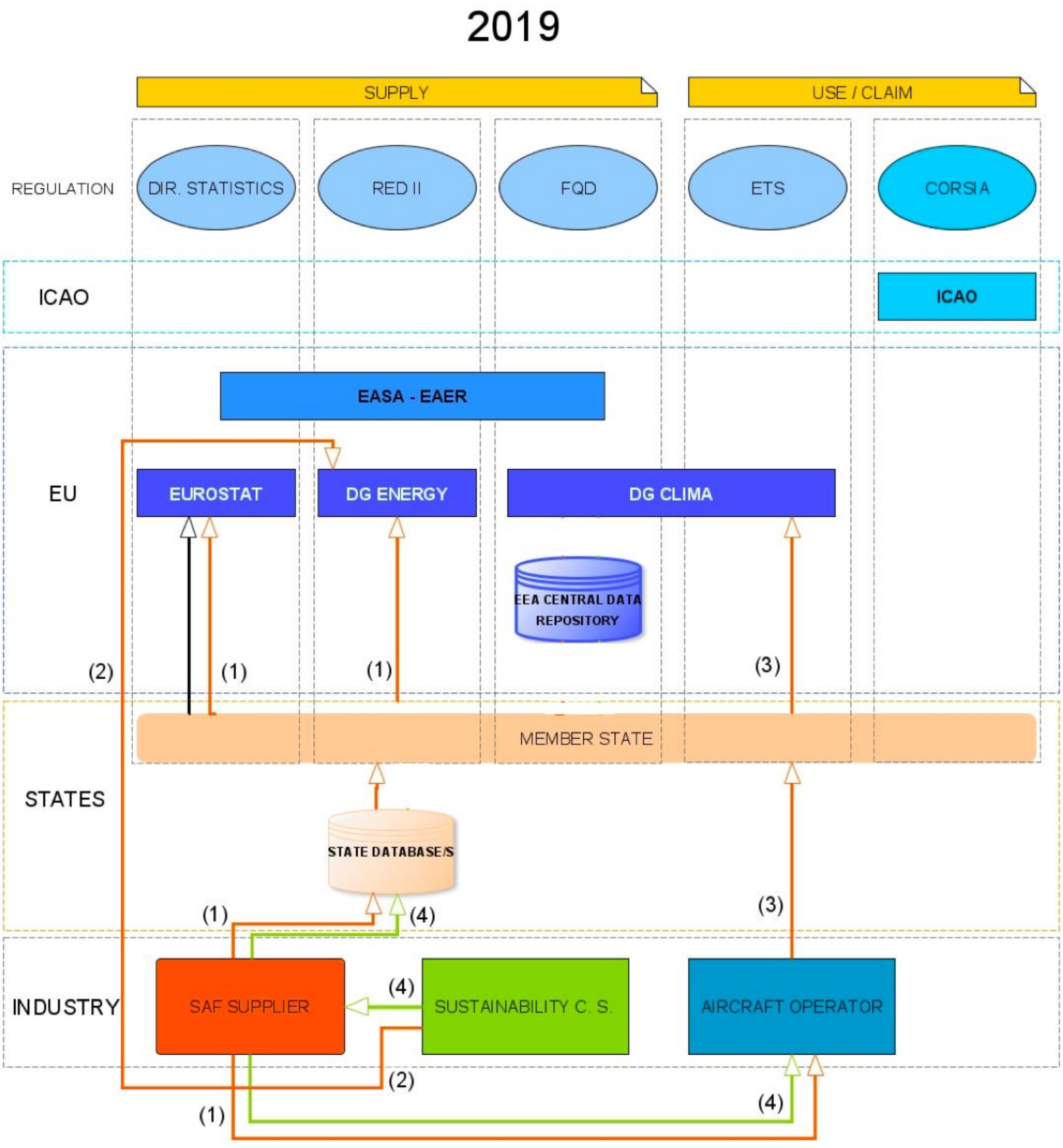
2) Mid-term (EAER 2025) SAF Monitoring process

For the 2025 report, the EU RED Union Database that is currently under development should be ready to supply the necessary information to support the identified PIs.

If that is the case, formal agreements between EASA and the relevant European body should be put in place to gain access to the information contained in the Union Database on a regular basis. The systematic monitoring process could then be done on an annual basis, as information becomes available, and then incorporated into future EAERs.

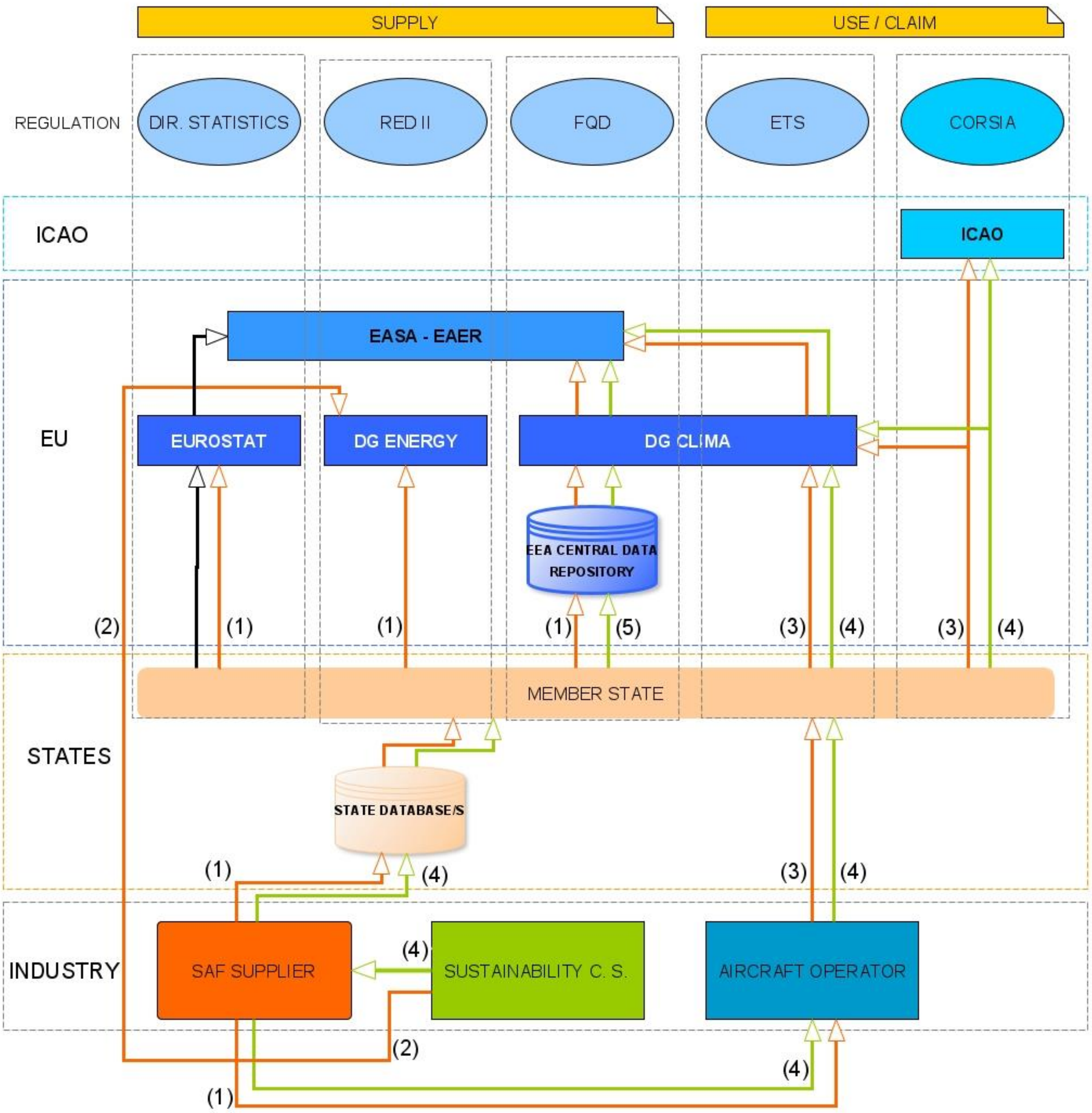
Identification of data streams

The three flow-charts included below show the identification of datasets and streams available today (2019) and the ones expected in the short-term (2022) and mid-term (2025).



#	DATA STREAM
(1)	Quantity of SAF SUPPLY in EEA markets data (RED II compliant) – Tonnes
(2)	Quantity of SAF CERTIFIED under EU RED II by voluntary schemes – Tonnes
(3)	Quantity of SAF USE data (RED II and/or CORSIA compliant) reported by aircraft operators – Tonnes
(4)	Sustainability characteristics (RED II and/or CORSIA compliant): conversion process, country of origin, year, feedstock, GHG value, fulfilment of land-use criteria
(5)	Partial Sustainability characteristics (RED II compliant): Feedstock used, GHG intensity value and GHG emissions savings against fossil fuel comparator

2022



→ **SAF QUANTITY**

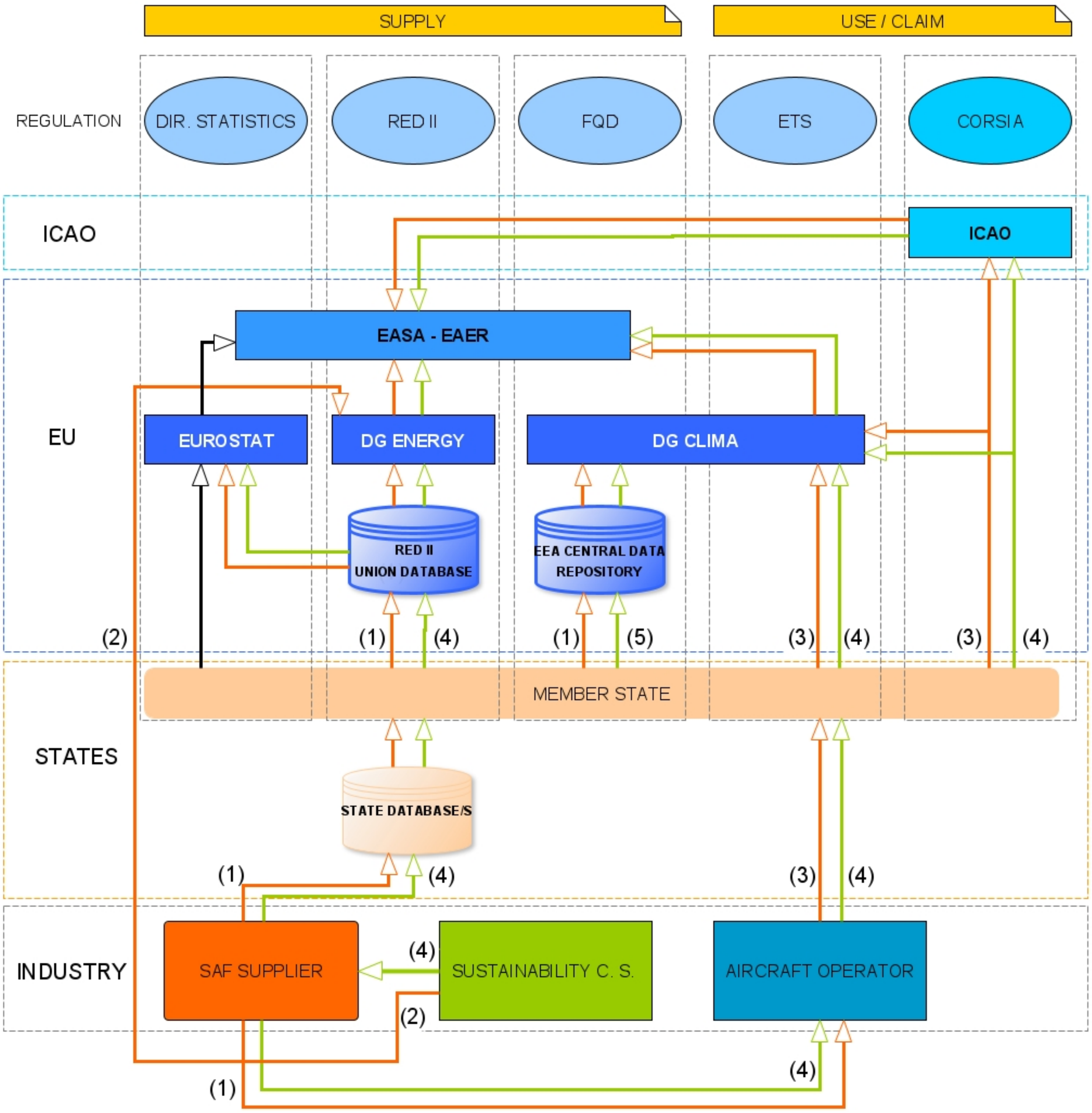
→ **FUEL SUSTAINABILITY CHARACTERISTICS**

→ **FOSSIL JET FUEL QUANTITY**

(1) **NUMBERS REPRESENT DIFFERENT DATA FLOWS**

#	DATA STREAM
(1)	Quantity of SAF SUPPLY in EEA markets data (RED II compliant) – Tonnes
(2)	Quantity of SAF CERTIFIED under EU RED II by voluntary schemes – Tonnes
(3)	Quantity of SAF USE data (RED II and/or CORSIA compliant) reported by aircraft operators – Tonnes
(4)	Sustainability characteristics (RED II and/or CORSIA compliant): conversion process, country of origin, year, feedstock, GHG value, fulfilment of land-use criteria
(5)	Partial Sustainability characteristics (RED II compliant): Feedstock used, GHG intensity value and GHG emissions savings against fossil fuel comparator

2025



→ SAF QUANTITY

→ FUEL SUSTAINABILITY CHARACTERISTICS

→ FOSSIL JET FUEL QUANTITY

(1) NUMBERS REPRESENT DIFFERENT DATA FLOWS

#	DATA STREAM
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(3)	Quantity of SAF USE data (RED II and/or CORSIA compliant) reported by aircraft operators – Tonnes
(4)	Sustainability characteristics (RED II and/or CORSIA compliant): conversion process, country of origin, year, feedstock, GHG value, fulfilment of land-use criteria
(5)	Partial Sustainability characteristics (RED II compliant): Feedstock used, GHG intensity value and GHG emissions savings against fossil fuel comparator

The table below shows the information required per each data stream.

➡ **Table 1** Required information per data stream Summary of SAF offtake agreements involving European producers and/or buyers

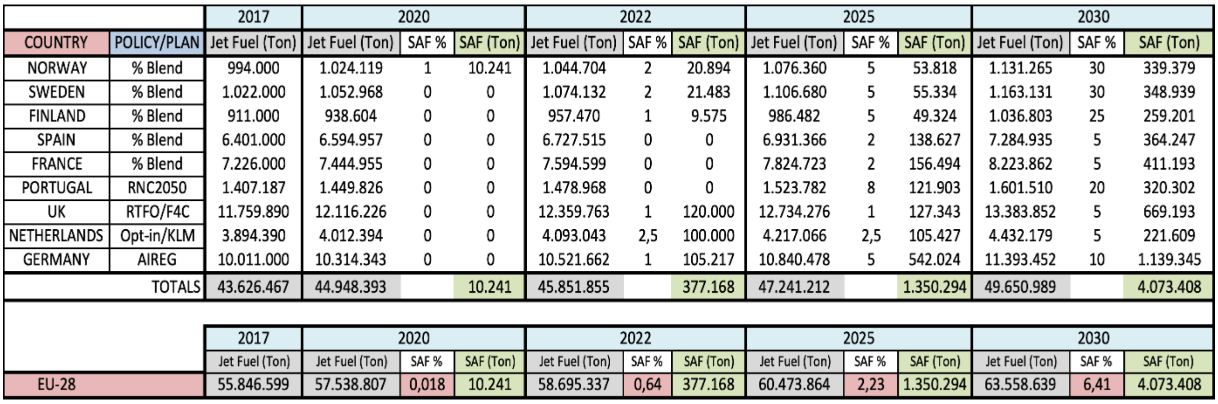
		DATA STREAM		
REGULATION & Data Requirements References	**DATA STREAM**	**SAF QUANTITIES**	**SUSTAINABILITY DATA**	**NOTES**
EUROSTAT [1] **Regulation (EC) No 1099/2008 on Energy Statistics** **Eurostat datasheets**	(1)	**MEMBER STATES to EU:** - Inland consumption of bio jet kerosene [2] (ToE) - International/Domestic. - Gross inland consumption of bio jet kerosene (ToE) - Domestic only. - Primary production of bio jet kerosene (ToE) - Imports of bio jet kerosene (ToE) - Exports of bio jet kerosene (ToE)	Eurostat does not collect sustainability certification related data.	[1] > States use different data sources and methods to compile information for EU reporting requirements. For example, administrative data (e.g. market supply or customs data) or survey data collection (voluntary / compulsory) from industry (producers/suppliers) [2] > Such terminology excludes non-bio based SAF which are considered under the RED II
RED **MSs to EU:** **Template for the Member States reports under the Directive 2009/28/EC** **SCS to EU:** **SCS Reporting Template** **EC to Parl.:** **Renewable Energy Progress Report**	(1) (2)	**MEMBER STATES to EU:** - Gross final consumption of energy from RES in transport (ktoe) - Not disaggregated across transport sectors. - Total actual contribution from each renewable energy technology (fuel type) in the transport sector (ktoe). - RES support schemes (e.g. % quota) **SUST.CERTIF. SCHEMES to EU: (Voluntary. Excludes National Schemes)** - Type of product [3] - Country of origin - Feedstock - Calendar Year - Value (tonnes) **EURO COMMISSION to EURO PARLIAMENT** - Final consumption in EU Transport of Bio Jet Kerosene (ktoe) International/Domestic [5]	Under the RED there is no collection of sustainability certification related data. **MEMBER STATES to EU:** - Estimated net GHG saving from the use of renewable energy in transport (t CO_2eq) [4]	[3] > Under EU RED the Types of products identified are: Biodiesel; Bioethanol; HVO; Pure vegetable oil; Biomethane; FT diesel; DME; Methanol; Other > SAF is not identified among fuel type categories and so reported under "others" > There is no terminology consistency with "Fuel Type" under the FQD nor under EU ETS. [4] > Estimation of GHG savings reported from MS´s is aggregated. Not by sub-sector [5] > Nothing reported to date
FQD **Directive 2015/652/EU Annex III** **(Currently aviation fuels are not in its scope)**	(1) (5)	**If a modification would be made to include aviation in its scope for reporting purposes, the information currently required for other transportation fuels is:** **FUEL SUPPLIERS and MEMBER STATES to EU:** - Country of origin - Supplier - Fuel Type (CN code) [6] - Quantity by litres (L) and by energy (MJ) [7] - Feedstock (& CN code)	**FUEL SUPPLIERS and MEMBER STATES to EU:** - GHG intensity - Upstream Emission Reduction -Reduction on 2010 average	[6] > Fuel Type under FQD refers to CN code. There is no consistency with "Type of product" under the RED and "Fuel Type" under EU ETS. [7] > Total energy supplied is expressed in mega joules (MJ) and converted from reported volumes of fuel expressed in litres (temperature of 15 °C)
EU ETS[8] **Aircraft ops:** **Annual Emissions Report for Aircraft Ops. Template** **MSs to EU:** EU ETS Questionnaire: Question 5.17 **EC to public:**	(3) (4)	**AIRCRAFT OPERATORS to MS:** - Name of fuel [9] - Sustainable biomass content (%) [10] - Fuel Type - Feedstock - Conversion process - Fuel consumption (Tonnes) **MEMBER STATES to the EU:** Aggregated data on Biomass reported: - number of installations using biomass; - energy content of the biomass which is considered zero rated. **THE EU TO THE PUBLIC:**	**AIRCRAFT OPERATORS to MS:** - Life Cycle Emissions value (t CO_2) **MEMBER STATES to the EU:** Aggregated data on Biomass reported: - total emissions from biomass which are considered zero rated.	[8] > Reporting caveats: - SAF supplied in EEA to flights outside the EEA may not be reported under the EU ETS by non-EEA operators. - SAF supplied in a non-EEA State could be reported - SAF supplied in the EEA might not reported under the EU ETS. [9] > No guidance is provided on what is referred by "Name of fuel"/"Fuel Type". [10] > % of sustainable biomass accounts as Zero emissions under EU ETS.

Report on the functioning of the European carbon market		Reported use of biomass by aircraft ops.		
CORSIA [11] **OPS to MSs:** **EU ETS Annual Emissions Report for Aircraft Ops. Template** **ICAO Annex 16 Vol IV, Appendix 5 Table A5-2** **MSs to ICAO: ICAO Annex 16 Vol IV, Appendix 5** **ICAO to Public: ICAO doc entitled "*CORSIA Central Registry (CCR): Information and Data for Transparency*"**	(3) (4)	**AIRCRAFT OPERATORS to MS:** - Fuel Type - Feedstock - Conversion process - Total mass of neat CORSIA eligible fuel claimed (Tonnes) Additional info to be reported in the future as per ICAO Annex 16 Vol IV, Appendix 5 Table A5-2: *Supplementary information to an aeroplane operator's Emissions Report if emissions reductions from the use of each CORSIA eligible fuel being claimed.* **MEMBER STATES to ICAO**: Additional info to be reported in the future as per ICAO Annex 16 Vol IV, Appendix 5 Table A5-6: *CORSIA eligible fuels supplementary information to the Emissions Report from a State to ICAO*. **ICAO TO THE PUBLIC**: - Production year of the CORSIA eligible fuel claimed - Producer of the CORSIA eligible fuel claimed - Type of fuel, feedstock and conversion process for each CORSIA eligible fuel claimed - Batch number(s) of each CORSIA eligible fuel claimed - Total mass of each batch of CORSIA eligible fuel claimed. - State reporting the information	**AIRCRAFT OPERATORS to MS:** - Life Cycle Emissions value (t CO_2) - Emissions reductions claimed (t CO_2)	[11] Non-EEA airlines will not report in Europe SAF supplied in the EEA

SAF use today and expectations for the future in Europe

There is currently no SAF regular supply in Europe, although the study has determined that **the current European States SAF promotion plans could lead to a SAF demand equal to at least 6% of jet-fuel use in 2030**.

➨ **Table 2** SAF Use today and future expectations



		2017	2020			2022			2025			2030		
COUNTRY	POLICY/PLAN	Jet Fuel (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)
NORWAY	% Blend	994.000	1.024.119	1	10.241	1.044.704	2	20.894	1.076.360	5	53.818	1.131.265	30	339.379
SWEDEN	% Blend	1.022.000	1.052.968	0	0	1.074.132	2	21.483	1.106.680	5	55.334	1.163.131	30	348.939
FINLAND	% Blend	911.000	938.604	0	0	957.470	1	9.575	986.482	5	49.324	1.036.803	25	259.201
SPAIN	% Blend	6.401.000	6.594.957	0	0	6.727.515	0	0	6.931.366	2	138.627	7.284.935	5	364.247
FRANCE	% Blend	7.226.000	7.444.955	0	0	7.594.599	0	0	7.824.723	2	156.494	8.223.862	5	411.193
PORTUGAL	RNC2050	1.407.187	1.449.826	0	0	1.478.968	0	0	1.523.782	8	121.903	1.601.510	20	320.302
UK	RTFO/F4C	11.759.890	12.116.226	0	0	12.359.763	1	120.000	12.734.276	1	127.343	13.383.852	5	669.193
NETHERLANDS	Opt-in/KLM	3.894.390	4.012.394	0	0	4.093.043	2,5	100.000	4.217.066	2,5	105.427	4.432.179	5	221.609
GERMANY	AIREG	10.011.000	10.314.343	0	0	10.521.662	1	105.217	10.840.478	5	542.024	11.393.452	10	1.139.345
	TOTALS	43.626.467	44.948.393		10.241	45.851.855		377.168	47.241.212		1.350.294	49.650.989		4.073.408

	2017	2020			2022			2025			2030		
	Jet Fuel (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)
EU-28	55.846.599	57.538.807	0,018	10.241	58.695.337	0,64	377.168	60.473.864	2,23	1.350.294	63.558.639	6,41	4.073.408

The above analysis concludes that the major challenge in responding to future SAF demand in Europe will not necessarily be linked to the technology/refining capacity, but on sourcing sustainable and no food/feed feedstock to cover such demand.

Regulatory-related recommendations

- Revision of EU FQD:

The report notes that currently the FQD scope does not include aviation fuels, while establishing fuel reporting requirements for other transportation modes. A simple change of scope to the FQD to include aviation fuels (sustainable or not) as part of the Directive's reporting requirements of Article 7a (GHG emissions reductions) would enable access to data on SAF supplied.

- Revision of EU ETS:

The report notes that the future revision of the EU ETS to implement CORSIA in the EU, will need to address whether SAF supplied in Europe, which necessarily will need to comply with EU RED II, will also have to go through a CORSIA sustainability certification and report emissions reductions according to CORSIA or RED GHG values.

The CORSIA sustainability framework for SAF is similar but not equal to the EU RED II and it is understood that SAF reported under CORSIA will use CORSIA GHG emissions values but will also need to fulfil RED II sustainability criteria to be supplied in Europe.

- Revision of EU RED II:

The RED reporting obligations from Member States currently do not include CO_2 savings per types of fuels reported: Those could be adjusted in order to include all sustainability certification data, so as to provide the relevant information needed for the development of a process to monitor and report on the characteristics and CO_2 savings of SAF used in Europe.

The RED II establishes a 1.2 multiplier for SAF, if the feedstock does not originate from food or feed. While the sustainability certificate identifies the feedstock used, it does not indicate today whether such feedstock is classified as food or feed. Such additional information will need to be provided by certificates issued by sustainability certification schemes.

Potential use of EASA Environmental Portal for SAF monitoring

EASA Environmental Portal could be expanded to include a special SAF section in order to provide a one stop reference source of authoritative data and public information regarding the use of SAF in Europe and its respective environmental benefits.

Operators already report to the Environmental Portal on noise certification. Those could be requested to report on SAF use as they already monitor it for ETS/CORSIA purposes. But this option would require a regulatory development to request such reporting.

Additional recommendations for SAF monitoring

This report includes a number of final suggestions and additional recommendations for EASA and other European institutions:

- ✓ It will be necessary to standardise the definition of Sustainable Aviation Fuels (SAF) and related terminology in Europe and identify the scope of fuels included under that definition. It is recommended to consider as SAF any of the pathways approved by ASTM/Def Stan and certified as sustainable under the EU RED rules in any Member State, including of non-biological origin. That would comprise the use of any feedstock recognized by Member States to comply with the EU RED.
- ✓ EASA and DG ENER agreed to continue to work together in the development of a future EU RED II Union Database, utilising the output of this scoping study, to identify data input fields that would support future SAF monitoring: EASA could support EC DG ENER on the identification of key SAF monitoring needs to be considered.
- ✓ EASA should be granted access to datasets reported by Member States to the European Commission in order to support the SAF monitoring process.
- ✓ A dedicated European discussion forum is required to coordinate discussions between European Member States on identified policy challenges related to the promotion of SAF.
- ✓ A discussion in ICAO on the development of common SAF Use indicators could be useful in order to standardise how SAF use is monitored worldwide.

CONTENTS

ABBREVIATIONS

ACRONYM	DESCRIPTION
A4A	Airlines For America
AESA	Agencia Estatal de Seguridad Aérea
AFF	ART Fuel Forum
AFTF	Alternative Fuels Task Force
AIREG	Aviation Initiative for Renewable Energy In Germany, 4
ANA	All Nippon Airways
ARA	Applied Research Associates
ART	Alternative and Renewable Transport
ASTM	American Society for Testing and Materials
ATJ	Alcohol-to-Jet
AvGas	Aviation Gasoline
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CA	Competent Authority
CAAFI	Commercial Aviation Alternative Fuels Initiative
CAEP	Committee on Aviation Environmental Protection
CBSI	Canada's Biojet Supply Chain Initiative
CCS	Carbon Capture and Storage
CEF	CORSIA Eligible Fuel
CEMIE-Bio	Mexican Centre for Innovation in Bioenergy
CH-SK	Catalytic Hydrothermolysis
CI	Carbon Intensity
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPI	Complementary Performance Indicators
DfT	Department for Transport
DG CLIMA	Directorate-General for Climate Action
DG ENER	Directorate-General for Energy
DG Energy	Directorate-General for Energy
DG JRC	Directorate-General Joint Research Centre
DG Move	Directorate-General for Mobility and Transport
DLUC	Direct Land Use Change
DME	Dimethyl ether
DOE	Department of Energy
EAER	European Aviation Environmental Report
EASA	European Aviation Safety Agency
EBB	European Biodiesel Board
EC	European Commission
EEA	European Economic Area
EF	Emission Factor

EPA	Environmental Protection Agency
ETBE	Ethyl Tertiary Butyl Ether
ETS	Emissions Trading Scheme
EU	European Union
EU ETS	European Union Emissions Trading Scheme
EU RED	European Union Renewable Energy Directive
EUSEW	EU Sustainable Energy Week
EUTL	European Union Transaction Log
EV	Electric Vehicle
F4C	Future fuels for Flight and Freight Competition
FAA	Federal Aviation Administration
FAME	Fatty Acid Methyl Esters
FAO	Food and Agriculture Organization
FOG	Fats, Oils and Greases
FQD	Fuel Quality Directive
FRED	Fuel Reporting & Emissions Database
FT	Fischer-Tropsch
FTG	Fuels Task Group
GBEP	Global Bioenergy Partnership
GFAAF	Global Framework for Aviation Alternative Fuels
GHG	Greenhouse Gas
HBEs	Biofuel Certificates
HDCJ	Hydrotreated Depolymerized Cellulosic Jet
HDO-SAK	Hydro-deoxygenation Synthetic Aromatic Kerosene
HDO-SK	Hydro-deoxygenation Synthetic Kerosene
HEFA	Hydroprocessed Esters and Fatty Acids
HFS	Hydroprocessed Fermented Sugars
HVO	Hydrotreated Vegetable Oil
IATA	International Air Transport Association
ICAO	Internation Civil Aviation Organization
IDAE	Ministry of Industry, Energy and Tourism
IEA	International Energy Agency
IH2	Integrated Hydropyrolisis and Hydroconversion
ILUC	Indirect Land Use Change
INAF	Japanese Initiatives for Next Generation Aviation Fuels
IPCC	International Panel on Climate Change
IRENA	International Renewable Energy Agency
ISCC	International Sustainability and Carbon Certification
ISO	International Organization for Standardization
ISPO	Indonesian Palm Oil
ITF	International Transport Forum
JAL	Japan Airlines
KPI	Key Performance Indicator

KTN	Knowledge Transger Network
LCA	Life Cycle Assessment
LCAF	Lower Carbon Aviation Fuels
LCFS	Low Carbon Fuel Standard
LPG	Liquified Petroleum Gas
LULUCF	Land Use Change and Forestry
MAGRAMA	Ministry of Agriculture, Food and Environment
MS	Member State
MSW	Municipal Solid Waste
MTBE	Methyl Tert-Butyl Ether
NASA	National Aeronautics and Space Administration
NCA	Nippon Cargo Airlines
NEA	Dutch Emission Authority
NISA	Nordic Initiative for Sustainable Aviation
NREAP	National Renewable Energy Action Plan
NUTS	Nomenclature of Territorial Units for Statistics
PtL	Power to Liquid
RED	Renewable Energy Directive
RES	Renewable Energy Sources
RFS	Renewable Fuel Standard
RIN	Renewable Identification Number
RSB	Roundtable on Sustainable Biomaterials (RSB)
RSPO	Roundtable on Sustainable Palm Oil (RSPO)
RTFO	Renewable Transport Fuel Obligation
RTRS	Roundtable on Responsible Soy
RVO	Renewable Volumen Obligation
SAF	Sustainable Alternative Fuels
SAF SIG	Sustainable Aviation Fuel Special Interest Group
SAFA	Sustainability Assessment of Food and Agriculture
SARPS	Standards and Recommended Practices
SCS	Sustainability Certification Schemes
SDS	Sustainable Development Scenario
SENASA	Servicios y Estudios para la Navegación Aérea y la Seguridad Aeronáutica
SIG	Special Interest Group
SIP	Synthesised Iso-Paraffinic
SK	Synthetic Kerosene
SKA	Synthetic Kerose with Aromatics
SPK	Synthetic Paraffinic Kerosene
TAEE	Tertiary-Amyl-Ethyl-Ether
TEA	Technoeconomic Analysis
TOE	Thousand tonnes of Oil Equivalent
UNECE	United Nations Economic Commission for Europe
USAF	United States Air Force

USDA	US Department of Agriculture

1. Study Scope and work plan

1.1 Study Scope

The objective of this study is to identify and propose a metric for monitoring the use of Sustainable Aviation Fuels (SAF) in Europe as well the associated aviation CO_2 emissions reductions achieved, with the aim to include it in further editions of the EASA European Aviation Environmental Report (EAER) and follow-up progress towards European aviation & environment goals.

The starting point for the work should be a stock-taking exercise. Before deciding whether it is necessary to develop a new process for monitoring and reporting on SAF production and use in Europe, and what form this could take, the work should consider what information (metrics/indicators) is required (and why) and identify / evaluate existing processes (e.g. RED, EUROSTAT, SAF Cert Schemes, EU ETS and CORSIA). As part of this process, consideration should be given to the information required under existing processes and the potential to build on these with limited further improvements.

Engagement with key industry stakeholders (fuel producers, suppliers, airports, airlines, brokers, associations), possibly through the platforms such as the ART Fuels Forum (supported by the European Commission DG Energy), would be useful to understand:

- their roles and functions along the SAF pathway
- the type of relevant data/information they could report on
- how potential requests for their input to SAF data collection are designed.

A consistent framework to monitor and report use of SAF could in principle also be applied to Member States considering their current regulatory reporting obligations (e.g. RED II) as well as for EU institutions.

The Study will take the following steps:

1) Identification of possible metrics/indicators:

> Look at the State of the Art on whether other organizations worldwide are using SAF indicators
> Identify a minimum set of key information/indicators, doable and reasonable for stakeholders and economic operators, we consider should be reported by the EAER (Volumes/Mass used, GHG reductions achieved)
> Identify additional information/indicators which could provide valuable info (feedstocks used, conversion processes, LCA values/sources used/reported etc.)
> Propose an initial set of indicators

2) Identification of data sources:

The main possible sources of SAF use data are: ETS, CORSIA, RED II, FQD, Eurostat and EU approved Certification Schemes (which report certified renewable fuels to DG ENER). Others can be identified through discussions with stakeholders.

The main focus of this second step would be to identify which are the reporting channels and processes for each source, and where exactly is the repository of the reported data (Organization, department, team).

It should also look at fossil fuels reporting tools/databases and what kinds of specifications are reported.

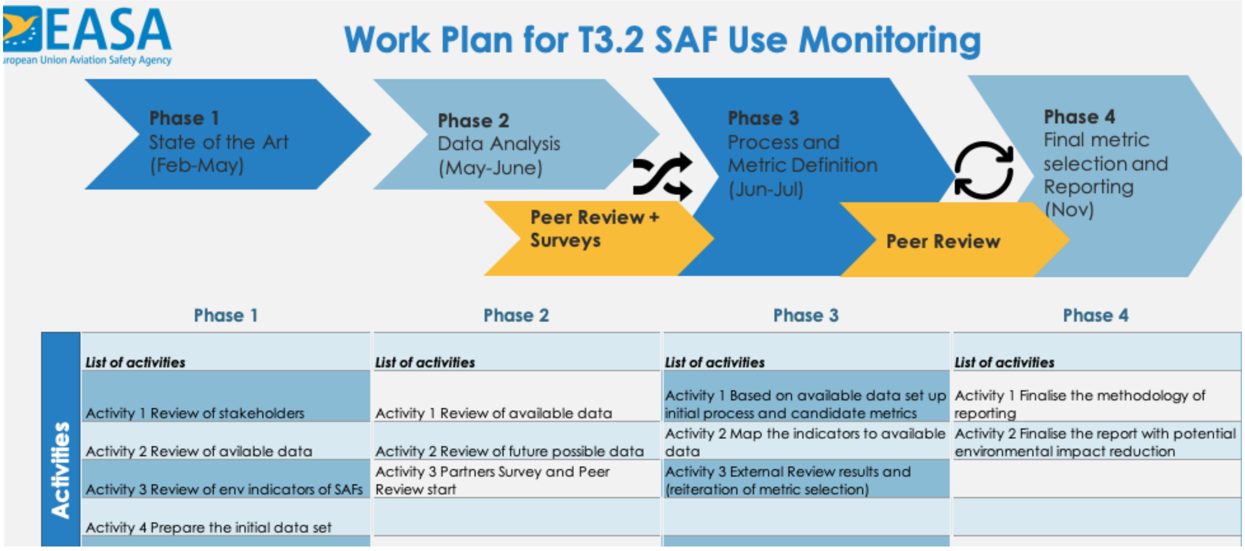
3) Definition of the reporting process:

Finally the data sources need to be linked to feed the proposed set of indicators: design a process and procedure, which the different "data repositories" could accept/follow, through which to ensure that EASA receives regularly data inputs (at least on an annual basis).

It will be assessed whether it is possible to monitor and report on SAF used in Europe, and the associated emissions reductions, through a fuel module of the EASA Environmental Portal.

The main key findings and recommendations are identified with green boxes along the report, and with blue boxes in the last key findings and recommendations chapter.

1.2 Work Plan



Phase 1	Phase 2	Phase 3	Phase 4
List of activities	***List of activities***	***List of activities***	***List of activities***
Activity 1 Review of stakeholders	Activity 1 Review of available data	Activity 1 Based on available data set up initial process and candidate metrics	Activity 1 Finalise the methodology of reporting
Activity 2 Review of avilable data	Activity 2 Review of future possible data	Activity 2 Map the indicators to available data	Activity 2 Finalise the report with potential environmental impact reduction
Activity 3 Review of env indicators of SAFs	Activity 3 Partners Survey and Peer Review start	Activity 3 External Review results and (reiteration of metric selection)	
Activity 4 Prepare the initial data set			

Figure 1 Work plan SAF Use Monitoring

2. SAF Use Indicators - State of the Art

To complete the first step of this scoping study, the identification of possible SAF use indicators, three sources of indicators have been reviewed:

1) European Union / EEA official indicators
2) Indicators used by other international agencies or stakeholders
3) Indicators used in scientific and technical literature

2.1 European energy, transport and environment indicators

The only official European Union reference for indicators addressing renewable energy used in transport is the annual *Energy, transport and environment indicators* book (Statistical Books – Eurostat)[1].

The 2018 edition reviewed for this analysis, presents statistics produced primarily by the European Statistical System. It provides information on where the European Union stands and where current trends may lead us in the areas of transport, energy and environment policies.

It is intended to contribute to making informed decisions in those closely related areas. The statistical book states that the indicators presented on it are by no means exhaustive.

This book does not contain all the most recent data for energy, transport and environment, which are available and can be consulted and downloaded at the Eurostat database[2]. The Eurostat database is specifically addressed as part of the 'SAF use data - state of the art' in this report.

The indicators provide national data for the 28 EU Member States. When available, the EU-28 aggregate is also provided. Data availability varies between indicators, but for most of them time series are available for at least 10 years. The data presented include the most recent reference years available.

The different regulatory obligations for reporting renewable energy use are addressed in detail in Chapter 0 of this report.

In the Energy chapter of the *Energy, transport and environment indicators 2018* referred in this chapter, the main data sources are reported under Regulation (EC) No 1099/2008 on Energy Statistics. In addition, the legal background for the share of renewable energy sources in gross final energy consumption is the Directive 2009/28/EC.

The transport indicators cover infrastructure, transport equipment, freight and passenger transport, transport safety and transport-related emissions for the different modes of transport. In the Transport chapter, the most important data sources are being reported under the EU legal acts on transport statistics and the Eurostat/United Nations Economic Commission for Europe (UNECE)/International Transport Forum (ITF) common questionnaire on inland transport.

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[1] https://ec.europa.eu/eurostat/web/products-statistical-books/-/KS-DK-18-001

[2] https://ec.europa.eu/eurostat/web/energy/data/database

The EU legal acts for the statistical reporting of different modes of transport including Regulation (EC) No 437/2003 on air transport statistics[3]. This contains information in respect of the carriage of passengers, freight and mail by air, but does not include fuel use, which is only reported within the above-mentioned Energy Statistics regulation.

Eurostat reported emissions data are taken from the European Environment Agency.

The following Energy and Environment indicators from Eurostat have been analysed as relevant for this study in terms of products they refer to, as well as metrics used:

2.1.1 Energy indicators

Within the Eurostat European energy, transport and environment indicators, SAF (nor bio-kerosene type jet fuel) are not referenced as such. It is included in some figures within "other liquid biofuels" under the renewable energy sources chapter.

Kerosene type jet fuel (without bio components) appears in some indicators/figures within the *oil and petroleum products* chapter.

- Primary energy production:

  Products: Primary production of nuclear heat, renewable energies, solid fuels, gas, total petroleum products and non-renewable wastes.

  Unit: **million tonnes of oil equivalent (Mtoe)**

  Figures of interest: Primary production of renewable energy; Primary energy production, by fuel.

- Energy consumption:

  Products: nuclear heat, renewable energies, solid fuels, gas, total petroleum products and non-renewable wastes.

  Unit: **million tonnes of oil equivalent (Mtoe)**

  Figures of interest: Energy consumption by transport mode, EU-28 (including International aviation, Domestic aviation, Road, Rail Inland waterway).

- Renewable energy sources

  Products: Liquid biofuels: Biogasoline, Biodiesels, other liquid biofuels.

  Unit: **million tonnes of oil equivalent (Mtoe) and percentage (%)**

  Figures of interest: Primary production of liquid biofuels, EU-28; Gross inland consumption[4] of renewables, EU-28 (Mtoe); Share of renewable energy sources in transport (%).

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[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003R0437&from=EN

[4] Gross inland energy consumption is the total energy demand of a country or region. It covers: consumption by the energy sector itself; distribution and transformation losses; final energy consumption by end users; and 'statistical differences' (not already captured in the figures on primary and final energy consumption). Gross inland consumption does not include energy (fuel oil) provided to international bunkers. It is calculated as follows: primary production + recovered products + net imports + variations of stocks – bunkers.

- Oil and petroleum products:

  Products: Kerosene type jet fuel (without bio components); Gas/diesel oil (without bio components); Liquified petroleum gas (LPG); Gasoline (without bio components); All other oil products and Total fuel oil.

  Unit: **million tonnes of oil equivalent (Mtoe)**

  Figures of interest: Final energy consumption of petroleum products, EU-28.

2.1.2 Environment indicators

It should be noted that while Member States report energy indicators to Eurostat (kerosene type jet fuels supplied in the country), CO_2 emissions indicators included in the *Energy, transport and environment indicators 2018* are reported to the European Environmental Agency, as part of the annual national GHG emissions inventories reporting obligations.

States should use the same energy supply data to calculate GHG emissions for reporting under the UNFCCC rules through multiplying mass of fuels per its respective emissions factors, including air transport, and then differentiate between domestic and international aviation fuel burn to report its related GHG emissions separately.

- Emissions of greenhouse gases and air pollutants

  Sectors: Agriculture; forestry and fishing; Mining and quarrying; Manufacturing; Electricity, gas, steam and air conditioning supply; Transport and storage; Other services, water supply and construction; Households.

  Unit: **thousand tonnes of CO_2 equivalent.**

  Figures of interest: Greenhouse gas emissions by economic activity.

2.1.3 Possible related SAF metrics/Performance Indicators identified

For the interest of this study, an initial identification of metrics and indicators that are currently used in the existing European *Energy, transport and environment indicators*, at least the ones that are considered as the minimum set to be monitored and reported:

- **SAF consumption (supply), EU-28 - million tonnes of oil equivalent (Mtoe)**
- **Share of SAF in gross final consumption (supply) of aviation fuels use – percentage (%).**
- **Greenhouse gases emissions savings of from SAF supply – tonnes of carbon dioxide equivalents (t CO_2eq)** -as per EU RED calculation methodology-**.**

2.2 Stakeholder consultation for SAF indicators

The following stakeholders have been consulted to check whether their organizations are using any SAF use indicators and/or monitoring system.

2.2.1 International Civil Aviation Organization (ICAO)

Consulted experts:

- ✓ Jane Hupe, Deputy Director Environment at ICAO.
- ✓ Dr. Bruno Silva, Environment Officer at ICAO.

- ➢ The ICAO *Global Framework for Aviation Alternative Fuels (GFAAF)*:

ICAO follows-up global initiatives to promote and use SAF through its GFAAF website.

This portal[5] includes different information pages:

- Initiatives and Projects: dedicated to the presentation of multi-stakeholders initiatives for the development and deployment of alternative fuels in aviation.
- News and activities: display news and activities related to SAF for use in the aviation industry. These articles date back to 2005 and the page is regularly updated with the latest announcements.
- Updated Facts and Figures: Includes among other information, worldwide announced SAF offtake agreements with expected annual production.

The indicators, which ICAO is using in relation with SAF, are qualitative and mainly focused in market follow-up rather than actual SAF use:

- ✓ News Announcements and Initiatives on the ICAO GFAAF
- ✓ Announced offtake agreements
- ✓ ASTM Certified Conversion Processes
- ✓ Conversion Processes Within the ASTM Approval Process

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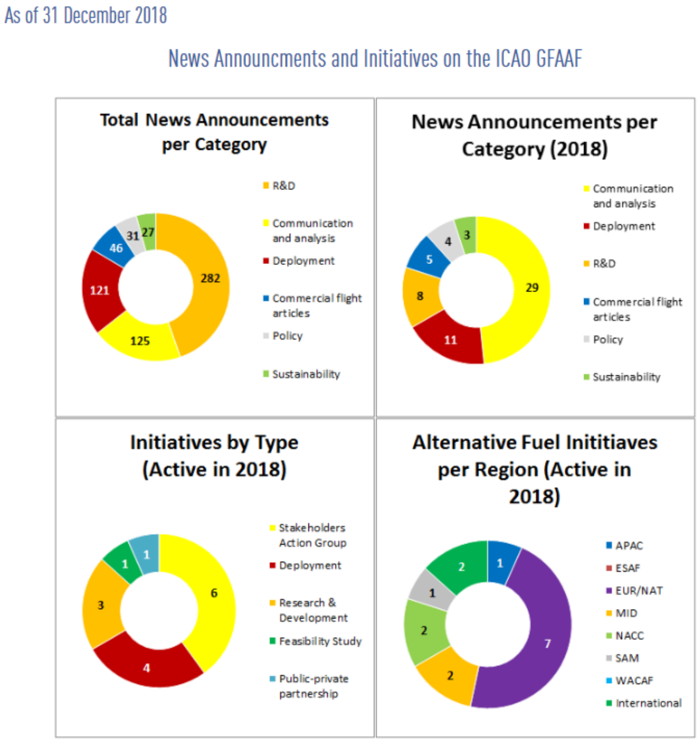
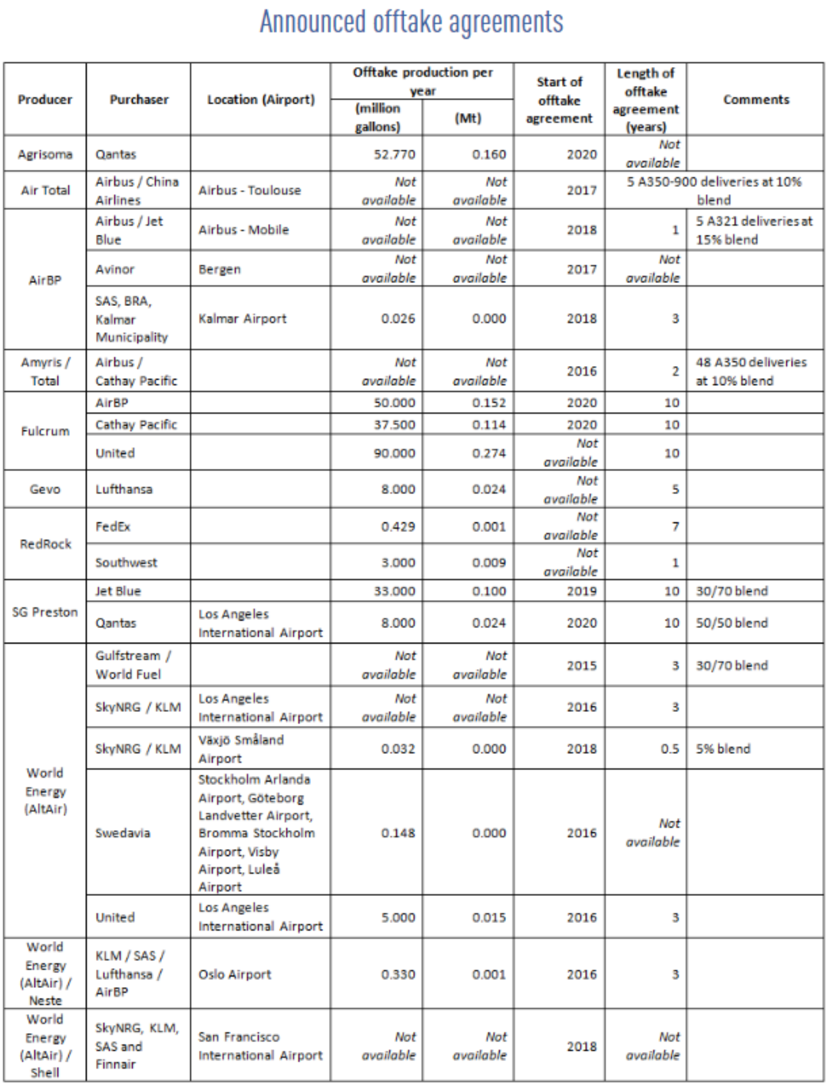
[5] https://www.icao.int/environmental-protection/gfaaf/pages/default.aspx



➨ **Figure 2** ICAO GFAAF news announcements (as of December 2018)



Announced offtake agreements

Producer	Purchaser	Location (Airport)	Offtake production per year		Start of offtake agreement	Length of offtake agreement (years)	Comments
			(million gallons)	(Mt)			
Agrisoma	Qantas		52.770	0.160	2020	*Not available*	
Air Total	Airbus / China Airlines	Airbus - Toulouse	*Not available*	*Not available*	2017	5 A350-900 deliveries at 10% blend	
AirBP	Airbus / Jet Blue	Airbus - Mobile	*Not available*	*Not available*	2018	1	5 A321 deliveries at 15% blend
	Avinor	Bergen	*Not available*	*Not available*	2017	*Not available*	
	SAS, BRA, Kalmar Municipality	Kalmar Airport	0.026	0.000	2018	3	
Amyris / Total	Airbus / Cathay Pacific		*Not available*	*Not available*	2016	2	48 A350 deliveries at 10% blend
Fulcrum	AirBP		50.000	0.152	2020	10	
	Cathay Pacific		37.500	0.114	2020	10	
	United		90.000	0.274	*Not available*	10	
Gevo	Lufthansa		8.000	0.024	*Not available*	5	
RedRock	FedEx		0.429	0.001	*Not available*	7	
	Southwest		3.000	0.009	*Not available*	1	
SG Preston	Jet Blue		33.000	0.100	2019	10	30/70 blend
	Qantas	Los Angeles International Airport	8.000	0.024	2020	10	50/50 blend
World Energy (AltAir)	Gulfstream / World Fuel		*Not available*	*Not available*	2015	3	30/70 blend
	SkyNRG / KLM	Los Angeles International Airport	*Not available*	*Not available*	2016	3	
	SkyNRG / KLM	Växjö Småland Airport	0.032	0.000	2018	0.5	5% blend
	Swedavia	Stockholm Arlanda Airport, Göteborg Landvetter Airport, Bromma Stockholm Airport, Visby Airport, Luleå Airport	0.148	0.000	2016	*Not available*	
	United	Los Angeles International Airport	5.000	0.015	2016	3	
World Energy (AltAir) / Neste	KLM / SAS / Lufthansa / AirBP	Oslo Airport	0.330	0.001	2016	3	
World Energy (AltAir) / Shell	SkyNRG, KLM, SAS and Finnair	San Francisco International Airport	*Not available*	*Not available*	2018	*Not available*	

➨ **Figure 3** Announced SAF offtake agreements

There are no specific indicators on SAF use.

- ICAO SAF Stocktaking Seminars:

In April 2019 ICAO has started a "Stocktaking" exercise (with plans to do annual seminars) with the intention to quantify and monitor the development and future use of SAF worldwide. The first ICAO Stocktaking Seminar (30 April 2019 - 1 May 2019) toward the 2050 Vision for Sustainable Aviation Fuels (SAFS2019) provided the first global forum for the exchange of information related to SAF production, policies to create demand and use plans. Results of this first stocktaking exercise have not been published.

There has **not been defined specific global SAF use indicators** beyond the stocktaking exercise mentioned above. Most of the production plans announced in the stocktaking seminar are related to specific industry conversion technologies and feedstocks, which could be used to estimate its associated CO_2 emissions reductions, but such exercise has not been done.

- ICAO Committee on Aviation and Environmental Protection (CAEP) work:

The ICAO CAEP Fuels Task Group (FTG) has on its 2019-2021 work program the task *S.09: Fuel Production Evaluation*: Using data on current offtake of CORSIA Eligible Fuels (CEFs) (with mainly includes SAF) and technoeconomic analysis (TEA) methods and information from CAEP/10 AFTF Fuel Production Assessment, assess CORSIA Eligible Fuel availability through 2035 (end of CORSIA timeframe initially considered) based on the range of estimated offset prices that have been developed by CAEP.

The result of this scientific exercise together with the ICAO stocktaking future data will be a useful source to contrast SAF information collected/reported in Europe.

Nevertheless, much caution will be needed when it comes to address the differences between Europe and the rest of the world on dealing with definitions and data, as EU rules for its development might defer from other jurisdictions. Participation of EU level experts in CAEP FTG will facilitate reporting EU definitions and approaches within ICAO.

It could be of interest to propose a discussion in ICAO (either through the Stocktaking Seminars or CAEP) on the development of common SAF Use indicators to standardise how SAF use is monitored worldwide.

2.2.2 US FAA and Commercial Aviation Alternative Fuels Initiative (CAAFI)

Consulted experts:

- ✓ Nate Brown, Alternative Jet Fuels Project Manager at FAA.
- ✓ Dr. James Hileman, Chief Scientist for the Office of Environment and Energy at FAA.
- ✓ Steve Csonka, Executive Director CAAFI.

The US currently does an annual SAF use tracking with data collected via voluntary reporting by airlines (via A4A), manufacturers, fuel providers, the US Department of Defense and some SAF producers.

It is acknowledged that the process is imperfect and requires outreach to collect info, but parties involved have been responsive and it has been manageable with the low quantities of fuel currently in use (1.2M gallons in 2018).

They are beginning to think about other ways to monitor SAF as production ramps up.

They have **not defined specific SAF use indicators**.

It should be noted that the quality of voluntary reporting information might not be very high and data not necessarily sufficiently accurate.

2.2.3 International Air Transport Association (IATA)

Consulted experts:

- ✓ Robert Boyd, Senior Manager, Aviation Environment - Alternative Fuels. IATA.
- ✓ Aaron Robinson, Senior Manager - Environmental Strategy and Sustainability at United Airlines. Company representative in A4A and IATA.

IATA, as well as A4A, collect information from their associated operators regarding mass of SAF use. But they do not collect info regarding the nature and LCA values of such SAF.

All IATA airline members report through the Fuel Reporting & Emissions Database (FRED+), which is the online reporting system used to report fuel consumption data, including SAF. It does not include emissions reductions data.

With the data reported by airlines plus IATA team research, they publish periodically *Sustainable Aviation Fuels Fact sheets*[6] with information regarding number of commercial flights using SAF, which have been performed to date. The last one (issued in May 2019) **does not include any SAF use indicator**.

More information on the reported data by airlines is provided below on Section 3.8.1.

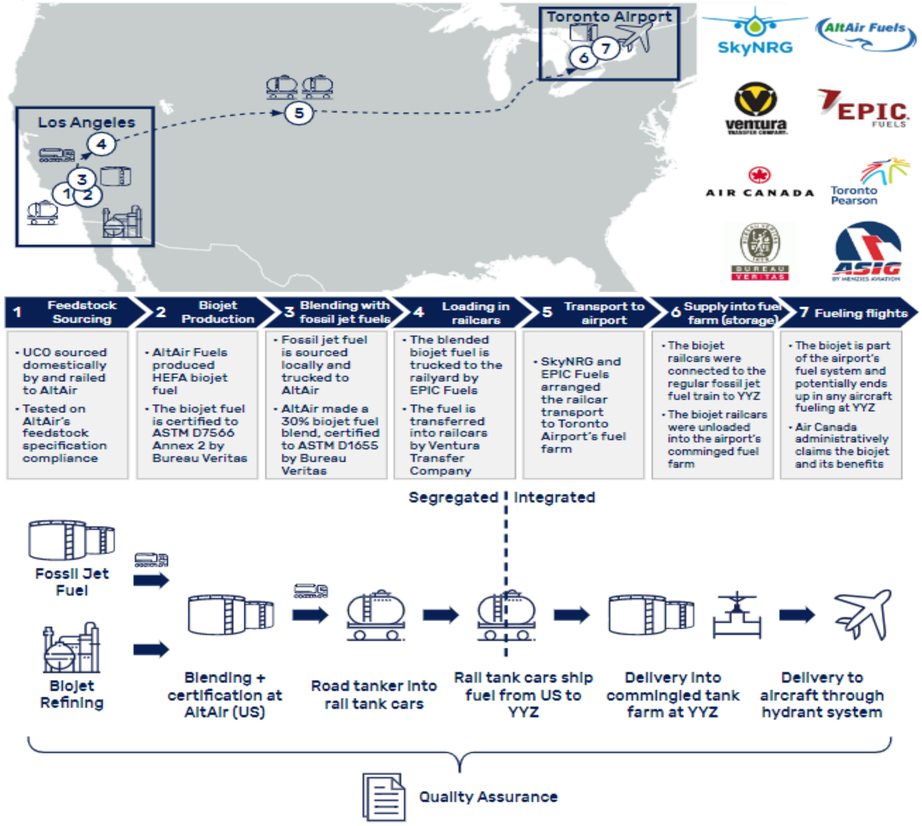
2.2.4 Canada's Biojet Supply Chain Initiative

Consulted experts:

- ✓ Fred Ghatala, Canada's Biojet Supply Chain Initiative. Waterfall Group.

Canada has launched in 2019 the Canada's Biojet Supply Chain Initiative (CBSI) with the objectives to develop a full domestic biojet supply chain that integrates into the logistics of the existing fossil jet supply chain. Accounting and reporting of biojet volumes and characteristics is part of the project demonstration.

Figure 12. Schematic representation of CBSCI biojet supply chain



1 Feedstock Sourcing	2 Biojet Production	3 Blending with fossil jet fuels	4 Loading in railcars	5 Transport to airport	6 Supply into fuel farm (storage)	7 Fueling flights
• UCO sourced domestically by and railed to AltAir • Tested on AltAir's feedstock specification compliance	• AltAir Fuels produced HEFA biojet fuel • The biojet fuel is certified to ASTM D7566 Annex 2 by Bureau Veritas	• Fossil jet fuel is sourced locally and trucked to AltAir • AltAir made a 30% biojet fuel blend, certified to ASTM D1655 by Bureau Veritas	• The blended biojet fuel is trucked to the railyard by EPIC Fuels • The fuel is transferred into railcars by Ventura Transfer Company	• SkyNRG and EPIC Fuels arranged the railcar transport to Toronto Airport's fuel farm	• The biojet railcars were connected to the regular fossil jet fuel train to YYZ • The biojet railcars were unloaded into the airport's comminged fuel farm	• The biojet is part of the airport's fuel system and potentially ends up in any aircraft fueling at YYZ • Air Canada administratively claims the biojet and its benefits

➨ **Figure 4** Schematic representation of CBSCI biojet supply chain

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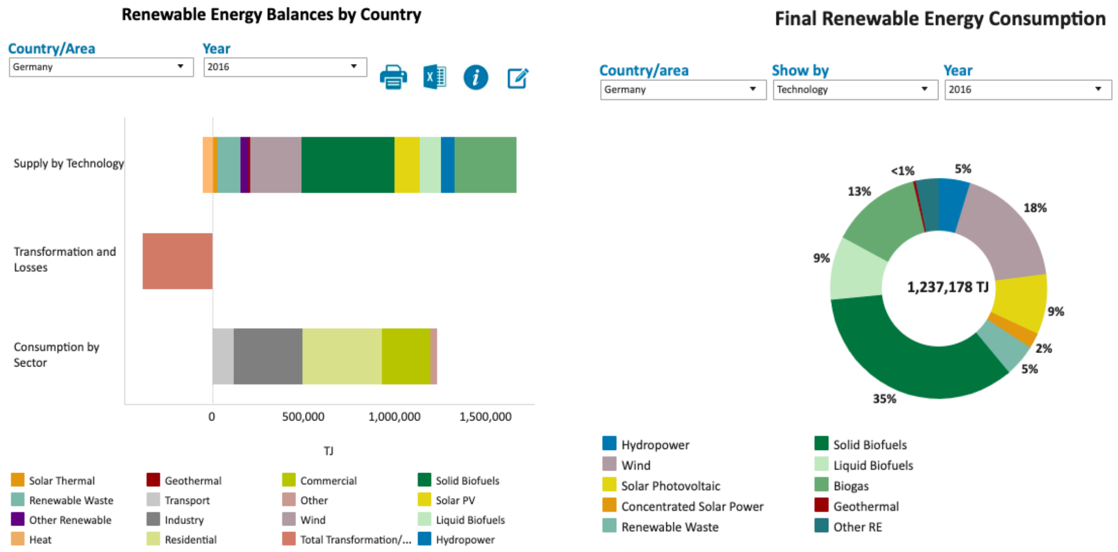
[6] https://www.iata.org/policy/environment/Documents/saf-what-is-saf.pdf

They will initially develop a full supply-chain from a single producer, so annual reporting the volumes used will be straightforward. But nevertheless, part of the project will test a system of accounting and reporting of biojet volumes and characteristics substantiates that the fuel has been delivered to, and used by, the intended airline. Accounting will differ based on the fuelling method used: Direct fuelling (where tracking fuel can be done through a single batch number created at source) or commingled systems (where batch numbers will change).

2.2.5 International Renewable Energy Agency (IRENA)

IRENA publishes[7] detailed statistics on renewable energy capacity, power generation and renewable energy balances, including supply by technology, and within that category, liquid biofuels.

Data are collected directly from members using the IRENA Renewable Energy Statistics questionnaire[8] and is also supplemented by desk research where official statistics are not available.



Country/Area: Germany
Year: 2016

Country/area: Germany
Show by: Technology
Year: 2016

➨ **Figure 5** IRENA Renewable Energy Statistics

Liquid biofuels information collection from States, include Bio jet kerosene but IRENA does not publish any Bio jet kerosene disaggregated indicator.

2.3 Indicators literature review

A literature review has been performed to analyse the use of Performance Indicators (PIs) in energy and bioenergy.

The following list of keywords was searched in order to find the scientific papers and reports consulted:

PI bioenergy use	Aviation Bioenergy use

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[7] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jul/IRENA_Renewable_energy_statistics_2019.pdf
[8] https://www.irena.org/-/media/Files/IRENA/Agency/Data-Statistics/4-The-IRENA-Renewable-Energy-Template.pdf?la=en&hash=BBCD43915E3D81FE83C9145FE71C3CE4E69CA5CC

PI biofuel use
PI bioenergy use
PI Sustainable alternative fuels use
PI SAF use
PI SAF
PI Renewable energies use
PI Energy use
Reporting Energy use
SAF use
Energy use
Indicator SAF
Indicators biofuels
Indicator energy use
PI fuel use
Aviation energy use indicators
Indicators bioenergy

2.3.1 Literature revision list

The following list of papers and reports has been analysed, from which indicators have been extracted.

➡ **Table 3** Literature revision list

Index	Date	Authors	Title
1	12/2/16	Miao Guoa Goetz M., Richterb Robert A., Holland Felix, et al.	Implementing land-use and ecosystem service effects into an integrated bioenergy value chain optimisation framework
2	16/10/12	Virginia H.DaleacRebecca A.EfroymsonaKeith, et al.	Indicators for assessing socioeconomic sustainability of bioenergy systems: A short list of practical measures
3	3/3/09	Francesco Cherubinia,∗, Neil D. Birda, Annette Cowieb, Gerfried Jungmeiera,Bernhard Schlamadingerc,1, Susanne Woess-Gallascha	Energy- and greenhouse gas-based LCA of biofuel and bioenergy systems:Key issues, ranges and recommendations
4	21/6/15	Laszlo Torjaia, Judit Nagyb,*, Attila Bai	Decision hierarchy, competitive priorities and indicators in large-scale‘herbaceous biomass to energy’s supply chains
5	24/1/11	Allen C. McBridea, Virginia H. Dalea,∗, Latha M. Baskarana, et al.	Indicators to support environmental sustainability of bioenergy systems
6	24/10/14	Uwe R. Fritsche 1,* and Leire Iriarte 2	Sustainability Criteria and Indicators for the Bio-Based Economy in Europe: State of Discussion and Way Forward
7	11/11/10	Sylvestre Njakou Djomo Ouafik El Kasmioui, et al.	Energy and greenhouse gas balance of bioenergy production from poplar and willow: a review
8	7/7/16	Devin Diran	An Economic, Environmental and Sustainability Assessment of a large scale biofuel industry in Suriname
9	1/1/18	Ayla Uslu	Monitoring framework and the KPIs for advanced renewable liquid fuels (RESfuels)
10	21/8/17	K. Yankovska	Economic efficiency of the technologies of agricultural biomass use for energy purposes
11	1/1/13	Azad Rahman*, M.G. Rasul, M.M.K. Khan, S. Sharma	Impact of alternative fuels on the cement manufacturing plant performance: an overview
12	1/4/03	Annik Magerholm Fet	Eco-efficiency reporting exemplified by case studies
13	8/9/13	Stephanie Searle and Chris Malins	A reassessment of global bioenergy potential in 2050
14	4/1/15	Helen T.MurphyaDeborah A.O’ConnellbR. et al.	Biomass production for sustainable aviation fuels: A regional case study in Queensland
15	14/9/08	James I. Hileman, Jeremy B. Katz. José G. Mantilla and Gregg Fleming	Payload Fuel Energy Efficiency as A Metric for Aviation Environmental Performance

16	28/11/12	Virginia H. Dale, Matthew H. Langholtz, Beau M. Wesh, and Laurence M. Eaton	Environmental and Socioeconomic Indicators for Bioenergy Sustainability as Applied to Eucalyptus

2.3.2 Literature indicators

Within this literature review, the following renewable energy indicators have been found and are listed below. The column source directs to the respective reference paper in 2.1.1.

Table 4 Literature Indicators

Index	Indicator	Unit	Source (Paper index)
1	Land allocation for transport fuel	ha	1
2	Land allocation % for biofuel type	%	1
3	Cost of SAF type	€	1
4	Carbon fixation rate of crops	Mass of CO_2 assimilated	1
5	Employment	Number of full time equivalent jobs	2
6	Trade volume	€	2
7	Return on investment	% (net investment/initial investment)	2
8	Public opinion	% favorable opinion	2
9	Depletion of non-renewable energy resources	Amount of petroleum used per year	2
10	Life cycle GHG emissions of biofuels	g CO_2-eq./MJ	3
11	Percentage of the total energy input coming from SAFs	%	3
12	Investment expenditures (fields, storage, equipment, etc)	€	4
13	Carbon footprint (saving)	tonnes of CO_2	4
14	CO_2 equivalent emissions (CO_2 and N2O)	Kg Ceq/GJ	5
15	Energy efficiency (usable energy/energy contained in the biomass feedstock	%	7
16	Life cycle efficiency ((usable energy produced-energy consumed by the upstream processes)/energy contained in the biomass feedstock	%	7
17	Energy ratio (energy contained in the biomass/energy inputs to produce the biomass feedstock)	Ratio (%)	7
18	Energy requirement (inverse of Energy ratio)	%	7
19	Net energy yield	Ratio per surface unit	7
20	Energy use efficiency ((primary energy yield - energy consumption)/energy consumption)	%	7
21	Biofuel production	liter/year	8
22	Biofuel export	liter/year	8
23	Total Biofuel profits	€/year	8
24	Share of bio-power	%	8

25	Forest and protected area	ha	8
26	Wood pellet & wood chip prices	€/t	9
27	Straw price	€/t	9
28	Total investments on SAFs	M€ or k€/MW installed	9
29	SAF output	t/ha	10
30	% Substitution	%	11
31	Percentage of different type of SAFs used	%	11
32	Eco-efficiency (economic performance indicator/ environmental performance indicator) An example could be SAF Cost/GHG emissions	Could be different units	12
33	Bioenergy potential (Mass or Energy that could potentially be obtained per year)	J/year	13
34	SAF Volume produced	ML	14
35	Return time per SAF type	years	14
36	Fuel efficiency	km/MJ	15
37	Food security (% change in food price volatility)	%	16

2.4 Initial identification of SAF possible Performance Indicators

On the basis of the previous review, an initial wide list of potential indicators is identified for consultation with stakeholders aiming to propose a smaller selection of final metrics. It is important to note that **the list included below IS NOT the final selection**, which will be proposed after stakeholders review.

These indicators have been differentiated below into what could be considered minimum **Performance Indicators (PI)** that should be reported, and additional **Complementary Performance Indicators (CPI),** which might provide additional valuable info.

PI	**Performance Indicator**
CPI	Complementary Performance Indicators

➨ **Table 5** Initial list of Performance Indicators (PI) and Complementary Performance Indicators (CPI) proposed for consultation

Index	Type	Indicator	Unit	Source
1	**PI**	**SAF consumption, EU-28**	**Million tonnes of oil equivalent (Mtoe)**	This Study 3.1.3
2	**PI**	**Share of SAF in gross final consumption of aviation fuels use**	**%**	11
3	**PI**	**Greenhouse gases emissions savings from SAF use**	**Tonnes of carbon dioxide equivalents (tCO_2eq)**	This Study 3.1.3
4	CPI	Types of feedstock used	List of feedstocks and %	This Study
5	CPI	Types of conversion technologies used	List of conversion technologies and %	This Study
6	CPI	Life cycle GHG emissions of biofuels	gCO_2-eq./MJ	3
7	CPI	Biofuel production	liter/year	8
8	CPI	Biofuel export	liter/year	8
9	CPI	Biofuel import	liter/year	8

10	CPI	Percentage of SAFs used per type	%	11
11	CPI	Cost of SAF type	€	1
12	CPI	Employment	Number of full time equivalent jobs	2
13	CPI	Trade volume	€	2
14	CPI	Return on investement	% (net investment/initial investment)	2
15	CPI	Public opinion	% favorable opinion	2
16	CPI	Investment expenditures (fields, storage, equipment, etc)	€	4
17	CPI	Total Biofuel profits	€/year	8
18	CPI	Total investments on SAFs	M€ or k€/MW installed	9
19	CPI	Bioenergy potential (Mass or Energy that could potentially be obtained per year)	J/year	13
20	CPI	Production surface land for SAF used within the EU in a certain year	Sq Km/year	1

Note: The column *source* either directs to the literature reference listed in 2.1.1 or indicates whether it is result of this Study proposal.

2.5 Data needed for the proposed selection of indicators

In order to feed the proposed initial list of indicators, at least the following data would be needed:

Table 6 Data needed for the proposed selection of indicators

Indicator	Data needed
SAF consumption, EU-28	**Mass of SAF consumption, EU-28**
Share of SAF in gross final consumption of aviation fuels use	**Mass of Kerosene type jet fuel consumption, EU-28**
Greenhouse gases emissions savings from SAF use	**Life cycle GHG emissions of used biofuels**
Types of feedstock used	Types of feedstock used
Types of conversion technologies used	Types of conversion technologies used
Life cycle GHG emissions of biofuels	Life cycle GHG emissions of used biofuels
Biofuel production	Primary production of Bio jet kerosene
Biofuel export	Exports of Bio jet kerosene
Biofuel import	Imports of Bio jet kerosene
Percentage of SAFs used per type	Mass of SAF consumption per type, EU-28
Cost of SAF type	Costs of SAF per type
Employment	Estimation of direct/indirect jobs
Trade volume	SAF trade volume data
Return on investment	Profit from producers

Public opinion	Public surveys results
Investment expenditures (fields, storage, equipment, etc)	Investment data
Total Biofuel profits	Profit from producers
Total investments on SAFs	Investment data
Bioenergy potential (Mass or Energy that could potentially be obtained per year)	Technical potential estimation in EU-28
Production surface land for SAF used within the EU in a certain year	EU-28 land-use feedstock certification data

3. SAF Use Data State of the Art

3.1 Regulatory background

The following regulatory backgrounds and reporting obligations in Europe affecting SAF have been identified:

- ➢ Related to supply:
  - ✓ **EU Regulation on Energy Statistics**:
    - ➢ States reporting to Eurostat
  - ✓ **Renewable Energy Directive (RED):**
    - ➢ States reporting to the EC.
    - ➢ EC reporting to the EU parliament & Council.
    - ➢ Sustainability Certification Schemes: annual reports to the EC.
  - ✓ **Fuel Quality Directive**:
    - ➢ States reporting to the European Environmental Agency.
    - ➢ Fuel operators reporting to Member States (national databases).
  - ✓ **UNFCCC GHG emissions reporting EU regulation**:
    - ➢ States reporting to the EC.
- ➢ Related to final use:
  - ✓ **EU ETS/CORSIA**: airlines reporting obligation.
  - ✓ **ICAO Form M**: States reporting obligation.

Each of those obligations and reference regulations are detailed below.

3.2 Statistics Reporting Obligations to Eurostat

Eurostat is the statistical office of the European Union, situated in Luxembourg. Collects data from Member States under Regulation (EC) No 1099/2008 on Energy Statistics[9].

Eurostat's mission is 'to be the leading provider of high-quality statistics on Europe' and aims to provide other European institutions and the governments of the EU Member States with the information needed to design, implement, monitor and evaluate EU policies;

Eurostat collects and publicly discloses statistics regarding energy, and renewable energy in Europe (EU-28), which include among others, biofuels and the renewable part of waste.

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[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008R1099&from=EN

3.2.1 Energy statistics in Europe and Eurostat database

Eurostat collects, processes and publishes annual and monthly energy statistics on quantities of numerous energy commodities, both primary (e.g. crude oil, natural gas, hard coal, etc.) as well as secondary (e.g. motor gasoline, gas/diesel oil, coke, patent fuels, etc.). The 2017 edition of the *Quality report of European Union Energy Statistics* has been the consulted reference for the below analysis.

Collected statistics (most are joint collections with the International Energy Agency, IEA) cover essentially the production, transformation and consumption of numerous energy commodities; details on external trade of energy commodities and structural characteristics of the energy industry are also included. The annual Energy Balances of the Member States and the EU are the key output of this data collection.

This statistics module provides valuable information on the structure of the energy systems across the EU; it allows monitoring of major EU and national energy policies and targets (energy dependency, penetration of renewable energy sources, energy efficiency) while it contributes significantly in assessing the carbon dioxide annual emission inventories.

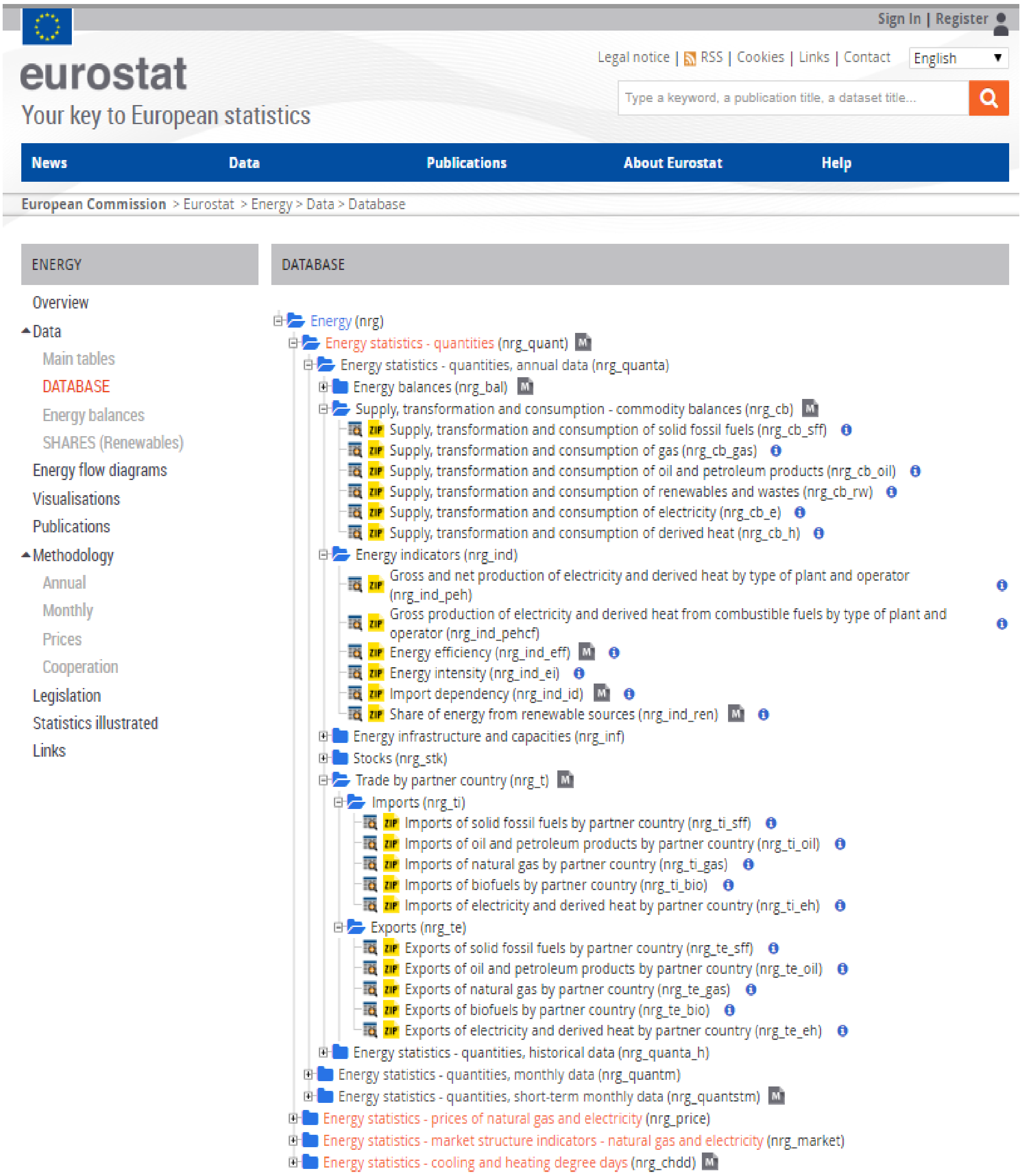
Some energy data are reported monthly but oil and petroleum products as well as renewable energy and wastes statistics are reported annually.

In order to fill out the questionnaires of the EU data collections with the required data, countries use their own data collections, sources and aggregation methods : Some countries' internal data collections are structured according to the phase of the supply chain (production, imports, exports, consumption, etc.), whereas other countries use different data collection methods depending on the type of fuel (liquid, solid, electricity and heat, renewables, etc.). Mixed approaches are also found.

There are two main ways used by States to collect data:

- ✓ Administrative data collection
- ✓ Data collection (voluntary or mandatory) through survey

Administrative data collection is the set of activities involved in the collection, processing, storage and dissemination of statistical data from one or more administrative sources (for example, EU ETS, customs data or business registers). The equivalent of a survey but with the source of data being administrative records rather than direct contact with respondents.



- Energy (nrg)
  - Energy statistics - quantities (nrg_quant)
    - Energy statistics - quantities, annual data (nrg_quanta)
      - Energy balances (nrg_bal)
      - Supply, transformation and consumption - commodity balances (nrg_cb)
        - Supply, transformation and consumption of solid fossil fuels (nrg_cb_sff)
        - Supply, transformation and consumption of gas (nrg_cb_gas)
        - Supply, transformation and consumption of oil and petroleum products (nrg_cb_oil)
        - Supply, transformation and consumption of renewables and wastes (nrg_cb_rw)
        - Supply, transformation and consumption of electricity (nrg_cb_e)
        - Supply, transformation and consumption of derived heat (nrg_cb_h)
      - Energy indicators (nrg_ind)
        - Gross and net production of electricity and derived heat by type of plant and operator (nrg_ind_peh)
        - Gross production of electricity and derived heat from combustible fuels by type of plant and operator (nrg_ind_pehcf)
        - Energy efficiency (nrg_ind_eff)
        - Energy intensity (nrg_ind_ei)
        - Import dependency (nrg_ind_id)
        - Share of energy from renewable sources (nrg_ind_ren)
      - Energy infrastructure and capacities (nrg_inf)
      - Stocks (nrg_stk)
      - Trade by partner country (nrg_t)
        - Imports (nrg_ti)
          - Imports of solid fossil fuels by partner country (nrg_ti_sff)
          - Imports of oil and petroleum products by partner country (nrg_ti_oil)
          - Imports of natural gas by partner country (nrg_ti_gas)
          - Imports of biofuels by partner country (nrg_ti_bio)
          - Imports of electricity and derived heat by partner country (nrg_ti_eh)
        - Exports (nrg_te)
          - Exports of solid fossil fuels by partner country (nrg_te_sff)
          - Exports of oil and petroleum products by partner country (nrg_te_oil)
          - Exports of natural gas by partner country (nrg_te_gas)
          - Exports of biofuels by partner country (nrg_te_bio)
          - Exports of electricity and derived heat by partner country (nrg_te_eh)
      - Energy statistics - quantities, historical data (nrg_quanta_h)
    - Energy statistics - quantities, monthly data (nrg_quantm)
    - Energy statistics - quantities, short-term monthly data (nrg_quantstm)
  - Energy statistics - prices of natural gas and electricity (nrg_price)
  - Energy statistics - market structure indicators - natural gas and electricity (nrg_market)
  - Energy statistics - cooling and heating degree days (nrg_chdd)

Figure 6 Eurostat database

3.2.1.1 The ENERGY database is available on the Eurostat portal[10]. Relevant EU statistics datasets

This database includes among others, the following relevant statistics datasets:

- **Supply, transformation and consumption of oil and petroleum products**

  Products (Eurostat dissemination codes): **Kerosene type jet fuel** (O4661). **Kerosene-type jet fuel** (excluding biofuel portion) (O4661XR5230B); **Blended bio jet kerosene** (R5230B).

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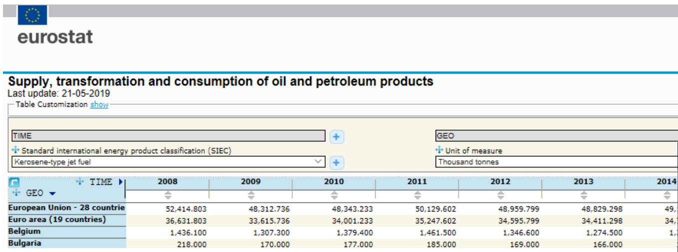
[10] https://ec.europa.eu/eurostat/web/energy/data/database

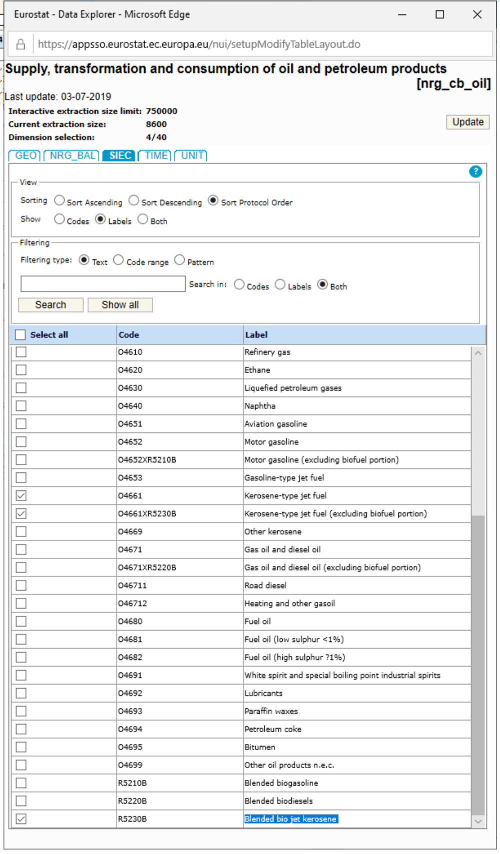
Unit: Thousand tonnes
Energy balance: Final consumption – energy use



Supply, transformation and consumption of oil and petroleum products
Last update: 21-05-2019
Table Customization show

TIME
Standard international energy product classification (SIEC): Kerosene-type jet fuel
GEO
Unit of measure: Thousand tonnes
Energy balance: Final consumption - energy use

GEO / TIME	2008	2009	2010	2011	2012	2013	2014
European Union - 28 countrie	52,414.803	48,312.736	48,343.233	50,129.602	48,959.799	48,829.298	49,
Euro area (19 countries)	36,631.803	33,615.736	34,001.233	35,247.602	34,595.799	34,411.298	34,
Belgium	1,436.100	1,307.300	1,379.400	1,461.500	1,346.600	1,274.500	1,
Bulgaria	218.000	170.000	177.000	185.000	169.000	166.000	



https://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do

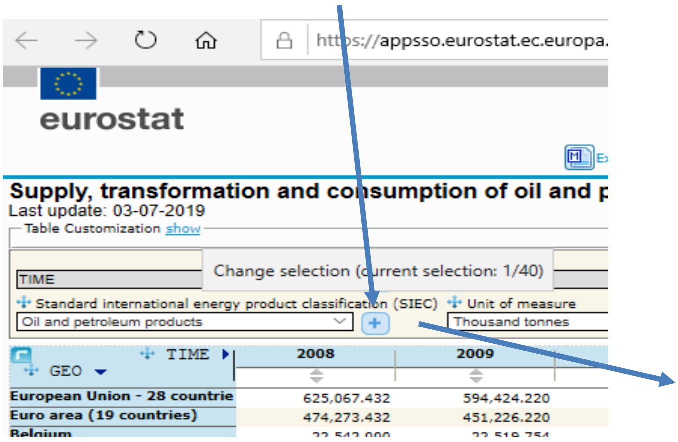
Supply, transformation and consumption of oil and petroleum products [nrg_cb_oil]
Last update: 03-07-2019
Interactive extraction size limit: 750000
Current extraction size: 8600
Dimension selection: 4/40

View
Sorting ○ Sort Ascending ○ Sort Descending ● Sort Protocol Order
Show ○ Codes ● Labels ○ Both

Filtering
Filtering type: ● Text ○ Code range ○ Pattern
Search in: ○ Codes ○ Labels ● Both

☐ Select all	Code	Label
☐	O4610	Refinery gas
☐	O4620	Ethane
☐	O4630	Liquefied petroleum gases
☐	O4640	Naphtha
☐	O4651	Aviation gasoline
☐	O4652	Motor gasoline
☐	O4652XR5210B	Motor gasoline (excluding biofuel portion)
☐	O4653	Gasoline-type jet fuel
☑	O4661	Kerosene-type jet fuel
☑	O4661XR5230B	Kerosene-type jet fuel (excluding biofuel portion)
☐	O4669	Other kerosene
☐	O4671	Gas oil and diesel oil
☐	O4671XR5220B	Gas oil and diesel oil (excluding biofuel portion)
☐	O46711	Road diesel
☐	O46712	Heating and other gasoil
☐	O4680	Fuel oil
☐	O4681	Fuel oil (low sulphur <1%)
☐	O4682	Fuel oil (high sulphur ?1%)
☐	O4691	White spirit and special boiling point industrial spirits
☐	O4692	Lubricants
☐	O4693	Paraffin waxes
☐	O4694	Petroleum coke
☐	O4695	Bitumen
☐	O4699	Other oil products n.e.c.
☐	R5210B	Blended biogasoline
☐	R5220B	Blended biodiesels
☑	R5230B	Blended bio jet kerosene

Note: To access those datasets the selection of products should be changed



Supply, transformation and consumption of oil and p
Last update: 03-07-2019
Table Customization show

TIME
Standard international energy product classification (SIEC): Oil and petroleum products
Unit of measure: Thousand tonnes

GEO / TIME	2008	2009
European Union - 28 countrie	625,067.432	594,424.220
Euro area (19 countries)	474,273.432	451,226.220

Codes are according to **Standard International Energy Product Classification** (SIEC)[11]

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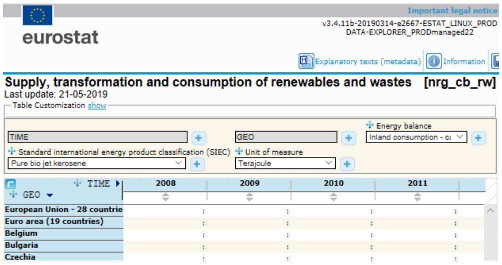
[11] https://unstats.un.org/unsd/classifications/Family/Detail/2007

The datasheets referred below are prepared to include "***pure bio jet kerosene***" (code: R5230P) but today those are **empty**. It should be noted that excludes non bio-based SAF.

- **Supply, transformation and consumption of renewables and wastes:**



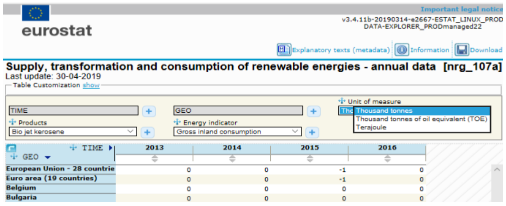
Supply, transformation and consumption of renewables and wastes [nrg_cb_rw]
Last update: 21-05-2019

TIME
GEO
Energy balance: Inland consumption - c
Standard international energy product classification (SIEC): Pure bio jet kerosene
Unit of measure: Terajoule

GEO \ TIME	2008	2009	2010	2011
European Union - 28 countrie	:	:	:	:
Euro area (19 countries)	:	:	:	:
Belgium	:	:	:	:
Bulgaria	:	:	:	:
Czechia	:	:	:	:

Product: Pure bio jet kerosene.
Unit: Terajoule
Energy balance: Inland consumption – calculated

- **Supply, transformation and consumption of renewable energies - annual data:**



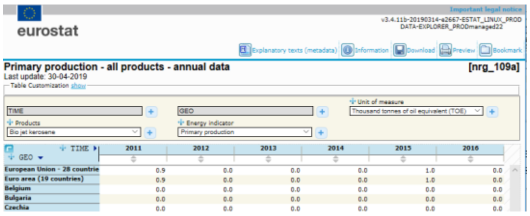
Supply, transformation and consumption of renewable energies - annual data [nrg_107a]
Last update: 30-04-2019

TIME
GEO
Unit of measure: Thousand tonnes / Thousand tonnes of oil equivalent (TOE) / Terajoule
Products: Bio jet kerosene
Energy indicator: Gross inland consumption

GEO \ TIME	2013	2014	2015	2016
European Union - 28 countrie	0	0	-1	0
Euro area (19 countries)	0	0	-1	0
Belgium	0	0	0	0
Bulgaria	0	0	0	0

Product: Bio jet kerosene.
Unit: Thousand tonnes of oil equivalent (TOE) / Thousand tonnes / Terajoule
Energy indicator: Gross inland consumption

- **Primary production - all products - annual data:**



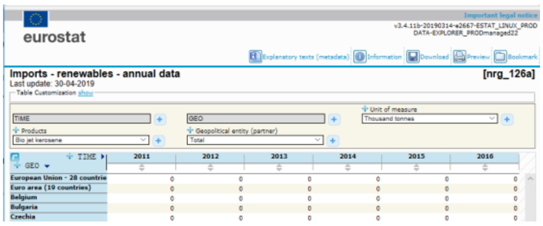
Primary production - all products - annual data [nrg_109a]
Last update: 30-04-2019

TIME
GEO
Unit of measure: Thousand tonnes of oil equivalent (TOE)
Products: Bio jet kerosene
Energy indicator: Primary production

GEO \ TIME	2011	2012	2013	2014	2015	2016
European Union - 28 countrie	0.9	0.0	0.0	0.0	1.0	0.0
Euro area (19 countries)	0.9	0.0	0.0	0.0	1.0	0.0
Belgium	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria	0.0	0.0	0.0	0.0	0.0	0.0
Czechia	0.0	0.0	0.0	0.0	0.0	0.0

Product: Bio jet kerosene.
Unit: Thousand tonnes of oil equivalent (TOE) / Thousand tonnes / Terajoule
Energy indicator: Primary production

- **Imports - renewables - annual data:**



Imports - renewables - annual data [nrg_126a]
Last update: 30-04-2019

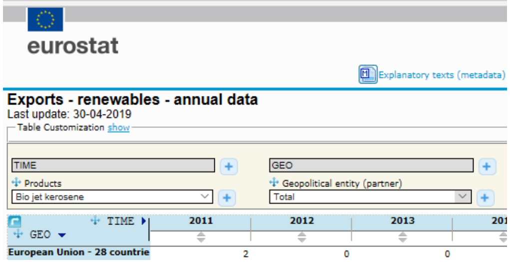
TIME
GEO
Unit of measure: Thousand tonnes
Products: Bio jet kerosene
Geopolitical entity (partner): Total

GEO \ TIME	2011	2012	2013	2014	2015	2016
European Union - 28 countrie	0	0	0	0	0	0
Euro area (19 countries)	0	0	0	0	0	0
Belgium	0	0	0	0	0	0
Bulgaria	0	0	0	0	0	0
Czechia	0	0	0	0	0	0

Product: Bio jet kerosene.
Unit: Thousand tonnes

- **Exports - renewables - annual data:**

Product: Bio jet kerosene.
Unit: Thousand tonnes



Exports - renewables - annual data
Last update: 30-04-2019

TIME
GEO
Products: Bio jet kerosene
Geopolitical entity (partner): Total

GEO \ TIME	2011	2012	2013	201
European Union - 28 countrie	2	0	0	

3.3 Reporting under the Renewable Energy Directive (RED)

The Renewable Energy Directive (RED - Directive 2009/28/EC)[12] mandates that 20% of all energy usage in the EU, including at least 10% of all energy in transport fuels, be produced from renewable sources by 2020. The revised RED II (Directive (EU) 2018/2001)[13] increases from 10% in 2020 to 14% in 2030, the percentage of renewable energy to be used in transport.

The RED does not apply directly to the economic operators but puts an obligation on the European Member States. In 2010, all European Union member states were required to submit a National Renewable Energy Action Plan (NREAP) that detailed how they intended to meet their contribution to the RED Reporting obligations.

In general, Member States have imposed requirements on transport fuel suppliers to supply renewable energy, including biofuels for transport, such as mandatory blend percentages. The renewable fraction of those blends, need to comply with several sustainability requirements, as detailed in section 5.3 of this report.

Economic operators must show Member States that the RED sustainability criteria have been met. They can do this in three ways:

1. By providing the relevant national authority with data, in compliance with requirements that the Member State has laid down (a 'national system' administered by a Member State);
2. By using a 'voluntary scheme' that the Commission has recognised for the purpose;
3. In accordance with the terms of a bilateral or multilateral agreement concluded by the Union with third countries and which the Commission has recognised for the purpose.

All should certify according to the same EU RED rules.

The EC requests voluntary schemes to go through an "approval process" in order to be able to operate, and it offers this process as an option for national schemes if those want to access to mutual recognition all over the EU, in the same conditions as a voluntary scheme.

MS have the possibility to set up a national scheme, but they are not required by the EC to get an approval in order to start to operate (EC though can issue recommendations on national schemes if it has misgivings about their accuracy).

For the certification process, an external auditor verifies the whole production chain and sustainability certificates should flow from the feedstock producer to the biofuel producer or trader. The RED establishes the obligation at economic operators' level to calculate GHG emissions reductions on a life-cycle basis (and based on a specific methodology established in the RED regulation) and to include it in the sustainability certificates for each single batch of biofuel brought to the market.

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[12] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0028

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

The Life-Cycle CO_2 emissions values of certified fuel can be extracted from those certificates, but currently there is no requirement under the Renewable Energy Directives (RED and RED II) referred above to report such values.

The Renewable Energy Directives establishes reporting obligations to:

- ✓ The Member States
- ✓ The European Commission
- ✓ The EC approved Sustainability Certification Schemes

3.3.1 Reporting obligations from Member States

Member States' have obligations under the RED to draft renewable energy progress reports. Those obligations are referred in RED Article 22 -*Reporting by the Member States*- and in RED II Chapter 4 -*Reporting*-. Every two years, each Member State shall report to the Commission on the progress in the promotion and use of energy coming from renewable sources (implementation of its *integrated national energy and climate plan*) by means of an *integrated national energy and climate progress report*.

Error! Reference source not found. of this report includes detail of RED and RED II reporting bligations applicable to transportation. Among others, MS´s are requested to report on the:

- ➢ Estimation of the net greenhouse gas emission savings due to the employment of the energy from renewable sources;

But this GHG emissions savings is reported at an aggregated data, therefore not disaggregated by sectors or energy types. In order to mainstream the use of renewable energy in the transport sector, each Member State shall set an obligation on fuel suppliers to ensure that the share of renewable energy within the final consumption of energy in the transport sector is at least 14 % by 2030 (minimum share). Member States shall take measures to ensure that economic operators submit reliable information regarding the compliance with the greenhouse gas emissions savings thresholds set in the RED and RED II, and with the sustainability criteria and that they make available to the relevant Member State, upon request, the data that were used to develop the information.

The report shall detail, among other information, the level of fulfilment of the % share objective of energy from renewable sources in the transport sector, but without providing detailed breakdown of the types of renewable liquid fuels used nor its associated GHG emissions.

Member States shall submit this information, in aggregated form, to the Commission which shall publish it in summary form preserving the confidentiality of commercially sensitive information.

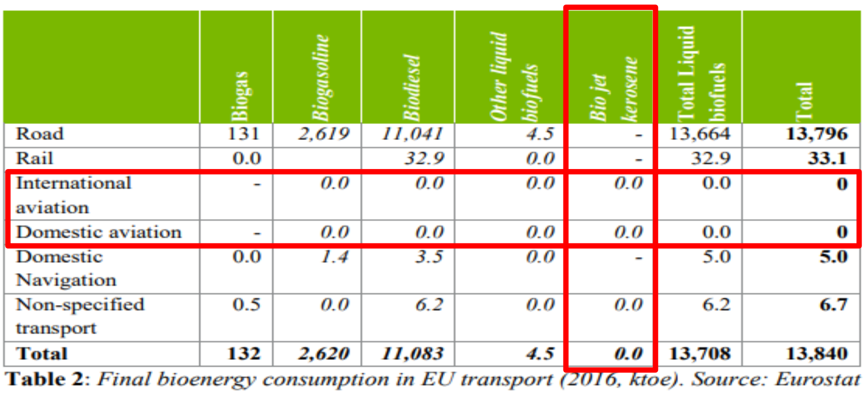
The current RED reporting obligations from Member States, thus, does not offer relevant information needed for the development of a process to monitor and report on characteristics (including CO_2 savings) of SAF used in Europe.

3.3.2 Reporting obligations to the European Commission

The Commission is required by the RED to report annually (to the European Parliament, the Council, the European Economic and Social Committee and The Committee of the Regions) on the production patterns of biofuels and on the impact of the demand for biofuels: *Renewable Energy Progress Report*[14].

It includes an assessment of the Impacts of biofuels consumed in the EU, including SAF, and differentiating between International and domestic aviation, which could be a useful source of SAF monitoring data in the EU.

Table 7 Annual RED Reporting Table from the EC



	Biogas	Biogasoline	Biodiesel	Other liquid biofuels	Bio jet kerosene	Total Liquid biofuels	Total
Road	131	*2,619*	*11,041*	*4.5*	-	13,664	**13,796**
Rail	0.0		*32.9*	*0.0*	-	32.9	**33.1**
International aviation	-	*0.0*	*0.0*	*0.0*	*0.0*	0.0	**0**
Domestic aviation	-	*0.0*	*0.0*	*0.0*	*0.0*	0.0	**0**
Domestic Navigation	0.0	*1.4*	*3.5*	*0.0*	-	5.0	**5.0**
Non-specified transport	0.5	*0.0*	*6.2*	*0.0*	*0.0*	6.2	**6.7**
Total	**132**	***2,620***	***11,083***	***4.5***	***0.0***	**13,708**	**13,840**

Table 2: *Final bioenergy consumption in EU transport (2016, ktoe). Source: Eurostat*

The 2019 document includes zero bio jet kerosene reported.

Nevertheless, it should be noted here that even though on a country level no SAF volumes are reported, it can still happen that SAF is supplied. This has to do with the "bioticket" system in some States (UK and The Netherlands), where SAF supply is not obliged but can contribute to fuel suppliers' road obligations.

The Renewable Energy Progress Report provides the latest insights into progress made towards the EU targets for renewable energy (currently the 2020 targets) and addresses other European Commission reporting obligations under RED.

The statistics on energy transmitted by Member States to Eurostat (under Regulation EC No 1099/2008 on energy statistics) are used as primary data source for evaluating progress towards the EU targets and the reports builds on the Member States biannual renewable energy progress reports, as well as complementary technical analysis made by the EC.

3.3.3 Reporting obligations from Sustainability Certification Schemes (SCS)

The so-called ILUC Directive (EU) 2015/1513[15] introduced a requirement for recognised voluntary schemes to report annually to the Commission with the aim to increase transparency and the

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[14] https://ec.europa.eu/commission/sites/beta-political/files/report-progress-renewable-energy-april2019_en.pdf

[15] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L1513&from=ES

information available on the operation of the Voluntary Sustainability Certification Schemes (SCS) already recognised by the European Commission (EC), to improve oversight by the Commission.

Such reports should be made public on the EC transparency platform[16] in order to increase transparency and to improve supervision by the Commission.

Voluntary schemes help to ensure that biofuels are sustainably produced by verifying that they comply with the EU sustainability criteria. As such, the schemes check that:

- ✓ Production of biofuel feedstock does not take place on land with high biodiversity
- ✓ Land with a high amount of carbon has not been converted for biofuel feedstock production
- ✓ Biofuel production leads to sufficient greenhouse gas emissions savings

The reporting requirement applies only to voluntary schemes that have operated for at least 12 months. The EC letter of September 2015[17], explains the reporting requirements. Annex 1 of such letter includes the list of information to be reported by the voluntary schemes.

A Reporting Template has been also developed and it is accessible in the EC Voluntary Schemes webpage[18]. The data requested on such template are indicated below.

It does not include information on the carbon intensity (GHG value) of the products (fuels).

The Commission shall make the reports drawn up by the voluntary schemes available, in an aggregated form or in full if appropriate, as indicated in Article 28 of Regulation (EU) 2018/1999[19].

The reports should not include confidential information and if part of the information cannot be published - for instance for commercial reasons - this should be communicated to the EC services and the confidential information be submitted in a separate document.

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[16] https://ec.europa.eu/energy/en/renewable-energy-transparency-platform

[17] https://ec.europa.eu/energy/sites/ener/files/documents/PAM%20to%20vs%20annual%20reporting.pdf

[18] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

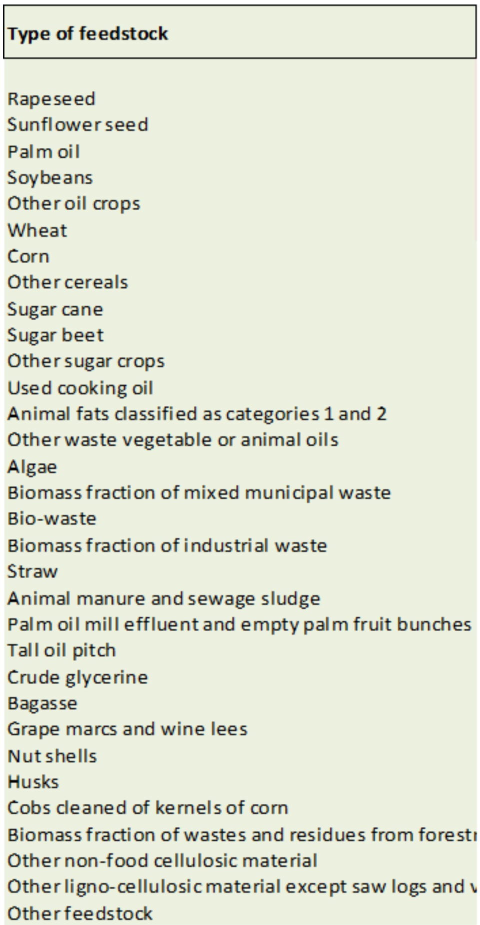
[19] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1999&from=EN

Data reported annually by SCS to the EC:

Data should be reported in thousands of metric tonnes.

- ✓ Feedstock
- ✓ Type of product
- ✓ Country of origin
- ✓ Calendar year
- ✓ Final biofuels produced (tonnes)

- ○ Biodiesel
- ○ Bioethanol
- ○ HVO
- ○ Pure vegetable o
- ○ Biomethane
- ○ FT diesel
- ○ DME
- ○ Methanol
- ○ Other



Type of feedstock
Rapeseed
Sunflower seed
Palm oil
Soybeans
Other oil crops
Wheat
Corn
Other cereals
Sugar cane
Sugar beet
Other sugar crops
Used cooking oil
Animal fats classified as categories 1 and 2
Other waste vegetable or animal oils
Algae
Biomass fraction of mixed municipal waste
Bio-waste
Biomass fraction of industrial waste
Straw
Animal manure and sewage sludge
Palm oil mill effluent and empty palm fruit bunches
Tall oil pitch
Crude glycerine
Bagasse
Grape marcs and wine lees
Nut shells
Husks
Cobs cleaned of kernels of corn
Biomass fraction of wastes and residues from forest
Other non-food cellulosic material
Other ligno-cellulosic material except saw logs and
Other feedstock

There is only one national scheme (Austria) that is on the list of EC recognized schemes and thus is recognized in all EU, but other national systems are in place and do not report to the EC, so that information would be missed if SCS reporting were used to monitor SAF use.

Annual reports from voluntary schemes to the EC do not provide information on GHG values (carbon intensity) and in any case would not be able to provide a complete information regarding all sustainability certified SAF supplied in Europe, as there are other ways (as indicated in section 3.3) for verifying sustainability, mainly national systems, which are not included in the above reporting obligation to the EC.

3.3.4 The Union Database

There are some articles (reflected below) within the Directive 2018/2001 (RED II) establishing that a Union database should be put in place to enable the tracing of liquid and gaseous transport fuels that are eligible for being counted under the scope of the directive and to ensure transparency and traceability of renewable fuels. While Member States should be allowed to continue to use or establish national databases, those national databases should be linked to the Union database, in order to ensure instant data transfers and harmonisation of data flows.

The referred RED II articles are:

(84). A Union database should be put in place to ensure transparency and traceability of renewable fuels. While Member States should be allowed to continue to use or establish national databases, those national databases should be linked to the Union database, in order to ensure instant data transfers and harmonisation of data flows.

Art 28

2. The Commission shall ensure that a Union database is put in place to enable the tracing of liquid and gaseous transport fuels that are eligible for being counted towards the numerator referred to in point (b) of Article 27(1) or that are taken into account for the purposes referred to in points (a), (b), and (c) of the first subparagraph of Article 29(1). Member States shall require the relevant economic operators to enter into that database information on the transactions made and the sustainability characteristics of those fuels, including their life-cycle greenhouse gas emissions, starting from their point of production to the fuel supplier that places the fuel on the market. A Member State may set up a national database that is linked to the Union database ensuring that information entered is instantly transferred between the databases.

Fuel suppliers shall enter the information necessary to verify compliance with the requirements laid down in the first and fourth subparagraphs of Article 25(1) into the relevant database.

4. Member States shall have access to the Union database referred to in paragraph 2 of this Article. They shall take measures to ensure that economic operators enter accurate information into the relevant database. The Commission shall require the schemes that are the subject of a decision pursuant to Article 30(4) of this Directive to verify compliance with that requirement when checking compliance with the sustainability criteria for biofuels, bioliquids and biomass fuels. It shall publish, every two years, aggregated information from the Union database pursuant to Annex VIII to Regulation (EU) 2018/1999.

RED II Article 27(1) states that all types of energy from renewable sources supplied to all transport sectors shall be taken into account. Member States may also take into account recycled carbon fuels. All types of SAF (including non bio-based) are to be reported in the future Union Database.

Member States shall have access to the Union database and require the relevant economic operators to provide information on the SAF supplied and its respective sustainability characteristics, including their carbon intensity greenhouse gas emission values, starting from their point of production to the fuel supplier that places the fuel on the market.

It might be expected that economic operators will work within the framework of their respective national databases, and data will be then conveyed from those to the Union Database afterwards (by the national entity in charge of the certification process).

3.3.4.1 Potential of the Union Database for SAF use and GHG monitoring

This Union database could be in the future a key element for the development of a process to monitor and report on characteristics of SAF used in Europe, as could collect the necessary data to support PIs on SAF use, and their associated emissions reductions as contained on the sustainability certificates (including GHG Life-Cycle assessment).

3.3.4.2 Development of the Union Database

As per information provided by the EC DG ENER in Brussels during the stakeholders meeting held in June 18 as referred in section 4.3, (SAF Use Stakeholders informal group discussion), such a Union Database is still at a very early development stage, pending the launch of a tender to perform a feasibility study on how it will be developed. There is no fixed deadline for the Commission to put this database in place and according to DG ENER, they do not, at this stage, have very well developed views about what data it might contain. However, it clearly provides a main potential vehicle for collecting information on the use of SAF in Europe.

The responsible department for developing the Union Database is DG ENER Unit C1 - Renewable Energy and CCS Policy. The DG JRC and EASA will be consulted during the development process.

DG ENER has offered the possibility to have exchanges with the Unit C1 in order to update the EASA plans to establish a process to monitor and report on characteristics of SAF used in Europe and consider such plans in the Union Database technical definition.

EASA and Unit C1 had a first meeting in Brussels on September 17th that established an initial channel for information exchange regarding the identification of potential Union Database future needs for renewable fuels monitoring, as result of this scoping study.

A number of suggestions for consideration on the design and development of the future RED II Union Database (UDat), are included in the final chapter 9.4 (recommendations), made based on expert´s peer-review feedback. The consultation was made for SAF monitoring, but most suggestions are applicable to any other sustainable fuels. It is proposed to share it with DG ENER Unit C1 for their consideration.

3.4 Reporting under the European Fuel Quality Directive (FQD)

Alongside the RED, an amended Fuel Quality Directive (FQD) (Dir. 2009/30/EC)[20] was passed requiring that, by 2020, the fuel and energy supplied in the EU should be 6% less carbon intensive. FQD imposes the requirements on fuel suppliers to report life cycle greenhouse gas emissions per unit of energy supplied.

Currently FQD scope (Article 1) **does not include aviation fuels** and is limited to the following transportation fuels: *Road vehicles, and non-road mobile machinery (including inland waterway vessels when not at sea), agricultural and forestry tractors, and recreational craft when not at sea*.

Nevertheless, its current reporting obligations are generic to all types of fuels so could easily cover SAF reporting needs if a simple change in FQD scope could be made to include aviation among its Article 7a reporting obligations.

The reporting obligations indicated below are for the current FQD scope and thus, do not include SAF nor other aviation fuels.

3.4.1 Reporting obligations from fuel suppliers

Article 7a requires suppliers to report annually, to the authority designated by the Member State, on the greenhouse gas intensity of fuel and energy supplied within each Member State by providing information on:

- ✓ *The total volume of each type of fuel or energy supplied, indicating where purchased and its origin.*

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[20] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0030&from=EN

- ✓ *And the life cycle greenhouse gas emissions per unit of energy (calculated in accordance to the EU RED methodology).*

Member States need to ensure that reports are subject to verification.

3.4.2 Reporting obligations from Member States

The FQD implementing Directive 2015/652/EU specifies in Article 5 and Annex III that Member States have to report the data showing the GHG reductions by means of electronic data transfer to the Central Data Repository[1] managed by the European Environment Agency. Member States have to report the data showing these reductions by using the ReportNet Tools[1] of the Agency.

The Central Data Repository is not a database, but just a documentary repository where each State places their respective reports.

Although initially the greenhouse gas intensity objectives of fuel supplied end in 2020, the reporting requirement does not end, which means that **the total volume of each type of fuel or energy supplied and the life cycle GHG emissions per unit of energy will have to be reported beyond 2020**. However, recent Regulation 2018/1999[1] has eliminated the obligation of reporting on the origin and place of purchase of fuels from the FQD**.**

By 31st of August each year the Member States must submit a summary of fuel quality monitoring data collected during the period January to December of the previous calendar year, in accordance with Article 8(1) of Directive 98/70/EC as amended by Directive 2009/30/EC. The delivery process is managed by European Environmental Agency.

The data to be reported annually after 2020 by the Member States to the EC (as per Annex III) are:

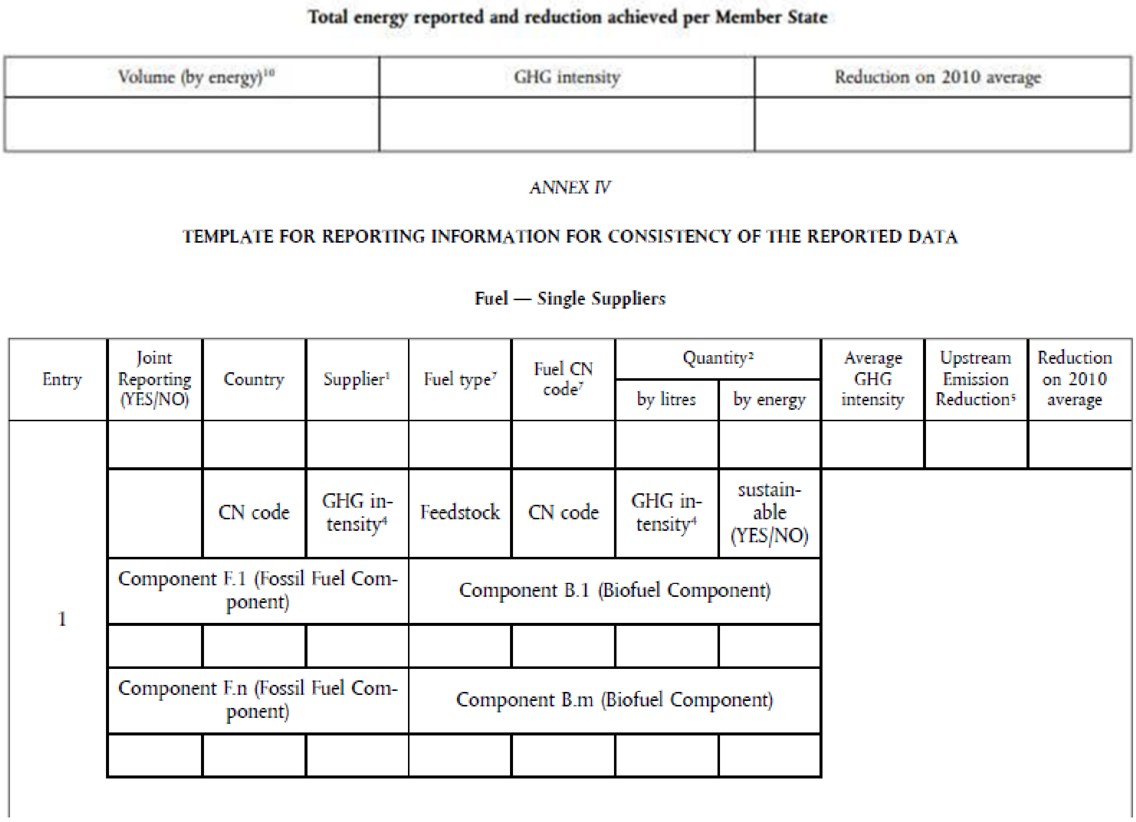
1. By 31 December each year, Member States are to report the data listed in point 3. These data must be reported for all fuel and energy placed on the market in each Member State. Where multiple biofuels are blended with fossil fuels, the data for each biofuel must be provided.

2. The data listed in point 3 are to be reported separately for fuel or energy placed on the market by suppliers within a given Member State (including joint suppliers operating in a single Member State).

3. For each fuel and energy, Member States are to report the following data to the Commission, as aggregated according to point 2 and as defined in Annex I:

(a) Fuel or energy type;
(b) Volume or quantity of fuel or electricity;
***(c) Greenhouse gas intensity**;*

Both fuel suppliers and Member States must use the reporting template included in Annex IV and shown below:



Total energy reported and reduction achieved per Member State

Volume (by energy)[10]	GHG intensity	Reduction on 2010 average

ANNEX IV

TEMPLATE FOR REPORTING INFORMATION FOR CONSISTENCY OF THE REPORTED DATA

Fuel — Single Suppliers

Entry	Joint Reporting (YES/NO)	Country	Supplier[1]	Fuel type[7]	Fuel CN code[7]	Quantity[2]		Average GHG intensity	Upstream Emission Reduction[5]	Reduction on 2010 average
						by litres	by energy			
1										
		CN code	GHG intensity[4]	Feedstock	CN code	GHG intensity[4]	sustainable (YES/NO)			
	Component F.1 (Fossil Fuel Component)			Component B.1 (Biofuel Component)						
	Component F.n (Fossil Fuel Component)			Component B.m (Biofuel Component)						

➨ **Figure 7** Reporting template under FQD Implementing Directive (2015/652/EU)

Member States have brought into force the laws, regulations and administrative provisions necessary to comply with this Directive, although in some States this has been done with some delay with respect to the deadline of 21 April 2017 set in the implementing Directive 2015/652/EU.

SAF data will not be available through this directive as per its today´s scope, but its reporting requirements have the potential to provide a complete SAF data stream including supply volumes and GHG emissions values, if its scope would be amended to cover it.

3.5 GHG emissions reporting from EU Member States (Under UNFCCC)

The European Union (EU), as a party to the United Nations Framework Convention on Climate Change (UNFCCC), reports annually (together with Iceland) on greenhouse gas (GHG) inventories for the years between 1990 and each calendar year (t) minus two (t-2), for GHG emissions and removals within the area covered by its Member States (i.e. emissions taking place within its territory). The EU and Iceland have agreed to fulfil their quantified emission limitation and reduction jointly and they also report to UNFCCC jointly.

The legal basis for the compilation of the EU inventory is Regulation (EU) No 525/2013[21] of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC[22].

The national inventories are calculated under the UNFCCC reporting methodology. Such methodology does not consider the estimation of the life-cycle GHG emissions values (carbon intensity) from SAF use.

The use of aviation kerosene (including SAF) is reported under "domestic air traffic" in the Energy chapter, and GHG emissions are based on the fuel supplied/consumed in domestic flights. That is either calculated through modelling or Member State estimation. International flights fuel use is considered under "bunker fuels" and included for information purposes only.

Biomass-based SAF consumption (as any other biomass-based fuel) is accounted as having zero emissions, while GHG emissions produced on the different steps of the production/distribution chain, are accounted on its respective sector (agriculture, industry, transport, etc.).

IPCC has just issued the *2019 Refinement to the 2006 Guidelines for National Greenhouse Gas Inventories*, which were adopted and accepted during the 49th Session of the IPCC in May 2019[23]. Future SAF CO_2 emissions reporting from Member States should consider it. IPCC updates these guidelines only every 5-10 years.

This reporting mechanism does not provide information on the life-cycle GHG emissions savings from the use of SAF and thus is not considered a complete source of data for SAF use monitoring.

3.6 Reporting under the Emissions Trading System and CORSIA

CO_2 emissions from aviation have been included in the EU emissions trading system (EU ETS) since 2012. Under the EU ETS, aircraft operators are required to monitor, report and verify their emissions, and to surrender allowances against those emissions. They receive tradeable allowances covering a certain level of emissions from their flights per year.

The legislation, adopted in 2008, was designed to apply to emissions from flights from, to and within the European Economic Area (EEA) – the 28 EU Member States, plus Iceland, Liechtenstein and Norway. The EU, however, decided to limit the scope of the EU ETS to flights within the EEA until 2016 to support the development of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) by the International Civil Aviation Organization (ICAO).

Considering the adoption of a Resolution by the 2016 ICAO Assembly on CORSIA, the EU decided to maintain the geographic scope of the EU ETS limited to intra-EEA flights from 2017 onwards.

As such, the system is incomplete for SAF use monitoring, and as SAF supplied in Europe to flights outside the EEA might not be reported under the EU ETS by non-EU operators, which might choose to report it under CORSIA to their respective Administering State.

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[21] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R0525

[22] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&qid=1527153180542&from=EN

[23] https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

The EU ETS for aviation will be subject to a new review in the light of the international developments related to the operationalisation of CORSIA. The next review should consider how to implement the global measure in Union law through a revision of the EU ETS legislation. In the absence of a new amendment, the EU ETS would revert to its original full scope from 2024.

CORSIA aims to stabilise CO_2 emissions at 2020 levels by requiring aeroplane operators to offset the overall sector´s emissions growth from 2021.

Aeroplane operators will be required to monitor emissions on all international routes, and offset emissions from routes included in the scheme by purchasing eligible emission units generated by projects that reduce emissions in other sectors.

3.6.1 EU ETS Reporting data

3.6.1.1 Current EU ETS reporting

The aircraft operators that fall under the scope of the EU ETS need to submit Annual Emissions Reports regarding all intra-EEA flights to its respective reporting Member State.

Aircraft operators provide their annual verified EU ETS emissions report every year before 31 March to their Competent Authority (CA). Once approved by the CA, emissions are reported, either by the operator or the CA (depending on the State) in the operator's EU ETS registry account. Operators must surrender equivalent allowances by 30 April.

The use of biomass-based aviation fuels which are certified as compliant with the sustainability criteria under the RED or RED II reduce the number of allowances to be surrendered by the operators as the emissions factor from the use of biomass-based SAF is zero under the EU ETS.

It should be noted that the **EU ETS refers only to biomass-based fuels**.

3.6.1.2 Specific MRV requirements applicable to biofuels

The European Commission MRR Guidance document No.2 (Updated version 11 January 2018)[24] details the rules for the specific monitoring and reporting processes for the attribution of biomass-based SAF use to flights under the EU ETS. The Guidance states:

Where an aircraft operator carries out flights within and outside the EU ETS starting from airports where biofuels are available, the attribution might be done following two options:

Option 1: biomass-based SAF are attributed to the flights as much corresponding to real fuel consumption as possible. This requires accounting for physically traceable fuel (e.g delivered by truck); therefore, not applicable at airports with pipeline/hydrant systems.

Option 2: Simplified approach for accounting biomass-based SAF used, based on purchase records. In this case the operator has to demonstrate to the verifier and the competent authority that:

- ✓ The total amount of biomass-based SAF claimed does not exceed the total fuel used in EU ETS flights, taking into account applicable technical limits for biofuel use (maximum content of biofuel certified)

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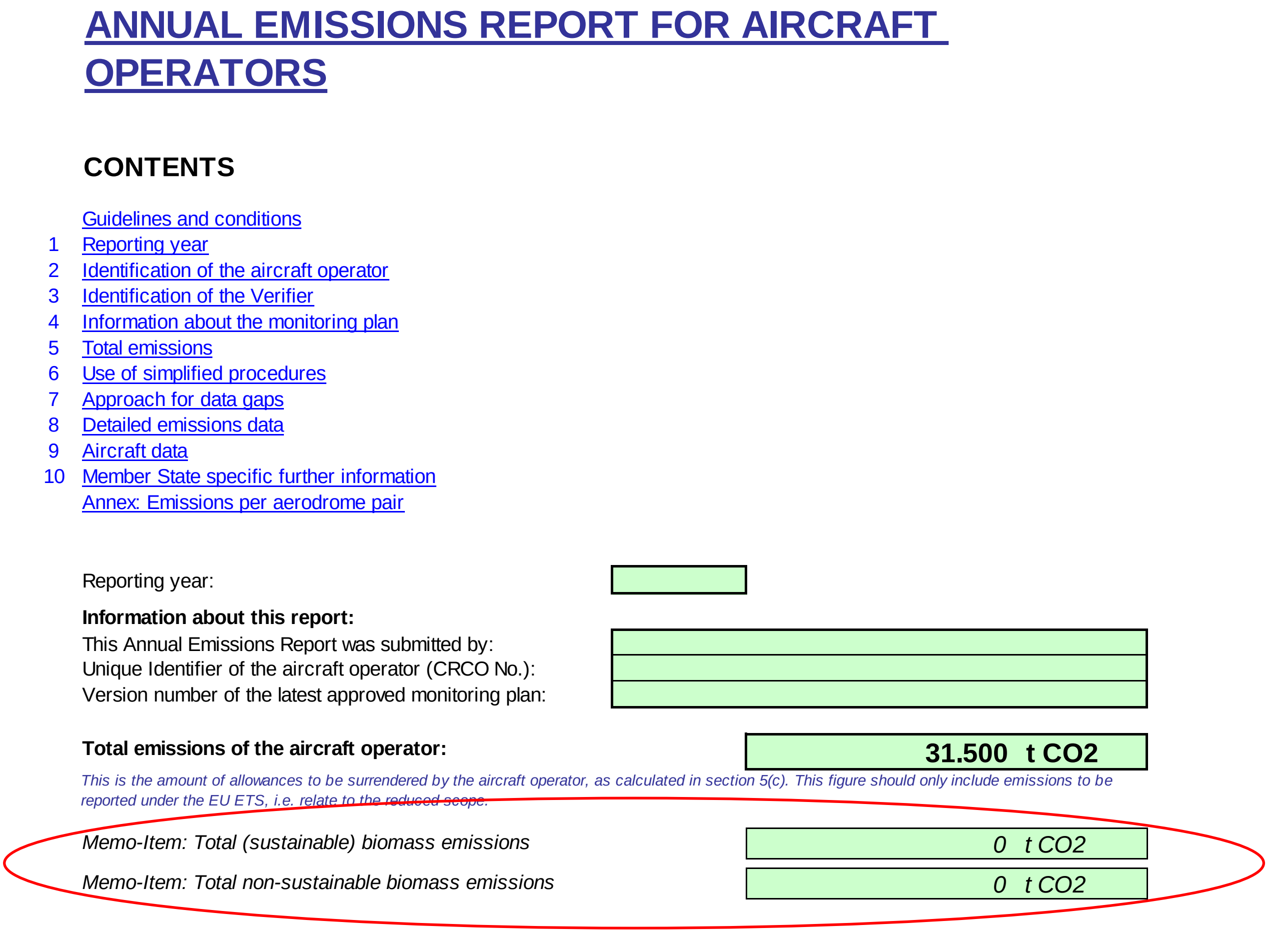
[24] https://ec.europa.eu/clima/sites/clima/files/ets/monitoring/docs/gd2_guidance_aircraft_en.pdf

- ✓ SAF accounted for under the EU ETS does not exceed the total quantity of SAF purchased minus the total quantity of biomass-based SAF sold to third parties.
- ✓ The aggregated biomass fraction in the fuel claimed does not exceed the amount of biomass proved as sustainable.
- ✓ The same amounts of biomass-based SAF have not been accounted for in other GHG regulation systems.

Operators provide the information about biomass-based SAF use in their Annual Emissions Report. The Template currently provides two memo items detailing the Total (sustainable) biomass emissions as well as the total non-sustainable biomass emissions for fuels that cannot be demonstrated to comply with the sustainability criteria and for which the biomass is therefore treated like fossil material.

The above guidance seems to leave open the option to report within the EU ETS, SAF supplied in an airport outside the EU, as the system allows a decoupling of physical fuel and the quantities of fuel accounted for in the annual emission report, by using a so-called "book & claim" system. Such flexibility renders the EU ETS System incomplete as a reliable source of a total SAF use supplied or used in Europe.

The simplified approach among the reporting options would also not ensure enough level of detail in the set of data reported, to differentiate in which specific flights (domestic / international, etc) SAF has been actually used.



ANNUAL EMISSIONS REPORT FOR AIRCRAFT OPERATORS

CONTENTS

Guidelines and conditions
1 Reporting year
2 Identification of the aircraft operator
3 Identification of the Verifier
4 Information about the monitoring plan
5 Total emissions
6 Use of simplified procedures
7 Approach for data gaps
8 Detailed emissions data
9 Aircraft data
10 Member State specific further information
Annex: Emissions per aerodrome pair

Reporting year:

Information about this report:
This Annual Emissions Report was submitted by:
Unique Identifier of the aircraft operator (CRCO No.):
Version number of the latest approved monitoring plan:

Total emissions of the aircraft operator: **31.500 t CO2**

This is the amount of allowances to be surrendered by the aircraft operator, as calculated in section 5(c). This figure should only include emissions to be reported under the EU ETS, i.e. relate to the reduced scope.

Memo-Item: Total (sustainable) biomass emissions *0 t CO2*

Memo-Item: Total non-sustainable biomass emissions *0 t CO2*

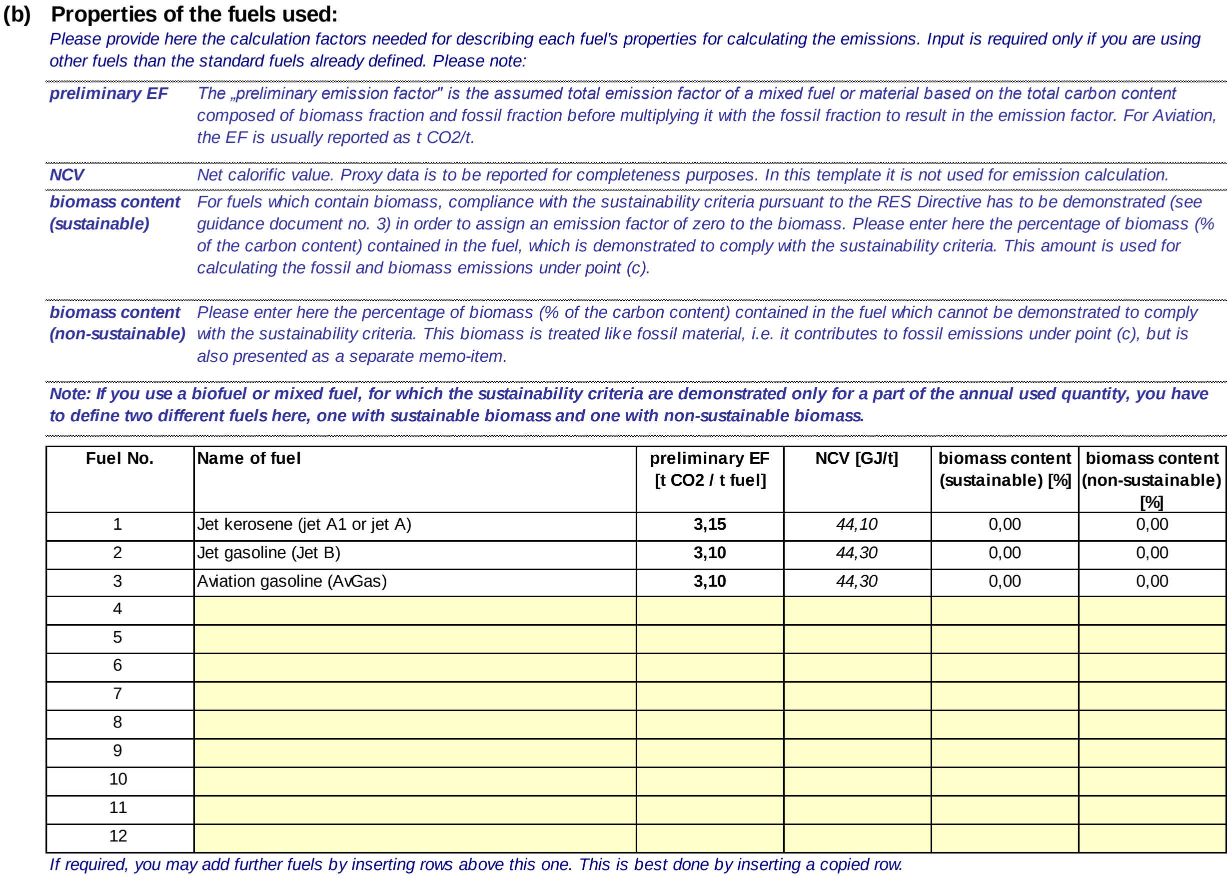
➨ **Figure 8** EU ETS Annual Emissions Report for Aircraft Operators

Operators are requested to provide information in the following sections of the Report: "***Properties of fuels used***", "***Fuel consumption and Emissions***" "***Fuel use per aircraft type***" and "***Detailed emissions data***".

Details are provided below.

Properties of fuels used: Where SAF is used the emissions factor is determined from the "*preliminary emission factor*" (see definition in the chart below) and the biomass fraction of the fuel. This ensures that mix fuels containing a defined quantity of biofuel are correctly considered.

If pure biofuels have been purchased before the blending process, the operator needs to list the pure biofuel as separate source stream.



(b) Properties of the fuels used:

Please provide here the calculation factors needed for describing each fuel's properties for calculating the emissions. Input is required only if you are using other fuels than the standard fuels already defined. Please note:

preliminary EF	*The „preliminary emission factor" is the assumed total emission factor of a mixed fuel or material based on the total carbon content composed of biomass fraction and fossil fraction before multiplying it with the fossil fraction to result in the emission factor. For Aviation, the EF is usually reported as t CO2/t.*
NCV	*Net calorific value. Proxy data is to be reported for completeness purposes. In this template it is not used for emission calculation.*
biomass content (sustainable)	*For fuels which contain biomass, compliance with the sustainability criteria pursuant to the RES Directive has to be demonstrated (see guidance document no. 3) in order to assign an emission factor of zero to the biomass. Please enter here the percentage of biomass (% of the carbon content) contained in the fuel, which is demonstrated to comply with the sustainability criteria. This amount is used for calculating the fossil and biomass emissions under point (c).*
biomass content (non-sustainable)	*Please enter here the percentage of biomass (% of the carbon content) contained in the fuel which cannot be demonstrated to comply with the sustainability criteria. This biomass is treated like fossil material, i.e. it contributes to fossil emissions under point (c), but is also presented as a separate memo-item.*

Note: If you use a biofuel or mixed fuel, for which the sustainability criteria are demonstrated only for a part of the annual used quantity, you have to define two different fuels here, one with sustainable biomass and one with non-sustainable biomass.

Fuel No.	Name of fuel	preliminary EF [t CO2 / t fuel]	NCV [GJ/t]	biomass content (sustainable) [%]	biomass content (non-sustainable) [%]
1	Jet kerosene (jet A1 or jet A)	**3,15**	*44,10*	0,00	0,00
2	Jet gasoline (Jet B)	**3,10**	*44,30*	0,00	0,00
3	Aviation gasoline (AvGas)	**3,10**	*44,30*	0,00	0,00
4					
5					
6					
7					
8					
9					
10					
11					
12					

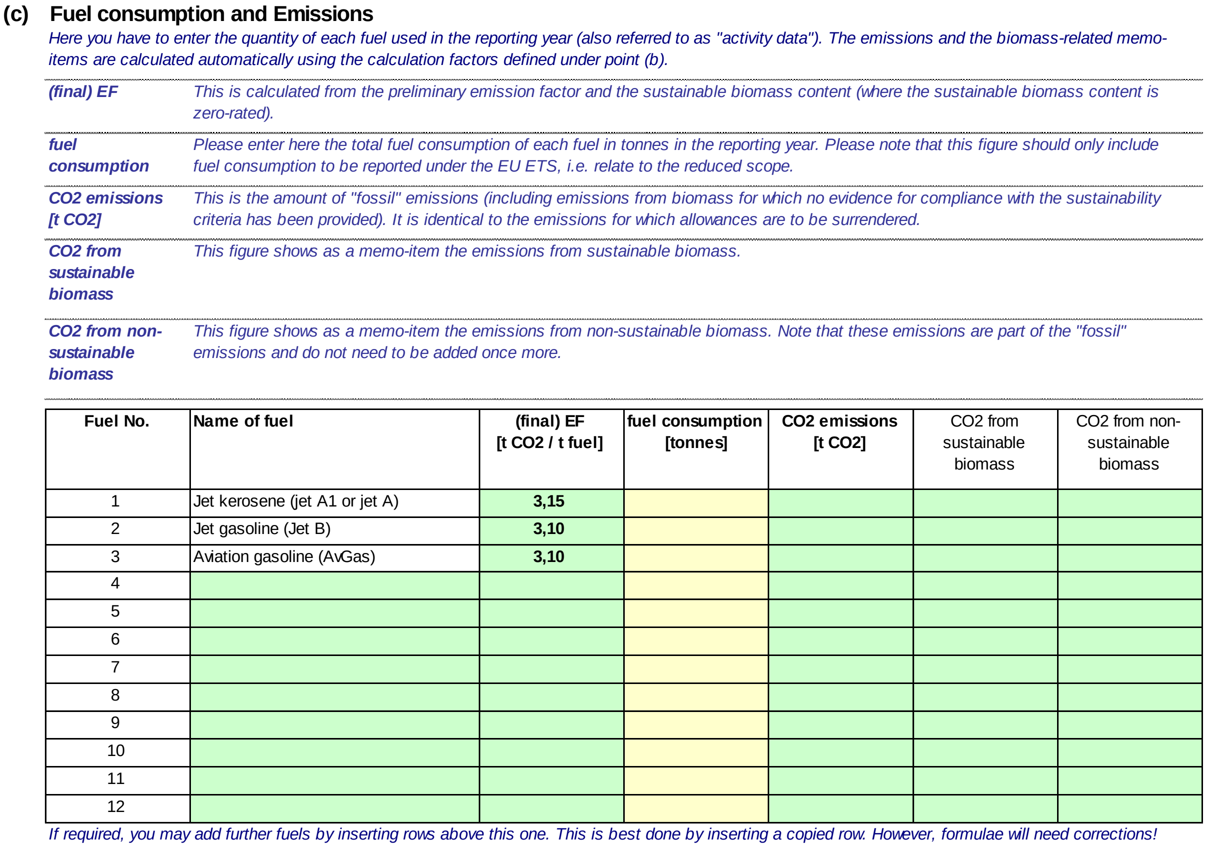
If required, you may add further fuels by inserting rows above this one. This is best done by inserting a copied row.

➨ **Figure 9** EU ETS Annual Emissions Report: Properties of the fuels used

Fuel Consumption and emissions: Once the operator has filled in the properties of fuels as described above, the operator must enter the quantity of each fuel used, including SAF.

The emissions and the biomass related memo items are calculated automatically using the factors defined in the previous point "Properties of fuels".

In the EU ETS reporting requirements, sustainable biomass content is rated as zero emissions factor.



(c) Fuel consumption and Emissions

Here you have to enter the quantity of each fuel used in the reporting year (also referred to as "activity data"). The emissions and the biomass-related memo-items are calculated automatically using the calculation factors defined under point (b).

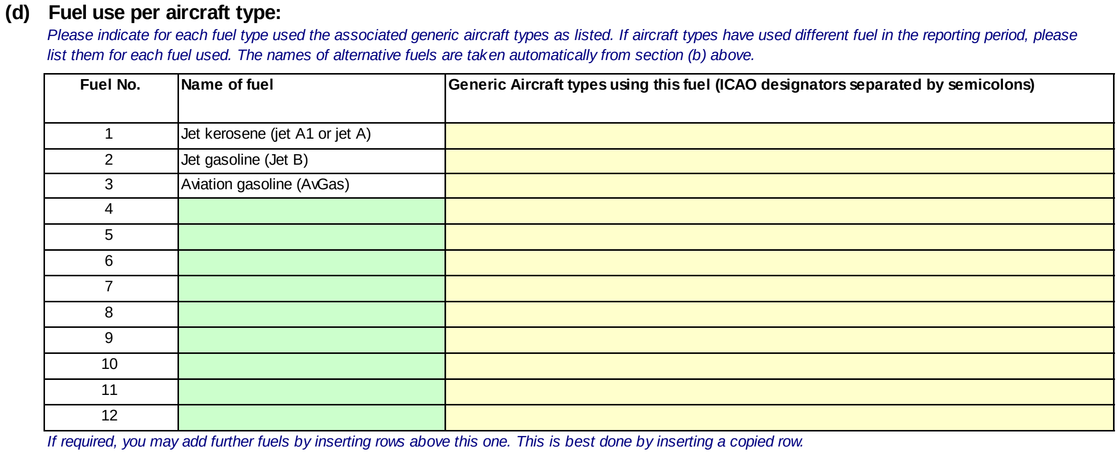
(final) EF	*This is calculated from the preliminary emission factor and the sustainable biomass content (where the sustainable biomass content is zero-rated).*
fuel consumption	*Please enter here the total fuel consumption of each fuel in tonnes in the reporting year. Please note that this figure should only include fuel consumption to be reported under the EU ETS, i.e. relate to the reduced scope.*
CO2 emissions [t CO2]	*This is the amount of "fossil" emissions (including emissions from biomass for which no evidence for compliance with the sustainability criteria has been provided). It is identical to the emissions for which allowances are to be surrendered.*
CO2 from sustainable biomass	*This figure shows as a memo-item the emissions from sustainable biomass.*
CO2 from non-sustainable biomass	*This figure shows as a memo-item the emissions from non-sustainable biomass. Note that these emissions are part of the "fossil" emissions and do not need to be added once more.*

Fuel No.	**Name of fuel**	**(final) EF [t CO2 / t fuel]**	**fuel consumption [tonnes]**	**CO2 emissions [t CO2]**	CO2 from sustainable biomass	CO2 from non-sustainable biomass
1	Jet kerosene (jet A1 or jet A)	**3,15**				
2	Jet gasoline (Jet B)	**3,10**				
3	Aviation gasoline (AvGas)	**3,10**				
4						
5						
6						
7						
8						
9						
10						
11						
12						

If required, you may add further fuels by inserting rows above this one. This is best done by inserting a copied row. However, formulae will need corrections!

➨ **Figure 10** EU ETS Annual Emissions Report: Fuel consumption and Emissions

Fuel use per aircraft: In this section the operator enters the generic aircraft type using the SAF. In theory this is only possible when the operator is able to track the fuel that is physically and identifiably uplifted in the aircraft.



(d) Fuel use per aircraft type:

Please indicate for each fuel type used the associated generic aircraft types as listed. If aircraft types have used different fuel in the reporting period, please list them for each fuel used. The names of alternative fuels are taken automatically from section (b) above.

Fuel No.	**Name of fuel**	**Generic Aircraft types using this fuel (ICAO designators separated by semicolons)**
1	Jet kerosene (jet A1 or jet A)	
2	Jet gasoline (Jet B)	
3	Aviation gasoline (AvGas)	
4		
5		
6		
7		
8		
9		
10		
11		
12		

If required, you may add further fuels by inserting rows above this one. This is best done by inserting a copied row.

➨ **Figure 11** EU ETS Annual Emissions Report: Fuel use per aircraft type

3.6.1.3 EU ETS SAF use information from States to the European Commission

Before 30 June, each Member State must provide information on ETS implementation, including use of biofuels (through which operators can reduce their allowance surrendering obligations), to the Commission under Article 21 of the EU ETS Directive, through a standard questionnaire of 80-100 questions. It is available online[25]. Question 5.17. addresses reporting of biomass use. Member States gather the information from all Emission Reports submitted by the aircraft operators under its administration, therefore States gather the information not only from EU operators, but also from non-EU operators administered by them for EU ETS purposes.

All national reports from the EU/EEA Member States are then compiled into a European level implementation report: *Report on the functioning of the European carbon market*. The last report (December 2018)[26] does not include any amount of SAF use. Only refers the following: *For 2017, only Sweden reported use of biofuel for two aircraft operators (for 2016 and 2015, both Germany and Sweden reported such use for three and four aircraft operators, respectively).*

However, it is important to note that, even though, on a country level, no SAF use is reported, it can still be that SAF is supplied and sold. For example, in The Netherlands airlines must register fossil kerosene, even if they have bought, and are flying using SAF. This has to do with the bio-ticket system (see section 6.2.4.1), where SAF use can be accounted under EU RED road transport biofuels objectives and cannot be claimed under the EU ETS.

3.6.1.4 EU ETS data repository

The European Environment Agency has a dedicated public repository of EU ETS data which is accessible in two ways:

1) Dashboard: EU Emissions Trading System (ETS) data viewer

The EU ETS data viewer[27] provides an easy access to emission trading data contained in the European Union Transaction Log (EUTL). The EUTL is a central transaction log, run by the European Commission, which checks and records all transactions taking place within the trading system. The EU ETS data viewer provides aggregated data by country, by main activity type and by year on the verified emissions, allowances and surrendered units of the more than 12 000 stationary installations reporting under the EU emission trading system, as well as 1400 aircraft operators.

For aviation, it does not provide information on biomass use reported.

2) Datasets: European Union Emissions Trading System (EU ETS) data from EUTL.

The EU ETS datasets[28] provides access to aggregated data on emissions and allowances, by country, sector and year. The data mainly comes from the EU Transaction Log (EUTL). Additional information on auctioning and scope corrections is included.

No data on the use of biomass is currently included.

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[25] https://webforms.eionet.europa.eu/webform/project/eu-ets-art21/file/index.html?&instance=/download/user_file?fileId=79695&fileId=79695&base_uri=

[26] https://ec.europa.eu/clima/sites/clima/files/ets/docs/com_2018_842_final_en.pdf

[27] https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

[28] https://www.eea.europa.eu/data-and-maps/data/european-union-emissions-trading-scheme-12

3.6.1.5 Future EU ETS reporting

EU ETS Directive questionnaire (from Article 21), might be reviewed for phase 4 of the ETS (period 2021-2030), which would provide an opportunity to fine-tune it (while keeping in mind that many MS are likely to ask for simplifications in the questionnaire, rather than complications).

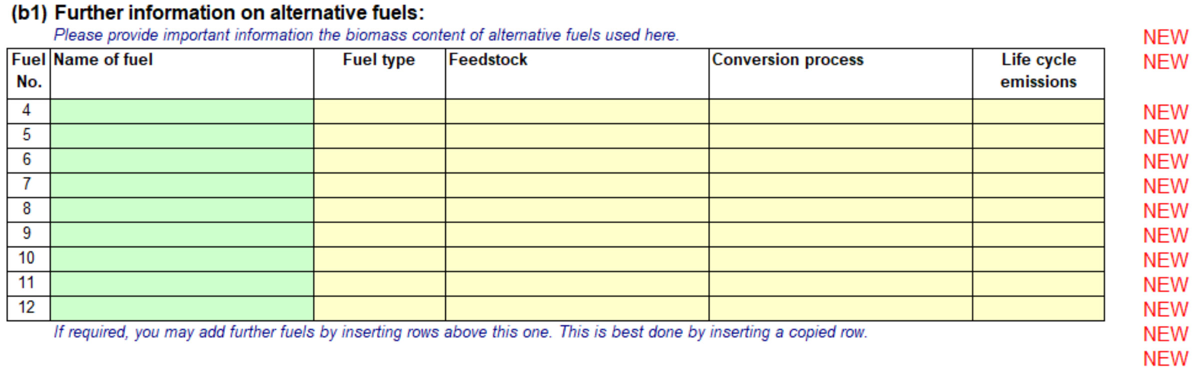
On the other hand, the aircraft operator EU ETS emissions report template of data to be submitted by the operators to their respective Member States is currently being reviewed to accommodate not just ETS but also CORSIA. The reporting data should be compliant with RED II rules.

This process may provide sufficient granularity to support a robust data stream for intra EEA flights. A first Draft for Discussion has been sent to Member States to collect comments prior to its final approval, expected on the 4th quarter of 2019.

The circulated draft includes a new section (b1) under the ETS reporting, collecting relevant characteristics of the SAF reported by operators to benefit from the EU ETS zero emissions incentive:

(b1) *Further information on alternative fuels: Please provide important information on the biomass content of alternative fuels used here*.

In addition to the amount of SAF used, the new data to be reported are: Name of fuel; Fuel type; Feedstock; Conversion process and Life cycle emissions.



(b1) Further information on alternative fuels:

Please provide important information the biomass content of alternative fuels used here. NEW

Fuel No.	Name of fuel	Fuel type	Feedstock	Conversion process	Life cycle emissions	
						NEW
4						NEW
5						NEW
6						NEW
7						NEW
8						NEW
9						NEW
10						NEW
11						NEW
12						NEW

If required, you may add further fuels by inserting rows above this one. This is best done by inserting a copied row. NEW

NEW

➨ **Figure 12** Future EU ETS reporting: Further information on alternative fuels

The inclusion of this additional information links life-cycle emissions to the SAF reported, which are two of the key parameters for scoping a SAF monitoring process.

This information in principle should be in line with the one provided by suppliers under the RED II and FQD, as long as the fuel is purchased and delivered in an EEA airport.

But if SAF supplied in a non-EEA is reported under EU ETS, that SAF would have not been reported under the RED II or FQD -as would be out of those regulations' jurisdiction-. In a similar way, if SAF supplied in Europe is reported outside Europe (for example under CORSIA in a non-EEA State), that would be accounted in RED II/FQD but not under EU ETS.

3.6.1.6 Comments on the draft EU ETS-CORSIA emissions report template (SAF)

The feedback indicated below has been provided to the European Commission regarding the content of the SAF reporting section of the above referred draft template.

It should be noted that during the peer review process of this report, some experts have expressed different views, which are also pointed out.

EMISSIONS OVERVIEW: **Section 5 - Total Emissions**

Comment 1:

Field b) Name of Fuel: Possible confusion with "Fuel Type".

Guidance is needed on what is expected by "Name of Fuel" (as per distinction of Fuel Type). For the numbering (Fuel No) it is understood that additional names of fuel refer to different "alternative fuels" but there is no clarity on what names of fuel should be given. As here are only considered fuels with biomass content, those are defined as biofuels.

Those can be named according to its main characteristics: The RED refers only to advanced biofuels and other biofuels so we could have bio Jet kerosene, advanced bio Jet kerosene, bio Jet gasoline, advanced bio Jet gasoline, bio aviation gasoline, and advanced bio aviation gasoline.

But within each of those classifications we could have different combinations of feedstocks + conversion process and thus, those should receive different "Name" to be listed individually and complete fields in b1.

How should we name all those biofuels options?

A possibility is to leave it "open" with the suggestion to name them according to its main characteristics, ex. UCO HEFA bio Jet kerosene, MSW FT advance bio Jet kerosene, Sugarbeet SIP bio Jet kerosene, etc.

Note: An expert during the peer-review has indicated that names used for ASTM certified fuels would be the more adequate, and that mixing the name of the fuel and feedstock could generate a risk of confusion. The feedstock, in the EU, is already indicated in the sustainability certificate.

Suggested amendment 1: Include some guidance in the existing Note

Note: If you use a biofuel or mixed fuel, for which the sustainability criteria are demonstrated only for a part of the annual used quantity, you have to define two different fuels here, one with sustainable biomass and one with non-sustainable biomass. Please, name them according to its main characteristics (ex. UCO HEFA bio Jet kerosene, MSW FT advance bio Jet kerosene, Sugar beet SIP bio Jet kerosene, etc.).

Comment 2: **Field b1)**

As here are only considered fuels with biomass content, those are defined as biofuels. The ETS Directive and draft Delegated Act refers to "the use of biofuels", so it is more adequate to refer to biofuels than to alternative fuels, which is a terminology not used neither in the RED nor in ICAO.

It is also considered important to refer to the methodology to calculate lifecycle emissions, which for EU ETS is the EU RED (different from CORSIA, which has its own one).

As a result, the following amendments are suggested:

Suggested amendment 2:

It is proposed to change the title "*Further information on alternative fuels*" by "*Further information on biofuels*"

Note: During the peer-review process, some experts have expressed the concern that this would exclude non-biomass SAF but it was clarified that the EU ETS only incentivizes the use of fuels with biomass content and initially this is not expected to change in the short-term.

Suggested amendment 3:

The note reads: *Please provide important information the biomass content of alternative fuels used here*.

It is suggested to change it for: *Please provide important information related to the biomass content of biofuels used here. Note that the life cycle emissions value should be calculated according to the EU Renewable Energy Directive*.

EMISSIONS DATA **Section 5 - Detailed emissions data – EU ETS**

Comment 1: **Fields (a), (b) & (c)** As per above suggested amendments:

Suggested amendment 4: It is suggested to change "*Alternative Fuel 1*" by "*Biofuel 1*"

CORSIA EMISSIONS

Comment 1: **Field b1)**

It is considered necessary to refer to the methodology to calculate lifecycle emissions, which is established by the CORSIA SARPS (different from EU ETS, which is the EU RED).

Suggested amendment 4:

If claiming emission reductions from the use of CORSIA eligible fuels, please complete the table below in accordance with CORSIA rules. Supplementary information about the claim is also required and can be reported using the appropriate supplementary template on CORSIA eligible fuels supplementary information.

3.6.2 CORSIA Reporting data

Under CORSIA, operators would reduce their CORSIA offsetting requirements by claiming emissions reductions from "CORSIA Eligible Fuels". A CORSIA Eligible Fuel is defined as a CORSIA sustainable aviation (A renewable or waste-derived aviation fuel that meets CORSIA Sustainability criteria) or a CORSIA lower carbon aviation fuel (A fossil-based aviation fuel that meets CORSIA Sustainability criteria), which an operator may use to reduce their offsetting requirements.

These CORSIA eligible fuels can be produced and uplifted anywhere in the world, but in order to claim emission reductions against their offsetting requirements, , the operator will:

- Use the amounts of CORSIA Eligible Fuels purchased, based on purchase records;
- Use the life-cycle emissions values to determine emissions reduction factors for each CORSIA Eligible Fuel;
- Obtain valid sustainability certification document; and

- Report and claim verified reductions of its emissions from the use of CORSIA Eligible Fuels to the State.

3.6.2.1 Specific MRV requirements:

Under CORSIA, an aeroplane operator can only claim a reduction to its offsetting requirements from the use of such fuel if it was blended during the associated compliance period. An aeroplane operator may therefore purchase a batch of CORSIA Eligible Fuel at an earlier date and make the claim in a later compliance period during which the blending occurs.

The aeroplane operator that intends to claim for emissions reductions from the use of CORSIA eligible fuels needs to ensure that the fuel meets the CORSIA Sustainability Criteria as defined within the ICAO document entitled "*CORSIA Sustainability Criteria for CORSIA Eligible Fuels*". ICAO has published a first version of this document, including the themes of Greenhouse Gases and Carbon Stock.

The table below reflect these criteria, although it should be noted that the document indicates that work on other themes is on-going under the Committee on Aviation Environmental Protection (CAEP) and will be subject to approval by the Council by the end of the pilot phase.

➨ **Table 8** CORSIA Sustainability Criteria For Corsia Eligible Fuels

Theme	Principle	Criterion
1. Greenhouse Gases (GHG)	**Principle**: CORSIA eligible fuel should generate lower carbon emissions on a life cycle basis.	**Criterion 1**: CORSIA eligible fuel shall achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline life cycle emissions values for aviation fuel on a life cycle basis.
2. Carbon stock	**Principle**: CORSIA eligible fuel should not be made from biomass obtained from land with high carbon stock.	**Criterion 1:** CORSIA eligible fuel shall not be made from biomass obtained from land converted after 1 January 2008 that was primary forest, wetlands, or peat lands and/or contributes to degradation of the carbon stock in primary forests, wetlands, or peat lands as these lands all have high carbon stocks. **Criterion 2:** In the event of land use conversion after 1 January 2008, as defined based on IPCC land categories, direct land use change (DLUC) emissions shall be calculated. If DLUC greenhouse gas emissions exceed the default induced land use change (ILUC) value, the DLUC value shall replace the default ILUC value.

Guidance on the application of sustainability criteria

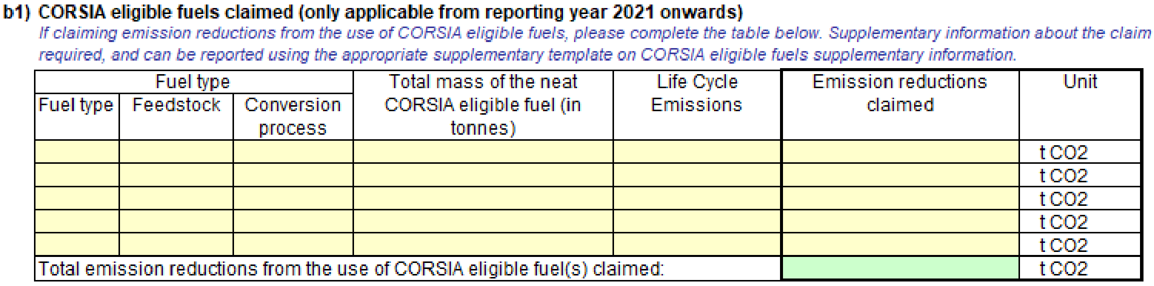
a) Compliance with Themes 1 and 2 is granted on the basis of independent attestation by CORSIA approved Sustainability Certification Schemes;

b) Work on other themes such as Water; Soil; Air; Conservation; Waste and Chemicals; Human and labour rights; Land use rights and land use; Water use rights; Local and social development; and Food security, and related criteria, and on the application of these criteria, is ongoing under the Committee on Aviation Environmental Protection (CAEP) and will be subject to approval by the Council by the end of the pilot phase; c) CORSIA Sustainability Criteria for CORSIA Eligible Fuels does not set a precedent for, or prejudge the outcome of negotiations in other fora.

In accordance with the criteria of the table above, the GHG requirements for a fuel to be considered eligible under CORSIA would differ from the criteria to be accounted under the RED II and FQD, which are more stringent in terms of GHG reductions. However, national competent authorities receiving the emissions reports will be able to see the GHG reduction percentage of the reported fuels since, according to the draft EU ETS-CORSIA emissions report template, the report includes information on the lifecycle emissions of the fuel declared by each aeroplane operator under each scheme.

Under CORSIA, only the fuels produced by producers certified by an approved Sustainability Certification Scheme included in the ICAO document "*CORSIA Approved Sustainability Certification Schemes*" will be eligible. Such certification schemes will need to meet the requirements included in the ICAO document "*CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes*". Both these two documents will be available at the ICAO website[29].

In order to be eligible to claim emissions reductions from the use of CORSIA eligible fuels in the Emissions Report, the aeroplane operators shall include, in addition to the emissions reductions claimed, **information on the total mass of neat CORSIA eligible fuel, information on the fuel type, feedstock, conversion process, total mass, life cycle emissions and emissions claimed**.



b1) CORSIA eligible fuels claimed (only applicable from reporting year 2021 onwards)

If claiming emission reductions from the use of CORSIA eligible fuels, please complete the table below. Supplementary information about the claim is also required, and can be reported using the appropriate supplementary template on CORSIA eligible fuels supplementary information.

Fuel type			Total mass of the neat CORSIA eligible fuel (in tonnes)	Life Cycle Emissions	Emission reductions claimed	Unit
Fuel type	Feedstock	Conversion process				
						t CO2
						t CO2
						t CO2
						t CO2
						t CO2
Total emission reductions from the use of CORSIA eligible fuel(s) claimed:						t CO2

➡ **Figure 13** CORSIA reporting: eligible fuels claimed

In addition to this information the aeroplane operator shall do this by submitting, along with the emissions report, an appropriate **supplementary template on CORSIA eligible fuels**. The emissions reduction claim and provision of supplementary information shall be done by the end of a given compliance period for all CORSIA eligible fuel received by a blender within that compliance period. However, the SARPs, includes a recommendation for an aeroplane operator to make CORSIA Eligible Fuel claims on an annual basis, in order to ensure all documentation is dealt with in a timely manner.

The content of the supplementary template is described in the CORSIA SARPS (ICAO Annex 16, Vol IV) Appendix 5 Table A5-2.

The information is provided through to the blend point, and includes information received from both the neat (unblended) fuel producer and the fuel blender.

The following data fields should be reported by operators using SAF through the supplementary template:

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[29] https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

Table 9 CORSIA supplementary information from SAF use from operators

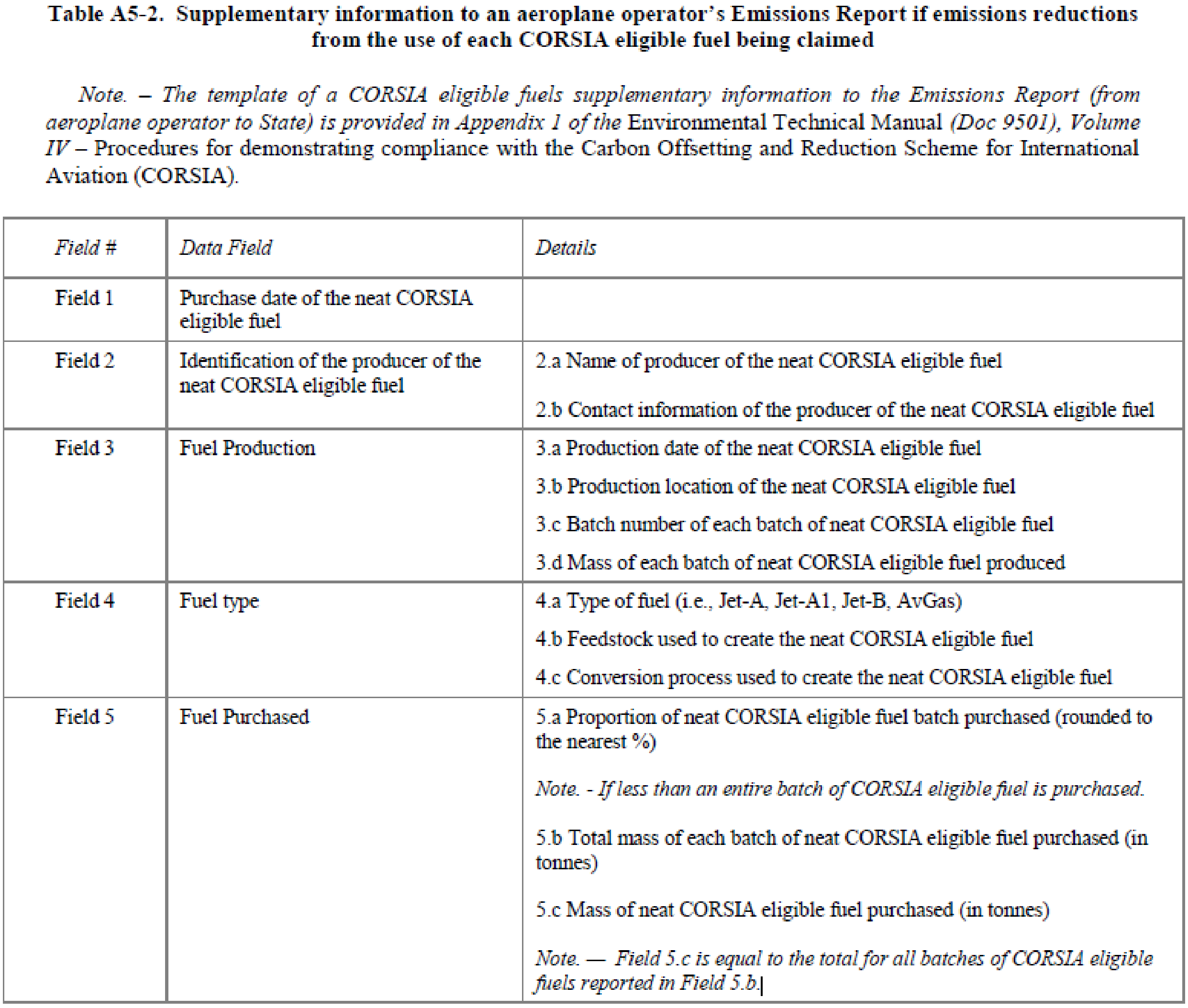
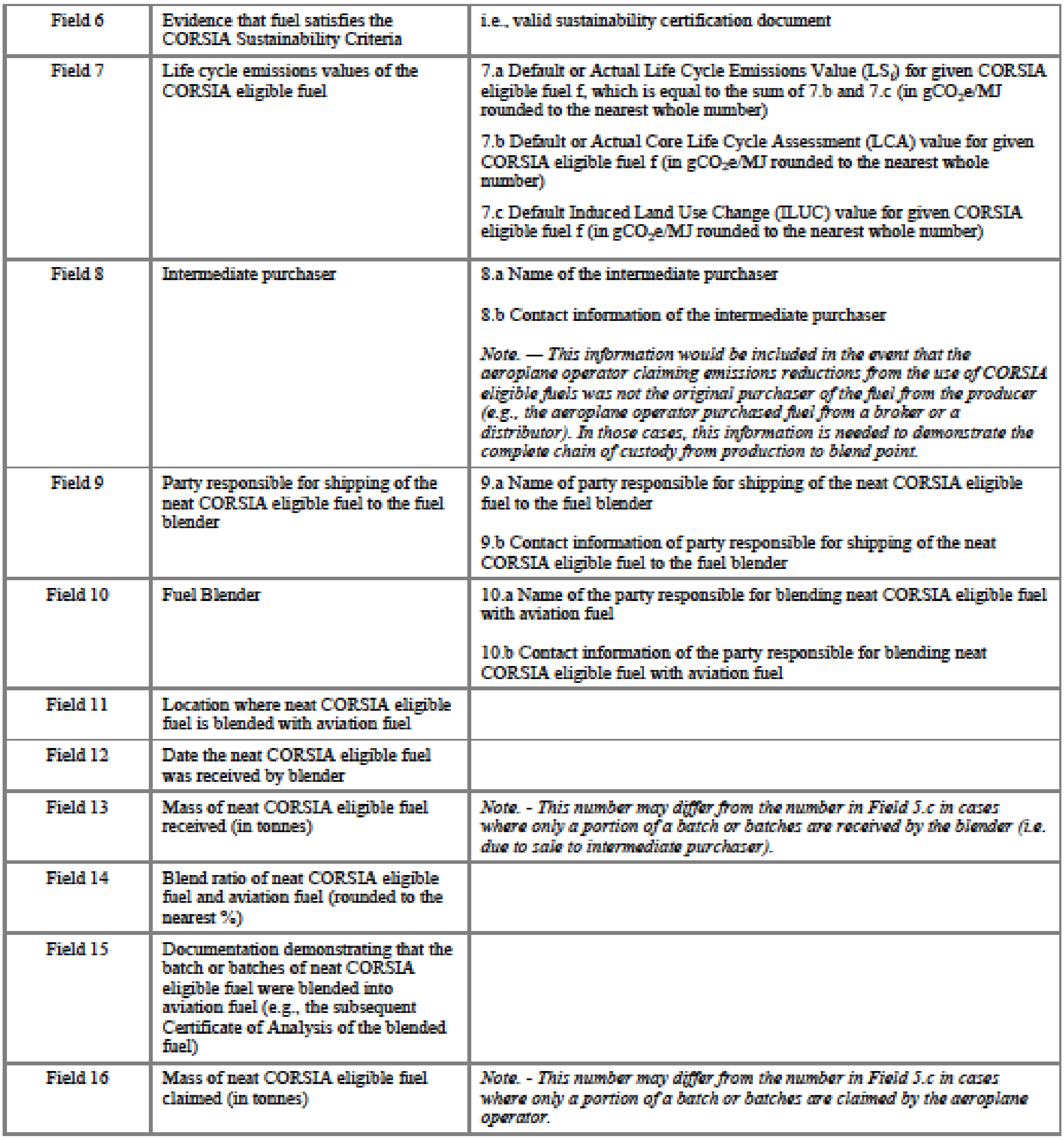


Table A5-2. Supplementary information to an aeroplane operator's Emissions Report if emissions reductions from the use of each CORSIA eligible fuel being claimed

Note. – The template of a CORSIA eligible fuels supplementary information to the Emissions Report (from aeroplane operator to State) is provided in Appendix 1 of the Environmental Technical Manual *(Doc 9501), Volume IV –* Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

Field #	*Data Field*	*Details*
Field 1	Purchase date of the neat CORSIA eligible fuel	
Field 2	Identification of the producer of the neat CORSIA eligible fuel	2.a Name of producer of the neat CORSIA eligible fuel 2.b Contact information of the producer of the neat CORSIA eligible fuel
Field 3	Fuel Production	3.a Production date of the neat CORSIA eligible fuel 3.b Production location of the neat CORSIA eligible fuel 3.c Batch number of each batch of neat CORSIA eligible fuel 3.d Mass of each batch of neat CORSIA eligible fuel produced
Field 4	Fuel type	4.a Type of fuel (i.e., Jet-A, Jet-A1, Jet-B, AvGas) 4.b Feedstock used to create the neat CORSIA eligible fuel 4.c Conversion process used to create the neat CORSIA eligible fuel
Field 5	Fuel Purchased	5.a Proportion of neat CORSIA eligible fuel batch purchased (rounded to the nearest %) *Note. - If less than an entire batch of CORSIA eligible fuel is purchased.* 5.b Total mass of each batch of neat CORSIA eligible fuel purchased (in tonnes) 5.c Mass of neat CORSIA eligible fuel purchased (in tonnes) *Note. — Field 5.c is equal to the total for all batches of CORSIA eligible fuels reported in Field 5.b.*



Field 6	Evidence that fuel satisfies the CORSIA Sustainability Criteria	i.e., valid sustainability certification document
Field 7	Life cycle emissions values of the CORSIA eligible fuel	7.a Default or Actual Life Cycle Emissions Value (LS_f) for given CORSIA eligible fuel f, which is equal to the sum of 7.b and 7.c (in gCO_2e/MJ rounded to the nearest whole number) 7.b Default or Actual Core Life Cycle Assessment (LCA) value for given CORSIA eligible fuel f (in gCO_2e/MJ rounded to the nearest whole number) 7.c Default Induced Land Use Change (ILUC) value for given CORSIA eligible fuel f (in gCO_2e/MJ rounded to the nearest whole number)
Field 8	Intermediate purchaser	8.a Name of the intermediate purchaser 8.b Contact information of the intermediate purchaser *Note. — This information would be included in the event that the aeroplane operator claiming emissions reductions from the use of CORSIA eligible fuels was not the original purchaser of the fuel from the producer (e.g., the aeroplane operator purchased fuel from a broker or a distributor). In those cases, this information is needed to demonstrate the complete chain of custody from production to blend point.*
Field 9	Party responsible for shipping of the neat CORSIA eligible fuel to the fuel blender	9.a Name of party responsible for shipping of the neat CORSIA eligible fuel to the fuel blender 9.b Contact information of party responsible for shipping of the neat CORSIA eligible fuel to the fuel blender
Field 10	Fuel Blender	10.a Name of the party responsible for blending neat CORSIA eligible fuel with aviation fuel 10.b Contact information of the party responsible for blending neat CORSIA eligible fuel with aviation fuel
Field 11	Location where neat CORSIA eligible fuel is blended with aviation fuel	
Field 12	Date the neat CORSIA eligible fuel was received by blender	
Field 13	Mass of neat CORSIA eligible fuel received (in tonnes)	*Note. - This number may differ from the number in Field 5.c in cases where only a portion of a batch or batches are received by the blender (i.e. due to sale to intermediate purchaser).*
Field 14	Blend ratio of neat CORSIA eligible fuel and aviation fuel (rounded to the nearest %)	
Field 15	Documentation demonstrating that the batch or batches of neat CORSIA eligible fuel were blended into aviation fuel (e.g., the subsequent Certificate of Analysis of the blended fuel)	
Field 16	Mass of neat CORSIA eligible fuel claimed (in tonnes)	*Note. - This number may differ from the number in Field 5.c in cases where only a portion of a batch or batches are claimed by the aeroplane operator.*

As in the EU ETS, an aeroplane operator cannot claim the amount of CORSIA Eligible Fuels that have been sold to a third party. In addition, the aeroplane operator is required to provide a declaration of all other Greenhouse Gas schemes it participates in where the emissions reductions from the use of CORSIA Eligible Fuels may be claimed, and a declaration that it has not made claims for the same batches of CORSIA Eligible Fuel under these other schemes

3.6.2.2 CORSIA SAF use information from States to ICAO:

In addition to the reporting obligation of the aeroplane operator to the State, ICAO Annex 16, Volume IV provides a CORSIA eligible fuels table of supplementary information to the Emissions Report from the State to ICAO. Such emissions report will need to be sent every year starting in 2022 relative to the 2021 emissions reporting (when offsetting obligations start to be accounted for). The information from ICAO Annex 16, Volume IV, includes:

Table 10 CORSIA supplementary information from to the Emissions Report from a State to ICAO

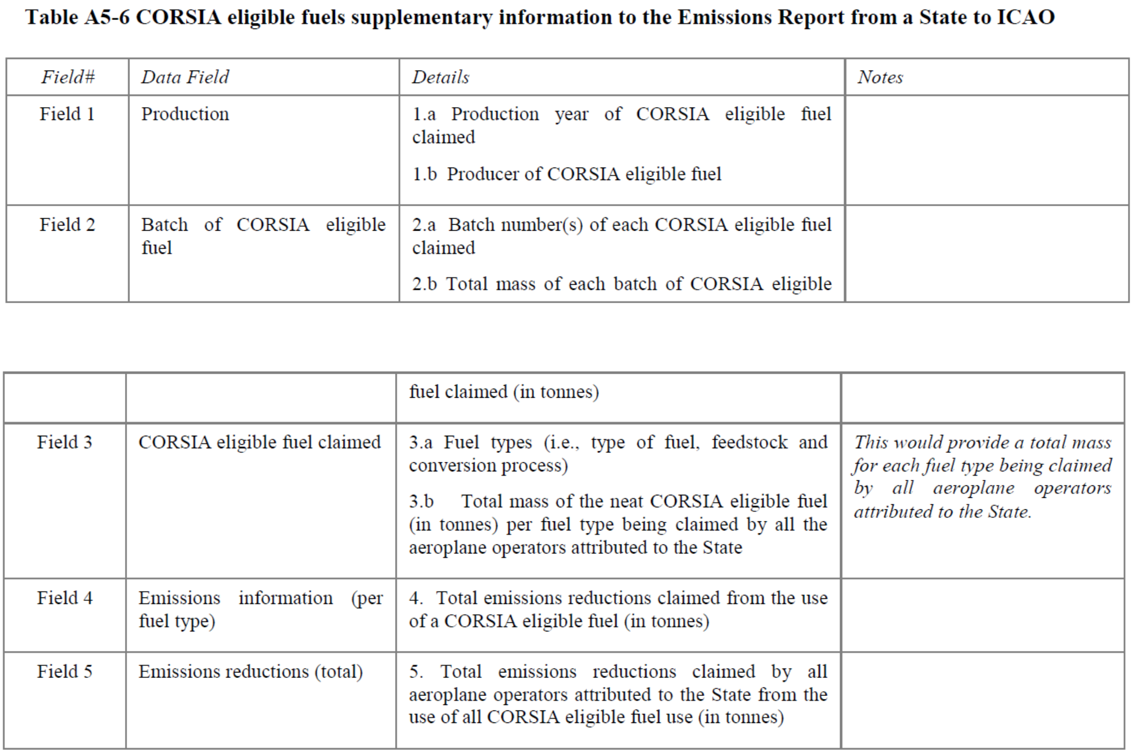


Table A5-6 CORSIA eligible fuels supplementary information to the Emissions Report from a State to ICAO

Field#	*Data Field*	*Details*	*Notes*
Field 1	Production	1.a Production year of CORSIA eligible fuel claimed 1.b Producer of CORSIA eligible fuel	
Field 2	Batch of CORSIA eligible fuel	2.a Batch number(s) of each CORSIA eligible fuel claimed 2.b Total mass of each batch of CORSIA eligible fuel claimed (in tonnes)	
Field 3	CORSIA eligible fuel claimed	3.a Fuel types (i.e., type of fuel, feedstock and conversion process) 3.b Total mass of the neat CORSIA eligible fuel (in tonnes) per fuel type being claimed by all the aeroplane operators attributed to the State	*This would provide a total mass for each fuel type being claimed by all aeroplane operators attributed to the State.*
Field 4	Emissions information (per fuel type)	4. Total emissions reductions claimed from the use of a CORSIA eligible fuel (in tonnes)	
Field 5	Emissions reductions (total)	5. Total emissions reductions claimed by all aeroplane operators attributed to the State from the use of all CORSIA eligible fuel use (in tonnes)	

Consequently, ICAO will have consolidated information of the use of SAF in international flights included in CORSIA as long as aeroplane operators wish to declare its use under CORSIA and claim the benefit towards reducing their offsetting obligations under this scheme.

It should be noted that if an aeroplane operator declares the use of a batch of SAF under another scheme, such as, for example EU ETS (or the other way around), it would not be possible to claim the use of that same fuel under CORSIA. In fact, in order to avoid double claiming of CORSIA eligible fuels, the following information will be included by ICAO in the document entitled “CORSIA Central Registry (CCR): Information and Data for Transparency” that will be made available from the ICAO CORSIA website:

- Production year of the CORSIA eligible fuel claimed
- Producer of the CORSIA eligible fuel claimed
- Type of fuel, feedstock and conversion process for each CORSIA eligible fuel claimed
- Batch number(s) of each CORSIA eligible fuel claimed
- Total mass of each batch of CORSIA eligible fuel claimed.
- State reporting the information

3.7 The ICAO Form M reporting requirement

Form M is an International Civil Aviation Organization (ICAO) reporting requirement to its Member States for the purpose of reporting air carrier statistics to ICAO.

Through Form M, States are requested to compile total aviation fuel consumption data and emissions for each type of aircraft, both for domestic and international flights for each of their commercial air carriers that operate scheduled and/or non-scheduled flights.

Form M considers Biofuels as non-fossil energy sources which are made from living organisms or from biogenic feedstocks (plant oils or animal fats). In order to be considered as biofuel, the fuel must contain over 80 percent renewable materials. Form M also describes "Fuel consumed" as the mass of fuel uplifted for all aircraft in each aircraft type, including fuel consumption by the auxiliary power unit.

Form M includes a column for the purposes of including information regarding the "per cent of biofuels" for the total services per aircraft type. According to the ICAO reporting instructions to fill in Form M template, the share of biofuels in total fuel uplift can be calculated from the fuel purchase records, which indicate the biomass fraction and net caloric value of the fuel.

There is no public information on whether EU/EEA MS reports Form M to ICAO nor access to the reports from Member States. That information is not required by any European institution and thus no related data streams are identified or available.

While Form M reporting information, if available, could facilitate having an estimate of SAF used at Member State level, the fact that it is not included in any EU/EEA reporting obligation renders it a less-effective source of data for SAF monitoring at European level.

3.8 Additional data in hands of stakeholders

3.8.1 Airlines – International Air Transport Association (IATA)

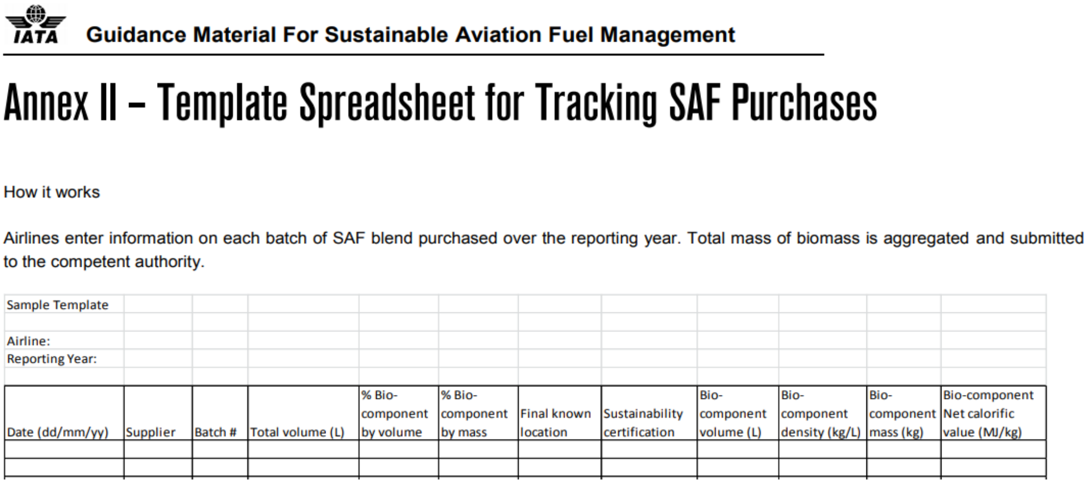
As indicated in paragraph 2.2 (Stakeholder consultation for SAF indicators), all IATA airline members report fuel use through the online reporting system Fuel Reporting & Emissions Database (FRED+), including SAF.

IATA published in 2012 and updated in 2015, the ***IATA Guidance Material for Sustainable Aviation Fuel Management***, which proposes industry-standard best practices for managing SAF transactions.

Its Annex II includes a *Template Spreadsheet for Tracking SAF Purchases* indicating information to be collected by airlines on each batch of SAF blend purchased over the year for reporting purposes.

The following information is collected and reported by the IATA airlines:

- ✓ Date (dd/mm/yy)
- ✓ Supplier Batch #
- ✓ Total volume (L)
- ✓ % Biocomponent by volume
- ✓ % Biocomponent by mass
- ✓ Final known location
- ✓ Sustainability certification
- ✓ Biocomponent volume (L)
- ✓ Biocomponent density (kg/L)
- ✓ Biocomponent mass (kg)
- ✓ Bio-component Net calorific value (MJ/kg)



IATA Guidance Material For Sustainable Aviation Fuel Management

Annex II – Template Spreadsheet for Tracking SAF Purchases

How it works

Airlines enter information on each batch of SAF blend purchased over the reporting year. Total mass of biomass is aggregated and submitted to the competent authority.

Sample Template

Airline:
Reporting Year:

Date (dd/mm/yy)	Supplier	Batch #	Total volume (L)	% Bio-component by volume	% Bio-component by mass	Final known location	Sustainability certification	Bio-component volume (L)	Bio-component density (kg/L)	Bio-component mass (kg)	Bio-component Net calorific value (MJ/kg)

➨ **Figure 14** International Air Transport Association (IATA) collected SAF use data

3.8.2 Bioenergy sector

3.8.2.1 Fuel Suppliers

✓ Fuels Europe

It represents the refining industry in Europe. According to its own data, the members of the association account for "almost 100% of EU petroleum refining capacity and more than 75% of EU motor fuel retail sales". In its website[30] there are plenty of data about oil production, refining and trading in the European market, even though that information shows no particular attention to SAF or low carbon fuels.

✓ Concawe

Concawe[31] is, together with Fuels Europe, a division of the European Petroleum Refiners Association. The scope of Concawe's activities is focused on environmental, health and safety issues, including fuels quality and emissions and they conduct research programmes to provide impartial scientific information. Concawe contributes to EU Commission initiatives relevant to its field of activity.

Both Fuels Europe (Daniel Leuckx, Policy Executive) and Concawe (Heather Hamje, Science Executive Fuels Quality and Emissions) have been contacted (in September 2019) and would be available for follow-up actions as result of this scoping study.

3.8.2.2 European Technology and Innovation Platform Bioenergy (ETIP Bioenergy)

It is the European Technology Platform dealing with innovation on Bioenergy. Within the scope of its work, advanced biofuels have a special importance, so this forum gathers the most relevant existing information on this topic (news, technology developments, demo & flagships announcements).

The Platform convenes the most relevant stakeholders in the advanced biofuels sector, so the information produced and collected within it, could be a good way of checking data and provide

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[30] https://www.fuelseurope.eu/dataroom/

[31] https://www.concawe.eu/

market outlooks for SAF. They have a section on their website[32] of databases of Biofuels and Bioenergy Stakeholders in Europe and Production Facilities but is not much up to date.

3.8.2.3 Regulators: Renewable Fuels Regulators Club (REFUREC)

REFUREC[33] is an informal network of European governmental institutions responsible for regulating biofuels. It works as a forum for discussion on the practical issues of enforcing legislation dealing with biofuels market in the European Union and beyond (e.g. the cap on food and feed feedstocks or the multipliers for aviation and shipping).

For the purpose of this report, REFUREC could be very useful as a way of checking market data and knowing first-hand when SAF is introduced in the market and how different Member States are reporting its presence in the market.

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[32] http://www.etipbioenergy.eu/databases

[33] http://www.refurec.org/

4. First stakeholders review

In June 17-18, several stakeholder's exchanges have been taken in Brussels, in coincidence with the EU ART Fuels Forum plenary and the EU Sustainable Energy Week. Outcomes of such discussions are presented below.

4.1 DG CLIMA: Review of the EU ETS/CORSIA emissions report template

As explained in the "Background Information" chapter of this report, the EU ETS emissions report template of data to be submitted by aircraft operators to their respective Member States (under Article 21 of the EU ETS Directive) is currently being reviewed to accommodate not just ETS but also CORSIA data requirements. It was identified the opportunity of this review process to facilitate additional SAF data collection for the establishment of a robust EU SAF data stream and in that regard early action should be taken.

A first meeting was held with DG CLIMA (Tilman and Guillaume) for that purpose on 8 April 2019 in which it was pointed out the interest of including in such template the collection of key SAF use related data in line with CORSIA data requirements, at this revision time. DG CLIMA took note of EASA´s suggestion and agreed to share the EU ETS/CORSIA emissions report template draft prior to its circulation for comments.

In June 17, a second meeting has been held with DG CLIMA (Tilmann and Andrei) to review the final draft right prior to its circulation to Member States for comments, with the following results:

It is confirmed that DG CLIMA has included in the draft template requirements for reporting SAF use both under CORSIA and ETS, including some of the main SAF characteristics.

Under the CORSIA reporting requirements section, it is requested to provide data on:

- ✓ Type of fuel (i.e., Jet-A, Jet-A1, Jet-B, AvGas)
- ✓ Mass of fuel used
- ✓ Feedstock used to create the fuel
- ✓ Conversion process used to create the fuel
- ✓ Life cycle emissions values of the fuel

Under the ETS reporting requirements section, it is requested to provide similar data but initially it did not include life cycle emissions values of the fuel.

It was proposed to request similar SAF data (including life values) for ETS CORSIA. DG CLIMA agreed to propose it for consideration of the consultant in charge of the template drafting.

The template has been circulated to Member States in late June 2019 and there will be further chances to provide comments for improvements.

After the detailed revision of such template, some comments have been sent in an informal basis to DG CLIMA, while they receive formal feedback from Member States.

4.2 ART Fuels Forum

During preliminary discussions held by EASA and EC DG ENER with respect to this project in early 2019, it was suggested to engage with the Alternative Renewable Transport Fuels Forum (ART Fuels Forum - AFF), which is an industry advisory group established by DG ENER. This forum includes an Aviation Working Group with fuel producers (NESTE, TOTAL), wholesalers (SKY ENERGY), airline operations (KLM/Air France, Lufthansa) and associations (EBB[34]).

The ART Fuels Forum plenary meets 2 times per year with a continuous work programme. The first two-year contract expired end of 2018, and DG ENER approved its extension for another 2 years in December 2018. It was suggested that the question of how to put in place a robust data stream to monitor the production and use of SAF, and the associated emissions reduction, could form part of the ART Fuels Forum future work. The use of this data stream to monitor the success of policy initiatives to develop the SAF market could support engagement from industry in this work. However, there would need to be a long-term commitment to support the data stream.

One of the two annual Alternative Renewable Transport Fuels Forum (ART Fuels Forum - AFF) plenary meetings was held in June 17-18 in Brussels, and EASA and the Task 3.2 consultant were invited to participate by DG ENER.

It was shared within the Aviation Working Group participants, EASA´s current work to develop a robust data stream to monitor the production and use of SAF, and the associated emissions reduction, and it was raised whether this could form part of the ART Fuels Forum future work.

AFF was identified as a Forum of members with experience and knowledge that could support providing inputs to the scoping work to develop the data stream. However, it is not the right forum which could take this work under its own work program. It was more identified as a forum to support the peer review task, and it does not seem viable to establish a long-term commitment from AFF to permanently support the data stream.

4.3 SAF Use stakeholders' informal group discussion

In coincidence with the EU Sustainable Energy Week 2019 and a plenary meeting of the EU ART Fuels Forum in 17-18 June 2019, it was considered an excellent chance to benefit from the presence in Brussels of several stakeholders which could give good inputs for the above-mentioned scoping exercise.

A side informal group discussion was organized on 18 June 2016, right after the finalization of the ART Fuels Forum EUSEW Policy Session *"The role of low carbon fuels in achieving the Paris agreement"* in which most of invited stakeholders were participating.

DG Energy kindly offered to host the informal discussion meeting on their premises.

The following participants were invited through email exchanges and joined the SAF Use stakeholders' group discussion:

- ✓ Stephen Arrowsmith - EASA
- ✓ Kyriakos Maniatis – DG Energy
- ✓ Andrei Mungiu – DG CLIMA

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[34] Aim is to also include the association Fuels4Europe in 2019

- ✓ Gregoire Le-Comte – DG Move
- ✓ Laura Lonza – DG JRC
- ✓ Matteo Prussi –DG JRC
- ✓ David Chiaramonti – Univ. Firenze / ART Fuels Forum
- ✓ Marta Yugo - Concawe
- ✓ Maarten van Dijk - Skynrg
- ✓ Karlijn Arts - Skynrg
- ✓ Ruben Alblas – KLM
- ✓ César Velarde – EASA Consultant / Advisor Spanish AESA

As introduction, EASA explained the discussion background -summarized above- and invited participants to share their thoughts and "brainstorm" on possible best ways to progress towards building a robust data stream to feed indicators for SAF use and their associated emissions reductions.

Participants were asked to brainstorm around three discussion blocks:

1.- Identification of possible metrics/indicators

2.- Identification of data sources

3.- Definition of a robust and consistent process to monitor and report.

A summary of the discussions is presented below.

4.3.1 Identification of possible metrics/indicators

It was highlighted the need to have a clear understanding on what is referred by "SAF Use": Production, supply and use are different concepts.

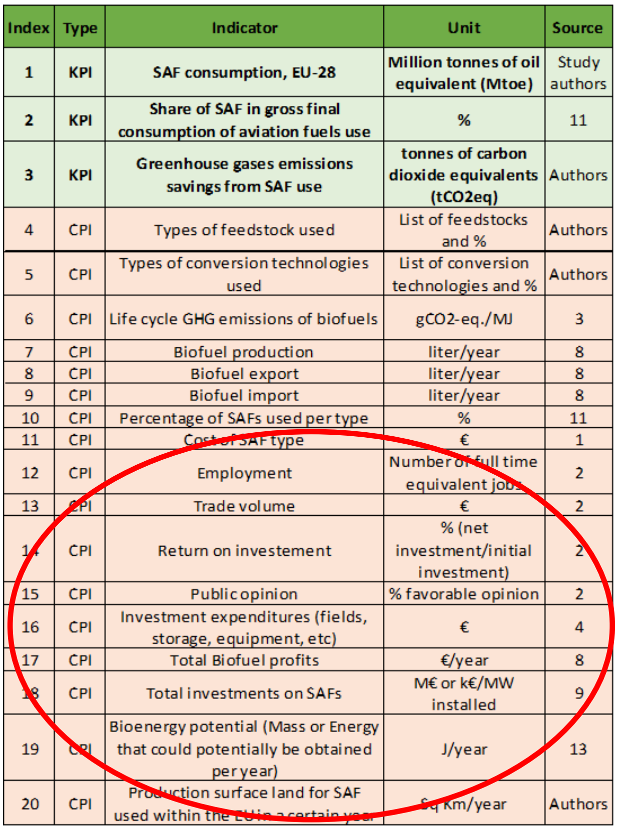
Do we refer to SAF supply and use by whom? Also, when we refer "in Europe" do we refer to the European aviation system, European airlines, territories?

It was acknowledged that a PI on SAF use in Europe could be based on statistical data of annual volumes of SAF supply in EU28/EFTA.

National disaggregation is thus a valuable information.

It was also discussed that PIs should provide accurate information to assess whether European policies are working or not. In that regard it is also important to consider that SAF supply incentives will much rely as well on the implementation of national policies under the REDII framework and thus is not only important to assess policies at EU/European level but also the effectiveness of national regulations or incentive mechanisms.

It was also highlighted that fuel suppliers will not be keen of providing market related and business sensitive information, as for instance to which airline and for which use a certain fuel has been sold. Fuel operators will likely be negative on sharing any information regarding their customers, even the list of these.



Index	Type	Indicator	Unit	Source
1	**KPI**	**SAF consumption, EU-28**	**Million tonnes of oil equivalent (Mtoe)**	Study authors
2	**KPI**	**Share of SAF in gross final consumption of aviation fuels use**	**%**	11
3	**KPI**	**Greenhouse gases emissions savings from SAF use**	**tonnes of carbon dioxide equivalents (tCO2eq)**	Authors
4	CPI	Types of feedstock used	List of feedstocks and %	Authors
5	CPI	Types of conversion technologies used	List of conversion technologies and %	Authors
6	CPI	Life cycle GHG emissions of biofuels	gCO2-eq./MJ	3
7	CPI	Biofuel production	liter/year	8
8	CPI	Biofuel export	liter/year	8
9	CPI	Biofuel import	liter/year	8
10	CPI	Percentage of SAFs used per type	%	11
11	CPI	Cost of SAF type	€	1
12	CPI	Employment	Number of full time equivalent jobs	2
13	CPI	Trade volume	€	2
14	CPI	Return on investement	% (net investment/initial investment)	2
15	CPI	Public opinion	% favorable opinion	2
16	CPI	Investment expenditures (fields, storage, equipment, etc)	€	4
17	CPI	Total Biofuel profits	€/year	8
18	CPI	Total investments on SAFs	M€ or k€/MW installed	9
19	CPI	Bioenergy potential (Mass or Energy that could potentially be obtained per year)	J/year	13
20	CPI	Production surface land for SAF used within the EU in a certain year	Sq Km/year	Authors

Therefore, from the initial proposed list of possible indicators presented in chapter 2.4, it would be very difficult to report on the ones listed with numbers 11 to 20.

The main proposed conclusions were:

Recognizing that the climate benefit of SAF use, from a CO_2 perspective, is independent from where it is used, it was recommended that to be able to serve as policy assessment tools, annual SAF supply/use PI´s should have a certain level of disaggregation:

- ✓ SAF supply per Member State.
- ✓ SAF used internally (domestic & intra-EU28/EEA flights) and SAF used internationally (international non-EU/EEA flights).
- ✓ SAF used by EU28/EEA operators and SAF used by non-EU28/EEA operators.

Requisite data (e.g. feedstock, pathway) would be needed in order to calculate SAF associated emissions reductions for each of the above levels of SAF supply/use disaggregation.

4.3.2 Identification of possible data sources

4.3.2.1 Data streams relevant for SAF supply/use

It was highlighted that the current SAF supply in Europe is small, and that in order for it to be reported by Member States in their EU energy statistics, it generally needs to achieve a minimum supply threshold (annual national supply below 200T of SAF may not be reported).

The existing EUROSTAT EU energy statistics collects and provides data on fossil kerosene supply at EU-28 level and disaggregated per Member State, and it is also ready to collect data on SAF supply at the same level of disaggregation in the future, whenever a higher supply scale is reached.

It collects and reports data from the EU-28 Member States (not all EEA data) and its databases already differentiates between Kerosene type jet fuel (without bio components) and pure bio jet kerosene.

Eurostat does not collect data to calculate SAF emissions reductions.

A question was raised on whether the EU ETS and CORSIA reporting obligations could be good SAF use data sources.

- ✓ Airlines operating in Europe on routes covered by the EU ETS are obliged to report their fuel use and any SAF use that they wish to claim. As such, the EU ETS reporting mechanism was identified as a possible good tool to consider for the disaggregation of SAF use data.

- ✓ The CORSIA scheme was also highlighted as a good source of data on the use of SAF, although the economic incentive to claim SAF use under CORSIA may be smaller than under the EU ETS.

It was acknowledged that there are likely to be differences regarding data of SAF supplied per Member State under Eurostat, and data on SAF use reported under EU ETS & CORSIA, as each operator will report SAF use to the State to which it has been attributed, regardless of the State in which the SAF was supplied.

4.3.2.2 Data streams relevant for SAF associated emissions reductions:

The sustainability reports of each SAF batch issued by the approved Sustainability Certification Schemes (SCSs), include accurate information on the fuel characteristics including type and origin of the feedstock as well as Life-Cycle associated emissions reductions. This data is currently not yet reported at the EU level by any Member State, although it was mentioned that MSs are requested (by the FQD) to collect that information from its national fuel suppliers and have very accurate national databases.

RED Union Database:

A question was also raised regarding the development of a "*Union Database to ensure transparency and traceability of renewable fuels*", as indicated in the RED II.

It was noted that such a Union Database could collect the necessary data to support PIs on SAF use, and their associated emissions reductions, as contained on the SCS sustainability certificates (including GHG Life-Cycle assessment). It was also highlighted that the Union database is still at a very early development stage, pending the launch of a tender to perform a feasibility study on how it will be developed.

The responsible department for developing the Union Database is DG ENER Unit C1 - Renewable Energy and CCS Policy. The DG JRC and EASA will be consulted during the development process.

4.3.3 Definition of a robust and consistent process to monitor and report.

Regarding the development of a process to monitor and report SAF use and associated emissions for the next editions of the EAER, it was suggested that the process could be defined in different steps:

1.- In the very short-term (EAER 2022 edition), due to the expected limited SAF supply in Europe, the PI´s could be based on data taken through industry surveys both from producers/suppliers and airlines as well as from existing data streams (Eurostat, national statistics).

2.- In the mid-term, enhanced official data streams such as the Union Database as well as the EU ETS/CORSIA reporting tools, could be available to build a more automated, robust and consistent process.

4.3.4 Agreed next steps

EASA explained that the intended timeframe of this work is to finalize a scoping proposal by October 2019. The meeting participants agreed to offer further cooperation in reviewing and providing feedback on the initial draft report once available.

It was proposed as next steps:

- ✓ A meeting summary would be prepared and circulated.
- ✓ A more extensive report, which is under development, would be shared in July to collect comments and ideas.
- ✓ ART-Fuels Forum aviation group could also be considered for consultation and inputs.
- ✓ DG-Energy would interact with colleagues from Unit C1 to make them aware of this EASA work and possible synergies with the future Union Database. A further meeting between DG ENER, DG MOVE and EASA would be set-up to consider how to best provide input into the development process of the Database.
- ✓ A participant suggested that some sort of “test case-study” could be considered, if needed, to be developed under existing Horizon 2020 projects. In particular, there is a SMART Airport call, and could be a part of the work in the projects. This option was proposed to be further explored in future discussions.

5. Sustainability assessment and calculation of SAF GHG savings

5.1 Overview of sustainability challenges

According to the Final report of the High-Level Panel of the European Decarbonisation Pathways Initiative (EC, Dec 2018)[35], aviation has a share of 13 % of the CO_2 emissions related to domestic and international transport services in the EU-28, and are about one fifth of the emissions attributable to road transport. However, aviation CO_2 emissions have grown by about 50% over the last two decades, which is much faster than that from the road sector, and they are expected to continue to grow by a further 45% between 2014 and 2035. With just 7 % of the world's population, European flights account for around 25 % of global air traffic.

Liquid biofuels in general, and SAF in particular, can play a significant role in the decarbonisation of transport activities and more in particular in the case of aviation, where currently other emissions reductions options (e.g. technology, operations, market-based measures) seem not to be sufficient to decarbonise the sector in the next decades.

However, biofuels production (including SAF) also raises concerns about its overall sustainability in terms of direct or indirect effects. This can include competition with food production, water use and other resources to produce biomass, or the release of stored carbon and impacts on biodiversity if land is cleared (directly or by displacement of crop production) to grow energy crops.

5.2 International sustainability approaches

In the European Union, the Renewable Energy Directives (RED - Directive 2009/28/EC & RED II, Directive 2018/2001) established the requirements related to sustainability criteria that all biofuels supplied within the EU need to comply with in order to be counted towards the overall RED targets and to be eligible for financial support by public authorities. As those shall apply irrespective of the geographical origin of the biomass, the RED requirements are being applied globally for producers targeting EU bioenergy markets.

There is not an internationally recognized common definition or framework of sustainability requirements for Sustainable Aviation Fuels. ICAO is currently working on the development of a global framework in the context of the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), but this is still under development and its environmental integrity will depend on political decision to achieve agreement in a solid sustainability framework.

There are nevertheless three types of sustainability approaches that are applicable and can be taken as existing references:

1) Internationally agreed sustainability approaches, such as:

- ISO 13065 - Sustainability criteria for bioenergy (2015),
- FAO Sustainability Assessment of Food And Agriculture Systems) (FAO SAFA) (2013)

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[35] https://ec.europa.eu/info/publications/final-report-high-level-panel-european-decarbonisation-pathways-initiative_en

- Global Bioenergy Partnership (GBEP) (2011)

2) Voluntary global sustainability certification schemes, such as:

- Bonsucro
- International Sustainability and Carbon Certification (ISCC)
- Roundtable on Responsible Soy (RTRS)
- Roundtable on Sustainable Biomaterials (RSB)
- Roundtable on Sustainable Palm Oil (RSPO)
- Etc[36].

3) Regulatory sustainability requirements, such as:

- European Union's Renewable Energy Directive (RED) (2009)
- Indonesian Sustainable Palm Oil (ISPO) (2015)
- United States' Renewable Fuel Standard (RFS) Program (2017)
- ICAO Carbon Offsetting and Reduction Scheme for International Aviation (2018)

While the first group establish reference recommendations, the second and third groups aim to establish frameworks (voluntary or mandatory) to ensure the achievement of sustainability compliance with sustainability reference frameworks.

This study will focus on the European framework and thus, the sustainability reference is the EU Renewable Energy Directive.

5.3 EU RED Sustainability requirements

The Renewable Energy Directive (RED - Directive 2009/28/EC)[37] established sustainability requirements for all biofuels supplied within the EU, which are fully applicable to the supply of SAF. These can be found in RED´s Article 17, "*Sustainability criteria for biofuels and bioliquids*" and Article 18, "*Verification of compliance with the sustainability criteria for biofuels and bioliquids*". As mentioned before, those shall apply irrespective of the geographical origin of the biomass.

Those sustainability requirements remain applicable on the revised RED II (Directive (EU) 2018/2001)[38], Article 29 "*Sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels*" paragraphs 2 to 7, although the RED II introduces some new specific criteria for forestry feedstocks.

These requirements are explained in detail in section 5.3.2 below.

Member States must transpose RED II provisions into national legislation by 30 June 2021, with several technicalities and revision clauses being defined via delegated and implementing acts.

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[36] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

[37] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0028

[38] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

For the purpose of this Report, the sustainability requirements referred to will be those included in the RED II as they will be the ones applicable for the next EAER.

5.3.1 RED II GHG savings calculations and thresholds

Transport renewable fuels (thus, including SAF) **must achieve 65% GHG emissions savings after January 2021**, with respect to a **fossil fuel comparator EF(t) for transportation fuels of 94 g CO_2eq/MJ**. In the case of transport renewable fuels of **non-biological origin, the threshold is raised to 70% GHG emissions savings**.

The fuel comparator can be updated periodically by the EC.

Default GHG emission values and calculation rules are provided in RED II Annex V (for liquid biofuels). The Commission can revise and update the default values of GHG emissions when technological developments make it necessary.

Economic operators have the option to use either default GHG intensity values provided in RED II (Parts A & B of Annex V) so as to estimate GHG emissions savings for some or all of the steps of a specific biofuel production process, or to calculate "actual values" for their pathway in accordance with the RED methodology laid down in Part C of Annex V;

In the case of non-biobased fuels, two types are considered:

- ✓ Waste gases, which are under the category of REcycled FUel from NOn BIOlogical origin (also known as REFUNIOBIO.
- ✓ Renewable liquid and gaseous transport fuels of non-biological origin (such as PtL from atmospheric CO_2).

A specific methodology to assess its greenhouse gas emissions savings is currently being developed by the European Commission by means of delegated acts to be issued by 2021.

Tables with those values are included in the APPENDIX I of this document.

5.3.2 RED II Sustainability requirements applicable to SAF

SAF from agricultural biomass must not be produced from raw materials originating from:

- ✓ **High biodiversity land** (as of January 2008), including primary forests; areas designated for nature protection or for the protection of rare and endangered ecosystems or species; and highly biodiverse grasslands;
- ✓ **High carbon stock land** that changed use after 2008 from wetlands, continuously forested land or other forested areas with trees higher than five meters and canopy cover between 10% and 30%;
- ✓ Land that was **peatland** in January 2008.

Biofuels produced from waste and residues, other than agricultural, aquaculture, fisheries and forestry residues, are required to fulfil only the greenhouse gas emissions saving criteria.

Biofuels produced from waste and residues, derived not from forestry but from agricultural land, are eligible only where operators or national authorities have monitoring or management plans in place in order to address the impacts on soil quality and soil carbon.

The RED II introduces new sustainability criteria for forestry feedstocks and mandates that harvesting takes place with legal permits, the harvesting level does not exceed the growth rate of the forest, and that forest regeneration takes place. In addition, biofuels and bioenergy from forest materials must comply with requirements, which mirror the principles contained in the EU Land Use, Land Use Change and Forestry (LULUCF) Regulation. The Commission will define implementation guidelines by 31 January 2021.

5.3.3 Indirect Land-Use Change (ILUC)

The original RED (Directive 2009/28/EC) introduced sustainability criteria protecting land with high biodiversity value and land with high-carbon stock but did not cover the issue of indirect land-use change (ILUC).

ILUC occurs when the cultivation of crops for biofuels, bioliquids and biomass fuels displaces traditional production of crops for food and feed purposes. Such additional demand increases the pressure on land and can lead to the extension of agricultural land into areas with high-carbon stock, such as forests, wetlands and peatland, causing additional GHG emissions.

To address that risk, the RED II establishes provisions to gradually limit food and feed crops-based biofuels, bioliquids and biomass fuels for which high ILUC risk has been observed. Starting from 31 December 2023, their contribution should be gradually reduced to 0 % by 2030 at the latest.

It also establishes provisions to exempt from the specific and gradually decreasing limits, biofuels, bioliquids and biomass fuels with "*low indirect land-use change-risk*" (hereinafter referred as low ILUC):

- *Yield increases in agricultural sectors by means of improved agricultural practices, investments in better machinery and knowledge transfer, beyond levels which would have prevailed in the absence of productivity-promoting schemes for food and feed crop-based biofuels, as well as the cultivation of crops on land not previously used for the cultivation of crops, can mitigate ILUC.*

- *Where there is evidence that such measures have led to an increase of production going beyond the expected increase in productivity, biofuels produced from such additional feedstock should be considered to be low ILUC. Annual yield fluctuations should be taken into account in that context*.

Voluntary schemes may certify low ILUC-risk biofuels, bioliquids and biomass fuels as they do for the purpose of certifying compliance with the sustainability criteria (see section 5.3.4)

In order to ensure that the information provided by economic operators is transparent, accurate, reliable and protected against fraud, overarching rules have been introduced on such certification, providing for an adequate standard of independent auditing, by virtue of the adoption of implementing acts in accordance with Article 30(8) of Directive (EU) 2018/2001, Low ILUC.[39]

5.3.4 RED II Sustainability certification

The European Union has adopted a common approach to assessing sustainability and is recommended by the International Organization for Standardization (ISO) to promote sustainable growth. This involves the certification and conformity of a process or product to meet certain sustainability requirements.

This approach implies the development of an "umbrella standard" in which a set of sustainability criteria is defined, and economic operators have to demonstrate that they comply with sustainability requirements, which can be done in accordance with a national system or making use of voluntary sustainability certification schemes (SCS) approved by the European Commission, as already explained in chapter 3.3.

Not all national schemes have been evaluated and approved by the EC, so those can operate at national level, but its certificates might not be recognized by other Member States and thus might not be suitable for biofuel exports.

Voluntary schemes are complementary with national schemes. There are even some specific cases where some steps of the sustainability verification should be verified only under the national scheme, as voluntary schemes are not able to deal with the whole chain of custody (an example of this is Spain, where most of the hydrocarbons logistics cannot be verified by external auditors and it is done through a national verification system).

The EU RED defines the sustainability criteria (the "umbrella standard") without establishing specific indicators to demonstrate compliance. These indicators should be developed by the national or voluntary schemes. Schemes may adopt their verification procedures, but must notify material changes that are relevant to the Commission, such as changes in auditing procedures. The Commission assesses the changes to establish whether the schemes still adequately covers the sustainability criteria.

An SCS wishing to be recognized as a means of compliance for the RED across all of the EU are evaluated by the European Commission, and those considered offering an adequate compliance framework are included in a list of approved EU RED SCSs on the publicly available EC portal[40].

For a scheme to be recognised by the European Commission, it must fulfil criteria such as:

- ✓ Feedstock producers comply with the sustainability criteria
- ✓ Information on the sustainability characteristics can be traced to the origin of the feedstock
- ✓ All information is well documented
- ✓ Companies are audited before they start to participate in the scheme and retroactive audits take place regularly

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[39] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2019.133.01.0001.01.ENG&toc=OJ%3AL%3A2019%3A133%3ATOC

[40] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

- ✓ The auditors have both the generic and specific auditing skills needed with regards to the scheme's criteria
- ✓ Recognition for a voluntary scheme can last for a period of five years.

At minimum, the **information included in the fuel certificate issued by an SCS is**:

- ➢ **Type of fuel;**
- ➢ **Origin country;**
- ➢ **Feedstock used**
- ➢ **Country of origin of the feedstock;**
- ➢ **GHG emissions value (gCO_2-eq/MJ);**
- ➢ **Fulfilment of the land use criteria.**

While CO_2 emissions savings may not be included in the certificate (it would just indicate that complies with RED) it can be calculated comparing the respective GHG emissions values with the EU RED fossil fuel comparator EF(t) (currently 94 g CO_2eq/MJ).

5.4 ICAO Sustainability requirements

The first ICAO International Conference on Aviation and Alternative Fuels (2009) recognized the need for a common definition of sustainability requirements at the international level.

The ICAO Assembly, at its 38th session (2013), acknowledged the need for sustainable aviation fuels to be developed and deployed in an economically feasible, socially and environmentally acceptable manner and the need for increased harmonization of the approaches to sustainability. The 39th Assembly (2016) subsequently requested States to recognize existing approaches to assess sustainability, which should achieve net GHG emissions reduction, contribute to local social and economic development. In addition, competition with food and water should be avoided.

The ICAO Council's adoption of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) Standards and Recommended Practices (SARPs) in 2018, established the requirement that both SAF and Lower Carbon Aviation Fuels (LCAF) need to comply with a set of Sustainability Criteria to be eligible to reduce offsetting obligations under the Scheme.

The ICAO CORSIA Sustainability Requirements are defined in the following ICAO documents which will be available at ICAO CORSIA website[41]:

- ✓ ICAO document "*CORSIA Sustainability Criteria for CORSIA Eligible Fuels*"
- ✓ ICAO document "*CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels*"
- ✓ ICAO document "*CORSIA Methodology for Calculating Actual Life Cycle Emissions Values*"

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[41] https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx

There is an additional CORSIA Supporting Document called "*CORSIA Eligible Fuels - LCA Methodology*" which provides technical information and describes ICAO processes to manage and maintain the ICAO document "CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels"[42].

It should be noted that the above-referred requirements have been developed for SAF at the moment, but further work is being performed to include Lower Carbon Aviation Fuels (LCAF) as CORSIA Eligible Fuels subject to compliance with CORSIA sustainability requirements.

5.4.1 CORSIA Sustainability Criteria for CORSIA Eligible Fuels

Considering the agreements from the Assembly, the ICAO Committee on Aviation Environmental Protection (CAEP) developed a list of 12 Sustainability Principles and Themes with 17 associated Criteria that should be met for a sustainable aviation fuel to generate carbon offset reductions under CORSIA. This list was agreed by CAEP at its 2017 Steering Group meeting (Montreal, Canada, 11 to 15 September 2017), and covers the three aspects of sustainability acknowledged by the ICAO Assembly (environmental, social and economic).

The 212th Session of the ICAO Council (Nov/2017) agreed that not only SAF would be eligible, but also LCAF, defining them as follows:

- ✓ *CORSIA sustainable aviation fuel*: A renewable or waste-derived aviation fuel that meets the CORSIA Sustainability Criteria under this Volume.
- ✓ *CORSIA lower carbon aviation fuel*: A fossil-based aviation fuel that meets the CORSIA Sustainability Criteria under this Volume.
- ✓ *CORSIA eligible fuel*: A CORSIA sustainable aviation fuel or a CORSIA lower carbon aviation fuel, which an operator may use to reduce their offsetting requirements.

Due to some concerns regarding national sovereignty, the ICAO Council endorsed just two of the sustainability criteria (1 Greenhouse Gases, and 2 Carbon stocks) and requested further work from CAEP concerning the others. Such work is currently under development.

As a result of Council decisions, the current CORSIA Sustainability Criteria for CORSIA Eligible Fuels, which are applicable at least during the CORSIA pilot phase (2021-2023), are the following:

1. Greenhouse Gases (GHG)

Principle: CORSIA eligible fuel should generate lower carbon emissions on a life cycle basis.

Criterion 1: CORSIA eligible fuel shall achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline LCA values for aviation fuel on a life cycle basis.

2. Carbon stock

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[42] https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA%20Supporting%20Document_CORSIA%20Eligible%20Fuels_LCA%20Methodology.pdf

Principle: CORSIA eligible fuel should not be made from biomass obtained from land with high carbon stock.

Criterion 1: CORSIA eligible fuel shall not be made from biomass obtained from land converted after 1 January 2008 that was primary forest, wetlands, or peat lands and/or contributes to degradation of the carbon stock in primary forests, wetlands, or peat lands as these lands all have high carbon stocks.

Criterion 2: In the event of land use conversion after 1 January 2008, as defined based on IPCC land categories, direct land use change (DLUC) emissions shall be calculated. If DLUC greenhouse gas emissions exceed the default induced land use change (ILUC) value, the DLUC value shall replace the default ILUC value.

5.4.2 CORSIA Sustainability certification

ICAO has adopted a similar approach applied to assess sustainability as the one used in the European Union, which is also in line with recommendations from the International Organization for Standardization (ISO) to promote sustainable growth. This involves the certification and conformity of a process or product to meet certain sustainability requirements.

The approach implies the development of an “umbrella standard”, as the EU does, in which a set of sustainability criteria is defined, and existing Sustainability Certification Schemes (SCS) can be recognized as a means of compliance if they cover all criteria of the “umbrella standard.”

The aeroplane operator that intends to claim emissions reductions from the use of CORSIA eligible fuels shall only use those fuels from fuel producers that are certified by an approved Sustainability Certification Scheme (SCS) included in the ICAO document entitled “*CORSIA Approved Sustainability Certification Schemes*”. SCS must meet the requirements included in the ICAO document entitled “*CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes*”. Both documents are available at the ICAO CORSIA Eligible Fuels website[43].

5.4.3 CORSIA GHG savings calculations

An airline seeking reductions in CORSIA CO_2 offsetting requirements from the use of SAF will have to provide documentation to their State on its life cycle emissions savings. The fuel supplier will provide such information through the sustainability certificate. For its calculation as part of an accepted fuel sustainability certification process, it may use either default or actual life cycle values.

Life-cycle emission values (LsF in gCO_2e/NJ) in the case of CORSIA include two components: Core LCA Value and ILUC LCA Value.

A table with default values is provided in the ICAO document “*CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels*” and included below.

Nevertheless, if a fuel producer can demonstrate lower core life cycle emissions compared to the default core life cycle values, or if a fuel producer has defined a new pathway that does not have a default core life cycle value, it can calculate its own ACTUAL Core LCA (not applicable for ILUC LCA Value) using the methodology of the ICAO document “*CORSIA Methodology for Calculating Actual Life Cycle Emissions Values*” available in ICAO website.

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[43] https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx

The following table shows the currently approved Core LCA Values (which at the moment of the elaboration of this Report is under State Letter consultation).

➡ **Table 11** CORSIA GHG savings calculations

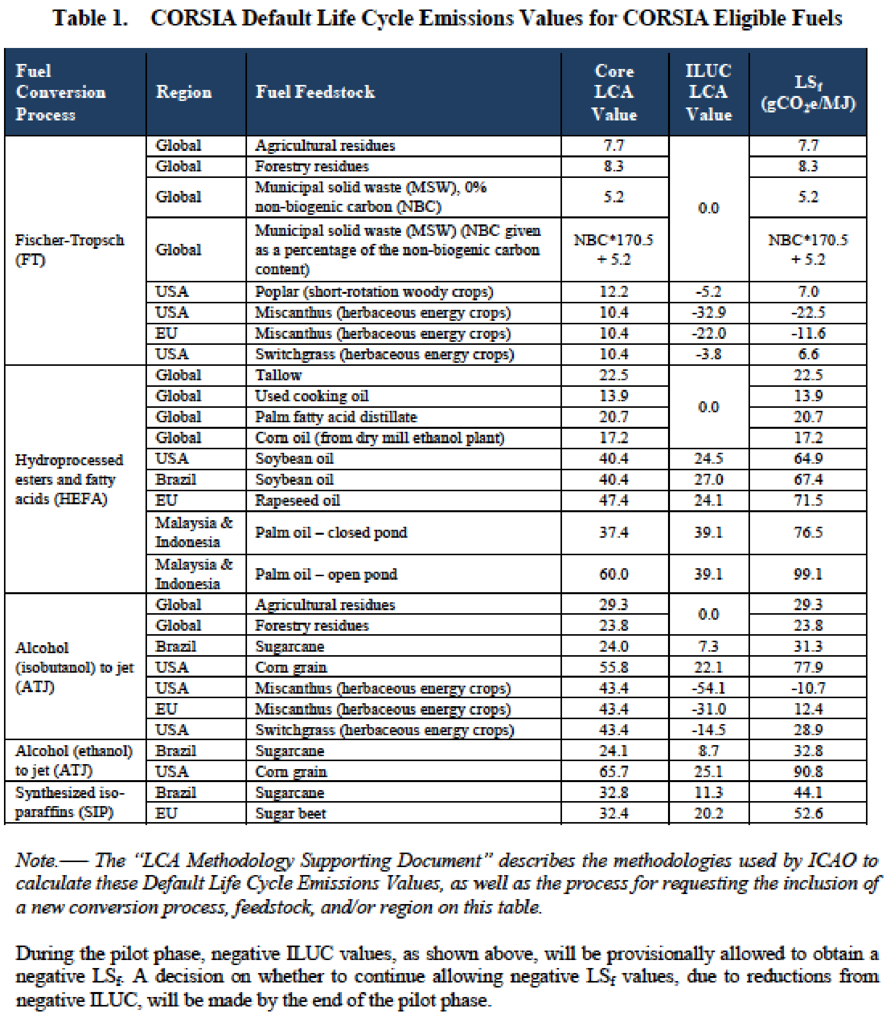

Table 1. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels

Fuel Conversion Process	Region	Fuel Feedstock	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Fischer-Tropsch (FT)	Global	Agricultural residues	7.7	0.0	7.7
	Global	Forestry residues	8.3		8.3
	Global	Municipal solid waste (MSW), 0% non-biogenic carbon (NBC)	5.2		5.2
	Global	Municipal solid waste (MSW) (NBC given as a percentage of the non-biogenic carbon content)	NBC*170.5 + 5.2		NBC*170.5 + 5.2
	USA	Poplar (short-rotation woody crops)	12.2	-5.2	7.0
	USA	Miscanthus (herbaceous energy crops)	10.4	-32.9	-22.5
	EU	Miscanthus (herbaceous energy crops)	10.4	-22.0	-11.6
	USA	Switchgrass (herbaceous energy crops)	10.4	-3.8	6.6
Hydroprocessed esters and fatty acids (HEFA)	Global	Tallow	22.5	0.0	22.5
	Global	Used cooking oil	13.9		13.9
	Global	Palm fatty acid distillate	20.7		20.7
	Global	Corn oil (from dry mill ethanol plant)	17.2		17.2
	USA	Soybean oil	40.4	24.5	64.9
	Brazil	Soybean oil	40.4	27.0	67.4
	EU	Rapeseed oil	47.4	24.1	71.5
	Malaysia & Indonesia	Palm oil – closed pond	37.4	39.1	76.5
	Malaysia & Indonesia	Palm oil – open pond	60.0	39.1	99.1
Alcohol (isobutanol) to jet (ATJ)	Global	Agricultural residues	29.3	0.0	29.3
	Global	Forestry residues	23.8		23.8
	Brazil	Sugarcane	24.0	7.3	31.3
	USA	Corn grain	55.8	22.1	77.9
	USA	Miscanthus (herbaceous energy crops)	43.4	-54.1	-10.7
	EU	Miscanthus (herbaceous energy crops)	43.4	-31.0	12.4
	USA	Switchgrass (herbaceous energy crops)	43.4	-14.5	28.9
Alcohol (ethanol) to jet (ATJ)	Brazil	Sugarcane	24.1	8.7	32.8
	USA	Corn grain	65.7	25.1	90.8
Synthesized iso-paraffins (SIP)	Brazil	Sugarcane	32.8	11.3	44.1
	EU	Sugar beet	32.4	20.2	52.6

Note.— The "LCA Methodology Supporting Document" describes the methodologies used by ICAO to calculate these Default Life Cycle Emissions Values, as well as the process for requesting the inclusion of a new conversion process, feedstock, and/or region on this table.

During the pilot phase, negative ILUC values, as shown above, will be provisionally allowed to obtain a negative LS_f. A decision on whether to continue allowing negative LS_f values, due to reductions from negative ILUC, will be made by the end of the pilot phase.

6. SAF Status Today

The European Aviation Environmental Report (EAER) 2019[44] includes an analysis of the status of SAF today and future expectations. The information included below complements that included in EAER 2019.

6.1 Refining and production technology

6.1.1 Existing SAF approved pathways

In June 2009, the American Society for Testing and Materials (ASTM) International, issued the ASTM D7566[45] Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons.

As indicated in EAER 2019, there are five (5) major fuel routes approved for the use in civil aviation of 'drop-in' jet fuels (can be blended at a certain percentage into conventional Jet-A1) under the specifications of the ASTM D7566 standard. The composition of these new fuels is mostly paraffinic, being known as Synthetic Paraffinic Kerosene (SPK) or iso-paraffins. Once blended, the fuel is considered as Jet-A1 (ASTM D1655 or DEFSTAN 91-091):

- ✓ Annex A1 Fischer Tropsch (FT) Synthetic Paraffinic Kerosene (**FT SPK**), approved in June 2009. Blend Level: Up to a 50%.
- ✓ Annex A2 Hydro-processed Esters and Fatty Acids (**HEFA SPK**), approved in July 2011. Blend Level: Up to a 50%
- ✓ Annex A3 Hydro-processed Fermented Sugar (**HFS-SIP**), approved in June 2014. Blend Level: Up to a 10%
- ✓ Annex A4 synthesized paraffinic kerosene plus aromatics (**FT-SPK/A**), approved in November 2015. Blend Level: Up to a 50%
- ✓ Annex A5 Alcohol to Jet (**ATJ-SPK**), approved in June 2018. Blend Level: Up to a 50%

In addition, approved in April 2018, co-processing of up to 5 vol% fats and oils in a conventional refinery to produce kerosene is certified under Annex A1 of specification ASTM D1655[46] standard (conventional Jet-A1).

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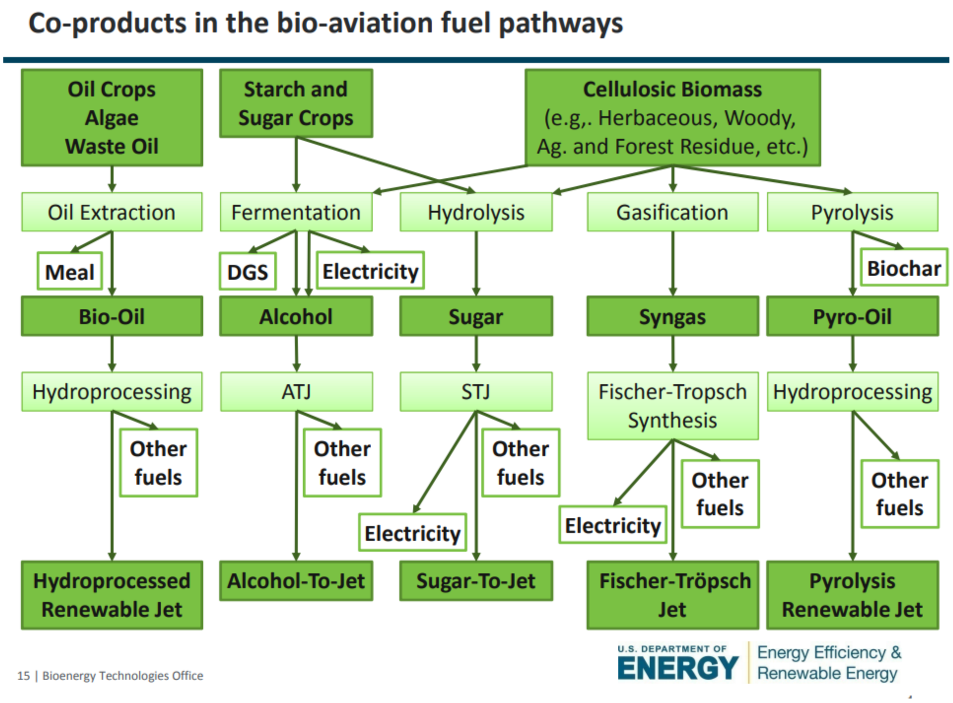
[44] https://www.easa.europa.eu/eaer/

[45] https://www.astm.org/Standards/D7566.htm

[46] https://www.astm.org/Standards/D1655.htm



➡ **Figure 15** Main current feedstocks, products and co-products in the SAF pathways [47]

6.1.2 SAF Pathways under approval process

To be added to the ASTM D7566 Specification, any new SAF pathway must go through ASTM's D4054 Evaluation & Fuel Approval Process to determine if it is equivalent (either neat or as a blend) to conventional jet fuel. All steps are described in the following guide: *Path to Alternative Jet Fuel Readiness* (developed by CAAFI®).[48]

If the fuel is determined to be equivalent, an Annex with the new SAF (including any required blending percentage) is added to the D7566 drop-in Fuel Specification. Since the D7566 Drop-In Fuels Specification meets the ASTM Conventional Fuel Specification, the new SAF once fully bended and tested as compliant to ASTM D7566 is actually re-certified and shipped out designated as ASTM D1655 (not D7566) and thus approved for use in all existing commercial jet aircrafts.

According to the US *Commercial Aviation Alternative Fuels Initiative* CAAFI® there are currently nine additional SAF pathways under review, one of those under the ASTM "Fast Track" procedure and eight under the D4054 Qualification Process[49].

The so-called "fast-track" is a short ASTM approval procedure based on chemistry analysis of the fuels under approval. Considering the ASTM knowledge base that has been created, in cases where the chemical composition of the new fuel is the same or very similar to approved ones, those can be approved at a low blending rate (up to 10%) without going through the whole process. The fast track still needs to go through OEM review and that can delay the approval in some cases.

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[47] http://www.wwenergyconference.com/wp-content/uploads/2017/03/FINAL-Alternative-Renewable-Fuels-Panel-Discussion-Technology-Development-and-Certification-Kostova.pdf

[48] http://caafi.org/tools/docs/Path_to_Aviation_Alternative_Fuel_Readiness_v24.pdf

[49] http://www.caafi.org/focus_areas/fuel_qualification.html

The current fuel on the "fast-track" corridor:

- ✓ Pathway: Algae-based HEFA-SPK **(Bb-oil HEFA)** *(new feedstock; existing pathway)
  Feedstock & leading company: Hydrocarbon-rich algae oil; IHI

This fuel and the following two are expected to be approved by end of 2019.

- ✓ Pathway: Co-processing using bio-crude from Fischer-Tropsch (**Co-Processing FT**); Feedstock & leading company: F-T Biocrude; Fulcrum. (Note: under ASTM D1655)
- ✓ Pathway: Catalytic Hydrothermolysis Synthetic Kerosene **(CH-SK)**
  Feedstock & leading company: Oils, fats, and greases; Applied Research Associates (ARA)

Other fuels under the D4054 Qualification Process are:

Phase 2 Testing:

- ✓ Pathway: Hydro-deoxygenation Synthetic Kerosene **(HDO-SK)**
  Feedstock & leading company: Sugars and cellulosics; Virent (inactive)

Phase 1 OEM Review:

- ✓ Pathway: High Freeze Point Hydroprocessed Esters and Fatty Acids Synthetic Kerosene **(HFP HEFA-SK).** Feedstock & leading company: Renewable FOG; Boeing

Phase 1 Research Report:

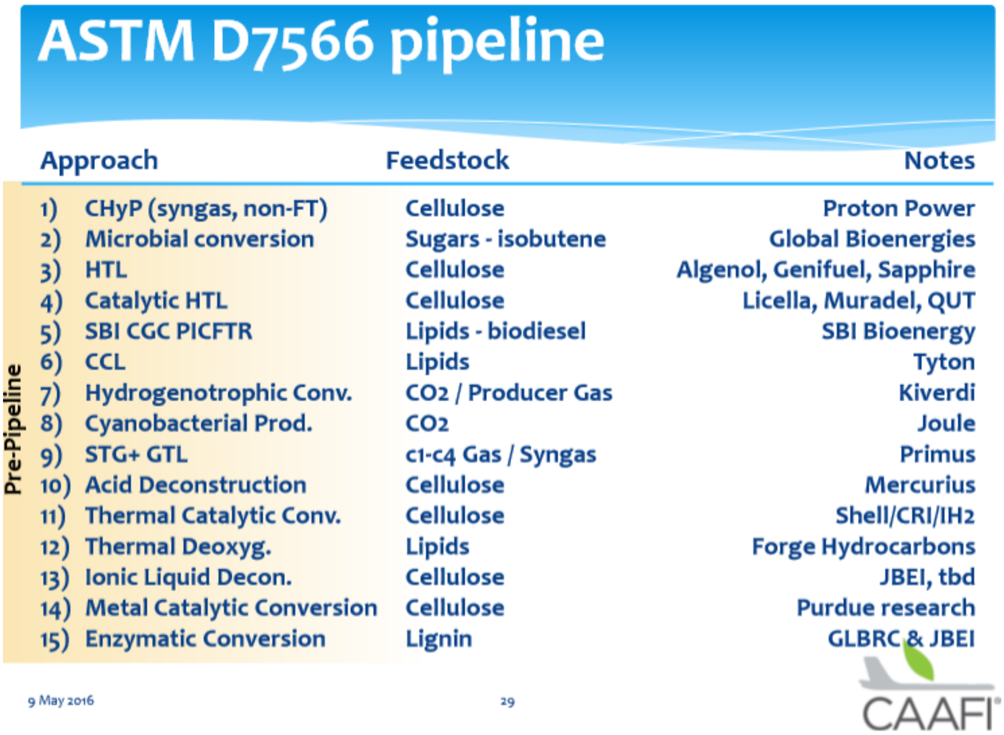
- ✓ Pathway: Hydro-deoxygenation Synthetic Aromatic Kerosene **(HDO-SAK)**
  Feedstock & leading company: Sugars and cellulosics; Virent

Phase 1 Testing:

- ✓ Pathway: Alcohol-to-Jet Synthetic Kerosene with Aromatics **(ATJ-SKA)**
  Feedstock & leading company: Sugars and lignocellulosics; Byogy, Swedish Biofuels

- ✓ Pathway: Integrated Hydropyrolysis and Hydroconversion **(IH2)**
- ✓ Feedstock & leading company: Multiple; ShellPathway: Hydrotreated Depolymerized Cellulosic Jet **(HDCJ)**
  Feedstock & leading company: Forest residues; KiOR (not existent anymore)

A significant number of other pathways (15 in 2016 as per chart below) are currently under Pre-Qualification Process Fuels, but have yet to enter the ASTM Certification Process. These approaches have the potential to convert the carbon or hydrocarbon content of various feedstocks using biological (fermentation or microbial conversion) or thermochemical (pyrolysis, hydrothermal liquefaction, catalytic conversion, etc.) processes into the chemical components of jet fuel.



ASTM D7566 pipeline

Pre-Pipeline

Approach	Feedstock	Notes
1) CHyP (syngas, non-FT)	Cellulose	Proton Power
2) Microbial conversion	Sugars - isobutene	Global Bioenergies
3) HTL	Cellulose	Algenol, Genifuel, Sapphire
4) Catalytic HTL	Cellulose	Licella, Muradel, QUT
5) SBI CGC PICFTR	Lipids - biodiesel	SBI Bioenergy
6) CCL	Lipids	Tyton
7) Hydrogenotrophic Conv.	CO2 / Producer Gas	Kiverdi
8) Cyanobacterial Prod.	CO2	Joule
9) STG+ GTL	c1-c4 Gas / Syngas	Primus
10) Acid Deconstruction	Cellulose	Mercurius
11) Thermal Catalytic Conv.	Cellulose	Shell/CRI/IH2
12) Thermal Deoxyg.	Lipids	Forge Hydrocarbons
13) Ionic Liquid Decon.	Cellulose	JBEI, tbd
14) Metal Catalytic Conversion	Cellulose	Purdue research
15) Enzymatic Conversion	Lignin	GLBRC & JBEI

9 May 2016

29

CAAFI®

Figure 16 ASTM D7566 pipeline[50]

6.1.3 Power-to-liquid (PTL)

SAF could also be produced from electric power and CO_2 captured from air, known as power-to-liquid (PtL). The German Environment Agency conducted a study in 2016, analysing *Potentials and Perspectives for the Future Supply of Renewable Aviation Fuel*[51].

PtL fuels produced via the FT pathway would fall under ASTM D7566 FT-SPK specification as long as iron or cobalt catalysts are used in the FT process and the fuels produced meet the chemical and physical specifications. Then FT-derived PtL jet fuel would not need to be newly approved and jet fuel blends can be considered drop-in.

In case of PtL kerosene derived via the methanol pathway, prior approval for use in commercial aviation according to ASTM D7566 would be required, but it can be expected that will have similar characteristics as Fischer-Tropsch-derived products.

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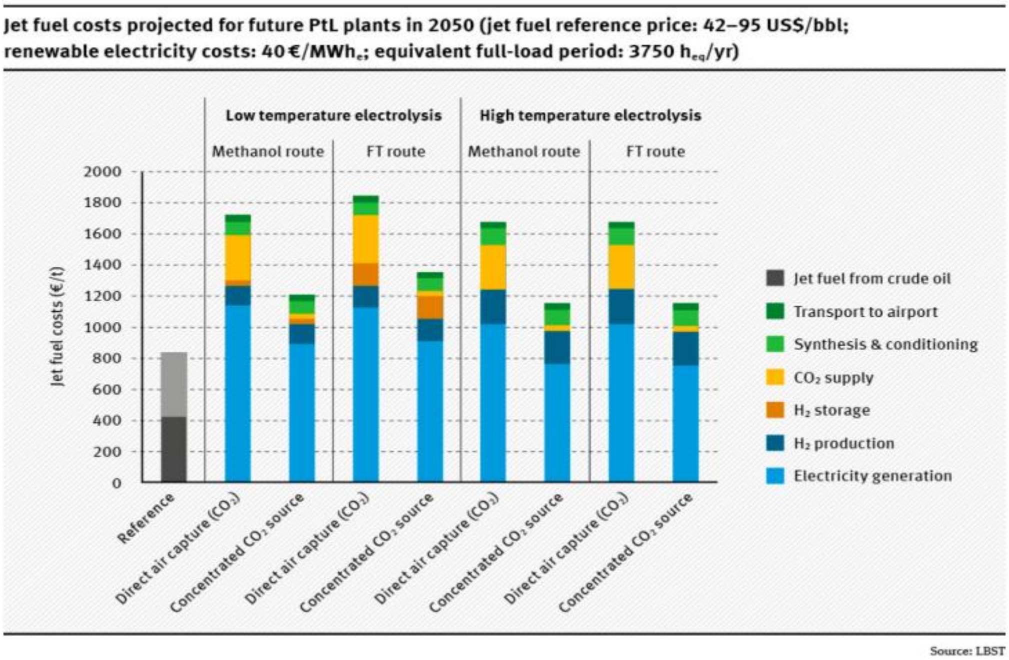
[50] http://www.caafi.org/resources/pdf/2_Intro_Csonka_CAAFI_04282016.pdf

[51] https://www.umweltbundesamt.de/en/publikationen/power-to-liquids-potentials-perspectives-for-the

The study shows significant environmental benefits of PtL, including non-CO_2 high-altitude radiative forcing, very low land and water demand and improved combustion with less pollutants. However, the study also highlights the challenge for short-term deployment of PtL due to its **very high production costs**.


Jet fuel costs projected for future PtL plants in 2050 (jet fuel reference price: 42–95 US$/bbl; renewable electricity costs: 40 €/MWh_e; equivalent full-load period: 3750 h_{eq}/yr)

Source: LBST

➡ **Figure 17** PtL projected costs 2050

It concluded that if jet fuel prices stay in the range that has been observed in the past few years (without a carbon price and without taxes), then a significant cost disparity between fossil jet fuel and renewable jet fuel will remain in the future.

The key advantage of PtL fuels, however, is the huge potential for wind[52] and solar power to exceed the total global energy demand of today and the future.

The first step of the PtL process is the renewable generation of synthesis gas (syngas), either by a steam electrolysis and CO_2 conversion by the reverse water gas shift (RWGS) reaction, or from a direct electrochemical transformation by co-electrolysis. The syngas is then converted to liquid hydrocarbons (e-crude) via Fischer-Tropsch (F-T) synthesis. The e-crude can then be further processed into high-value fuel components (e-fuels) and chemical base materials (e-chemicals).

PtL full system integration is recently progressing due to demonstration plants in Finland, Germany, Iceland and Spain, with first industrial-scale plants to be built in Norway[53] and in Canada[54] as detailed below.

Past and current PtL global initiatives include:

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[52] https://www.sussex.ac.uk/news/media-centre/press-releases/id/49312

[53] https://www.icao.int/environmental-protection/GFAAF/Pages/Project.aspx?ProjectID=46

[54] https://carbonengineering.com/history-and-trajectory/

- Coordinated by Bauhaus Luftfahrt e.V. (Germany), the EU FP7 SOLAR-JET[55] project explored from 2011 to 2015, solar-thermochemical cycles, producing the world's first sample of solar thermochemical kerosene.

- The H2020 four-year project SUN-to-LIQUID[56] started in 2016, following on the outcomes of SOLAR-JET project and aiming to design, fabricate, and validate a large-scale, complete solar fuel production plant. A high-flux solar concentrating subsystem was constructed at IMDEA Energía at Móstoles Technology Park, Madrid (Spain) in 2016.

- Sunfire GmbH, a Germany-based developer and Nordic Blue Crude AS, a Norwegian company, announced in 2017 that the first "*Blue Crude*" power-to-liquids (PtL) plant would be built in Heroya (Norway) and is initially expected to be operational in 2020. The plant should produce 8,000 tonnes/yr of "e-crude" from CO_2, water, and 20 MW of hydroelectric power. The crude oil would then be refined into "e-waxes and e-fuels."

- The Hague Airport in Rotterdam initiates a study to produce 1,000 litres/day renewable jet fuel (PtL) from air at the airport. First CO_2 is captured via Climeworks' direct air capture technology, subsequently transformed into syngas by Sunfire's electrolyser cells. Via Fischer-Tropsch the syngas is transformed to synthetic hydrocarbon by Ineratec and finally converted into SAF by EDL. SkyNRG is responsible for the commercialization strategy and Transavia the first potential off taker.

- An Air To Fuels™ plant is also planned by Carbon Engineering, a company based in Squamish (Canada) to be operational in 2021. CE envisions building individual facilities with a capacity of 2000 barrels per day.

- SAF+ Consortium (Montreal, Canada) was selected as one of four projects to continue the "Sky's the Limit Challenge." Through this challenge Canada is incentivizing the production of 2,500 litres of ASTM certified jet fuel by January 2021. The SAF+ Consortium comprises of Carbon Consult Group, CO_2 Solutions Inc., Air Transat, Aéroports de Montréal, Valorisation Carbone Québec Project, CIRAIG and Hatch and its technology is based in using captured and converted flue gas obtained from industrial sources.

6.2 Policy incentive and support frameworks

6.2.1 ICAO CORSIA

SAF use under the ICAO CORSIA will reduce the offsetting requirements of airlines using SAF in relation with the life-cycle CO_2 emissions reductions achieved by the specific SAF type. CORSIA will cover only international flights in participating States.

While this is the first globally applied incentive mechanism, such incentive is expected to be very small in economic terms compared with the price gap with fossil jet kerosene.

6.2.2 European Union Emissions Trading Scheme (EU ETS)

The only current applicable incentive at European level for the use of SAF is the EU ETS for intra-European flights, which accounts CO_2 emissions from SAF use as zero (which is equivalent to a 100%

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[55] http://www.solar-jet.aero/

[56] https://www.sun-to-liquid.eu/page/home.php

saving in the amount of CO_2 allowances corresponding to those emissions). However, this incentive is relatively small compared with the price gap with fossil jet kerosene, and has not been sufficient in the last years to increase SAF uptake in Europe.

6.2.3 European Union Renewable Energy Directive (EU RED)

Under the first RED, renewable energy targets did not apply to aviation fuel until 2015 when it recognised the possibility of implementing a so-called ‘voluntary aviation opt-in’ in national legislation (only the Netherlands and the UK have applied this opt-in).

The revised RED II establishes a more important policy incentive as SAF can contribute to the achievement of the RED targets in all Member States, on condition that they comply with the associated sustainability criteria.

Two specific incentive multipliers are applicable to SAF supply *(RED II Article 27, Para 2)*:

> For the purposes of demonstrating compliance with the minimum shares of renewables:
>
> - ✓ The share of biofuels for transport produced from the feedstock listed in Annex IX may be considered to be twice its energy content;
> - ✓ Except for fuels produced from food and feed crops, the share of fuels supplied in the aviation sector shall be considered to be 1,2 times their energy content.

The application of these two multipliers by Member States, either individually or combined, can encourage fuel producers to prioritize SAF production for the achievement of the respective supply obligations for their economic operators. Those multipliers are to be defined and handled at MS level.

The food and feed limitation applicable to the aviation multiplier, pose a constraint to the feedstock availability, and also an additional Sustainability Reporting requirement (currently sustainability certificates do not include whether the feedstock is food or feed).

6.2.4 European State's policy support mechanisms

6.2.4.1 The Netherlands: Aviation opt-in in the RED legislation.

The Netherlands included the aviation opt-in as part of their RED legislation in 2013.

Under the RED, the Dutch suppliers of road transport fuels have to supply a percentage of their fuels from renewable sources. The Dutch Emission Authority (NEA) uses biofuel certificates (known as bio-tickets or HBEs) to check on an annual basis that all parties comply with such obligation. Bio-tickets can be obtained through biofuels they produce or by purchasing them from parties with surplus production. Since 2013, SAF suppliers in the Dutch market can generate tradeable “bio-tickets” (equivalent to the SAF supplied) and as there is no supply obligation for the aviation sector but there is for road, those bio-tickets can be sold to the road sector for compliance with their supply obligation, receiving SAF suppliers an economic incentive to help covering the price gap with fossil fuels.

The Dutch company SkyNRG, in collaboration with Boeing, published in 2016[57] an analysis on how the voluntary aviation opt-in works in the Netherlands and how other EU member states could implement it into their local RED legislation.

6.2.4.2 United Kingdom: Renewable Transport Fuel Obligation (RTFO)

The UK RTFO[58] was amended in 2018 and while it does not include specific supply targets for aviation, it will for the first-time reward and support the production of sustainable aviation fuels in the UK, providing SAF with the same economic incentives given to road vehicles.

The RTFO promotes the development of cutting-edge technologies to turn waste into valuable low carbon fuels through a new sub-target for 'development fuels' to include waste based renewable fuels and renewable fuels of non-biological origin. There are increasing supply obligations for those "development fuels": 0,1% in 2019, 1,4% in 2025 and 8% in 2030. It is expected that this policy incentive will boost SAF related investments in the UK.

6.2.4.3 Norway: SAF supply obligation (%)

The Norwegian Ministry of Climate and Environment announced in 2018 an obligation to aviation fuel suppliers for a 0.5% minimum content of advanced biofuel to be mixed with jet fuel sold in the country from 1 January 2020. This corresponds to around 6 million litters (4.800 tonnes) and will result in a reduction of 14,000 tonnes of CO_2eq in the first year. The extra cost for the airlines in that year is estimated in about 1(?) Million Euro.

The government's goal is that by 2030, 30% of the airline fuels will SAF. The Norwegian government has stipulated that the biomass to produce it should come from wastes and residues and cannot be based on palm oil.

Avinor, the state-owned airport operator, has on a voluntary basis blended in jet biofuels in the hydrant system at Oslo Airport since 2016, thereby proving that no segregated distribution channels were necessary. The project was in 2017 extended to cover Bergen Airport.

6.2.4.4 Portugal: Roadmap for Carbon Neutrality - RNC2050.

In December 2018, the Portuguese government launched their Roadmap to Carbon Neutrality; a plan that would drive Portugal to produce 90% of its energy needs via renewable resources by 2050, making it effectively carbon neutral.

The plan includes an integrated approach to transport decarbonisation, focusing on electric vehicles for road and biofuels for Aviation, shipping, and long-distance transportation. The Portuguese first secretary of state for mobility, announced "*what we believe is that by 2030, we will have one-quarter of the consumption being biofuel; this is important, mainly for aviation, considering that it's not easy to fully electrify an airplane*,"[59]

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[57] https://skynrg.com/wp-content/uploads/2019/03/Publications-The-voluntary-RED-opt-in-for-aviation-biofuels.pdf

[58] https://www.gov.uk/government/news/new-regulations-to-double-the-use-of-sustainable-renewable-fuels-by-2020

[59] https://www.euractiv.com/section/climate-strategy-2050/news/biofuels-and-electromobility-are-the-keys-in-portugals-transport-decarbonisation/

6.2.4.5 Spain: SAF supply obligation (%) proposal

In 2019 the Spanish Ministries of Public Works (Transport) and for Ecological Transition (Environment) proposed two legislative frameworks which include a SAF supply obligation to aviation fuel suppliers from 2025:

1) The Spanish Climate Change Law[60]
2) The Spanish Integrated Plan for Energy and Climate (2019)[61]

In February 2019 Spain presented a paper in ICAO indicating the initial goal to establish a 2% SAF supply obligation from aviation fuels suppliers as part of the implementation of the EU Renewables Energy Directive (RED II). The final obligation will be established after analysing its technical and economic viability with stakeholders. A 2% requirement in 2025 would need a SAF supply of about 150.000 Tonnes.

It should be emphasized that the proposals are still going through parliamentary approval, so this information should still be taken with caution. The Integrated Plan for Energy and Climate must be submitted to the EC by December 2019.

6.2.4.6 Sweden: SAF supply obligation (%) proposal

In 2018, the Swedish Government established a research finance program to promote sustainable aviation fuels (SAF), with the aim of turning Swedish domestic aviation fossil free, and for international bunkers from Swedish Airports to use sustainable aviation fuels to as large extent as possible. By April 2019, 11 different projects had received support sharing 34 million SEK, the majority of those using forestry residues as a feedstock.

The Swedish Government has decided as well in 2019 to implement a GHG emissions reduction obligation for jet fuel suppliers in Sweden, in order to promote the use of SAF[62] from 2021. It would establish a GHG emissions reduction obligation for fuel suppliers, calculating such reductions on a life-cycle basis through use of SAF. The SAF volume ratio that is needed to meet the reduction obligation therefore depends on the greenhouse gas emissions from a lifecycle perspective from the SAF used.

Table 12 Sweden - Reduction levels, presumed LCA emissions and estimated volume ratios

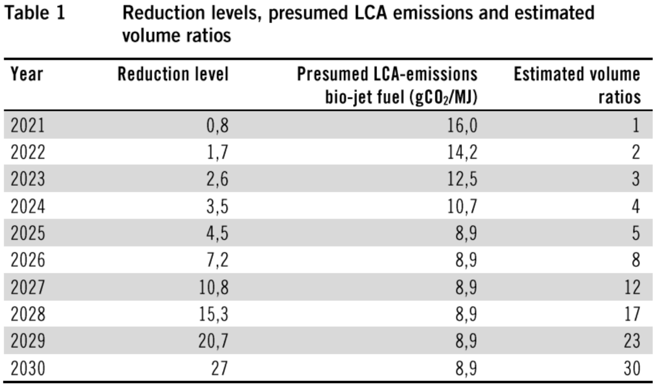

Table 1 Reduction levels, presumed LCA emissions and estimated volume ratios

Year	Reduction level	Presumed LCA-emissions bio-jet fuel (gCO_2/MJ)	Estimated volume ratios
2021	0,8	16,0	1
2022	1,7	14,2	2
2023	2,6	12,5	3
2024	3,5	10,7	4
2025	4,5	8,9	5
2026	7,2	8,9	8
2027	10,8	8,9	12
2028	15,3	8,9	17
2029	20,7	8,9	23
2030	27	8,9	30

The proposed SAF blend ratios into conventional jet fuel are defined for each year from 2021 to 2030 (see table above extracted from the report). These blend ratios increase from 1% by volume in 2021 to 30% in 2030.

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[60] https://www.lamoncloa.gob.es/consejodeministros/Paginas/enlaces/220219-proyecto.aspx
[61] https://ec.europa.eu/energy/sites/ener/files/documents/spain_draftnecp.pdf
[62] https://www.biofuelsflightpath.eu/images/Swedish_proposal_summary.pdf

Table 13 Sweden - Reduction obligation translated into volume of bio-jet fuel

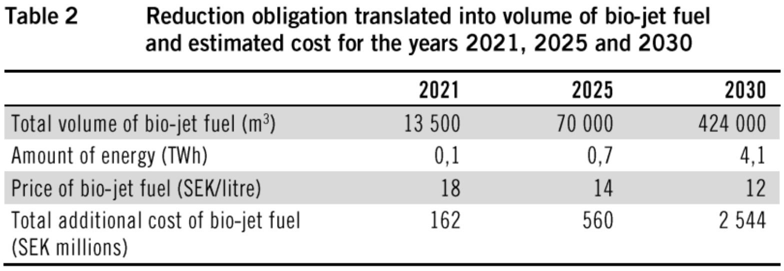

Table 2 Reduction obligation translated into volume of bio-jet fuel and estimated cost for the years 2021, 2025 and 2030

	2021	2025	2030
Total volume of bio-jet fuel (m^3)	13 500	70 000	424 000
Amount of energy (TWh)	0,1	0,7	4,1
Price of bio-jet fuel (SEK/litre)	18	14	12
Total additional cost of bio-jet fuel (SEK millions)	162	560	2 544

The SAF for the proposed mandate are potentially to be derived from the forest and paper industry residues and correspond to SAF volumes of 13,500 and 424,000 m3, respectively, in Sweden (see table above).

They correspond to GHG reductions of 0.8% in 2021 and 27% in 2030 (assuming an average SAF LCA of 16 and 8.9 g CO_2e/MJ for 2021 and 2030, respectively, considering improvements in production).

6.2.4.7 France: SAF supply obligation (%) and aviation Eco Tax proposals

In 2015, the French Ministry of Ecology, Sustainable Development and Energy and the Ministry of Agriculture, Agri-Food and Forest, developed a report on "*Aeronautical biofuels in France Prospects for the development of their production and their use by 2020*"[63].

While it has not yet been formally announced, in an interview held in June 20 2019 at the Paris Air Show[64], the French Minister of Transport announced she plans to accelerate the development of second-generation biofuels in aviation in France through a SAF use obligation similar to the existing for land transportation. The intention is to incorporation a SAF rate of 2% in 2025 and 5% in 2030.

France has also announced in June 2019 its plans to impose a green tax on all tickets for outbound flights from French airports from 2020. The amount of the tax will depend on the type of ticket being bought. Economy tickets on flights within France or the EU will have a tax of €1.50 imposed. Business tickets for flights out of the EU will have the highest tariff of up to €18. IATA has requested French government to use this revenue to promote SAF[65].

6.2.4.8 Finland: SAF supply obligation (%) and aviation Eco Tax.

In June 2019[66] the Finnish government announced a 30% SAF blending obligation among its ambitious climate targets for achieving a carbon neutral country by 2035, under a government programme called “Inclusive and competent Finland – a socially, economically and ecologically sustainable society”.

As part of government programme´s climate actions a specific SAF target was introduced for all aviation fuel uplifted in Finland. By using a blending obligation (mandate) the share of SAF should be 30 per cent in 2030.

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[63] https://agriculture.gouv.fr/sites/minagri/files/cgaaer_15098_cgedd_010298-01_2015_rapport.pdf

[64] https://www.latribune.fr/entreprises-finance/services/transport-logistique/la-france-envisage-d-obliger-les-compagnies-aeriennes-a-utiliser-des-biocarburants-821160.html

[65] https://www.iata.org/pressroom/pr/Pages/2019-07-09-02.aspx

[66] https://aviationbenefits.org/newswire/2019/06/finland-to-join-nordic-forefront-in-reducing-emissions-in-aviation/

Implementation of the SAF action has started in the 4th quarter of 2019 as a joint undertaking between the Ministry of Economic Affairs and Employment, the Ministry of Transport and Communications and the Ministry of Environment.

6.2.5 United States incentive frameworks

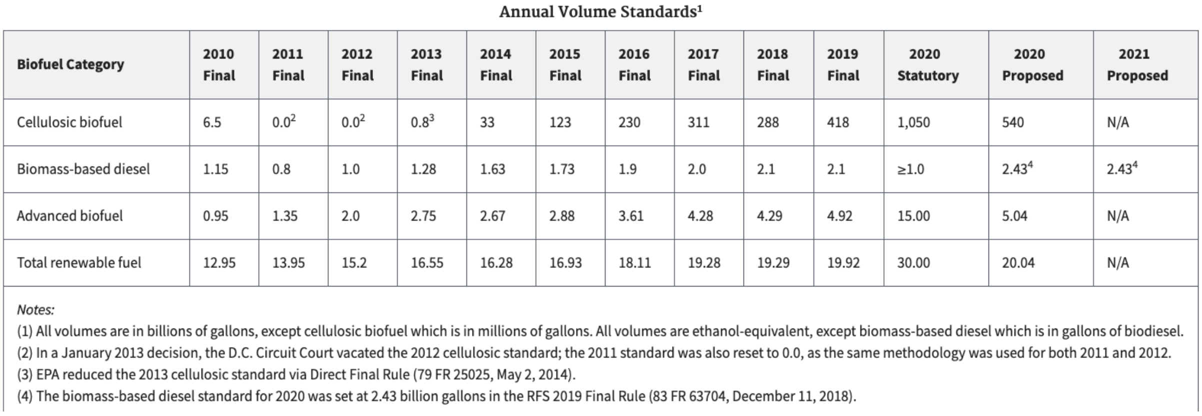
6.2.5.1 The Renewable Fuel Standard (RFS)

US Congress created in 2005 the RFS program to reduce greenhouse gas emissions and expand the nation's renewable fuels sector while reducing reliance on imported oil. The program was expanded in 2007 (RFS2). It requires transportation fuel sold in the United States (SAF can be accounted) to contain a minimum volume of renewable fuels.

Each year the government establishes the volumes of biofuel that must be blended with transportation fuels during the following calendar year known as the *Renewable Volume Obligation* or RVO. An RVO is determined by multiplying the output of the producer by the announced blending ratios for each of four renewable fuel categories: biomass-based diesel, cellulosic ethanol, second-generation biofuel, and total renewable fuel.

The table below provides the annual volume standards that have been finalized for 2010 to 2019 (and the final biomass-based diesel volume for 2020) and proposed for 2020 (and the proposed biomass-based diesel volume for 2021).

Table 14 RFS Annual Volume Standards



Annual Volume Standards[1]

Biofuel Category	2010 Final	2011 Final	2012 Final	2013 Final	2014 Final	2015 Final	2016 Final	2017 Final	2018 Final	2019 Final	2020 Statutory	2020 Proposed	2021 Proposed
Cellulosic biofuel	6.5	0.0[2]	0.0[2]	0.8[3]	33	123	230	311	288	418	1,050	540	N/A
Biomass-based diesel	1.15	0.8	1.0	1.28	1.63	1.73	1.9	2.0	2.1	2.1	≥1.0	2.43[4]	2.43[4]
Advanced biofuel	0.95	1.35	2.0	2.75	2.67	2.88	3.61	4.28	4.29	4.92	15.00	5.04	N/A
Total renewable fuel	12.95	13.95	15.2	16.55	16.28	16.93	18.11	19.28	19.29	19.92	30.00	20.04	N/A

Notes:

(1) All volumes are in billions of gallons, except cellulosic biofuel which is in millions of gallons. All volumes are ethanol-equivalent, except biomass-based diesel which is in gallons of biodiesel.

(2) In a January 2013 decision, the D.C. Circuit Court vacated the 2012 cellulosic standard; the 2011 standard was also reset to 0.0, as the same methodology was used for both 2011 and 2012.

(3) EPA reduced the 2013 cellulosic standard via Direct Final Rule (79 FR 25025, May 2, 2014).

(4) The biomass-based diesel standard for 2020 was set at 2.43 billion gallons in the RFS 2019 Final Rule (83 FR 63704, December 11, 2018).

The producer must show compliance through the Renewable Identification Number (RIN) system. Surplus RINs can be sold, and they can purchase RINs to compensate any shortfall in production.

6.2.5.2 The Farm To Fly initiative

The US Department of Agriculture (USDA), Boeing and airline trade body Airlines for America launched the *Farm to Fly* initiative in 2010 which included the creation and implementation of programs and incentives to assist US farmers in the selection and cultivation of energy crops for conversion into affordable and sustainable aviation biofuels.

The programme was extended for a further five years in 2014 (Farm to Fly 2.0) with additional partners including the Federal Aviation Administration (FAA), the Commercial Aviation Alternative Fuels Initiative (CAAFI) and other aviation industry representative groups. The aim of the second phase was to set up supply chains in the US that are able to support a goal of producing one billion gallons of sustainable jet biofuel for use by airlines by 2018. Although the objective was not achieved, the current existing capacity in the US (as detailed below in 6.6.1 SAF Developments in North America) was developed under the program.

6.2.5.3 California's Low Carbon Fuel Standard (LCFS)

The LCFS requires oil refineries and distributors to ensure that the mix of fuel they sell in the Californian market meets established declining targets (1.25% per year through 2030) for its Carbon Intensity (CI: greenhouse gas emissions measured in CO_2-equivalent grams per unit of fuel energy) sold for transport purposes. The LCFS calls for a reduction of at least 20 percent in the carbon intensity of California's transportation fuels by 2030. These reductions include all the fuel's full life cycle.

Fuels and fuel blends introduced into the California fuel system that have a CI higher than the benchmark generate deficits. Similarly, fuels and fuel blends with CIs below the benchmark generate credits. Annual compliance is achieved when a regulated party uses credits to match its deficits.

Effective on 1 January 2019, SAF were included to generate credits, although are not included in the declining CO_2 intensity targets (opt-in basis).

6.2.5.4 State of Oregon Clean Fuels Standard

Incentivizes carbon intensity reduction for transportation. In January 2019 SAF was included.

Other US states are considering similar policies[67].

6.2.6 Canada incentive frameworks

6.2.6.1 Renewable Fuel Standard:

Canada has a Renewable Fuel Standard which require fuel producers and importers to have an average renewable fuel content of at least 5% based on the volume of gasoline that they produce or import into Canada and of at least 2% based on the volume of diesel fuel. It does not target SAF.

6.2.6.2 Clean Fuel Standard:

The Government is currently developing a Clean Fuel Standard to reduce Canada's greenhouse gas emissions through the increased use of lower carbon fuels, expected to be approved in 2020. Key design elements include a carbon intensity reduction of approximately 11% in 2030, and credits to be generated when some fuel users switch from a higher carbon intensity fuel to a lower carbon intensity fuel.

Jet fuel that is used domestically will be subject to the Clean Fuel Standard but jet fuel that is used for international flights will not. Renewable or other low-carbon intensity aviation fuel produced and imported will be eligible to generate credits under the Clean Fuel Standard.

Compliance can be achieved through 3 options:

- ✓ Low CI fuel blending in Gasoline/Diesel/Jet/HFO/LFO
- ✓ Through fuel switching (e.g., EV's, natural gas displacing a liquid fuel)
- ✓ Through use of emission reductions achieved in the fossil fuel supply chain

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[67] https://www.icao.int/Meetings/SAFStocktaking/Documents/ICAO%20SAF%20Stocktaking%202019%20-%20AI2-3%20Nate%20Brown.pdf

Consideration is being given to the use of a multiplying factor for low carbon aviation fuel credits to incentivise SAF use and production.

6.3 State deployment support initiatives

6.3.1 The US Commercial Aviation Alternative Fuels Initiative (CAAFI)

CAAFI was launched in 2006 by a group of U.S. government agencies (including FAA, EPA, USAF, NASA, DOE and USDA) as a coalition with airlines, airports, aircraft and engine manufacturers, energy producers and researchers, in response to three concerns regarding aviation fuels: 1) supply security, 2) affordability and price stability, and 3) environmental impacts.

In a coordinated manner, those stakeholders are leading the development and deployment of SAF for commercial aviation in the US and CAAFI has been the key discussion forum to develop national actions.

A key CAAFI priority is to foster the near-term commercialization of SAF in a very pragmatic approach: CAAFI works closely with stakeholders from all parts of potential state or regional supply chains to identify, evaluate, select, develop, and execute specific deployment projects that could produce SAF. CAAFI facilitates connections with relevant resources and authorities (federal, state, and local authorities) to identify funding opportunities, and also links supply chain agents with a CAAFI network of fuel production companies and end users.

6.3.2 Spanish Bioqueroseno Initiative

The Spanish Initiative for the production and consumption of biokerosene for aviation has its origin after the first ICAO International Conference on Alternative Aviation Fuels held in 2009. After two years of work (2010 and 2011) with stakeholders, it was formalized in 2011, with an agreement between the Ministry of Industry, Energy and Tourism (through the IDAE), the Ministry of Transport (through AESA), the Ministry of Agriculture, Food and Environment (MAGRAMA), SENASA and various companies related to the production of raw materials, refining technologies, aeronautical logistics and sustainability processes.

This Initiative is structured as a stakeholder's platform to act as a bridge for the exchange of information, identification of needs and areas of action between the public and the private agents. After a few years of no activity (2014-2018) it has been reactivated in 2019 to evaluate the establishments of a mandatory supply in Spain in 2025.

6.3.3 Aviation Initiative for Renewable Energy in Germany (AIREG)

While not a Government but a stakeholder's initiative, AIREG[68] coordinates German activities to promote SAF since 2011. It was founded by a group of aviation industry companies, airports, research institutes and companies in the provision and processing of raw materials.

AIREG is committed to the increased production and use of SAF in Germany with the following goals:

- The amount of aviation fuel required in Germany will be blended with **10% sustainable kerosene from renewable energies in 2025**.

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[68] https://aireg.de/en/home-en/

- At least **one large-scale refinery** to produce renewable second-generation kerosene in Germany will be built by 2025.
- Government agreements to secure the long-term supply of raw materials will be concluded.

AIREG is requesting the German Government to establish a "*National Development Plan for Alternative Aviation Fuels*", including investment grants and loans at reduced interest rates to allow investments in bio-refineries. They estimate that a HEFA-based plant would require investments of approx. €600 million to €1 billion, and could produce approx. 800,000 tonnes of biojet, biodiesel and bio-naphtha. However, in order to achieve a 10% input by 2025, at least two such plants would be required. The investment grant provided by the Government therefore must be set at a total figure of between €360 and 600 million to incentivise the needed total investments by the industry.

6.3.4 Nordic Initiative for Sustainable Aviation (NISA)

NISA was formed in 2014 as an active Nordic association working to promote and develop a more sustainable aviation industry, with a specific focus on SAF.

To incentivise the development of sustainable biofuels and move the sector forward, NISA is required to coordinate initiatives at different maturity levels (R&D, approval, demonstration plants, airport integration), as well as involving different parts of the entire supply chain. This would involve investments into production facilities, feedstock, biofuels production, logistics, distribution, investors, demonstration plants, customer relationships, and the like.

6.3.5 Mexican Biojet Cluster

The Biojet Cluster is one of the five clusters that comprises the Mexican Centre for Innovation in Bioenergy (CEMIE-Bio in Spanish). It is supported by the Ministry of Energy and the National Council of Science and Technology, through the Energy Sustainability Fund. This is the largest government research investment initiative to develop biofuels in Mexico.

The biojet fuel cluster was formalized in 2017 as a 4-year research and development programme, which looks to advance the implementation of a value chain of SAF in Mexico.

6.3.6 Japanese Initiatives for Next-generation Aviation Fuels (INAF)

This initiative was launched in 2014 by ANA, JAL, NCA, Boeing Japan, Narita Airport, Japan Petroleum Exploration and University of Tokyo with the industry, government and academia collaborating to promote the introduction of next-generation aviation fuels. It has developed a roadmap to establish a supply chain for next-generation aviation fuels by the 2020 Tokyo Olympics and Paralympics.

6.3.7 United Kingdom Sustainable Aviation Fuel Special Interest Group (SAF SIG)

The UK´s SAF SIG[69] was created in 2017, and is sponsored by the Department for Transport and the industry coalition group Sustainable Aviation. It is run by the Knowledge Transfer Network (KTN), a government-backed programme to link business with R&D and investors.

The aim of SAF SIG is to bring together supply chain partners to build a world-leading sustainable aviation fuel industry in the UK.

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[69] https://ktn-uk.co.uk/interests/sustainable-aviation-fuel

6.3.8 United Kingdom Future Fuels for Flight and Freight Competition (F4C)

The F4C[70] was launched in 2017 by the Department for Transport (DfT) with £22 million of government funding to promote the development of an advanced low carbon fuels industry within the UK, including supplier capabilities and skills in relevant technologies. It aims to increase domestic production of advanced low carbon fuels capable of tackling emissions from aviation, while maximising value for money for the taxpayer.

➨ **Table 15** F4C Projects and lead organisation

Project Title	Lead Organisation
Straw to Liquid Biomethane (LBM) Demonstration Plant	Rika Biogas Technologies Ltd
Altalto (Velocys Waste to Jet Fuel Project)	Altalto Immingham Ltd
Sustainable Aviation Fuel From Waste-Based Ethanol	LanzaJet UK Limited
Integrated ATC & F-T Demonstration Plant	Kew Projects Limited

The F4C operates in two stages:

- Stage One (Project Development) with £2 million of funding in 2018 to support the development of proposals. Four projects were shortlisted to proceed to Stage Two.
- Stage Two (Capital Funding) will provide up to £20 million in capital grant funding over 3 years (2019-21).

There will be no further calls for applications under the F4C programme.

6.3.9 Canada's Biojet Supply Chain Initiative (CBSI)

Canada has launched in 2019 the Canada's Biojet Supply Chain Initiative (CBSI)[71] aiming to demonstrate the operational feasibility of biojet fuels in the domestic jet fuel supply system using existing delivery infrastructure (e.g., co-mingled airport fuel system).

6.3.10Canada´s Green Aviation Fuels Innovation Competition

The government has also launched the *Green Aviation Fuels Innovation Competition*[72] aiming to develop a made-in-Canada SAF with the best GHG reduction, the lowest production cost, and the greatest potential for commercial scale-up by 2021.

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[70] https://ee.ricardo.com/transport/case-studies/f4c
[71] https://cbsci.ca/
[72] https://impact.canada.ca/en/challenges/green-aviation/challenge

6.4 SAF industry developments in Europe

6.4.1 Current SAF supply (2019)

The use of SAF blends has increased from one commercial flight in 2008 to more than 180.000 in 2019, according to ICAO GFAAF[73]. Nevertheless, SAF commercial availability is still very limited globally, mainly due to high production costs and insufficient policy incentives compared to road transport.

The current existing production, albeit limited, has grown faster in the US than in Europe:

- ✓ There are no public data available on SAF uptake in Europe and there is no actual regular supply. Only Neste has produced and supplied SAF HEFA-SPK specific commissioned batches, while primarily producing sustainable biofuels for road transportation.

- ✓ Only a European airline, KLM, is using SAF on a regular basis under the *KLM Corporate BioFuel Programm*, but SAF is currently supplied from the US on its flights Los Angeles-Amsterdam.

- ✓ In the US since 2016 there is a dedicated SAF refinery with continuous production of HEFA-SPK (the AltAir fuels refinery in Los Angeles, purchased by World Energy in 2018). Between 2016 and 2019, about 4.000 tonnes (1.2 million gallons) of SAF per year were produced and supplied. It is expected to increase the supply to 16.000 tonnes/year after 2019 (United Airlines already purchased 3 million gallons since 2016 and signed an off-take agreement of 10 million gallons of SAF supplied in the next two years) [74].

This is mainly due to the lack of significant incentive programs within Europe in comparison to the US. For example, California has implemented its Low Carbon Fuel Standard (LCFS) Program, where aviation has been included since the start of 2019 following the definition of how LCA emissions are tracked and measured.

Other worldwide announcements have not yet boosted additional supply, as is the case with the Indonesian 2% SAF mandate for 2016, which was announced in 2014 but never implemented.

Important changes might occur within Europe in the short- and mid-term as some States have announced the establishment of mandatory SAF supply objectives. This will be addressed below, under *SAF production plans*.

SAF commercial availability will be fully linked to the development of policies, and ICAO has encouraged States to promote policies that strive to establish a level playing field with other transportation modes on sustainable fuels use.

6.4.2 SAF short-term supply plans in Europe

Europe's SAF production and supply has been mainly limited to pilot or demonstration plants. Only recently did HEFA refineries capable of producing renewable diesel and other distillates also start to produce SAF in small batches.

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[73] https://www.icao.int/environmental-protection/GFAAF/Pages/default.aspx

[74] https://hub.united.com/united-biofuel-commitment-world-energy-2635867299.html

At this stage, limited supply is mainly driven by the lack of demand and the higher profitability of renewable road transportation fuels pushed by EU regulations.

The following table provides an overview of producers that have received governmental funding, conducted research or otherwise stated intention to produce SAF in the near future.

Quantity values refer to the entire output of refined products. It should be noted that if a refinery is operated towards jet production (Jet-Mode) the output will be significantly lowered as Jet-fuel yield is estimated about 50% of the total refining capacity.

This yields for the HEFA plants have been based on announced World Energy[75] production ratios (first HEFA plant with regular SAF production). The company further invested in an extension in its retrofitted petrol refinery that supposed to produce 150 MMgal bio-jet fuel out of 306 MMgal total capacity.

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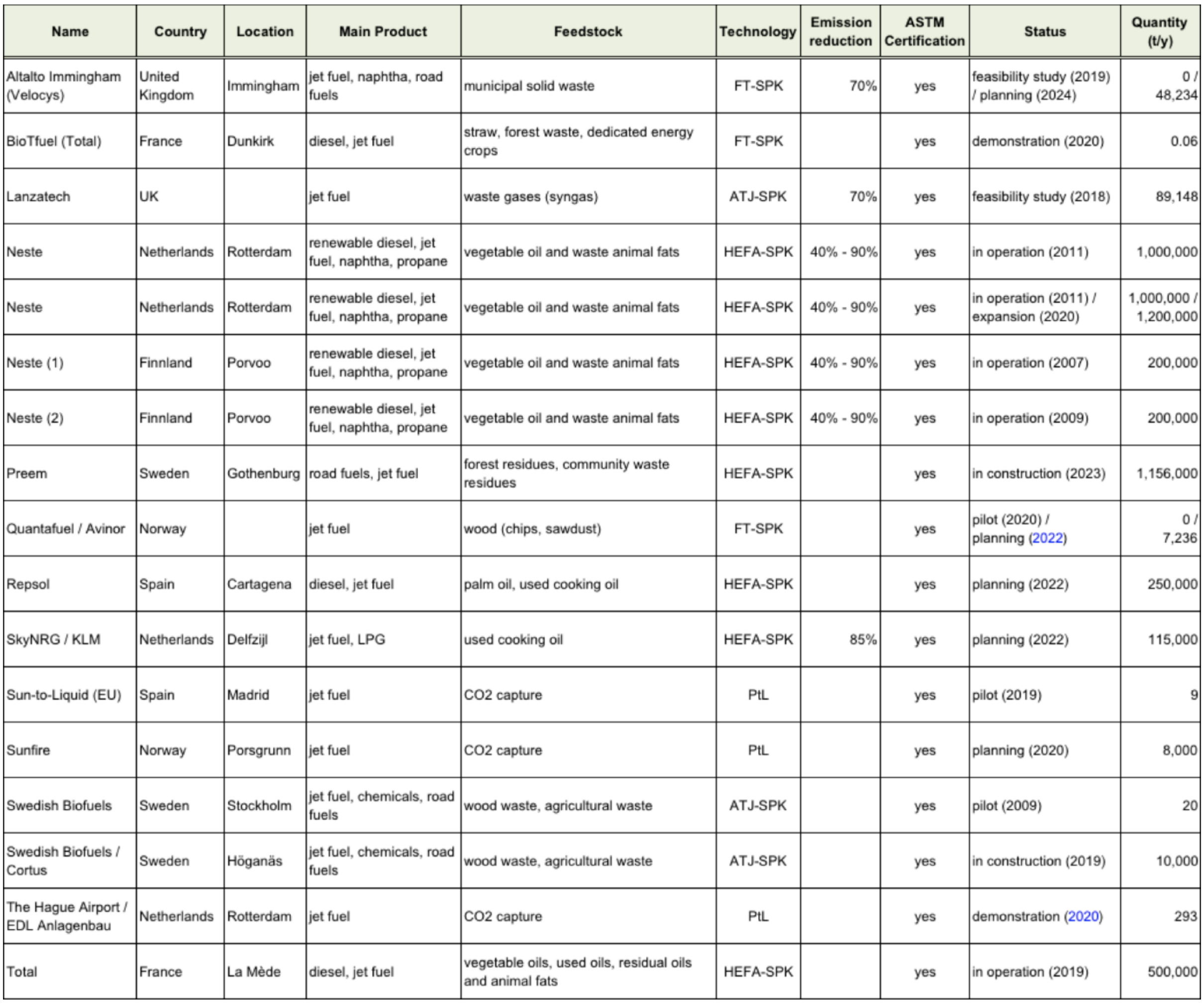
[75] http://www.globenewswire.com/news-release/2018/10/24/1626529/0/en/World-Energy-to-Complete-Conversion-of-California-Petroleum-Refinery-to-Renewable-Fuels.html

Table 16 SAF short-term supply plans in Europe



Name	Country	Location	Main Product	Feedstock	Technology	Emission reduction	ASTM Certification	Status	Quantity (t/y)
Altalto Immingham (Velocys)	United Kingdom	Immingham	jet fuel, naphtha, road fuels	municipal solid waste	FT-SPK	70%	yes	feasibility study (2019) / planning (2024)	0 / 48,234
BioTfuel (Total)	France	Dunkirk	diesel, jet fuel	straw, forest waste, dedicated energy crops	FT-SPK		yes	demonstration (2020)	0.06
Lanzatech	UK		jet fuel	waste gases (syngas)	ATJ-SPK	70%	yes	feasibility study (2018)	89,148
Neste	Netherlands	Rotterdam	renewable diesel, jet fuel, naphtha, propane	vegetable oil and waste animal fats	HEFA-SPK	40% - 90%	yes	in operation (2011)	1,000,000
Neste	Netherlands	Rotterdam	renewable diesel, jet fuel, naphtha, propane	vegetable oil and waste animal fats	HEFA-SPK	40% - 90%	yes	in operation (2011) / expansion (2020)	1,000,000 / 1,200,000
Neste (1)	Finnland	Porvoo	renewable diesel, jet fuel, naphtha, propane	vegetable oil and waste animal fats	HEFA-SPK	40% - 90%	yes	in operation (2007)	200,000
Neste (2)	Finnland	Porvoo	renewable diesel, jet fuel, naphtha, propane	vegetable oil and waste animal fats	HEFA-SPK	40% - 90%	yes	in operation (2009)	200,000
Preem	Sweden	Gothenburg	road fuels, jet fuel	forest residues, community waste residues	HEFA-SPK		yes	in construction (2023)	1,156,000
Quantafuel / Avinor	Norway		jet fuel	wood (chips, sawdust)	FT-SPK		yes	pilot (2020) / planning (2022)	0 / 7,236
Repsol	Spain	Cartagena	diesel, jet fuel	palm oil, used cooking oil	HEFA-SPK		yes	planning (2022)	250,000
SkyNRG / KLM	Netherlands	Delfzijl	jet fuel, LPG	used cooking oil	HEFA-SPK	85%	yes	planning (2022)	115,000
Sun-to-Liquid (EU)	Spain	Madrid	jet fuel	CO2 capture	PtL		yes	pilot (2019)	9
Sunfire	Norway	Porsgrunn	jet fuel	CO2 capture	PtL		yes	planning (2020)	8,000
Swedish Biofuels	Sweden	Stockholm	jet fuel, chemicals, road fuels	wood waste, agricultural waste	ATJ-SPK		yes	pilot (2009)	20
Swedish Biofuels / Cortus	Sweden	Höganäs	jet fuel, chemicals, road fuels	wood waste, agricultural waste	ATJ-SPK		yes	in construction (2019)	10,000
The Hague Airport / EDL Anlagenbau	Netherlands	Rotterdam	jet fuel	CO2 capture	PtL		yes	demonstration (2020)	293
Total	France	La Mède	diesel, jet fuel	vegetable oils, used oils, residual oils and animal fats	HEFA-SPK		yes	in operation (2019)	500,000

See foot notes [76]

Below are described in more detail, the main European industry SAF dedicated production plans:

- Neste (Finland, Netherlands, Singapore):

Neste was the first to invest in an HEFA refinery in Porvoo in 2007. Currently, Neste has a production capacity of 2.4 million tonnes per year, with stand-alone refineries in Porvoo (Finland), Singapore and Rotterdam (the Netherlands). For 2019 the company has anticipated a possible production of 30.000 SAF tonnes subject to demand, but there is no evidence that such supply is being achieved.

Neste is planning to increase renewable jet fuel production volumes significantly over the course of the next few years to meet demand. Neste has announced that it is ramping up capacity to produce up to a total of 100,000 tonnes per year between the US and Europe in 2020-21 and 400,000 tonnes in 2022. With the planned Singapore refinery expansion Neste will have the capacity to produce over 1 million tonnes of low-emission renewable jet fuel by 2022.

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[76] All stated years are commission years, except for "feasibility study", they represent the year when the study has been started respectively conducted. Blue numbers are estimates, as no data was available.

In September 2018, the company signed a Memorandum of Understanding with Alaska Airlines to expand the use of sustainable aviation fuels by the carrier. In October 2018, Neste and Air BP entered into an agreement to explore opportunities to increase the supply and availability of sustainable aviation fuel for airline customers.

- SkyNRG (Netherlands):

SkyNRG's latest project is called DSL-01 and will be dedicated to production of sustainable aviation fuel. From 2022, the plant will annually produce 100,000 tonnes of SAF, as well as 15,000 tonnes of bioLPG, as a by-product. It will mean a CO_2 reduction of 270,000 tonnes per year for the aviation industry, equal to 85% on a life cycle assessment when compared to conventional jet fuel.

KLM Royal Dutch Airlines has committed itself for a 10-year period to the development and purchase of 75,000 tonnes of sustainable aviation fuel per year. SkyNRG is the only European future producer 100% committed to SAF production.

- Air BP:

In 2016 Air BP created a strategic partnership with Fulcrum BioEnergy who provided an initial investment of $30 million. Air BP has supplied sustainable aviation fuel in Nordic countries since 2014 at around 10 airports, including at Oslo airport where they were the first to supply SAF through the existing airport fuelling infrastructure, in collaboration with Neste and other key industry stakeholders in the framework of the EU ITAKA[77] project.

In 2019 Air BP announced a partnership with Neste to supply SAF in Sweden[78]. The two companies are delivering sustainable aviation fuel to Stockholm Arlanda Airport, Malmö Airport, Umeå Airport, Åre Östersund Airport and Göteborg Landvetter Airport to enable Swedavia to deliver its greenhouse gas emissions reduction targets. Swedavia will utilise the fuel primarily to offset carbon emissions of staff who travel across its different locations.

- Altalto (UK):

Project partners Velocys in collaboration with British Airways and Shell submitted an application to develop a refinery site in Immingham[79]. The project partners target a final investment decision in the first half of 2020. Based on this outcome, the plant is due to begin construction in 2021 and to start producing commercial SAF volumes in 2024. Velocys provides the central processing unit, Fischer-Tropsch reactors with the proprietary Actocat catalyst. The site would take approximately 500k tonnes/yr of non-recyclable everyday household and commercial solid waste and convert it into more than 60 million litres/yr (48.000 tonnes) of SAF and road fuel reducing emission of up to 70%. British Airways has pledged to purchase the jet fuel produced.

- Preem (Finland):

Preem is the largest Finnish supplier of petroleum products, with 80% of Sweden's refining capacity at its two facilities in Gothenburg and Lysekil. The Gothenburg refinery started in 2010 to co-process bio crude from forest and wood residues. A special design has enabled Preem to co-process 30% raw tall diesel with light gas oil to produce a renewable diesel. The current ASTM bio-feed limit of up to 5%

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[77] https://cordis.europa.eu/project/rcn/106229/factsheet/en

[78] https://www.neste.com/releases-and-news/transportation/neste-and-air-bp-ready-deliver-sustainable-aviation-fuel-sweden

[79] https://www.velocys.com/2019/08/20/plans-submitted-for-the-first-waste-to-jet-fuel-plant-in-the-uk-and-europe/

would require Preem to drastically reduce the bio-oil component for SAF production. That might be the reason why the company invests in new HEFA production units at its Gothenburg location, increasing the renewable fuel output to 1 million tonnes/yr.

Preem and Scandinavian airline SAS signed a letter of intent for a SAF offtake agreement. The new plant is expected to go live in 2022. SAS has the ambition to replace today's fuel volume for domestic airplanes with biojet/biofuel by 2030[80].

- Total (France):

Total has rebuilt the refinery at La Mede (France), a 500,000 metric tonnes per day facility, to process vegetable oil, initially palm oil and local rapeseed oil to diesel. The facility has been at the center of a giant controversy about the sustainability of importing palm oil. Total will limit its use of palm oil to 75% of production capacity with the remainder sourced from used cooking oil. This plant uses the Vegan technology from Axens. In late 2018 the plant was in commissioning and is expected to come to nameplate capacity in 2019. La Mède will produce both biodiesel and SAF and is participating in the EU H2020 project BIO4A[81] – *Advanced Sustainable Biofuels for Aviation*– enabling pre-commercial production of advanced aviation SAF.

The project will demonstrate the first large industrial-scale production and use of sustainable aviation fuel in Europe (HEFA), obtained from residual lipids such as Used Cooking Oil. The target production of jet fuel in BIO4A is 5,000 t of jet fuel from sustainable lipids.

- Quantafuel / Avinor (Norway):

Avinor (that operates most of the civil airports in Norway) has entered into an agreement with Quantafuel to buy sustainable aviation fuel based on Norwegian biomass, such as solid wood in the shape of chips, sawdust and other wood qualities. The pilot project, planned for 2020, will give the company the necessary experience to consider a full-scale plant. Preliminary capacity targets for a full-scale plant is a minimum of 7-9 million litres (5,600-7,200 tonnes) of fuel per year.

- LanzaTech (UK, USA, China, India, Canada):

LanzaTech, originally based in New Zealand with current world HQ in the US, has pilot, demonstration and commercial plants with partners in China (Shougang & Baosteel), India (Indian Oil), South Africa (Swayana), New Zealand (Glenbrook), Taiwan (Kaohsiung) and Belgium (ArcelorMittal) using its gas fermentation technology to produce syngas from industrial off-gases (e.g. steel mill) and then eventually turn the syngas into ethanol. The ethanol can if desired be further processed into SAF (ATJ-SPK).

In addition to off-gas processing, Lanzatech also has demonstration plants and commercial projects in development to convert municipal waste or agriculture waste into ethanol in the USA (Freedom Pines, Aemetis) and Japan (Sekisui).

In 2018, LanzaTech announced with Virgin Atlantic and other partners the intention to build the world's first large scale Alcohol to Jet (ATJ) facility producing commercial quantities of fuel in the UK. The commercial facility would convert low carbon ethanol produced from waste emissions, to jet fuel. In that year, ASTM International had added ethanol as an approved feedstock in ASTM D7566.

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[80] https://www.sasgroup.net/en/renewable-energy-in-the-wings/

[81] https://www.bio4a.eu/

LanzaTech submitted a bid to the UK Department for Transport (DfT) Future Fuels for Flight and Freight Competition (F4C) for partial funding of this facility and has been selected for project development funding with a £410k grant from the UK government[82].

- Swedish Biofuels (Sweden):

Swedish Biofuels got in 2007 an award from the US Department of Defense to develop 100% hydrocarbon jet fuel base for military aircraft and developed a pilot to demonstrate a production method in which the feed are alcohols, obtained from biochemically converted wood waste or agricultural waste. After the alcohol gets converted into a mixed hydrocarbon product stream to produce gasoline, kerosene and diesel by rectification. The plant has been in operation since 2009.

The next step in the development of the technology is the construction of a pre-commercial industrial scale plant. The project is supported by an EU FP7 grant. The main goal of the project is the production of synthetic biofuels for use in aviation using the Alcohol to Jet (ATJ) pathway. The capacity of the plant will be 10,000 tonnes/yr.

In 2019 and in partnership with the biomass gasification technology specialist Cortus Energy, they announced a preliminary agreement to project a first commercial facility for the production of SAF for Stockholm Arlanda Airport needs[83].

- Repsol (Spain):

According to local news[84], Repsol prepares to build a biofuel plant in Cartagena (Spain) from 2020, which construction would be taking three years. The oil company finalizes the project to invest 200 million euros in a factory that will use fats and used oils as raw material. Expected capacity would be 250.000 Tonnes, potentially including SAF.

Repsol, together with other partners participates in a consortium which has applied in 2019 for an EU H2020 project funding, targeting SAF production. The funding is still pending of EC decision. As referred in section 6.2.4.5, Spain plans a SAF mandate in 2025.

6.5 European additional SAF potential capacity

6.5.1 European additional HEFA production capacity

In addition to the HEFA refineries mentioned in paragraph 6.4.2, the following table lists all remaining plants in Europe that focus on renewable diesel as prime product. Nevertheless, HEFA-SPK SAF production might be in their focus in the coming years driven by market and/or policy mechanisms.

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[82] https://www.lanzatech.com/2018/07/04/lanzatech-virgin-atlantic-secure-uk-government-grant-develop-world-first-waste-carbon-jet-fuel-project-uk/

[83] https://bioenergyinternational.com/biofuels-oils/cortus-energy-and-swedish-biofuels-planning-worlds-first-bio-jet-fuel-plant-based-on-forest-raw-materials

[84] https://www.laverdad.es/murcia/cartagena/repsol-prepara-construir-20190513005115-ntvo.html

Table 17 European additional HEFA production capacity

Name	Country	Location	Main Product	Feedstock	Technology	Emission reduction	ASTM Certification	Status	Quantity (t/y)
ENI Italy	Italy	Venice	diesel, naphtha, LPG, (potentially) jet fuel	vegetable oils (used oils, animal fats and by-products of palm-oil processing)	HEFA-SPK	35%	yes	in operation (2014) / expansion (2021)	350,000 / 560,000
ENI Italy	Italy	Gela	diesel, naphtha, LPG, (potentially) jet fuel	vegetable oils (used oils, animal fats and by-products of palm-oil processing)	HEFA-SPK	35%	yes	in construction (2019)	700.000
Preem	Sweden	Gothenburg	road fuels, jet fuel	forest residues, community waste residues	HEFA-SPK		yes	in construction (2023)	1.156.000
St1 / SCA	Sweden	Östrand	diesel, jet fuel	tall oil (residual product from the production of kraft pulp)	HEFA-SPK		yes	in construction (2021)	100.000
St1	Sweden	Gothenburg	diesel, jet fuel	tall oil (residual product from the production of kraft pulp)	HEFA-SPK		yes	in construction (2022)	200.000
UPM	Finnland	Kotka	diesel, jet fuel	Brassica carinata oil (from Uruguay), forestry residue	HEFA-SPK / Pyrolysis		yes / in process	feasibility study (2018) / planning (2023)	500.000

- ENI (Italy):

ENI has biorefineries in Gela and Venice (Italy) converting feedstocks like vegetable oils, animal fats and greases to “drop in” hydrocarbon fuels. There were plans to expand the Venice capacity further, up to 560,000 tonnes/yr of products, but this decision is still pending. Also, the Gela refinery in Sicily has been converted to process 700,000 tonnes/yr feedstock and is due to come into operation in 2019[85].

- ST1 / SCA (Sweden):

The Swedish pulp and paper company SCA and Finish fuel company St1 are cooperating on a commercial biorefinery project with a capacity of 100,000 tonnes/yr based on tall oil. The biorefinery will be co-located with the Östrand mill outside Sundsvall (Sweden) and permitting procedures have been initiated[86]. The Östrand mill will also be expanded to increase the tall oil output, while tall oil from the Obbola and Munksund mills will be used in the biorefinery.

- UPM (Finland):

UPM has a biorefinery in Lappeenranta[87] producing wood-based renewable diesel from forestry residue that started commercial production in 2015 using a catalytic pyrolysis process. In addition, UPM studies a second biorefinery project in Kotka with a capacity of 500,000 tonnes/year. UPM’s cultivation of the *Brassica carinata* crop in Paysandu (Uruguay) could be part of the feedstock basis, together with wood residues and other wastes.

6.5.2 European co-processing production capacity

Co-processing refers to the simultaneous conversion of biogenic residues and intermediate petroleum distillates in existing petroleum refineries to produce renewable hydrocarbon fuels. In contrast to the now common blending of biofuels into the finished petroleum product, co-processing makes use of

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[85] https://www.eni.com/en_IT/innovation/technological-platforms/bio-refinery.page

[86] https://www.sca.com/en/top-news-startpage/2019-03/environmental-permit-application-for-ostrands-biorefinery-submitted/

[87] https://www.upmbiofuels.com/about-upm-biofuels/production/upm-lappeenranta-biorefinery/

biomass within the processing of petroleum. The following refining processes may be suitable for co-processing[88]:

- ✓ Thermal cracking
- ✓ Catalytic cracking
- ✓ Hydrocracking
- ✓ Hydrotreating

Instead of building or retrofitting a facility to produce 100% biofuels, a common crude oil refinery feeds bio-oils, such as bio-crude, vegetable oils, used cooking oils, lining or sugars, into the refinery unit together with fossil feeds. Usually the bio-matter content supported today is between 5-10% weight with some higher exceptions. Under ASTM co-processing a range of bio-oils at up to 5% in combination with middle distillates on jet fuel is approved.

In Europe public information about co-processed bio-volumes are not available. However, considering the EU's refining capacity of 230 million tonnes/yr and assuming that 30% could co-process 5% biomaterial, the potential of co-processed bio fuel could be in the range of 3.5 million tonnes/yr. Assuming a 30% yield of jet fuel output could translate into approximately 1 million tonnes/yr of SAF.

Co-processing challenge:

As the refinery processes are complex and production lines integrated, co-processing results in fractionation of the bio-components in multiple products streams. In Europe there is not yet an agreed methodology to calculate/attribute the life-cycle values of the co-processing products. A Delegated Act is expected by end of 2020.

A free attribution of CO_2 reductions from the bio-component input to a single or selected number of final products (approach based on the CO_2 impact and not on the direct mass-balance) could significantly incentivize SAF supply as a 5% bio-component input in the refinery could be fully attributed to the kerosene fraction, resulting in a significant higher SAF yield that if the CO_2 savings are attributed in similar proportion to all multiple products streams.

Such attribution should be limited to the total amount of biomass coming into the process and certification should ensure that no other products claim the emissions reductions.

Sustainability certification standards such as ISCC or RSB already apply this approach to non-energy products, instead of using the mass-balance approach.

ISCC PLUS[89] allows the free attribution of sustainable share to one output material.

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[88] http://www.etipbioenergy.eu/value-chains/conversion-technologies/advanced-technologies/co-processing-in-refineries

[89] https://www.iscc-system.org/wp-content/uploads/2019/09/ISCC-PLUS-System-Document_V3.1-1.pdf

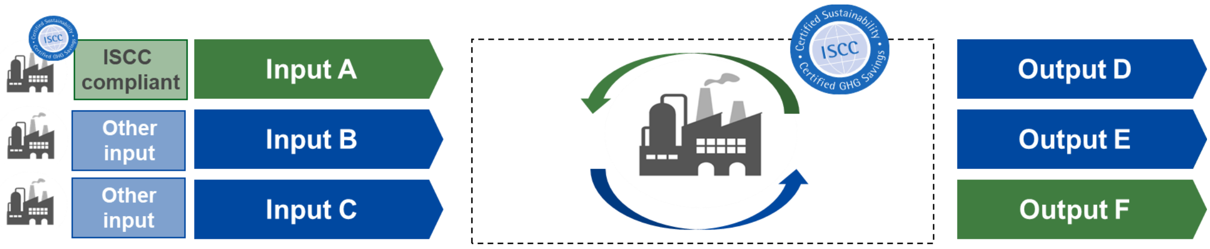

Figure 18 ISCC PLUS « Free Attribution » certification approach for co-processing

The following table provides an overview of active and co-processing refineries in Europe and their bio-hydrocarbon products, mainly hydro-treated vegetable oil (HVO) diesel.

Table 18 European co-processing production capacity

Name	Country	Location	Main Product	Feedstock	Technology	Status	Quantity (t/y)
BP	Spain	Castellon	diesel	palm oil, used cooking oil	Co-processing	in operation	90,000
Cepsa	Spain	San Roque	diesel	vegetable oils (soybean, rapeseed or palm)	Co-processing	in operation (2011)	0
Cepsa	Spain	La Rabida	diesel	vegetable oils (soybean, rapeseed or palm)	Co-processing	in operation (2011)	278,000
Cepsa	Spain	Tenerife	diesel	used cooking oil	Co-processing	in operation (2013)	1,200
GALP / Petropbras	Portugal	Sines	diesel	waste oils, waste animal fats	Co-processing	in operation (2017)	25,000
PKN ORLEN	Poland	Plock	diesel	used cooking oil	Co-processing	feasibility study (2018)	
PKN ORLEN	Czech Republic	Litvinov	diesel	used cooking oil	Co-processing	feasibility study (2018)	
Preem	Sweden	Gothenburg	fuels, jet fuel	tall oil, triglycerides	Co-processing	in operation (2010)	150,000
Repsol	Spain	La Coruña	diesel	palm oil, used cooking oil	Co-processing	in operation (2018)	60,000
Repsol	Spain	Tarragona	diesel	palm oil, used cooking oil	Co-processing	in operation (2018)	60,000
Repsol	Spain	Bilbao	diesel	palm oil, used cooking oil	Co-processing	in operation (2018)	60,000
Repsol (1)	Spain	Cartagena	diesel	palm oil, used cooking oil	Co-processing	in operation (2018)	60,000
Irving Oil	Ireland	Whitegate	diesel	soybean oil	Co-processing	in operation	46,000
ÖMV	Austria		gasoline, diesel		Co-processing	feasibility study / planning (2025)	200,000

Note: All stated years are commission years, except for "feasibility study", they represent the year when the study has been started respectively conducted. Blue numbers are estimates, as no data was available.

Although co-processing provides a solution to fulfil EU renewable energy demand, many producers opt for a full hydro-treated esters and fatty-acids (HEFA) refinery, because of higher refining product flexibility and quality.

Some of the main European current co-processing capacity is further described below:

- BP (Spain):

Only little information is available about the BP refinery in Castellon, which has an estimated capacity bio-hydrocarbon, mainly diesel, of 60 – 120,000 tonnes/yr.

- Cepsa (Spain):

CEPSA's three refineries in Spain (La Rabida in Huelva, San Roque in Algeciras and Tenerife in Santa Cruz de Tenerife), are all capable of co-producing HVO. For the La Rabida refinery the percentage of biodiesel in automotive diesel produced, made from vegetable oils from the Bio Oils Energy plant, was 5.5%, plus a further 1.3% of HVO. It has a capacity of 278,000 tonnes/yr and started operating in 2011. The Tenerife and San Roque refineries were the first to test co-processing in 2007 with oil previously used for frying. No information was found for current co-processing activities at the San Roque refinery, and the Tenerife refinery is expected to produce 1.2k tonnes/yr from used cooking oils since 2013.

- Repsol (Spain):

Only little information about Repsol's co-processing refineries in La Corunna (Galicia), Tarragona (Catalonia), Bilbao (Biscay) and Cartagena (Murcia) is known. For Bilbao and Cartagena capacity numbers of 60k tonnes/yr of renewable fuels were found using mainly palm oil and used cooking oil as oil-feed. The facilities went online in 2018.

- GALP (Portugal):

The GALP refinery in Sines (Portugal) has an installed co-processing capacity of 25,000 tonnes/yr of biofuel per year, and it is 100% dedicated to processing waste oils and waste animal fats into biodiesel. It produced about 24,000 tonnes/yr of biodiesel, which represents around 83% lower emissions according the producer's information and started co-processing in 2017. Other sources indicate that it has a capacity of 47,000 tonnes/yr, this being even a smaller capacity than previously anticipated for the GALP and Petrobras joint project.

6.5.3 European ethanol industry production plans

In recent years, several lignocellulosic ethanol plants were forced to close because of difficult market conditions coupled with high costs. Europe has currently only one operational first of its kind demonstration plant from Borregaard Industries in Norway. Nevertheless, new projects are planned. Cellulosic ethanol can be used under the ATJ-SPK ASTM pathway to produce SAF, and an overview of production capacities can help to understand future expectations.

Some of the main European current ethanol industry plans are described below:

- Crescentino (Italy)

The ENI Versalis (formerly M&G/Biochemtex) industrial plant at Crescentino, northern Italy, is under a modification to restart its operation. It is a full industrial scale demo, the first of this technology.

Versalis, the chemicals arm of Eni, acquired in 2018 Mossi Ghisolfi Group, which filed for bankruptcy in 2017. That included the Biochemtex Crescentino plant and the Proesa technology, which is designed to use non-food biomass such as rice straw and sugarcane bagasse, to produce fuel and chemicals.

- Borregaard (Norway):

Borregaard Industries operates a first of its kind demonstration plant in Europe[90]. The plant has been producing ligno-cellulosic ethanol from spruce wood pulping since 1938. It has a capacity of approximately 16,000 tonnes/yr.

- Craiova (Rumania)

Switzerland-headed specialty chemicals Clariant started in 2018 the construction of the first large-scale commercial "sunliquid" plant for the production of cellulosic ethanol made from agricultural residues in Craiova (Romania), with a with a 50,000 tonnes annual production capacity.

In 2019, Clariant has also licensed a second ethanol plant technology to polish fuel company Orlen, with a 25,000 tonnes annual production capacity. Clariant is investing more than 100 million euros in the Romanian facility, it has said[91].

- W2C Rotterdam (Netherlands):

Air Liquide, Enerkem, Nouryon, the Port of Rotterdam and Shell are developing an advanced 'waste to chemicals' (W2C) plant in Rotterdam. The aim is that this will be the first plant of this type in Europe that make valuable chemicals and bio-fuels out of non-recyclable waste materials. It aims to take the final investment decision later in 2019 as it pursues the development work and finalizes the selection of an engineering and procurement contractor. The project realisation is being supported by the Ministry of Economic Affairs and Climate.

- Enerkem / Suez (Spain):

The Canadian company Enerkem and the French firm Suez plan to open a plant in Tarragona (Spain) to turn solid urban waste into biofuel in 2022. Estimates suggest that once the plant is up and running it will be able to treat some 375,000 tonnes of waste into 265,000 tonnes of green methanol[92].

The following table lists the most promising projects neglecting pilot, demonstration and idle plants that are less relevant.

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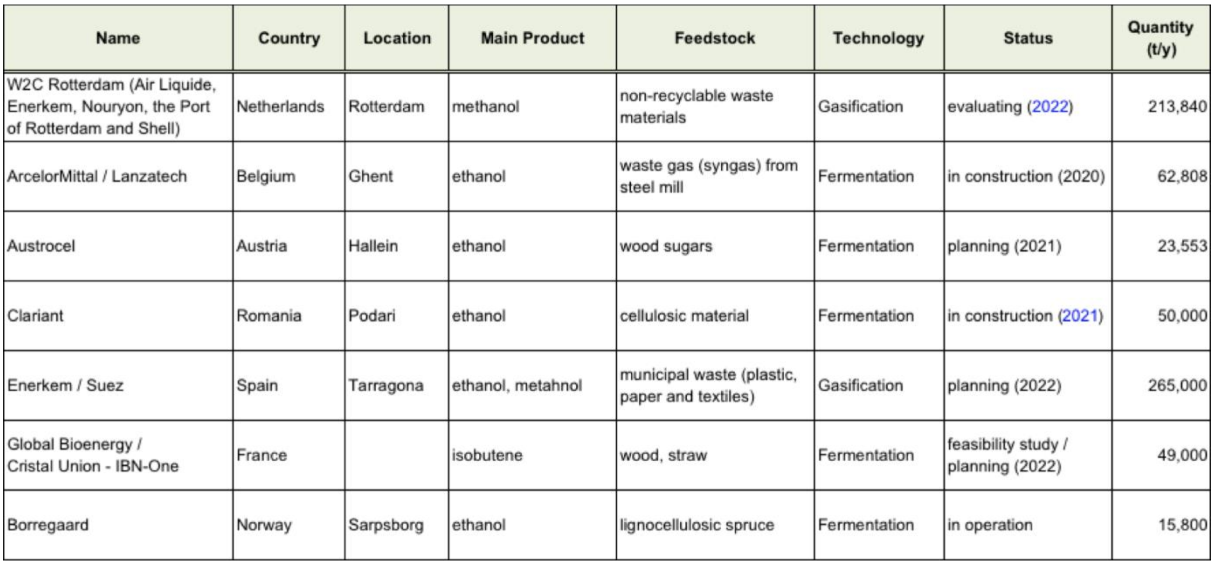
[90] https://www.borregaard.com/Sustainability/Green-Room/The-world-s-leading-biorefinery

[91] https://de.reuters.com/article/clariant-ethanol-idAFFWN26A0Q4

[92] https://elpais.com/ccaa/2018/05/08/catalunya/1525806374_617605.html

➨ **Table 19** European ethanol industry production plans



Name	Country	Location	Main Product	Feedstock	Technology	Status	Quantity (t/y)
W2C Rotterdam (Air Liquide, Enerkem, Nouryon, the Port of Rotterdam and Shell)	Netherlands	Rotterdam	methanol	non-recyclable waste materials	Gasification	evaluating (2022)	213,840
ArcelorMittal / Lanzatech	Belgium	Ghent	ethanol	waste gas (syngas) from steel mill	Fermentation	in construction (2020)	62,808
Austrocel	Austria	Hallein	ethanol	wood sugars	Fermentation	planning (2021)	23,553
Clariant	Romania	Podari	ethanol	cellulosic material	Fermentation	in construction (2021)	50,000
Enerkem / Suez	Spain	Tarragona	ethanol, metahnol	municipal waste (plastic, paper and textiles)	Gasification	planning (2022)	265,000
Global Bioenergy / Cristal Union - IBN-One	France		isobutene	wood, straw	Fermentation	feasibility study / planning (2022)	49,000
Borregaard	Norway	Sarpsborg	ethanol	lignocellulosic spruce	Fermentation	in operation	15,800

Note: All stated years are commission years, except for "feasibility study", they represent the year when the study has been started respectively conducted. Blue numbers are estimates, as no data was available.

6.6 Other SAF developments: Non-EU industry plans

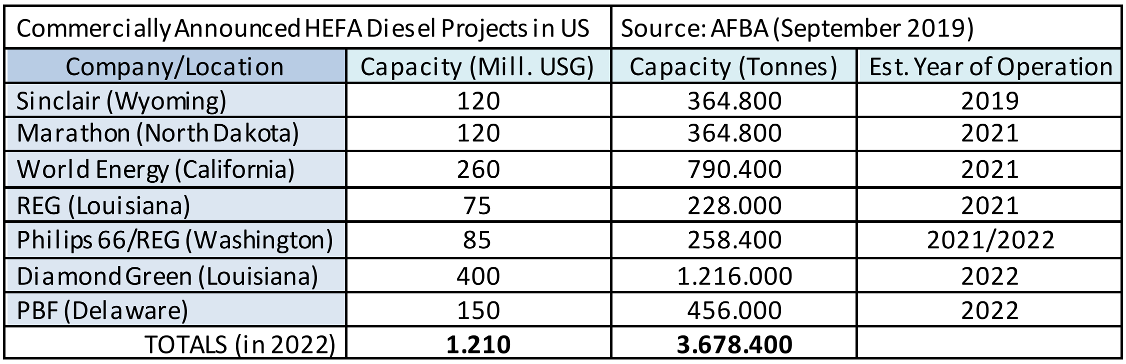
Outside of the EU main SAF developments happen in North America particularly in the US. World Energy Alternatives (former AltAir) is currently the only commercial active refinery that produces SAF on a continuous basis since 2014.

Nevertheless, many projects are in development backed by mainly US airlines with off take agreements or equity investments, as described below.

6.6.1 North America

Currently there are short-term industry plans to build almost 4 million tonnes of HEFA capacity for green diesel in the US.

➨ **Table 20** HEFA plans in North America



Commercially Announced HEFA Diesel Projects in US		Source: AFBA (September 2019)	
Company/Location	Capacity (Mill. USG)	Capacity (Tonnes)	Est. Year of Operation
Sinclair (Wyoming)	120	364.800	2019
Marathon (North Dakota)	120	364.800	2021
World Energy (California)	260	790.400	2021
REG (Louisiana)	75	228.000	2021
Philips 66/REG (Washington)	85	258.400	2021/2022
Diamond Green (Louisiana)	400	1.216.000	2022
PBF (Delaware)	150	456.000	2022
TOTALS (in 2022)	**1.210**	**3.678.400**	

Additionally, the following developments are SAF-specific:

- World Energy Alternatives - formerly Altair Fuels (USA):

United Airlines has begun using commercial scale alternative jet fuel volumes for regularly scheduled flights from LAX. Purchase 15 million gal/yr from AltAir Paramount over 3 years. Being the only commercial refinery producing SAF on a regular basis, the company supplied among others SAF to KLM / SkyNRG, World Fuel / Gulfstream, Swedavia, Lufthansa and Air Canada (Canada's Biojet Supply Chain Initiative). It announced recently to expand the plant to a capacity of over 900k tonnes/yr. Occasionally the SAF producer delivers fuel to Boeing for sustainable airplane deliveries. In addition, All Nippon Airways (ANA) entered into a purchase agreement with Showa Shell Sekiyu K.K. to purchase approximately 265k litres of SAF produced by World Energy Alternatives and supplied San Francisco.

- Gevo (USA):

Lufthansa agreement for alcohol-to-jet from Luverne, MN facility. 8 million gal/yr from Gevo or up to 40 million gallons/yr over 5 years. Also, Air TOTAL entered into a SAF (ATJ_SKA) purchase and sale agreement with Gevo for use and distribution in France and other parts of Europe. The three-year offtake agreement may be extended for an additional four years with the consent of both parties. Initial supply will come from the Silsbee plant and later from the plant in Luverne that is currently in development. In addition, Virgin Australia trials of low-carbon aviation fuel is being conducted in partnership with the Queensland Government, Brisbane Airport Corporation, US-based SAF producer Gevo, and supply chain partners Caltex and DB Schenker.

- Fulcrum (USA):

Strategic partnership between United, Cathay Pacific, BP Ventures, Air BP businesses to invest $30 million. 10 year off-take for 50 million gal/yr from plants in North America. A plant for FT-SPK based on municipal solid wastes is being built by Fulcrum Bioenergy and it is expected to start production in late 2019 partly funded by the U.S. Department of Energy (DOE).

- Red Rock (USA):

3 million gallons/year of renewable jet fuel for 3 years for FedEx Express. Southwest purchase agreement from Lakeview, Oregon facility to convert 140,000 dry tonnes/year of woody biomass into 15 million gallons/year of renewable jet, diesel, and naphtha. The company recently signed a technology agreement with Emerging Fuels Technology and is funded by the U.S. Department of Energy (DOE).

- Byogy (USA):

AVAPCO biomass-to-ethanol with Byogy alcohol-to-jet process to produce jet fuel from woody biomass. DOE award of $3.7 million to develop demonstration scale biorefinery. (DOE funded)

- Alliance BioEnergy Plus / Vertimass (USA):

Alliance BioEnergy Plus signed only recently (7/2019) a technology license agreement with Vertimass. Vertimass developed an Ethanol-to-Jet fuel technology called BTEX providing high product flexibility. Alliance produces cellulosic ethanol from sugars and subsequently to produce cellulosic jet fuel and diesel from the ethanol.

- D'Arcinoff Group (USA):

In 2013 D’Arcinoff signed an offtake agreement with GE Aviation to supply biomass FT jet fuel for engine testing, approximately 500,000 gallons per year. The company announced already in 2013 the first phase deployment of the Hudspeth County plant that will be developed in multiple phases. It is planned to provide full capacity by 2021.

- SG Preston (USA):

Qantas and Jet Blue announced 2017 an offtake agreement with US bioenergy company SG Preston in which it would purchase 8 million gallons of HEFA jet fuel for a 10-year period. Although it planned to use the fuel from 2020, it is unlikely that SG Preston will be able to hold the date, as the first installation has not yet come to construction.

- Sundrop Fuels (USA):

Sundrop Fuels ran a laboratory-scale demonstration and a pilot plant facility that was operational from 2009 to 2011. The company's next commercial biorefinery fuels plant is currently in engineering design stage and completion planned for 2020 transforming syngas into renewable fuels.

6.6.2 South America

- ECB Group (Paraguay):

Runs the first second-generation renewable fuels plant in the Southern Hemisphere. The Paraguayan government and the ECB Group signed a memorandum of understanding with intentions to start the works still in 2019. Most of the production will be exported to countries that are signatories of the Paris Agreement. It will produce renewable diesel (HVO) and renewable kerosene (Synthetic Paraffinic kerosene or SPK) for civil and military aviation.

6.6.3 Asia and Pacific

- Sinopec (China)

Sinopec owns a test plant with 20k tonnes/yr co-processing capacity and has plans for increasing its co-processing capacity. In 2012 Airbus and Sinopec announced to promote renewable aviation fuel production for regular commercial use in China. There is no information if the facility produces any low carbon jet fuel on a regular basis.

6.6.4 Middle East

- Petrixo (UAE)

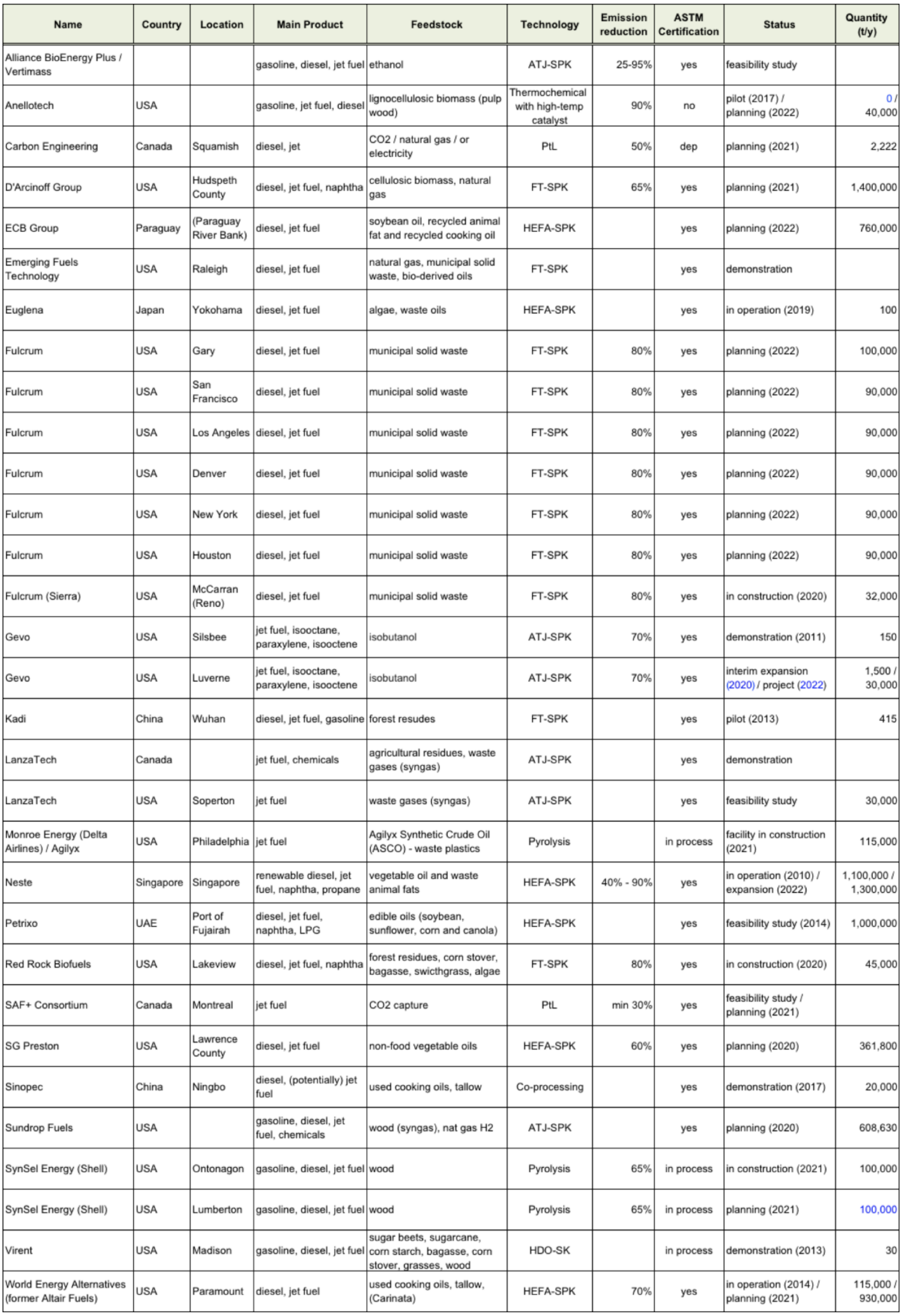
Petrixo Oil and Gas announced in 2014 its plans to establish Fujairah Biofuel Refinery to produce renewable jet and diesel to convert 500,000 metric tonnes of renewable feedstocks into 1 million tonnes/year of biofuels. According to some information from late 2018, the project did not come into construction.

6.6.5 Overview of non-EU SAF industry

The following table provides an overview of producers that have received governmental funding, conducted research or stated otherwise to produce SAF in the near future. Quantity values refer to the entire output of refined products.

Note: All stated years are commission years, except for "feasibility study", they represent the year when the study has been started respectively conducted. Blue numbers are estimates, as no data was available.

Table 21 Overview of non-EU SAF industry



Name	Country	Location	Main Product	Feedstock	Technology	Emission reduction	ASTM Certification	Status	Quantity (t/y)
Alliance BioEnergy Plus / Vertimass			gasoline, diesel, jet fuel	ethanol	ATJ-SPK	25-95%	yes	feasibility study	
Anellotech	USA		gasoline, jet fuel, diesel	lignocellulosic biomass (pulp wood)	Thermochemical with high-temp catalyst	90%	no	pilot (2017) / planning (2022)	0 / 40,000
Carbon Engineering	Canada	Squamish	diesel, jet	CO2 / natural gas / or electricity	PtL	50%	dep	planning (2021)	2,222
D'Arcinoff Group	USA	Hudspeth County	diesel, jet fuel, naphtha	cellulosic biomass, natural gas	FT-SPK	65%	yes	planning (2021)	1,400,000
ECB Group	Paraguay	(Paraguay River Bank)	diesel, jet fuel	soybean oil, recycled animal fat and recycled cooking oil	HEFA-SPK		yes	planning (2022)	760,000
Emerging Fuels Technology	USA	Raleigh	diesel, jet fuel	natural gas, municipal solid waste, bio-derived oils	FT-SPK		yes	demonstration	
Euglena	Japan	Yokohama	diesel, jet fuel	algae, waste oils	HEFA-SPK		yes	in operation (2019)	100
Fulcrum	USA	Gary	diesel, jet fuel	municipal solid waste	FT-SPK	80%	yes	planning (2022)	100,000
Fulcrum	USA	San Francisco	diesel, jet fuel	municipal solid waste	FT-SPK	80%	yes	planning (2022)	90,000
Fulcrum	USA	Los Angeles	diesel, jet fuel	municipal solid waste	FT-SPK	80%	yes	planning (2022)	90,000
Fulcrum	USA	Denver	diesel, jet fuel	municipal solid waste	FT-SPK	80%	yes	planning (2022)	90,000
Fulcrum	USA	New York	diesel, jet fuel	municipal solid waste	FT-SPK	80%	yes	planning (2022)	90,000
Fulcrum	USA	Houston	diesel, jet fuel	municipal solid waste	FT-SPK	80%	yes	planning (2022)	90,000
Fulcrum (Sierra)	USA	McCarran (Reno)	diesel, jet fuel	municipal solid waste	FT-SPK	80%	yes	in construction (2020)	32,000
Gevo	USA	Silsbee	jet fuel, isooctane, paraxylene, isooctene	isobutanol	ATJ-SPK	70%	yes	demonstration (2011)	150
Gevo	USA	Luverne	jet fuel, isooctane, paraxylene, isooctene	isobutanol	ATJ-SPK	70%	yes	interim expansion (2020) / project (2022)	1,500 / 30,000
Kadi	China	Wuhan	diesel, jet fuel, gasoline	forest resudes	FT-SPK		yes	pilot (2013)	415
LanzaTech	Canada		jet fuel, chemicals	agricultural residues, waste gases (syngas)	ATJ-SPK		yes	demonstration	
LanzaTech	USA	Soperton	jet fuel	waste gases (syngas)	ATJ-SPK		yes	feasibility study	30,000
Monroe Energy (Delta Airlines) / Agilyx	USA	Philadelphia	jet fuel	Agilyx Synthetic Crude Oil (ASCO) - waste plastics	Pyrolysis		in process	facility in construction (2021)	115,000
Neste	Singapore	Singapore	renewable diesel, jet fuel, naphtha, propane	vegetable oil and waste animal fats	HEFA-SPK	40% - 90%	yes	in operation (2010) / expansion (2022)	1,100,000 / 1,300,000
Petrixo	UAE	Port of Fujairah	diesel, jet fuel, naphtha, LPG	edible oils (soybean, sunflower, corn and canola)	HEFA-SPK		yes	feasibility study (2014)	1,000,000
Red Rock Biofuels	USA	Lakeview	diesel, jet fuel, naphtha	forest residues, corn stover, bagasse, swicthgrass, algae	FT-SPK	80%	yes	in construction (2020)	45,000
SAF+ Consortium	Canada	Montreal	jet fuel	CO2 capture	PtL	min 30%	yes	feasibility study / planning (2021)	
SG Preston	USA	Lawrence County	diesel, jet fuel	non-food vegetable oils	HEFA-SPK	60%	yes	planning (2020)	361,800
Sinopec	China	Ningbo	diesel, (potentially) jet fuel	used cooking oils, tallow	Co-processing		yes	demonstration (2017)	20,000
Sundrop Fuels	USA		gasoline, diesel, jet fuel, chemicals	wood (syngas), nat gas H2	ATJ-SPK		yes	planning (2020)	608,630
SynSel Energy (Shell)	USA	Ontonagon	gasoline, diesel, jet fuel	wood	Pyrolysis	65%	in process	in construction (2021)	100,000
SynSel Energy (Shell)	USA	Lumberton	gasoline, diesel, jet fuel	wood	Pyrolysis	65%	in process	planning (2021)	100,000
Virent	USA	Madison	gasoline, diesel, jet fuel	sugar beets, sugarcane, corn starch, bagasse, corn stover, grasses, wood	HDO-SK		in process	demonstration (2013)	30
World Energy Alternatives (former Altair Fuels)	USA	Paramount	diesel, jet fuel	used cooking oils, tallow, (Carinata)	HEFA-SPK	70%	yes	in operation (2014) / planning (2021)	115,000 / 930,000

7. SAF use future expectations

On 28 November 2018, the European Commission presented the communication "*A Clean Planet for All*"[93], its strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050.

It states that aviation must see a shift to advanced biofuels and carbon-free e-fuels (PtL), with hybridisation and other improvement in aircraft technology having a role in improving efficiency. The analysis accompanying the long-term strategy shows that **SAF may need to contribute up to 23-45% of the fuel mix by 2050 and e-fuels 10-34%** in order to achieve a climate-neutral economy.

This chapter analyses expectations on European SAF demand (based on States/aviation initiatives) as well as supply (from renewable energy industry announcements). Potentials from HEFA, co-processing, ethanol & other technologies are analysed, based on chapter 6.4 & 6.5 data.

7.1 SAF short/mid-term demand expectation

Based on the policy support frameworks already announced by European States (reviewed in 6.2.4) and Industry production plans, the following table includes estimates representing a feasible SAF demand scenario in Europe during the next decade.

An annual net 1% increase in jet fuel use has been estimated from 2017 (last Eurostat Jet Fuel use data in EU2852) until 2030.

It should be noted that this is an expert´s estimate based on announcements. Figures can change significantly upon further policy framework developments related with RED II implementation.

The estimation presented in Table 22 below shows that with the identified currently planned European policy support frameworks SAF demand could be boosted to cover almost 6,5% of the total jet fuel demand in the current EU 28.

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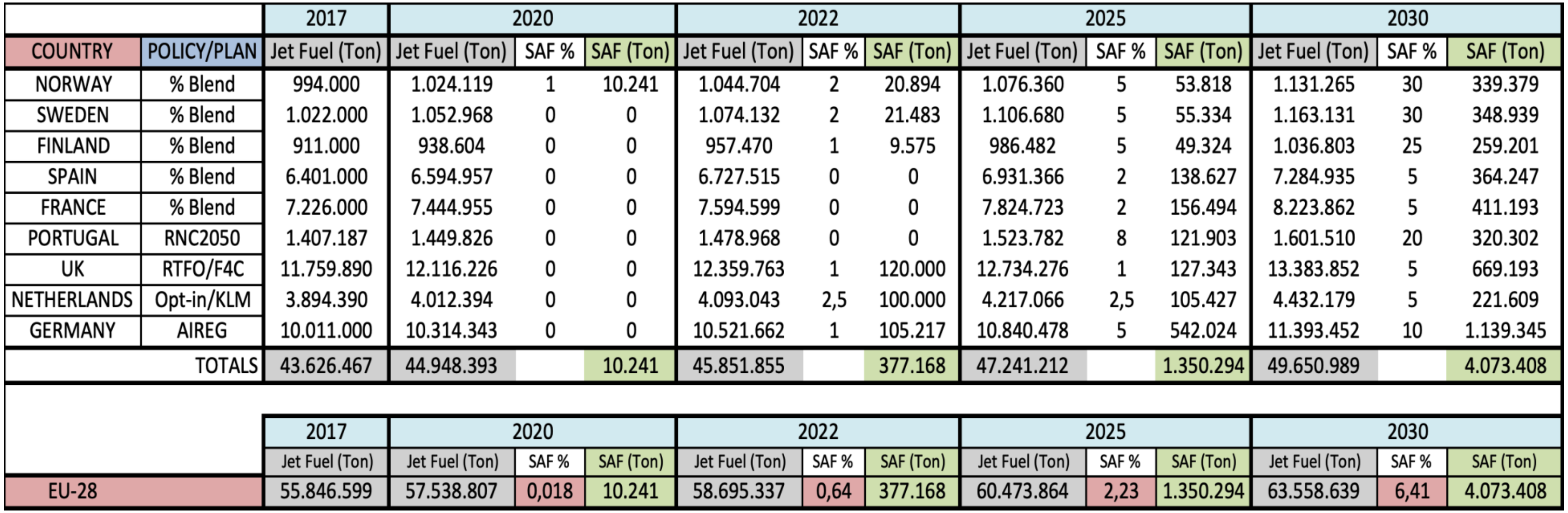
[93] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0773

Table 22 SAF short/mid-term demand expectation in Europe



		2017	2020			2022			2025			2030		
COUNTRY	POLICY/PLAN	Jet Fuel (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)
NORWAY	% Blend	994.000	1.024.119	1	10.241	1.044.704	2	20.894	1.076.360	5	53.818	1.131.265	30	339.379
SWEDEN	% Blend	1.022.000	1.052.968	0	0	1.074.132	2	21.483	1.106.680	5	55.334	1.163.131	30	348.939
FINLAND	% Blend	911.000	938.604	0	0	957.470	1	9.575	986.482	5	49.324	1.036.803	25	259.201
SPAIN	% Blend	6.401.000	6.594.957	0	0	6.727.515	0	0	6.931.366	2	138.627	7.284.935	5	364.247
FRANCE	% Blend	7.226.000	7.444.955	0	0	7.594.599	0	0	7.824.723	2	156.494	8.223.862	5	411.193
PORTUGAL	RNC2050	1.407.187	1.449.826	0	0	1.478.968	0	0	1.523.782	8	121.903	1.601.510	20	320.302
UK	RTFO/F4C	11.759.890	12.116.226	0	0	12.359.763	1	120.000	12.734.276	1	127.343	13.383.852	5	669.193
NETHERLANDS	Opt-in/KLM	3.894.390	4.012.394	0	0	4.093.043	2,5	100.000	4.217.066	2,5	105.427	4.432.179	5	221.609
GERMANY	AIREG	10.011.000	10.314.343	0	0	10.521.662	1	105.217	10.840.478	5	542.024	11.393.452	10	1.139.345
	TOTALS	43.626.467	44.948.393		10.241	45.851.855		377.168	47.241.212		1.350.294	49.650.989		4.073.408
		2017	2020			2022			2025			2030		
		Jet Fuel (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)	Jet Fuel (Ton)	SAF %	SAF (Ton)
EU-28		55.846.599	57.538.807	0,018	10.241	58.695.337	0,64	377.168	60.473.864	2,23	1.350.294	63.558.639	6,41	4.073.408

7.2 SAF short/mid-term supply expectation

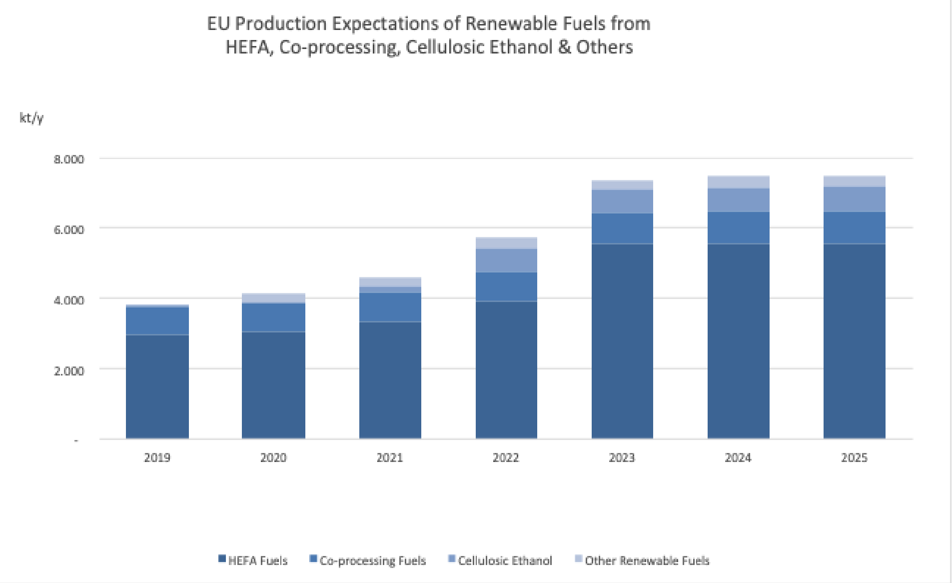
This chapter analyses expectations on European SAF supply based on renewable energy industry announcements from HEFA, co-processing, ethanol & other technologies.

It is pointed out that when it comes to consider these technologies there is a trade-off between the fact that most of that potential uses vegetable oils as feedstock and the fact that they are the most readily available technologies in the aviation field, while the RED II aviation specific incentive establishes a non-food & feed restriction.

7.2.1 European production expectations from HEFA, co-processing, cellulosic ethanol and others

ASTM approved multiple pathways (see chapter 6.1.1) to produce SAF from renewable resources. Those renewable feedstock resources can be used to produce a wide variety of other products, such as road fuels or chemicals. The latter often comes with higher financial margins, which explains the little supply of SAF today. Nevertheless, if circumstances change (e.g. through policy adjustments), the landscape for SAF demand might change rapidly. Renewable fuel producers have a certain flexibility to change the output of a refinery, thus produce more SAF instead of other renewable products.

The following diagram shows the expected renewable fuels production based on latest announcements that can be also used to produce SAF (as captured in chapters 6.4.2 & 6.5).



➨ **Figure 19** European production expectations from ASTM approved multiple pathways

Over the next 5 years the main production capacity for renewable fuels in Europe, mainly renewable (green) diesel will come from HEFA and co-processing. The ASTM HEFA-SPK pathway would allow part of that capacity for SAF production.

The high flexibility and quality of refined products from HEFA is also the reason why many producers consider refurbishing old crude oil refineries into HEFA refineries, instead of implementing a co-processing stream. The trend is clearly visible comparing HEFA and co-processing expectations.

Historically, cellulosic ethanol did not manage to establish itself at the market. High costs and better alternatives seem to make future investments into capacity building rather scarce.

The fourth category, “Other Renewable Fuels”, cover potential SAF production expectations from gasification processes or power to liquids in combination with the Fischer-Tropsch process, while the former (FT-SPK) is being a pathway more adopted in North America. Gasification might hold back the biggest unknown capacity potential for Europe in the short- to midterm future, but also a big uncertainty due to the current unsuccessful case studies of industrial scale-up.

7.2.2 European SAF potential capacity from HEFA, Co-processing and cellulosic ethanol

After evaluating the total transport renewable fuel capacity in Europe, further analysis can be done to better understand which of that could be estimated as the potential SAF capacity.

Every ASTM production pathway yields different amounts of SAF compared to the total output of the refinery. Company statements were analysed to understand the ratios. Although values diverged, it was assumed that the yields for SAF from HEFA is 50%, co-processing 30%, cellulosic ethanol 50% and for other renewable fuels 50%.

The fact that some co-processing plants might use slightly more than 5% of bio-content to be in accordance with ASTM has been neglected for this estimation.

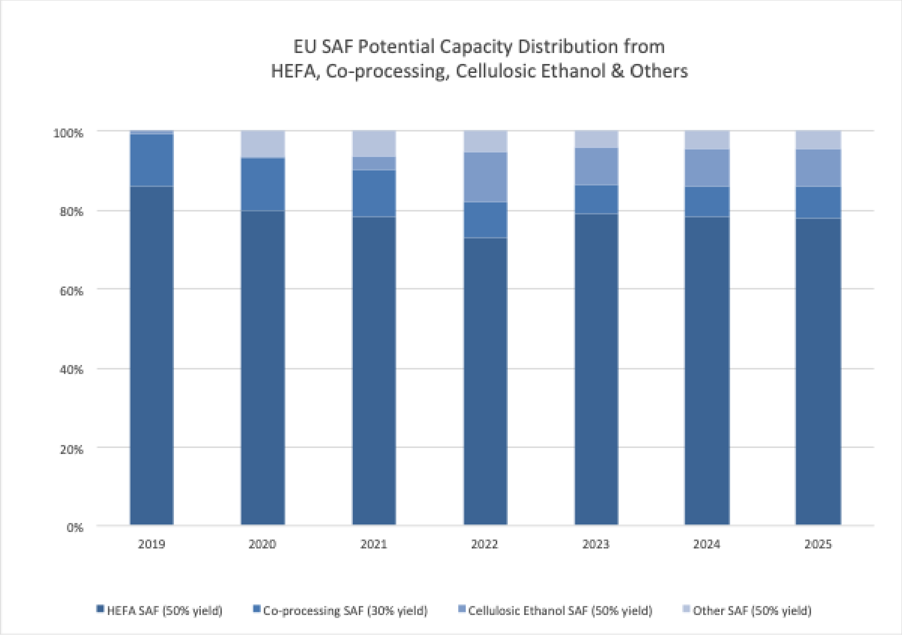


Figure 20 European SAF potential capacity from HEFA, Co-processing and cellulosic ethanol

The diagram further supports the statements made in the previous paragraph: **It is estimated that approximately 80% of Europe's SAF expected capacity would come from HEFA refineries**.

7.2.3 European policy framework induced demand coverage

Paragraph 7.1 discussed and estimated SAF capacity requirements representing an aviation industry demand. Furthermore, Paragraph 7.2.1 estimated Europe's SAF total capacity based on renewable fuel production announcements representing a potential aviation industry supply.

Overlaying both sides, demand and supply, allows us to deeper look into potential shortages of SAF. The following diagram shows the percentage of SAF required by policy frameworks compared to announced renewable fuel capacities that could be used for SAF production.

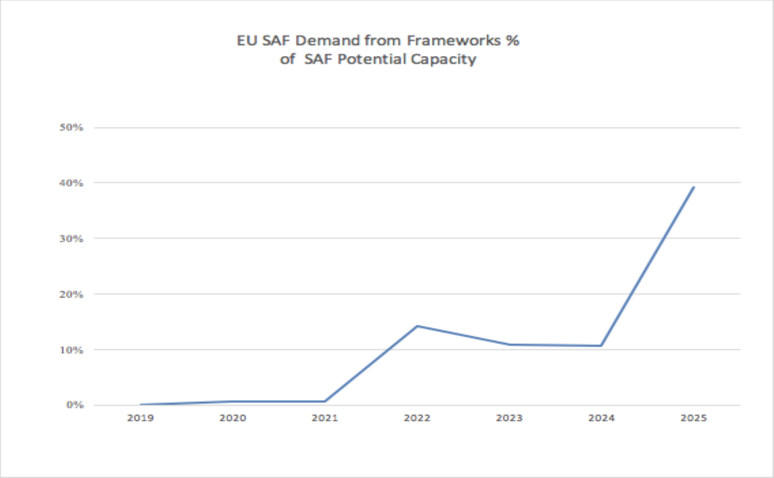


Figure 21 European policy SAF potential demand compared to SAF potential capacity

For the next two to three years no surprises are expected. Nevertheless, the graph clearly highlights the impact of framework developments visible in 2022 and 2025. More SAF demand will require bigger portions of the available potential SAF capacity.

The graph is an estimation, which can easily change trend with new market circumstances or framework changes. Lower percentages are rather unlikely, considering that SAF competes with renewable road fuel production capacities and environmental policies are expected to become stricter imposing higher commitments. The result would be that less SAF capacity is available while the total SAF demand increases.

It is highlighted here that **the real bottleneck to respond to such demand is not on the technology/refining capacity: it is about sourcing sustainable and no food/feed oils** from the EU and abroad to cover such demand.

7.3 Analysis of SAF mid-term expectations in Europe

The summary table included below shows an overview of European SAF Potential Capacity, Supply Expectations and supply needs based on the data and information referred in chapters 6.4, 6.5, 7.1 & 7.2.

The analysis shows that SAF demand in the short-term could be covered with existing renewable fuels production capacity in Europe, if that would be shifted from road transportation to aviation (what in fact is only partially possible due to electrification).

Additional SAF supply capacity will need to be developed in any case to respond to the demand set by policies.

Table 23 Analysis of SAF mid-term expectations in Europe

Overview of European SAF Potential Capacity, Supply Expectations and supply needs

	(kt/y)	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2030**
	EU Renewable transport fuels capacity which could feed SAF demand								
	HEFA Fuels	3.065	3.150	3.460	4.025	5.666	5.666	5.666	*5.666*
	Co-processing Fuels	784	830	830	830	850	890	927	*927*
	Cellulosic Ethanol	16	16	152	680	680	680	680	*680*
	Other Renewable Fuels	0	243	268	276	276	324	324	324
yield	EU SAF Production Potential from HVO, Co-processing and Cellulosic Ethanol								
50%	**HEFA SAF (50% yield)**	1.533	1.575	1.730	2.013	2.833	2.833	2.833	*2.833*
30%	**Co-processing SAF (30% yield)**	235	249	249	249	255	267	278	*278*
50%	**Cellulosic Ethanol SAF (50% yield)**	8	8	76	340	340	340	340	*340*
50%	**Other SAF (50% yield)**	-	122	134	138	138	162	162	162
	Total SAF Potential Capacity (k tonnes)	**1.776**	**1.954**	**2.189**	**2.739**	**3.566**	**3.602**	**3.613**	**3.613**
	EU SAF Demand from Mandates & Total Jet Fuel Consumption								
	EU-28 Jet Fuel Consumtion	56.969	57.539	58.114	58.695	59.282	59.875	60.474	*63.559*
	EU-28 SAF Deamnd from Mandates	**-**	**10**	**10**	**377**	**377**	**377**	**1.350**	***4.073***
	EU SAF Production Potential % of Total Jet Fuel Consumption								
	HEFA SAF (50% yield)	2,7%	2,7%	3,0%	3,4%	4,8%	4,7%	4,7%	*4,5%*
	Co-processing SAF (30% yield)	0,4%	0,4%	0,4%	0,4%	0,4%	0,4%	0,5%	*0,4%*
	Cellulosic Ethanol SAF (50% yield)	0,0%	0,0%	0,1%	0,6%	0,6%	0,6%	0,6%	*0,5%*
	Other SAF (50% yield)	0,0%	0,2%	0,2%	0,2%	0,2%	0,3%	0,3%	0,3%
	EU-28 SAF Capacity % of Total Jet Fuel Consumption	**3,1%**	**3,4%**	**3,8%**	**4,7%**	**6,0%**	**6,0%**	**6,0%**	**5,7%**
	EU SAF Supply Expectation from industry supply plans	**2.015**	**2.118**	**2.118**	**2.491**	**3.632**	**3.680**	**3.680**	***3.680***
	EU-28 SAF Demand from policy frameworks % of SAF Potential Capacity	**0%**	**1%**	**0%**	**14%**	**11%**	**10%**	**37%**	***113%***

7.4 Other SAF deployment scenarios of the IEA and ICAO

7.4.1 The International Energy Agency (IEA) scenarios

Aviation accounts for around 15% of global oil demand growth up to 2030 in the IEA's New Policies Scenario. Such a rise means that aviation will account for 3.5% of global energy related CO_2 emissions by 2030, up from just over 2.5% today, despite ongoing improvements in aviation efficiency.

The IEA's Sustainable Development Scenario (SDS), anticipates SAF reaching around 10% of aviation fuel demand by 2030, and close to 20% by 2040[94], with an estimated global SAF production of 18 billion litres (16 Million tonnes) in 2025, 37 billion litres (33 Million tonnes) in 2030, 56 billion litres (50 Million Tonnes) in 2035

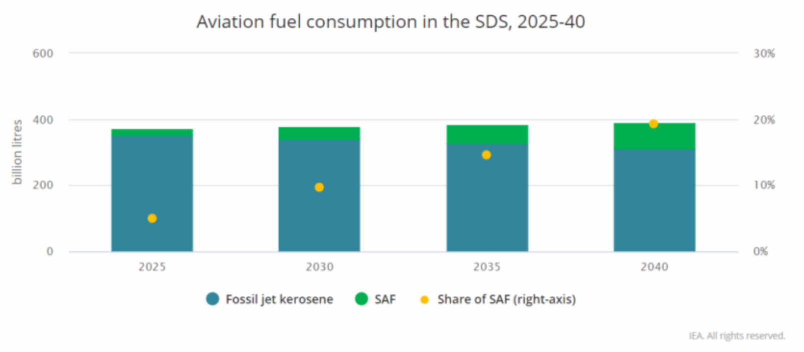


Figure 22 Aviation fuel consumption in the SDS, 2025-40[95]

Nevertheless it should be pointed out that SDS is based in the aviation industry commitment to reducing carbon emissions by 50% from their 2005 level by 2050.

7.4.2 The ICAO SAF Stocktaking

Based on the feedback of ICAO Member States and stakeholders, the first ICAO Stocktaking Seminar toward the 2050 Vision for Sustainable Aviation Fuels (SAFS2019) -which has a view to include a quantified proportion of SAF to be used by 2050- anticipated a **global SAF production capacity of 6.3 Billion litres (5 million tonnes) available in 2025 and 8 Billion litres (6.5 million tonnes) by 2032**.

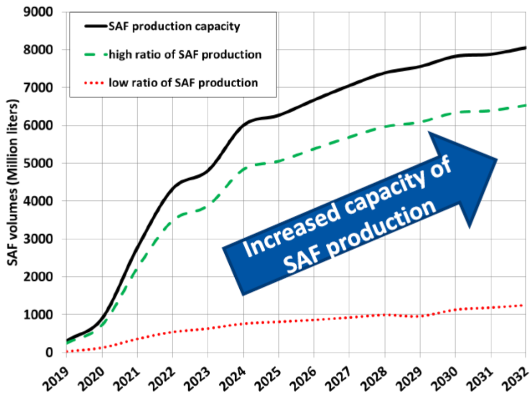


Figure 23 ICAO SAF Stocktaking

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[94] https://www.iea.org/tcep/transport/aviation/

[95] https://www.iea.org/newsroom/news/2019/march/are-aviation-biofuels-ready-for-take-off.html

8. Peer-Review Process

A stakeholder and expert peer-review and consultation has been made, based on the data analysis and preliminary key findings in this report, in order to provide views and comments on:

1) SAF Use metrics (Performance Indicators)

2) Data sources to feed in a systematic manner such PI´s in the future.

3) Suggestions regarding a possible process for monitoring SAF use in Europe.

Three consultation processes have been made:

8.1 Small-group stakeholders review

Alongside the EU ART Fuels Forum plenary and the EU Sustainable Energy Week (Brussels, June 17-18, 2019), an initial stakeholders' consultation via a dedicated meeting was organized.

The outcome of these discussions helped outline an initial set of desirable Performance Indicators that are detailed in this report.

On September 18, this discussion group was contacted again and a draft summary of the scoping study preliminary findings was circulated for consultation.

Its content was structured as follows:

1 PURPOSE OF THIS REPORT
2 PRELIMINARY KEY FINDINGS
  2.1 IDENTIFICATION OF POSSIBLE METRICS/PIS
  2.2 IDENTIFICATION OF DATA SOURCES
    2.2.1 EUROSTAT
    2.2.2 RENEWABLE ENERGY DIRECTIVE
    2.2.3 EMISSION TRADING SCHEME AND CORSIA
  2.3 SAF USE TODAY AND EXPECTATIONS FOR THE FUTURE
3 SAF MONITORING PROCESS INITIAL PROPOSAL
  3.1 SHORT-TERM (EAER 2022) SAF MONITORING PROCESS
  3.2 MID-TERM (EAER 2025) SAF MONITORING PROCESS
4 INPUT REQUEST: DEFINITION OF THE REPORTING PROCESS

Two of the most useful responses were:

➢ **Ms. Karlijn Arts (karlijn@skynrg.com) from SkyNRG[96]:**

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[96] https://skynrg.com

Thank you for sharing the draft once more! I for now, only have three questions:

1) Even though, on a country level, no SAF volumes are reported, it can still be that SAF is produced and sold.

For example, Dutch airlines have to register fossil kerosene, even if they have bought, and are flying on, SAF. This has to do with the bioticket system (Explained in 6.2.4.1, Netherlands SAF Opt-In RED Regulation) where SAF supply is not obliged but can contribute to fuel suppliers' road obligations. So, it could even be the case that the data provided by ETS and/ or EU MS themselves, do not cover the total amount of SAF produced and used in a country.

2) Before we define a monitoring system via which every EU MS has to rapport, should we not first ask the Member States which monitoring and reporting system they prefer?

If we can contribute to making their reporting systems less complicated, that would be a win-win situation.

3) With respect to sustainability: it would be marvellous if the type of feedstock for the production of SAF must be included.

If these results would then be accessible for every EU citizen, SAF producers will think twice before using palm/ soy oil. Is this possible as a standard PI (next to the GHG emission threshold)?

- **Mr. Daniel Leuckx (daniel.leuckx@fuelseurope.eu) from Fuels Europe[97]:**

  Thank you very much for giving FuelsEurope, the opportunity to comment on your proposal to develop a metric for SAF use in Europe. We included our comments in the attached version. FuelsEurope – the association representing the oil refining industry – is very interested in participating actively in this effort.

Three comments were given regarding the preliminary identification of possible metrics and performance indicators:

1) "Types of feedstock used": Need to be generic since this information could be confidential business information.

2) "Percentage of SAFs used per type": Will need to define a list of what is meant under SAF types.

3) Many of the following elements are part of business sensitive and confidential information:

- ✓ *Employment*
- ✓ *Cost of SAF per type*
- ✓ *Return on investment*
- ✓ *Public opinion*
- ✓ *Investment expenditures (fields, storage, equipment etc.)*
- ✓ *Total Biofuel profits*
- ✓ *Total investments on SAFs*
- ✓ *Bioenergy potential*

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[97] https://www.fuelseurope.eu

- ✓ *Production surface land for SAF used within the EU in a certain year*

At the request on whether FuelsEurope had any fuel supply data collected from its associates, the response was the following:

> *At this stage we do not operate any data collection system on renewable fuels supply, not even for road transport. However, our members agreed recently that FuelsEurope would contribute to the intended SAF supply collection initiative.*
>
> *Our next step is to develop further the understanding of what SAF data is needed – based on your proposal of PIs – and to agree on how to collect the data (within our competition compliance rules).*
>
> *However – as you know – we can only supply the SAF supply data coming from refiners. Our association doesn't cover non-oil refiners SAF suppliers.*
>
> *I propose to re-contact you at the end of November to see how far we already progressed on the topic within FuelsEurope.*

8.2 ART-Fuels Forum Aviation Group input

On 22 September, Mr. Darrin Morgan (Team Lead aviation at ART Fuels Forum[98]) circulated to the aviation group the same summary document mentioned above (Deliverable D3.3c) for consultation. One valuable reply that we received was:

- ➢ **Mr. Uwe Dietrich (Ralph-Uwe.Dietrich@dlr.de) from DLR:**

> *As a researcher at the German Aerospace Centre with a focus on sustainable aviation I would contribute the following comments:*
>
> *• It is a different point of view to focus on the SAF supply rather than on the abatement of fossil fuel usage in aviation – we'll have to turn the viewpoint.*
>
> *• The major PI to me should be Greenhouse gases emissions savings from SAF use (supply) in EEA (t CO_2eq) compared to total Greenhouse gases emissions of European aviation*
>
> *• Approximation and achievement of the IATA 2050 goal of 50 % CO_2 reduction compared to 2005 have to be measured in exact that measure (t CO_2eq)*
>
> *• Methods for calculation of Greenhouse gases emissions savings have to be harmonized and published to allow comprehension and fault diagnostics*
>
> *• Current data sources for monitoring are not sufficient to fulfil that task, member states / airlines reporting has to be double-checked for consistency and completeness*

All these inputs have been reflected in this report.

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[98] http://artfuelsforum.eu/

8.3 Selected Expert´s peer-review

This study has benefited from additional peer-review and contributions from the following external experts in different areas of expertise:

- Max Eichelbaum (Expert on SAF markets)
- Carlos Alberto Fernández (Expert on EU bioenergy policies)
- David Chiaramonti (Expert on bioenergy feedstocks, processes and policies)
- Gabriel Casas (Aviation & environment expert)
- África Abajas (Expert on EU ETS, CORSIA and carbon markets)

All their inputs and contributions to the scoping exercise have been captured in different sections of this report.

9. Key Findings and Recommendations

The last step of this study is focused on defining a process and procedure to link existing or future data sources and repositories to feed the proposed set of performance indicators in order to report on SAF use and GHG emissions savings on a regular basis. The procedure should identify possible roles and functions in this monitoring process for EASA but also other key European bodies and stakeholders.

This chapter summarises the main findings and suggested recommendations evolved from the report. The most important are highlighted in the blue boxes along the chapter. It also addresses a SAF monitoring process proposal and recommendations related with its implementation.

9.1 SAF data analysis

9.1.1 SAF use today and expectations for the future

The study referred in this document included an analysis of SAF status today and expectations for the future.

To achieve the EU long-term strategy of a climate-neutral economy goal, SAF may need to contribute up to 23-45% of the fuel mix by 2050 with e-fuels contributing 10-34%.

There is currently no SAF regular supply in Europe, although the study has concluded that, without additional measures, the current SAF policy incentives from European States (many of those recently announced) could drive SAF demand to over 6% of jet-fuel use in 2030.

The analysis highlighted that the announced bioenergy industry plans for SAF SUPPLY in Europe, together with the existing capacity dedicated today to road transportation, could cover most of the announced policy driven SAF demand by 2030.

Nevertheless, additional supply capacity is likely to be needed as it is highly unlikely that the current renewable fuels capacity for road transport will be fully available to the aviation sector. This will require further SAF promoting policies to be implemented in the short and mid-terms.

The study also shows that if further policy adjustment are made, then the landscape for SAF demand may change rapidly, leading to an increase in SAF use at the expense of other renewable products currently being supplied to road transport.

Over the next 5 years the main production capacity for renewable fuels will be HEFA green diesel. The ASTM HEFA-SPK pathway would allow part of that capacity for SAF production. Further analysis was done to assess the short-term SAF capacity, and it is estimated that approximately 80% of Europe's SAF capacity could come from HEFA refineries.

Nevertheless, there is a trade-off between the fact that most of that potential uses vegetable oils as feedstock, while the RED II aviation specific incentive establishes a non-food & feed restriction and a gradual phase-out of crop-based vegetable oils, so those will need to be replaced by wastes or other renewable feedstocks.

The real challenge to respond to future SAF demand is not expected be on the technology/refining capacity, which can be developed by the industry driven by regulation, but on the sourcing of sustainable and non-food/feed oils from the EU and abroad to cover such demand.

9.1.2 Sustainability and estimation of GHG emissions reductions

Economic operators will need to calculate GHG intensity values for each step of the production chain with the option to either use default values provided in RED II (Parts A & B of Annex V), or to calculate actual values calculated in accordance with the RED methodology laid down in Part C of Annex V; Those GHG values will be certified by Sustainability Certification Schemes and included in the sustainability certificates for each single batch of biofuel brought to the market.

The next EAER is due to be published in 2022. At this point, the reference European methodology for certification against sustainability requirements, and for estimating GHG emissions reductions from the use of SAF, will be the one established by the revised RED II (EU) 2018/2001.

The values can be extracted from those certificates that are held by both fuel operators and final users (aircraft operators). This information is currently collected within Member States databases, but not included in reporting obligations to the EU/EEA level.

The RED II also determines a **fossil fuel comparator EF(t) for transportation fuels of 94 g CO_2eq/MJ**, to estimate greenhouse gas emissions savings. This can be updated periodically.

In the case of non-biobased fuels (as waste gasses or PtL), a specific methodology to assess its greenhouse gas emissions savings is currently being developed by the European Commission by means of delegated acts to be issued by 2021.

It should be noted that CORSIA establishes a sustainability framework for SAF similar but not totally equal to the EU RED II. For example, its Fossil Fuel Comparator is 89 g CO_2eq/MJ and the default LCA values for different SAF pathways, although being very similar, are calculated under different methodologies.

The future revision of the EU ETS to implement CORSIA in the EU, will need to address whether SAF supplied in Europe, which necessarily will need to comply with EU RED II will need also to go through a CORSIA sustainability certification and report emissions reductions according to CORSIA or RED GHG values.

It is understood that SAF reported under CORSIA will use CORSIA values but will also need to fulfil RED II sustainability criteria to be supplied in Europe.

9.1.3 EU regulatory data collection findings

9.1.3.1 Eurostat

EUROSTAT collects and publicly discloses statistics regarding energy, and renewable energy in Europe (EU-28). Those are based on fuel supply and are reported annually, including consumption (based on supply data) of kerosene type jet fuel.

States use their own data sources and methods and not an existing standardised European approach. There are two main ways used by States to collect data:

- ✓ Administrative data collection from economic operators
- ✓ Data collection (voluntary or mandatory) through survey

The below datasheets have been prepared to include "bio jet kerosene" in this reporting process (with code: R5230P), but today are still empty as no supply has been reported yet.

- ✓ Inland consumption of pure bio jet kerosene.
- ✓ Gross inland consumption of bio jet kerosene.
- ✓ Primary production of bio jet kerosene.
- ✓ Imports of bio jet kerosene.
- ✓ Exports of bio jet kerosene.

Eurostat currently do not collect data that supports an estimation of SAF GHG emissions reductions.

It must be noted that **"bio jet kerosene" classification excludes SAF from non-biological origin**, such as waste gases or Power to Liquid (PtL), which can be approved to contribute to the RED II and accounted by some Member States.

This fact can generate inconsistency of terminologies and definitions between what SAF is supplied and reported under the RED II and what is reported to Eurostat.

9.1.3.2 Renewable Energy Directive (RED II)

For the purpose of this report, we refer to the revised RED II. Reporting under it is related to fuel SUPPLY and establishes obligations over Economic Operators, Member States, the European Commission (EC) and the approved Sustainability Certification Schemes.

- ➢ **Economic Operators:**

The RED II establishes an obligation at the economic operators' level to calculate GHG emissions reductions on a life-cycle basis (and based on a specific methodology established in the RED regulation) and to obtain

The calculated **life-cycle carbon intensity value (in CO_2eq/MJ) of certified fuel can be extracted from the sustainability certificates** and the estimated greenhouse gas emissions savings are relative to a reference fossil fuel comparator, which is currently set at 94 g CO_2eq/MJ.

sustainability certificates for each single batch of biofuel its sells on the market. Sustainability certificates should flow from feedstock producers, to fuel producers and suppliers, to reach the final user (airlines in the case of SAF).

Member States must collect from fuel suppliers all relevant information on renewable fuels that are to be accounted as contributing to the RED II targets.

- **Member States:**

Member States are expected to increase reporting on the use of SAF in the short-term, as there are currently several national policy initiatives to promote SAF use and SAF will contribute to the RED II targets.

SAF data provided at EU level will be focused on meeting national RED II targets (e.g. volumes of high and low ILUC SAF, overall food and feed). RED II does not require the calculation and reporting of segregated SAF related GHG emissions reductions.

The RED reporting obligations from Member States could be adjusted in order to include all sustainability certification data, so as to provide the relevant information needed for the development of a process to monitor and report on the characteristics and CO_2 savings of SAF used in Europe.

Under the RED II, the Member State retained the responsibility of defining some eligible feedstocks so there may be differences on the types of SAF supplied and reported. For example, some States might consider SAF from waste gases, while others not.

It is important to note that in the case of aviation (and maritime), in order to use the 1.2 multiplier established by the RED II, the feedstock must not originate from food or feed. This may also lead to differences based on what different States classify as food/feed. Another important related issue is that while **the sustainability certificate** identifies the feedstock used, it **does not indicate today whether such feedstock is classified as food or feed**, which might generate reporting challenges to demonstrate compliance with the multiplier requirement.

- **The future Union database:**

There are some articles within the RED II that require the Commission to develop a **Union database** to ensure transparency and traceability of renewable fuels. There is no fixed deadline for the EC to put this database in place and DG ENER do not, at this stage, have well-developed views about what data it may contain.

If the future Union database collects SAF characteristics from fuel suppliers based on the sustainability certification under the EU RED II, such database would provide the most promising data stream for collecting information on the use of SAF in Europe and its related CO_2 emissions reductions on a life-cycle basis.

Due to requirements of the FQD and RED II, EU MS request information to their fuel suppliers on renewable fuels supplied to the market, as those account for RED II obligations. Many MS collect very complete datasets on the characteristics of those fuels as per the content of each batch sustainability certificate, including Lifecycle GHG emissions values.

Recommendations for its development as result of the outcomes of this report, have been included in section 9.4.2 (Considerations on SAF Monitoring for a future Union Database).

9.1.3.3 The Fuel Quality Directive (FQD)

The development of the Union Database is the responsibility of the EC DG Energy. **EASA and DG ENER agreed to continue to work together, utilising the output of this scoping study, to identify data input fields that would support future SAF monitoring.**

Currently the FQD scope does not include aviation fuels, while establishes fuel reporting requirements for other transportation modes.

The FQD requires road fuel suppliers to report annually on the greenhouse gas intensity of fuel and energy supplied within each Member State by providing information on the total volume of each type of fuel supplied, and the life cycle greenhouse gas emissions per unit of energy (carbon intensity) calculated in accordance to the EU RED methodology. Member States need to ensure that reports are subject to verification.

The FQD implementing Directive 2015/652/EU requests Member States to report to a Central Data Repository managed by the European Environment Agency, disaggregated data by each type of fuel showing amounts of fuel *placed on the market by suppliers within a given Member State* and its respective GHG intensity and emissions reductions.

A simple change of scope to the FQD to include aviation fuels (sustainable or not) as part of the Directive's reporting requirements of its Article 7a (GHG emissions reductions) would enable access to data on SAF supplied.

The data to be reported annually after 2020 by the Member States include:

(a) Fuel or energy type;

(b) Volume or quantity of fuel or electricity;

(c) Greenhouse gas intensity;

SAF data might not be available yet at the EU level, but a robust data stream on SAF supply and related GHG values and reductions is already in place through the FQD.

Information provided by fuel suppliers to States, and from States to the EC, under the FQD will be very relevant for the purpose of this work. It is the key framework for the establishment of national fuel supply databases that contain GHG emissions, and a key information source for the purpose of this scoping work.

9.1.3.4 GHG emissions reporting from EU Member States (Under UNFCCC)

The European Union (EU), as a party to the United Nations Framework Convention on Climate Change (UNFCCC), reports annually (together with Iceland) on greenhouse gas (GHG) inventories, calculated under the UNFCCC reporting methodology.

UNFCCC methodology does not consider the estimation of the life-cycle GHG emissions savings. Biomass-based fuel is accounted as having zero emissions, while GHG emissions produced on the different steps of the supply chain are accounted for in that sector**.**

As such, **it is not considered a complete source of data for a future SAF monitoring process**.

9.1.3.5 Emission Trading Scheme and CORSIA

Reporting under the EU ETS or CORSIA is related to fuel used by aircraft operators.

An annual verified EU ETS emissions report is provided for intra EEA flights to their State of authority before 31 March.

EU ETS refers only to biofuels, excluding other SAF from non-biological origin. Sustainable biomass content is rated as zero emissions factor.

Before 30 June, each Member State must provide information on ETS implementation, including use of biomass-based SAF.

The collection of SAF data has so far shown extremely limited use thereof. For 2017, only Sweden reported use of biofuel for two aircraft operators, while for 2016 and 2015 both Germany and Sweden reported minimal use for three and four aircraft operators.

- **Current reporting:**

Current reporting **does not include any information regarding the fuel characteristics such as feedstock used, conversion process or life-cycle CO_2 values**.

- **Reporting after 2020:**

The aircraft operator EU ETS emissions reporting template is currently being reviewed by the EC to accommodate not just ETS but also CORSIA.

It is expected that the future template will request operators who report SAF use to **submit additional information on feedstock used, conversion process and life-cycle CO_2 values.** This information is already accessible via the respective sustainability certificates of each SAF batch used**.**

A first Draft for Discussion on the revised reporting template has been sent to Member States to collect comments prior to its final approval. This is expected during the 4th quarter of 2019.

This enhanced reporting process could provide enough granularity to support a more robust SAF data stream.

Nevertheless, some limitations have been identified for the use of EU ETS reporting as a reliable SAF data stream for monitoring its use in the EEA and associated emissions reductions.

- **Reporting limitations of EU ETS:**

  1. **The current geographic scope of the EU ETS is limited to intra-EEA flights. As such, SAF supplied in Europe to flights outside the EEA may not be reported under the EU ETS by non-EEA operators, but rather under CORSIA.**

  2. **SAF supplied in a non-EEA State could be reported under EU ETS (the "book and claim" approach).**

  3. **Finally, it may happen that SAF supplied and used within the EEA is not reported under the EU ETS. For example, in The Netherlands airlines must report fossil kerosene, even if they have been supplied with SAF. This has to do with the bio-ticket system** (see section 6.2.4.1, Netherlands Opt-In RED legislation)**, where SAF is accounted under road transportation RED supply objectives.**

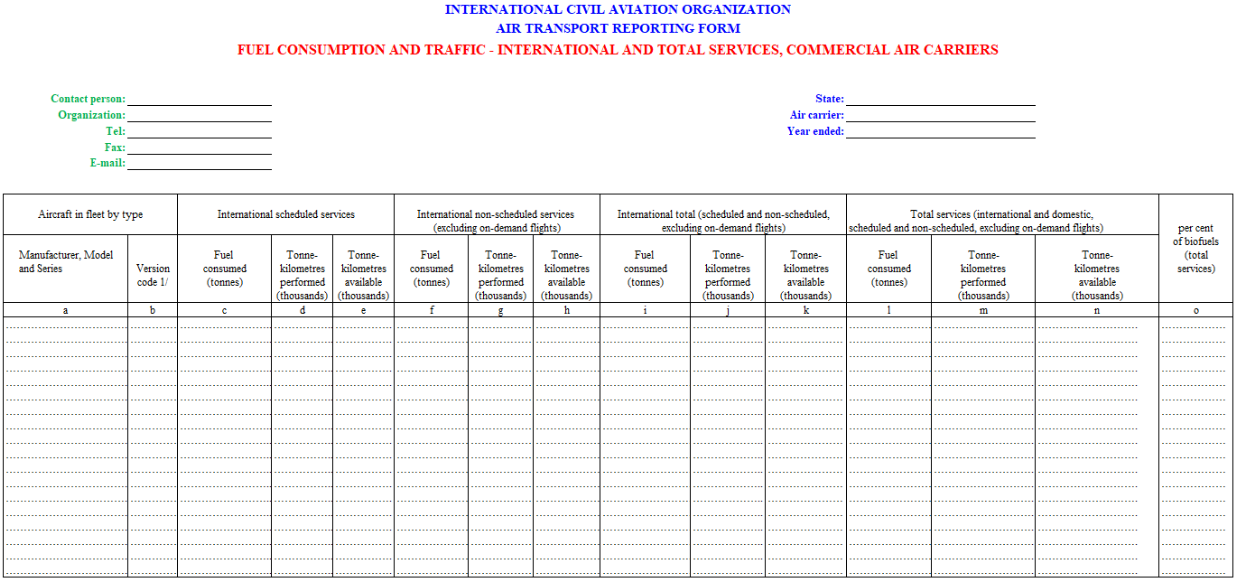
Such limitations can mismatch the information regarding total SAF supplied in Europe and total SAF used/reported under EU ETS.

Nevertheless, information regarding SAF -and its characteristics- reported by operators under the EU ETS (and CORSIA in the future), could be used to complement and cross-check SAF supply data taken from other sources (RED or FQD).

In this respect, **EASA should also request access to the Member State ETS and CORSIA reports and would require dedicating an analysis effort.** The ETS reporting template will include SAF GHG intensity values, but those will need to be compared with the Fossil Fuel comparator to estimate the achieved GHG savings.

9.1.3.6 The ICAO Form M reporting requirement

In addition, there is lack of transparency and public information regarding Form M reporting from European Member States.



INTERNATIONAL CIVIL AVIATION ORGANIZATION
AIR TRANSPORT REPORTING FORM
FUEL CONSUMPTION AND TRAFFIC - INTERNATIONAL AND TOTAL SERVICES, COMMERCIAL AIR CARRIERS

Contact person: ____________________
Organization: ____________________
Tel: ____________________
Fax: ____________________
E-mail: ____________________

State: ____________________
Air carrier: ____________________
Year ended: ____________________

Aircraft in fleet by type		International scheduled services			International non-scheduled services (excluding on-demand flights)			International total (scheduled and non-scheduled, excluding on-demand flights)			Total services (international and domestic, scheduled and non-scheduled, excluding on-demand flights)			per cent of biofuels (total services)
Manufacturer, Model and Series	Version code 1/	Fuel consumed (tonnes)	Tonne-kilometres performed (thousands)	Tonne-kilometres available (thousands)	Fuel consumed (tonnes)	Tonne-kilometres performed (thousands)	Tonne-kilometres available (thousands)	Fuel consumed (tonnes)	Tonne-kilometres performed (thousands)	Tonne-kilometres available (thousands)	Fuel consumed (tonnes)	Tonne-kilometres performed (thousands)	Tonne-kilometres available (thousands)	
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o

Figure 24 The ICAO Form M reporting template

9.1.4 Identification of current data sources and streams

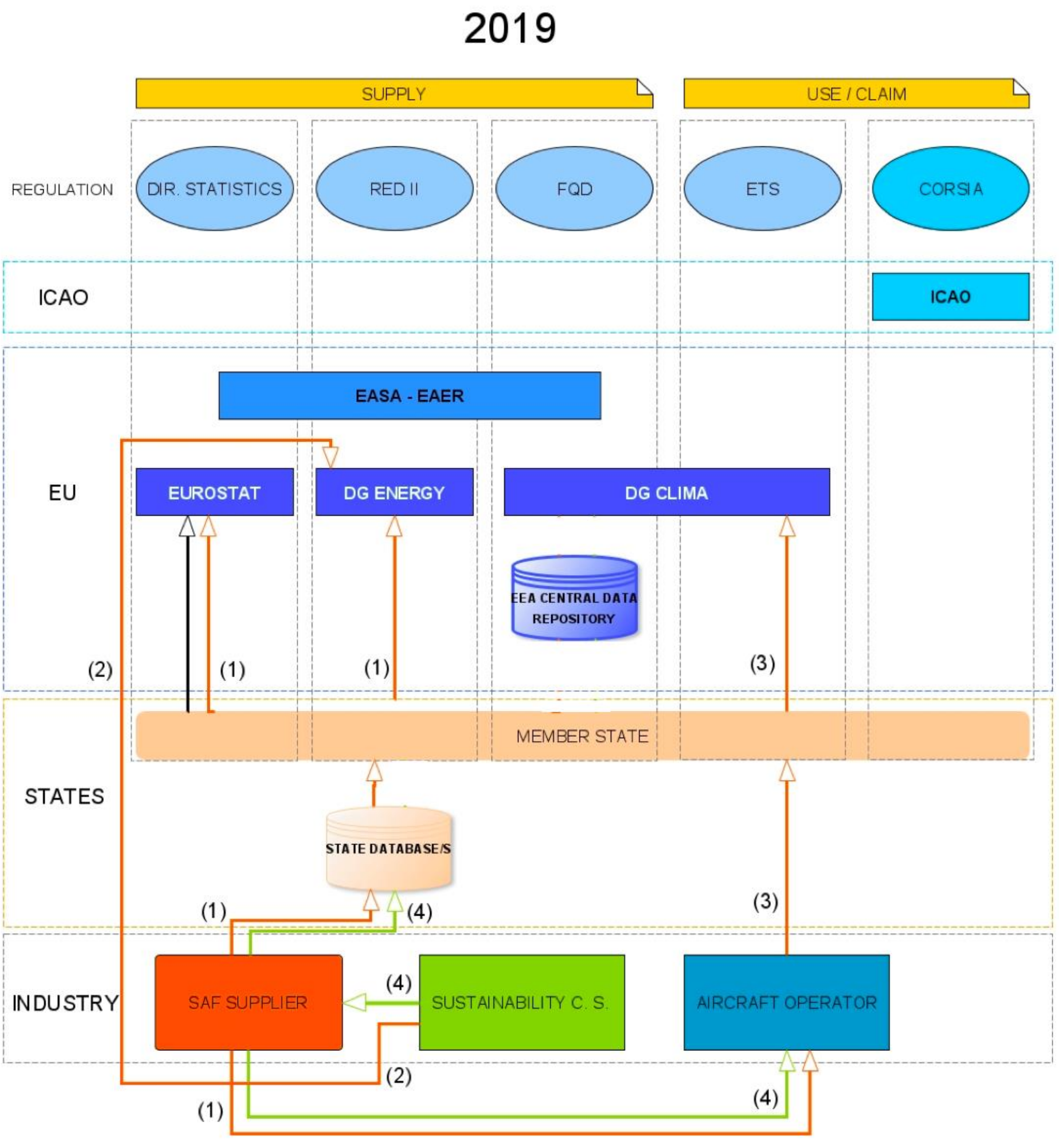
Two types of SAF possible data sources are identified:

- ✓ Data streams resulting from a regulatory reporting obligation.
- ✓ Data in hands of the industry and stakeholders.

The below data sources for scoping a SAF use monitoring process have been identified:

1. Existing **regulatory reporting** obligations and involved agencies are:
   - ➢ Related to <u>supply</u>:
     - ✓ **EU Regulation on Energy Statistics**:
       - ➢ States reporting to Eurostat
     - ✓ **Renewable Energy Directive (RED):**
       - ➢ States reporting to the EC.
       - ➢ EC reporting to the EU parliament & Council.
       - ➢ Sustainability Certification Schemes: annual reports to the EC.
     - ✓ **Fuel Quality Directive (FQD)**:
       - ➢ States reporting to the European Environmental Agency.
       - ➢ Road fuel operators reporting to Member States (national databases) but today aviation fuels are not in FQD scope
     - ✓ **UNFCCC GHG emissions reporting EU regulation**:
       - ➢ States reporting to the EC.
   - ➢ Related to <u>final use</u>:
     - ✓ **EU ETS/CORSIA**: airlines reporting obligation.
     - ✓ **ICAO Form M**: States reporting obligation.
2. **Surveys** by stakeholders:
     - ✓ **Airlines**: IATA collects SAF use.
     - ✓ **Refineries/Fuel provider's** data and reporting.

The figure below, represent the main SAF administrative reporting data streams in the EEA.



#	DATA STREAM
(1)	Amount of SAF SUPPLY in EEA markets data (RED II compliant) – Tonnes
(2)	Amount of SAF CERTIFIED under EU RED II by voluntary schemes – Tonnes
(3)	Sustainability characteristics (RED II compliant): Type (conversion process), country of origin, year, feedstock used, GHG intensity value, Fulfilment of land-use criteria
(4)	Amount of SAF USE data (RED II compliant) reported by aircraft operators – Tonnes
(5)	Partial Sustainability characteristics (RED II compliant): Feedstock used, GHG intensity value and GHG emissions savings against Fossil comparator

➨ **Figure 25** Current administrative SAF reporting data streams in the EEA

Member States collect information from fuel suppliers on SAF delivered to their markets, under the Eurostat, and RED reporting obligations. In some cases, data reported to Eurostat have different administrative origin than to RED.

Sustainability Certification Schemes provide the suppliers a Certificate including at minimum, the following information:

- **Type of fuel;**
- **Origin country;**
- **Feedstock used**
- **Country of origin of the feedstock;**
- **GHG emissions value (g CO_2-eq/MJ);**
- **Fulfilment of the land use criteria.**

While CO_2 emissions savings may not be included in the certificate it can be calculated comparing the respective GHG emissions values with the EU RED fossil fuel comparator EF(t) (currently 94 g CO_2eq/MJ).

SCS also report on fuels certified to the Commission, and on the feedstock used but not its GHG life-cycle values. Nevertheless, the information reported is not complete as would not include SAF certified under some national schemes, which do not report to the EC.

Member States have established national databases to collect such information to Fuel suppliers and normally also collect additional sustainability characteristics.

In the future it is expected that all renewable energy information collection will be centralized in a Union Database, as indicated in the revised RED II.

Aircraft operators report SAF use under the EU ETS, and after 2020 will include SAF sustainability characteristics in the reporting template, including CO_2 emissions values. Potential SAF reporting under CORSIA after 2021 would also include such information.

However, EU ETS reporting has some limitations (indicated in 9.1.3.5, ETS/CORSIA) which makes such data stream not sufficiently robust to cover all SAF supplied in the EEA.

9.1.5 Analysis of current data sources and streams

The existing European regulatory reporting mechanisms and data collection from Member States and industry operators, does not generate sufficient data streams to feed the identified Performance Indicators.

The above listed potential European SAF data sources have been analysed and a summary table of pros and cons of each data source is included below.

Table 24 Analysis of current data sources

SOURCE	TYPE	SAF Use?	LCA CO_2?	PROS	CONS
MS`s	Admin Survey	Yes	Yes	> MS have accurate information on biofuels (including SAF) supplied through different reporting mechanisms, including fiscal/tax > A group of Member States have very accurate databases of biofuels supplied, types and related LCA/GHG savings collected from respective sustainability certification under EU RED > Could be the basis of the future Union Database	> Not all MS have the same level of accuracy, compatibility, emission factors or feedstock definitions > MS are not yet obliged to report this disaggregated information in Europe > The databases are not accessible
IATA	Survey	Yes	No	> IATA regularly collects SAF use from its airlines	> Not all airlines are IATA members > The data does not include LCA/GHG savings > The databases are not accessible
Fuels suppl.	Survey	Yes	Yes	> Fuels suppliers have all needed information: SAF supplied and GHG reductions on a LCA basis (from sustainability certification of the fuel under EU RED and in future CORSIA)	> Suppliers does not normally provide such info unless requested by regulation
Airports	Survey	No	No	> Some airports can have SAF supply data	> Airports in Europe normally do not have databases of fuel supplied (including SAF)

Table 25 Information required per each identified data stream

		DATA STREAM		
REGULATION & Data Requirements References	**DATA STREAM**	**SAF QUANTITIES**	**SUSTAINABILITY DATA**	**NOTES**
EUROSTAT [1] Regulation (EC) No 1099/2008 on Energy Statistics Eurostat datasheets	(1)	**MEMBER STATES to EU:** - Inland consumption of bio jet kerosene [2] (ToE) - International/Domestic. - Gross inland consumption of bio jet kerosene (toe) - Domestic only. - Primary production of bio jet kerosene (toe) - Imports of bio jet kerosene (toe) - Exports of bio jet kerosene (toe)	Eurostat does not collect sustainability certification related data.	[1] > States use different data sources and methods to compile information for EU reporting requirements. For example, administrative data (e.g. market supply or customs data) or survey data collection (voluntary / compulsory) from industry (producers/suppliers) [2] > Such terminology excludes non-bio based SAF which are considered under the RED II

RED **MSs to EU:** Template for the Member States reports under the Directive 2009/28/EC **SCS to EU:** SCS Reporting Template **EC to Parl.:** Renewable Energy Progress Report	(1) (2)	**MEMBER STATES to EU:** - Gross final consumption of energy from RES in transport (ktoe) - Not disaggregated across transport sectors. - Total actual contribution from each renewable energy technology (fuel type) in the transport sector (ktoe). - RES support schemes (e.g. % quota) **SUST.CERTIF. SCHEMES to EU: (Voluntary. Excludes National Schemes)** - Type of product [3] - Country of origin - Feedstock - Calendar Year - Value (tonnes) **EURO COMMISSION to EURO PARLIAMENT** - Final consumption in EU Transport of Bio Jet Kerosene (ktoe) International/Domestic [5]	Under the RED there is no collection of sustainability certification related data. **MEMBER STATES to EU:** - Estimated net GHG saving from the use of renewable energy in transport (t CO_2eq) [4]	[3] > Under EU RED the Types of products identified are: Biodiesel; Bioethanol; HVO; Pure vegetable oil; Biomethane; FT diesel; DME; Methanol; Other > SAF is not identified among fuel type categories and so reported under "others" > There is no terminology consistency with "Fuel Type" under the FQD nor under EU ETS. [4] > Estimation of GHG savings reported from MS´s is aggregated. Not by sub-sector [5] > Nothing reported to date
FQD (Currently aviation fuels are not on its scope) Directive 2015/652/EU Annex III	(1) (5)	**If a modification would be made to include aviation on its scope for reporting purposes, the information currently required for other transportation fuels is:** **FUEL SUPPLIERS and MEMBER STATES to EU:** - Country of origin - Supplier - Fuel Type (CN code) [6] - Quantity by litres (L) and by energy (MJ) [7] - Feedstock (& CN code)	**FUEL SUPPLIERS and MEMBER STATES to EU:** - GHG intensity - Upstream Emission Reduction -Reduction on 2010 average	[6] > Fuel Type under FQD refers to CN code. There is no consistency with "Type of product" under the RED and "Fuel Type" under EU ETS. [7] > Total energy supplied is expressed in mega joules (MJ) and converted from reported volumes of fuel expressed in litres (temperature of 15 °C)
EU ETS[8] **Aircraft ops:** Annual Emissions Report for Aircraft Ops. Template **MSs to EU:** EU ETS Questionnaire: Question 5.17 **EC to public:** *Report on the functioning of the European carbon market*	(3) (4)	**AIRCRAFT OPERATORS to MS:** - Name of fuel [9] - Sustainable biomass content (%) [10] - Fuel Type - Feedstock - Conversion process - Fuel consumption (Tonnes) **MEMBER STATES to the EU:** Aggregated data on Biomass reported: - number of installations using biomass; - energy content of the biomass which is considered zero rated. **THE EU TO THE PUBLIC:** Reported use of biomass by aircraft ops.	**AIRCRAFT OPERATORS to MS:** - Life Cycle Emissions value (t CO_2) **MEMBER STATES to the EU:** Aggregated data on Biomass reported: - total emissions from biomass which are considered zero rated.	[8] > Reporting caveats: - SAF supplied in EEA to flights outside the EEA may not be reported under the EU ETS by non-EEA operators. - SAF supplied in a non-EEA State could be reported - SAF supplied in the EEA might not reported under the EU ETS. [9] > No guidance is provided on what is referred by "Name of fuel"/"Fuel Type". [10] > % of sustainable biomass accounts as Zero emissions under EU ETS.
CORSIA [11] **OPS to MSs:** EU ETS Annual Emissions Report for Aircraft Ops. Template ICAO Annex 16 Vol IV, **Appendix 5 Table A5-2** **MSs to ICAO:**	(3) (4)	**AIRCRAFT OPERATORS to MS:** - Fuel Type - Feedstock - Conversion process - Total mass of neat CORSIA eligible fuel claimed (Tonnes) Additional info to be reported in the future as per ICAO Annex 16 Vol IV, Appendix 5 Table A5-2: *Supplementary information to an aeroplane operator's Emissions Report if emissions reductions from the use of each CORSIA eligible fuel being claimed.* **MEMBER STATES to ICAO:**	**AIRCRAFT OPERATORS to MS:** - Life Cycle Emissions value (t CO_2) - Emissions reductions claimed (t CO_2)	[11] Non-EEA airlines will not report in Europe SAF supplied in the EEA

ICAO Annex 16 Vol IV, Appendix 5 **ICAO to Public: ICAO doc entitled "*CORSIA Central Registry (CCR): Information and Data for Transparency*"**		Additional info to be reported in the future as per ICAO Annex 16 Vol IV, Appendix 5 Table A5-6: *CORSIA eligible fuels supplementary information to the Emissions Report from a State to ICAO*. **ICAO TO THE PUBLIC**: - Production year of the CORSIA eligible fuel claimed - Producer of the CORSIA eligible fuel claimed - Type of fuel, feedstock and conversion process for each CORSIA eligible fuel claimed - Batch number(s) of each CORSIA eligible fuel claimed - Total mass of each batch of CORSIA eligible fuel claimed. - State reporting the information		

9.2 SAF performance indicators

9.2.1 Identification of metrics/performance indicators (PIs)

As there can be made different interpretations of "SAF Use in Europe", specific Performance Indictors (PIs) should be defined for the SAF reporting process.

A review of the state-of-the-art bioenergy and SAF use analytics and indicators has been done as part of this study, including the existing European key reference: annual *Energy, transport and environment indicators*[99]. An initial list of possible indicators and metrics was subsequently identified. And after a consultation process with stakeholders, and a peer-review by several SAF experts, the following disaggregated PIs are recommended to inform policy assessments:

- Total SAF supply in the European Economic Area (EEA) (Mtoe)
- Share of SAF in gross final supply of aviation jet fuels – percentage (%)
- SAF supply per EEA State (Mtoe)
- SAF used internally (domestic & intra-EEA flights) and internationally (international non-EEA flights)
- SAF used by EEA operators and SAF used by non-EEA operators
- Greenhouse gases emissions savings from SAF supply in EEA (t CO_2eq)

While additional PIs were identified, the general feedback supported the need to focus on a reduced number. However, among the additional potential indicators to consider using, the following ones were deemed feasible in terms of future data availability:

- ✓ Types of feedstock used
- ✓ Types of conversion technologies used
- ✓ Percentage of SAFs used per type
- ✓ SAF export
- ✓ SAF import
- ✓ Trade volume

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[99] https://ec.europa.eu/eurostat/web/products-statistical-books/-/KS-DK-18-001

The rest of initially identified PIs, are considered less reasonable in terms of availability of data and sensitiveness form a commercial perspective. To be able to feed the above-identified SAF use PIs, the following data are required:

➨ **Table 26** Data needed for Performance Indicators (PIs)

PI	DATA NEEDED	Existing datasets?	Future datasets?
SAF supply per EEA State (Mtoe)	EEA SAF SUPPLY data (RED II compliant)	YES[1]	YES[2]
Total SAF supply in the EEA. (Mtoe)	EEA SAF SUPPLY data (RED II compliant)	YES[1]	YES[2]
Share of SAF in gross final consumption of aviation fuels use - percentage (%).	EEA SAF SUPPLY data (RED II compliant) + jet kerosene supply data	YES[1,3]	YES[2]
SAF used internally (domestic & intra-EEA flights) and internationally (international non-EEA flights).	SAF USE data by type of operation reported by EEA aircraft operators (operations from EEA states)	NO	NO
SAF used by EEA operators and SAF used by non-EEA operators.	SAF USE data by type of operation reported by non-EEA aircraft operators (operations from EEA states)	NO	YES (partial)[4]
Greenhouse gases emissions savings from SAF use (supply) in EEA (t CO_2eq).	SAF supplied and respective Carbon intensity values (as in their Sustainability Certificates) for all EEA SAF SUPPLY data (RED II compliant)	NO	YES[2]

EEA is the European Economic Area, which includes EU-28 + Norway, Iceland

[1] Existing national RED databases.

[2] EEA Central Data Repository, future Union Database.

[3] Eurostat;

[4] EU ETS.

9.2.2 Final proposal of metrics/ Performance Indicators (PIs)

From the feedback received from stakeholder's consultation, and the above analysis of data needed to feed the proposed PIs, the following final Performance Indicators are proposed:

SAF supply PIs:

- **Total SAF supply in the European Economic Area (EEA) (Mtoe)**
- **Share of SAF in gross final consumption of aviation fuels use – percentage (%)**
- **SAF supply per EEA State (Mtoe)**
- **SAF used by EEA operators and SAF used by non-EEA operators**

CO_2 emissions savings KPIs:

- **Greenhouse gases emissions savings from SAF use (supply) in EEA (t CO_2eq)**

The following additional PIs are identified as desirable and feasible, in case data are available:

- ✓ **Types of feedstock used**
- ✓ **Types of conversion technologies used (ASTM / Def Stan pathway)**
- ✓ **Percentage of SAFs supplied per type of technology (ASTM / Def Stan pathway)**

Several reviewers indicated that providing information on the feedstock used would give transparency and avoid unfair criticism to the aviation sector which will mostly use non-food and feed raw materials as per requisite of the special RED II aviation/maritime multiplier, and also for social demand.

9.3 SAF monitoring process

The existing European regulatory reporting mechanisms and data collection from Member States and industry operators, does not generate sufficient data streams to feed the identified Performance Indicators.

Nevertheless an amendment of the existing Fuel Quality Directive (FQD) including aviation fuels among its reporting obligations could provide the required data.

The EASA European Aviation Environmental Report (EAER) is published every three years with the last one having been issued in early 2019. Subsequent reports are planned to be released in 2022 and 2025. Preparation of the report requires about 18 months, and so information collection should start in 2020.

The study also shows that on-going developments on the amendments of EU ETS and RED II regulations will develop additional data streams. Those are:

- ➢ The future RED II Union Database.
- ➢ The future combined EU ETS + CORSIA emissions reporting template.

It is proposed a 2-step approach as future SAF Use monitoring process:

9.3.1 Short-term (EAER 2022) SAF Monitoring process

An option by 2022 could be to request EC to consider a change of scope to the FQD to include aviation fuels (sustainable or not) as part of the Directive's scope for reporting purposes of Article 7a (GHG emissions reductions), and allow EASA access to data on SAF supplied.

If that amendment is done, data on SAF supplied in EU states and its respective GHG emissions savings would be reported by Member States and the respective reports would be placed at the Central Data Repository managed by the European Environment Agency as per FQD requirement.

As the data from FQD reports are not incorporated into a common database, EASA would require workload effort to analyse and extract the data.

If the amendment of FQD to include aviation is not possible by 2022, then as it would not be expected to have a robust SAF supply or use data stream in Europe, it is proposed to perform an estimation based on surveys to industry stakeholders (from energy and aviation sectors) as well as Member State authorities.

The annual *Renewable Energy Progress Report* from the European Commission required by the RED II should also provide information on the SAF supplied in the EU (not all EEA), but would not necessarily include information on GHG emissions reductions achieved from that specific supply, so access to the above referred reports would be needed.

The identification of States in which SAF could have been supplied can be done based on the identification of supply promotion policies and industry production plans made in this study.

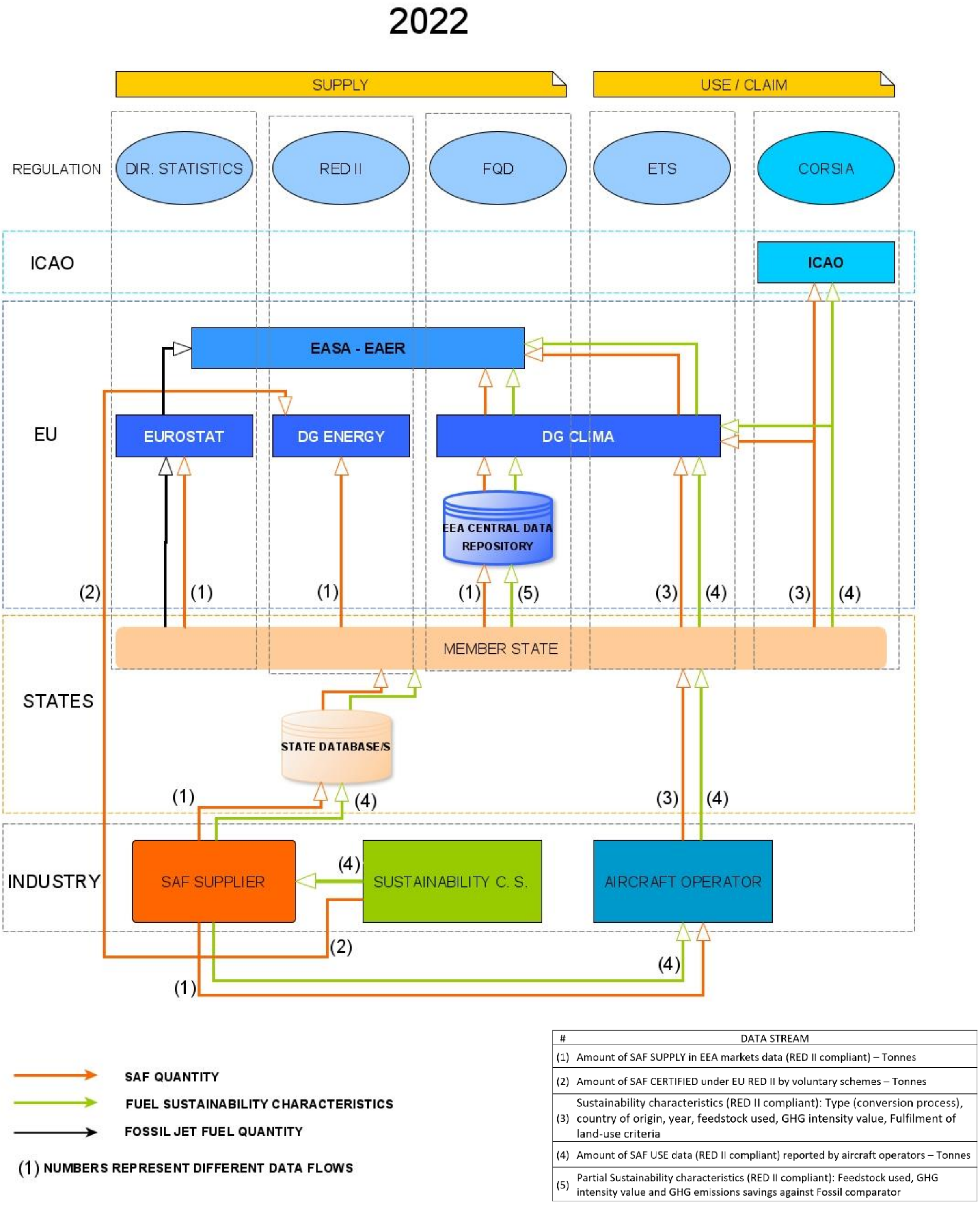
The present study has made an identification of:

- ✓ European Member States policies and incentives, including mandatory supply requirements and other supply promotion policies.
- ✓ European SAF specific industry production and use plans, and SAF compatible technology bioenergy industry agents, which could feed potential capacity.

Those listings can be used as an identification of stakeholders that could be approached to estimate actual supply in EEA Member States by 2022.

Information reported to the EC respectively by Sustainability Certification Schemes (SCS) under RED II and by Member States regarding SAF and its characteristics reported by operators under the **EU ETS, could be used for a cross-check exercise**, acknowledging that the information reported would not be complete as identified above in 9.1.5 (Analysis of current data sources and streams). **In this respect, EASA should also request access to the Member State ETS and CORSIA reports**.

The figure below shows the expected data streams available for the EAER 2022 edition.



#	DATA STREAM
(1)	Amount of SAF SUPPLY in EEA markets data (RED II compliant) – Tonnes
(2)	Amount of SAF CERTIFIED under EU RED II by voluntary schemes – Tonnes
(3)	Sustainability characteristics (RED II compliant): Type (conversion process), country of origin, year, feedstock used, GHG intensity value, Fulfilment of land-use criteria
(4)	Amount of SAF USE data (RED II compliant) reported by aircraft operators – Tonnes
(5)	Partial Sustainability characteristics (RED II compliant): Feedstock used, GHG intensity value and GHG emissions savings against Fossil comparator

➨ **Figure 26** Short-term (EAER 2022) SAF reporting data streams in the EEA

The data to collect includes:

➨ **Table 27** SAF Monitoring process data needed to feed the selected PIs.

PI	DATA NEEDED	SOURCE
SAF supply per EEA State (Mtoe)	Quantity SAF supply per EEA State	Survey data or FQD Reporting Templates
Total SAF supply in the EEA (Mtoe)	Quantity SAF supply in the EEA	Survey data or FQD Reporting Templates
Share of SAF in gross final supply of aviation fuels use (%).	Quantity SAF supply in the EEA + jet kerosene supply data	Survey data or FQD Reporting Templates + Eurostat jet kerosene statistics
Greenhouse gases emissions savings from SAF use (supply) in EEA (tCO_2eq).	GHG intensity values /GHG upstream emissions reductions for each type of SAF supplied in the EEA	Survey data or FQD Reporting Templates
Types of feedstock used	Feedstock used for each type* of SAF supplied in the EEA	Survey data or FQD Reporting Templates
Types of conversion technologies used (ASTM / Def Stan pathway)	ASTM pathway used for each type* of SAF supplied in the EEA	Sustainability certificates EU ETS reporting
Percentage of SAFs supplied per type of conversion technology (ASTM / Def Stan pathway)	Amount of SAF supplied per each ASTM pathway	Sustainability certificates EU ETS reporting

EEA is the European Economic Area, which includes EU-28 + Norway, Iceland

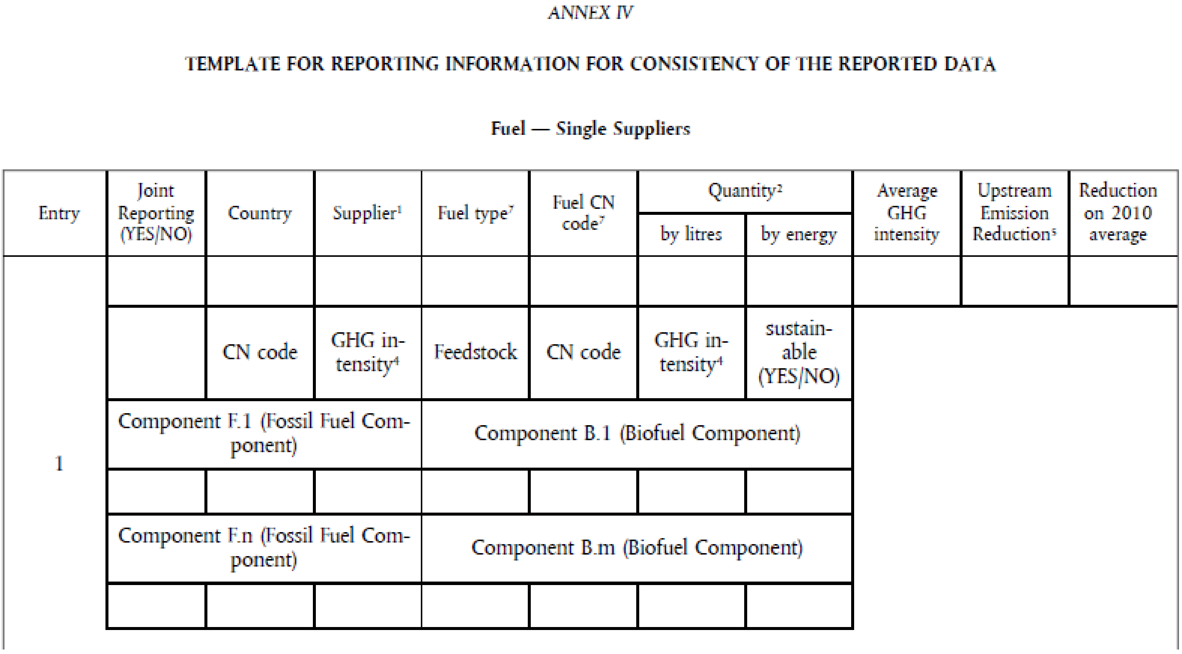
* The FQD reporting template refers by “Type of fuel” as the ones *expressed in point17(c) of Table 1 of Annex I to Regulation (EC) No 684/2009* -which refers to Combined Nomenclatures (CN codes)-. *If these data are not available, Member States shall collect equivalent data in accordance with a nationally established excise duty reporting scheme*.

The Combined Nomenclature (CN) is the EU's eight-digit coding system, which serves the EU's common customs tariff and provides statistics for trade inside the EU and between the EU and the rest of the world.

To report SAF it should be entered the Jet Fuel CN Code, which is 2710 19 21 and determine the “bio” component (SAF).

Nevertheless, types of SAF should be defined and standardised at EU level, as there are different references to “Type of fuel/product” in the different reporting templates referred below (see recommendations in 9.4, SAF use monitoring).

The data needs indicated above in Table 27, can be extracted from the following reporting templates:



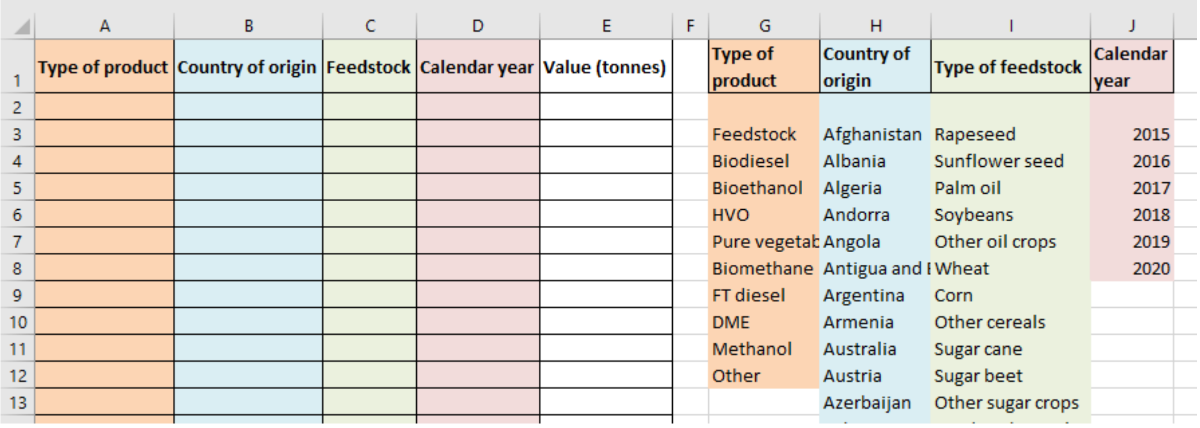
ANNEX IV

TEMPLATE FOR REPORTING INFORMATION FOR CONSISTENCY OF THE REPORTED DATA

Fuel — Single Suppliers

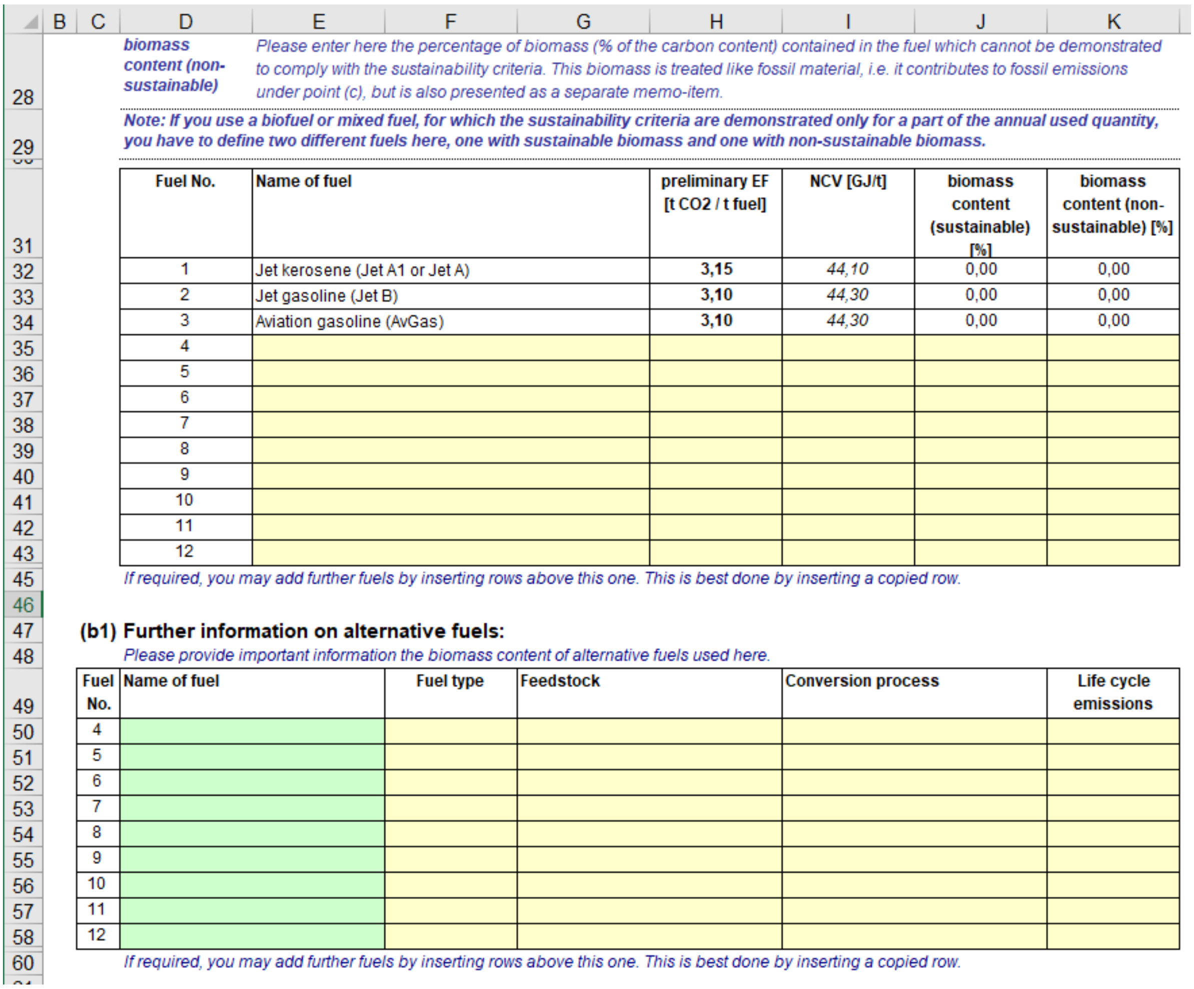
<table>
<tr><td rowspan="2">Entry</td><td rowspan="2">Joint Reporting (YES/NO)</td><td rowspan="2">Country</td><td rowspan="2">Supplier[1]</td><td rowspan="2">Fuel type[7]</td><td rowspan="2">Fuel CN code[7]</td><td colspan="2">Quantity[2]</td><td rowspan="2">Average GHG intensity</td><td rowspan="2">Upstream Emission Reduction[5]</td><td rowspan="2">Reduction on 2010 average</td></tr>
<tr><td>by litres</td><td>by energy</td></tr>
<tr><td rowspan="7">1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>CN code</td><td>GHG intensity[4]</td><td>Feedstock</td><td>CN code</td><td>GHG intensity[4]</td><td>sustainable (YES/NO)</td><td colspan="3" rowspan="6"></td></tr>
<tr><td colspan="3">Component F.1 (Fossil Fuel Component)</td><td colspan="4">Component B.1 (Biofuel Component)</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Component F.n (Fossil Fuel Component)</td><td colspan="4">Component B.m (Biofuel Component)</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Figure 27 Reporting template for Fuel Suppliers and Member States report on Fuel Quality Directive (FQD) requirements



	A	B	C	D	E	F	G	H	I	J
1	**Type of product**	**Country of origin**	**Feedstock**	**Calendar year**	**Value (tonnes)**		**Type of product**	**Country of origin**	**Type of feedstock**	**Calendar year**
2										
3							Feedstock	Afghanistan	Rapeseed	2015
4							Biodiesel	Albania	Sunflower seed	2016
5							Bioethanol	Algeria	Palm oil	2017
6							HVO	Andorra	Soybeans	2018
7							Pure vegetab	Angola	Other oil crops	2019
8							Biomethane	Antigua and	Wheat	2020
9							FT diesel	Argentina	Corn	
10							DME	Armenia	Other cereals	
11							Methanol	Australia	Sugar cane	
12							Other	Austria	Sugar beet	
13								Azerbaijan	Other sugar crops	

Figure 28 Reporting template for Sustainability Certification Schemes report on the revised Renewable Energy Directive (RED II) requirements



biomass content (non-sustainable) | *Please enter here the percentage of biomass (% of the carbon content) contained in the fuel which cannot be demonstrated to comply with the sustainability criteria. This biomass is treated like fossil material, i.e. it contributes to fossil emissions under point (c), but is also presented as a separate memo-item.*

Note: If you use a biofuel or mixed fuel, for which the sustainability criteria are demonstrated only for a part of the annual used quantity, you have to define two different fuels here, one with sustainable biomass and one with non-sustainable biomass.

Fuel No.	Name of fuel	preliminary EF [t CO2 / t fuel]	NCV [GJ/t]	biomass content (sustainable) [%]	biomass content (non-sustainable) [%]
1	Jet kerosene (Jet A1 or Jet A)	**3,15**	*44,10*	0,00	0,00
2	Jet gasoline (Jet B)	**3,10**	*44,30*	0,00	0,00
3	Aviation gasoline (AvGas)	**3,10**	*44,30*	0,00	0,00
4					
5					
6					
7					
8					
9					
10					
11					
12					

If required, you may add further fuels by inserting rows above this one. This is best done by inserting a copied row.

(b1) Further information on alternative fuels:

Please provide important information the biomass content of alternative fuels used here.

Fuel No.	Name of fuel	Fuel type	Feedstock	Conversion process	Life cycle emissions
4					
5					
6					
7					
8					
9					
10					
11					
12					

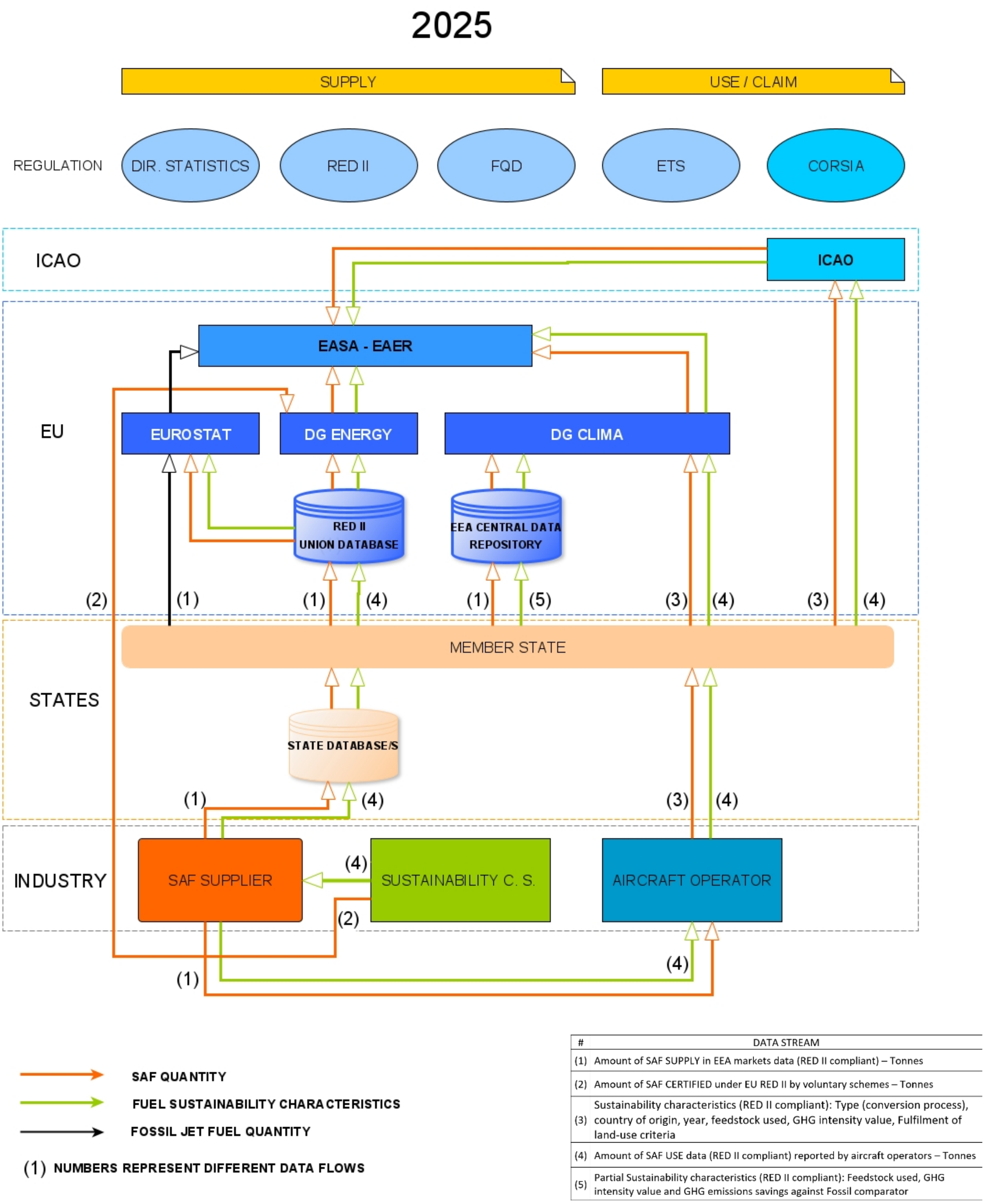
If required, you may add further fuels by inserting rows above this one. This is best done by inserting a copied row.

Figure 29 Reporting template for Aircraft Operators report on EU ETS requirements

9.3.2 Mid-term (EAER 2025) SAF Monitoring process

For the 2025 report, the EU RED Union Database that is currently under development should be ready to supply the necessary information to support the identified PIs.

If that is the case, formal agreements between EASA and the relevant European body should be put in place to gain access to the information contained in the Union Database on a regular basis. The systematic monitoring process could then be done on an annual basis, as information becomes available, and then incorporated into future EAERs.



#	DATA STREAM
(1)	Amount of SAF SUPPLY in EEA markets data (RED II compliant) – Tonnes
(2)	Amount of SAF CERTIFIED under EU RED II by voluntary schemes – Tonnes
(3)	Sustainability characteristics (RED II compliant): Type (conversion process), country of origin, year, feedstock used, GHG intensity value, Fulfilment of land-use criteria
(4)	Amount of SAF USE data (RED II compliant) reported by aircraft operators – Tonnes
(5)	Partial Sustainability characteristics (RED II compliant): Feedstock used, GHG intensity value and GHG emissions savings against Fossil comparator

Figure 30 Mid-term (EAER 2025) SAF reporting data streams in the EEA

9.3.3 Potential Monitoring through a Fuel Module in EASA Environmental Portal

The EASA Environmental Portal is a web database that enables secured online submission of environmental data by stakeholders and the publication of this data by EASA.

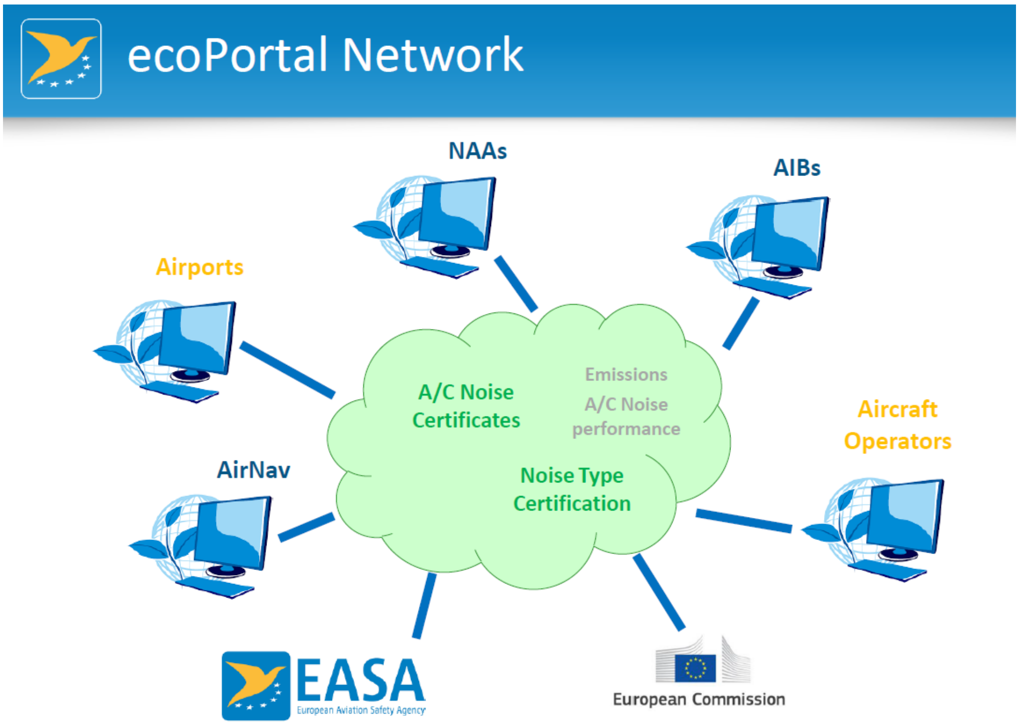
The project started in June 2016 and 3 databases are currently in scope:

- ✓ Aircraft Noise Certificates (ANCdb)
- ✓ EASA Certification Noise Levels (ECNLdb)
- ✓ Aircraft Noise and Performance (ANPdb)

The Environmental Portal currently collects information on the Aircraft Noise Certificates (ANC) of all aircraft operating in the EU directly from the operators and makes the information available to selected stakeholders and Member States.

It also collects, verifies and publishes Aircraft Noise and Performance (ANP) data for new aircraft configurations.

It is anticipated that it will later be expanded to include aircraft / engine emissions data.



➨ **Figure 31** Current structure of the Environmental Portal network

The development of the EASA Environmental Portal anticipates the potential to use the platform for the other environment data and indicators applicable to the civil aviation industry.

It is recommended that a special SAF section be created in the ecoPortal in order to provide a one-stop reference source of authoritative data regarding the use of SAF in Europe and its respective environmental benefits.

9.3.3.1 Existing European public portals informing on SAF

There are currently three European portals supported by the European Commission, providing SAF related information:

1. The European Commission portal:

https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/biofuels-aviation

Page includes general information on:

- ✓ European Advanced Biofuels Flightpath
- ✓ Related documents on advanced biofuels flightpath
- ✓ Recognition of aviation biofuels in the ETS - 6 July 2016
- ✓ High Biofuel Blends in Aviation (HBBA) Study and BioJetMap Workshop on 11 February 2015 in Brussels.

The current information of this site is not much up-to-date and does not provide any updates on technical or policy developments (for example the revised RED II).

2. The European Advanced Biofuels Flightpath Initiative

https://www.biofuelsflightpath.eu/

The 2011 Flightpath Initiative was launched by a group of aviation stakeholders and the European Commission.

The portal is not an official EU platform but is developed and maintained under EC funding. It provides general information about the initiative, its strategy, members, events and general news on SAF development.

3. EUROPA - SETIS | Strategic Energy Technologies Information System

https://setis.ec.europa.eu/publications/setis-magazine/bioenergy/biofuels-aviation-%E2%80%93-greening-skies

SETIS website provides public information regarding the implementation of the Integrated SET Plan and its related research, innovation (R&I) and competitiveness actions, to support the Energy Union strategy. It is set as an integrated reporting and effective monitoring tool to support the Energy Union's governance.

The portal provides general information on research and innovation activities developed under European research programs targeting the development and use of SAF.

9.3.3.2 Monitoring through a Fuel Module in Environmental Portal

EASA Environmental Portal can be expanded to include a Fuel Module, which could become a European reference library for information regarding the supply and use of SAF in Europe.

The EASA European Aviation Environmental Report (EAER), and its dedicated website, already includes general information on SAF. It is expected that, as result of this scoping study, it will also contain SAF Performance Indicators at some point in the future.

The SAF industry is in the early stages of development, and it is expected to see a significant expansion in Europe in the coming years. The EASA Environmental Portal could provide up-to-date information of such developments, with annual updates to the Performance Indicators that complement the triennial EAER.

The collection of updated data could be done through three different means:

1. **Information collection on SAF use from aircraft operators:**

As aircraft operators are already Environmental Portal users and are requested to provide environmental-related information, they could be requested to supply information on conventional jet fuel and SAF uplift in European airports.

Aircraft operators already monitor fuel burn and the use of SAF that is to be reported under the EU ETS or CORSIA, and so should not be a significant additional burden to them. It could also be requested to identify whether such fuel uplift it is done for domestic, intra-EEA or non-EEA flights.

Such a reporting system would also facilitate Member States national GHG emissions inventories (split on domestic/international fuel use) and reporting of Form M to ICAO.

If airlines would be requested to report SAF use through the EASA Environmental Portal, this option would require a regulatory background development.

2. **SAF performance Indicators update:**

The Environmental Portal could include a Performance Indicators section with updated info on the selected SAF Performance Indicators of the EAER.

Such update could be done annually following the process proposed in this report, or even in shorter periods if a more automatic system could be developed through direct link to the European Union Database SAF datasets in the future.

3. **SAF general information and progress update:**

The Environmental Portal could provide general information on the latest SAF developments.

Such updates would require a permanent effort, either from EASA environmental and Environmental Portal teams or from external support.

Information could follow a similar structure to that currently provided through the EAER site:

- ✓ SAF Background & overview of technology developments
- ✓ European policy actions and updates (including Member States actions).
- ✓ News / stakeholder actions

- ✓ Figures and Tables: Performance Indicators

9.4 SAF use monitoring

9.4.1 SAF definitions

Recipient organization: EASA, European Commission, Eurostat.

A key finding of this scoping study is that it will be necessary to give a clear definition of what is considered a Sustainable Aviation Fuels (SAF), for the purpose of reporting its use in Europe and identify the scope of fuels included under that definition.

Most of European reporting requirements and datasets refer mainly to **biofuels** (Eurostat for example collects statistics of "bio jet kerosene" only) but SAF include a wider concept with could comprise non-biological origin sustainable fuels.

The RED II has incorporated new sustainability requirements for renewable liquid and gaseous transport fuels of non-biological origin, as well as waste gasses. **But the consistency of terminologies throughout Europe is an important challenge to give coherence to data**.

It should be noted that at European Member State level there are different definitions of eligible feedstocks (what is a product, co-product, by-product or waste), which could drive to different national interpretations of what can be considered or certified as SAF.

Concepts and products used should be defined precisely, and that should include, as regards to this work, the catalogue of SAF to consider in the scope of the monitoring activity.

Finally, the different references to "types" of fuel or SAF in reporting requirements might generate confusion.

FQD reporting of "Type of fuel" refers to CN codes (and there is only Jet Fuel as CN code), while RED II does not have specific data fields on SAF or bio jet fuel among the identified fuel types, and is reported under the "other" category (as identified on the reporting template for Sustainability Certification Schemes above referred). The EU ETS reporting template on other hand refers to "Fuel Type" to distinguish among Jet A or A1, Jet B and Av Gas, or SAF, and then "name of fuel" with no clarity on what it refers to.

It is recommended to define SAF as those pathways approved by ASTM/Def Stan and certified as sustainable under the EU RED rules in any Member State, including of non-biological origin. That would comprise the use of any feedstock recognized by Member States to comply with the EU RED.

It is also recommended to standardise the reference to "types of fuel" in different EU requirements and include Sustainable Aviation Fuel (SAF) as a type of fuel. It is also suggested that, in the case of SAF, the "name of fuel" under the EU ETS reporting template should refer to the name of the ASTM/Def Stan certification pathway.

The names of the ASTM/Def Stan certification pathways are referred in section 6.1.1.

9.4.2 Considerations on SAF monitoring for building a Union Database

Recipient organization: European Commission, DG ENER Unit C1.

The following indications are made based on expert´s peer-review feedback, as suggestions for consideration on the design and development of the future RED II Union Database (UDat). The consultation was made for SAF monitoring, but most suggestions are applicable to any other sustainable fuels. It is proposed to share it with DG ENER Unit C1 for their consideration.

The Union Database will be expected to interlink the functioning of around 30 national databases from different Member States with diverse features, structures and data collections. Thus, three principles are suggested to be considered on the development of the Union Database: Simplicity, Consistency and Flexibility.

Important aspects to consider are:

- **Definitions**

Concepts and products used should be defined precisely, and that should include, as regards this study, the catalogue of Sustainable Aviation Fuels (SAF) to be considered in the scope of a European monitoring program.

In order to make things simple, consistent and flexible, it is proposed to consider as SAF in the UDat, those related to the technology pathways approved by ASTM International (as referred in 6.1.1 of this report) as Standard Specifications for Aviation Turbine Fuels certified as sustainable under the EU RED II rules in any Member State.

Member States can establish different definitions of eligible feedstocks (product, co-product, by-product, waste) and include or not some of them (such as waste gases), which could drive to different national interpretations of what can be considered or certified as SAF. But the above proposed approach would include any SAF put in the EU market using any feedstocks recognized by Member States to comply with the EU RED II.

Certain degree of flexibility will be necessary through provisions to facilitate adding up future developments either regarding feedstocks or technology pathways, especially in the realm of SAF, which is evolving very quickly.

A very important element to bear in mind is that the UDat is intended for *all types of energy from renewable sources* and *Member States may also take into account recycled carbon fuels*, so not only biofuels. That would require an effort for adapting the existing national databases to new materials (e.g. renewable fuels of non-biological origin).

- **Sustainability characteristics**

The UDat should track a set of “sustainability characteristics” linked to each batch of biofuels flowing through the European market.

Again, applying principles of simplicity, consistency and flexibility it is suggested to consider a short set of characteristics linked to the information contained in the RED II sustainability certificates, to make things easier for all stakeholders without compromising the goal of the UDat.

It is important to note that in the case of Aviation (and Maritime), in order to get the 1.2 multiplier established by the RED II, the feedstock must be of no food or feed origin, but such information today is not yet required to be included in the sustainability certificates, but will be needed to demonstrate compliance with such requirement.

It is proposed as a preliminary list of minimum data fields to be collected, the following:

- ✓ Amount of product supplied
- ✓ Type of product
  - Country of origin
  - Calendar year
- ✓ Feedstock used
  - Country of origin of the feedstock used
  - No-food/feed origin?
- ✓ GHG emissions value
- ✓ GHG emissions saving (with respect to the EU RED fossil fuel comparator)
- ✓ Fulfilment of the land use criteria

Reporting parties

Experience suggests that these parties are the entities that put the fuel into the market for consumption, but this issue should be carefully considered as it is key for the coherence of the system.

For consistency, every Member State should have the same reporting parties to ensure the information within the UDat is consistent.

- **Units**

The UDAt and the national databases should work with the same units (toe, MJ, etc.). Harmonization is key in order to facilitate the functioning of the database from the start.

Setting the energy conversion among those units such as toe to MJ or kWh, etc, (as are always reported at the end of any IEA reports) could be also an approach to consider.

- **Tracking renewable fuels and associated GHG savings**

It would be useful to have some further discussions at the EU level on the approaches for tracking the movement of renewable fuels and its GHG emissions reductions accounting and claiming. This would include the mass balance verification throughout the entire value chain steps (feedstock supply, SAF production, logistics & distribution, and use), track & trace, book & claim, etc.

If we continue to use the mass balance approach, some work should be done in order to:

- ✓ Check the coherence of the information between MS and the UDat.
- ✓ Address the issue of biomethane flows between different MS.

- **Procedures**

An ideal feature of the UDAt would be the ability to operate in real time through an interconnected databases system.

Its Terms of Reference should include provisions to cope with possible failures in the interconnection between the UDat and the national databases, and others related to how to deal with errors, mismatches of information and the issuing of aggregated data for the general public.

Transparency should be an asset of the new database, but at the same time the interests of the economic operators, privacy and sensitive data, should be protected.

It will be important to consider special characteristics that some MS have in their national markets (e.g. different pipeline or special national fuel logistic systems) that will be worth considering before setting up the UDat, in order to address compatibility issues between databases.

9.4.3 EASA future access to SAF datasets

Recipient organization: European Commission, DG CLIMA, DG ENER.

In order to implement the SAF monitoring process proposal, it is recommended to modify the scope of the EU Fuel Quality Directive (FQD) to include aviation fuels in its reporting requirements (Article 7a) and that EASA is granted access to the data reported by Member States under the FQD, as well as to States ETS reposts SAF related data.

In the future it will also be needed access to the SAF dataset of the future Union Database.

9.4.4 Additional information to be included in Sustainability Certificates under EU RED II.

Recipient organization: European Commission, DG ENER.

RED II (Dir. (EU) 2018/2001) Article 27, Para 2 establishes an incentivizing multiplier applicable to SAF supply: ***Except for fuels produced from food and feed crops****, the share of fuels supplied in the aviation sector shall be considered to be 1,2 times their energy content*.

The application of the multipliers is to be defined and handled at MS level and can encourage fuel producers to prioritize SAF production.

The food and feed limitation require economic operators on the fuel production chain to assess whether the feedstock use can be considered food or feed.

Red II Article 2.40 Defines ‘food and feed crops’ as *starch-rich crops, sugar crops or oil crops produced on agricultural land as a main crop excluding residues, waste or ligno-cellulosic material and intermediate crops, such as catch crops and cover crops, provided that the use of such intermediate crops does not trigger demand for additional land*;

The certificates issued under Sustainability Certification Schemes (SCS) verify compliance of the fuel with the Directive´s requirements and identify the feedstock used, but currently are not required to specify whether such feedstock does not come from food or feed crops according to the definition.

It is recommended to require SCS to provide such information on its fuel certificates.

9.4.5 EU RED reporting obligations of the European Commission

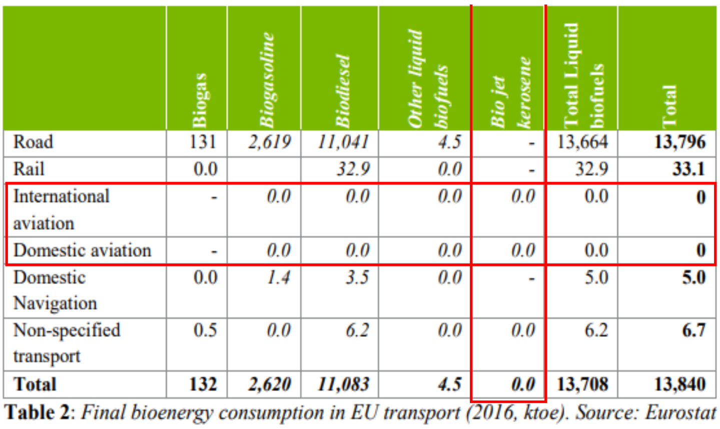
Recipient organization: European Commission.

The reporting obligations of the European Commission under the RED (revised in Section 3.3.2) include the requirement to report annually on the production of biofuels, including SAF, and relative contributions from International and domestic aviation.

The analysis included on this report has assessed that current EU reporting requirements on SAF use, including EU ETS reporting from aircraft operators, do not provide enough data to distinguish whether the SAF supplied has been used in domestic or international operations, as it is not reported per specific flight.

It is recommended to liaise with the Commission to assess whether they have means to establish such distinction between the relative contributions of SAF for domestic and international aviation, and if demonstrated feasible, to review the conclusions of this report and include such disaggregation as a Performance Indicator.

Table 28 Final bioenergy consumption EU transport (2016, ktoe)



	Biogas	Biogasoline	Biodiesel	Other liquid biofuels	Bio jet kerosene	Total Liquid biofuels	Total
Road	131	*2,619*	*11,041*	*4.5*	-	13,664	**13,796**
Rail	0.0		*32.9*	*0.0*	-	32.9	**33.1**
International aviation	-	*0.0*	*0.0*	*0.0*	*0.0*	0.0	**0**
Domestic aviation	-	*0.0*	*0.0*	*0.0*	*0.0*	0.0	**0**
Domestic Navigation	0.0	*1.4*	*3.5*	*0.0*	-	5.0	**5.0**
Non-specified transport	0.5	*0.0*	*6.2*	*0.0*	*0.0*	6.2	**6.7**
Total	**132**	***2,620***	***11,083***	***4.5***	***0.0***	**13,708**	**13,840**

Table 2: *Final bioenergy consumption in EU transport (2016, ktoe). Source: Eurostat*

9.4.6 Policy challenges in Europe

Recipient organization: EASA, European Commission, European Civil Aviation Conference.

There are some challenges related to the national transposition of the RED II that might affect SAF uptake in Europe. These were identified during the ART-Fuels Forum 5th Plenary meeting held in Brussels in June 2019[100]:

- ✓ Different RED II implementation within national regulations can drive to different regulatory frameworks applicable to SAF within the European Union Member States.
- ✓ Some States are considering to establish an incompatibility in claiming SAF benefits under the RED II and the EU ETS/CORSIA in order to avoid any risk of double claiming. SAF could then not be accounted for by aircraft operators under EU ETS/CORSIA if it is accounted for under RED II.
- ✓ RED II multipliers can be combined in order to optimize the SAF uptake incentives. It is a Member States prerogative to apply them or not, with risk of different market incentive frameworks within the EU/EEA.

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[100] http://artfuelsforum.eu/event/art-fuels-forum-5th-plenary-meeting/

- ✓ There is currently a lack of coordination and discussion among European states regarding the implementation of SAF related policies and possible market interactions.

- ✓ Europe does not have today a common strategy to promote SAF. The EC launched in 2011 the European Advanced Biofuels Flight Path to define a roadmap with milestones to achieve a target of 2 million tonnes of annual SAF use in European civil aviation by 2020. This objective will not be achieved, and the roadmap has not been yet defined.

In order to address them, it is recommended to facilitate coordination and discussion among European Member states regarding the implementation of SAF related policies and possible market interactions, though a dedicated European discussion forum..

9.4.7 Possible future work item for the ICAO CAEP

Recipient organization: ICAO.

It could be of interest to propose a discussion in ICAO Committee of Aviation and Environmental Protection (CAEP) on the development of common SAF Use indicators to standardise how SAF use is monitored worldwide.

Annex A RED and RED II reporting obligations

Member States' have obligations under the RED to draft renewable energy progress reports. Those obligations are referred in RED Article 22 -*Reporting by the Member States*- and in RED II Chapter 4 -*Reporting*-. Every two years, each Member State shall report to the Commission on the progress in the promotion and use of energy coming from renewable sources (implementation of its *integrated national energy and climate plan*) by means of an *integrated national energy and climate progress report*.

Regarding the report details, among others, the following items are identified as applicable to SAF:

- Sectoral (electricity, heating and cooling, and **transport**) and overall shares of energy coming from renewable sources during the previous two years, as well as the measures done or planned to foster the use of renewable sources;
- Description of any support schemes and other measures taken to promote the use of energy from renewable sources and information on how supported electricity is allocated to final customers;
- Support schemes developed by the Member State to be able to consider the renewable energy applications that give additional benefits but may also have higher costs;
- Developments regarding the availability and use of biomass resources for energy purposes;
- Changes in commodity prices and land use within the Member State linked to the higher biomass use and other types of energy coming from renewable sources;
- Developments and share of biofuels coming from wastes, residues, non-food cellulosic material, and ligno-cellulosic material;
- The estimated impacts of the biofuel and bioliquids production on biodiversity, water resources, water quality and soil quality within the Member State;
- **Estimation of the net greenhouse gas emission savings due to the employment of the energy from renewable sources;**
- Estimation of the energy from renewable sources demand to be satisfied by means other than domestic production; and

Regarding the estimation of the net greenhouse gas emission savings from the use of biofuels, the Member State economic operators may use the following typical values:

Biofuel production pathway	Typical greenhouse gas emission saving (%)	Default greenhouse gas emission saving (%)
sugar beet ethanol	61	52
wheat ethanol (process fuel not specified)	32	16
wheat ethanol (lignite as process fuel in CHP plant)	32	16
wheat ethanol (natural gas as process fuel in conventional boiler)	45	34
wheat ethanol (natural gas as process fuel in CHP plant)	53	47
wheat ethanol (straw as process fuel in CHP plant)	69	69

corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	56	49
sugar cane ethanol	71	71
the part from renewable sources of ethyl-tertio-butyl-ether (ETBE)	Equal to that of the ethanol production pathway used	
the part from renewable sources of tertiary-amyl-ethyl-ether (TAEE)	Equal to that of the ethanol production pathway used	
rape seed biodiesel	45	38
sunflower biodiesel	58	51
soybean biodiesel	40	31
palm oil biodiesel (process not specified)	36	19
palm oil biodiesel (process with methane capture at oil mill)	62	56
waste vegetable or animal (*) oil biodiesel	88	83
hydrotreated vegetable oil from rape seed	51	47
hydrotreated vegetable oil from sunflower	65	62
hydrotreated vegetable oil from palm oil (process not specified)	40	26
hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	68	65
pure vegetable oil from rape seed	58	57
biogas from municipal organic waste as compressed natural gas	80	73
biogas from wet manure as compressed natural gas	84	81
biogas from dry manure as compressed natural gas	86	82

Not including animal oil produced from animal by-products classified as category 3 material in accordance with Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules on animal by-products not intended for human consumption[101]

Biofuel production pathway	Typical greenhouse gas emission saving (%)	Default greenhouse gas emission saving (%)
wheat straw ethanol	87	85
waste wood ethanol	80	74
farmed wood ethanol	76	70

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[101] OJ L 273, 10.10.2002, p. 1.

waste wood Fischer-Tropsch diesel	95	95
farmed wood Fischer-Tropsch diesel	93	93
waste wood dimethylether (DME)	95	95
farmed wood DME	92	92
waste wood methanol	94	94
farmed wood methanol	91	91
the part from renewable sources of methyl-tertio-butyl-ether (MTBE)	Equal to that of the methanol production pathway used	

In the **Regulation (EU) 2018/1999**, the **Chapter 4** indicates the requirements of the integrated reporting on renewable energy. Specifically, Article 20 provides the information that Member States shall include when carrying out the integrated reporting on renewable energy.

Below are extracted requirements which might be applicable to SAF:

Trajectories and objectives:

- ✓ Estimated trajectories for the sectoral share of renewable energy in final energy consumption from 2021 to 2030 in the electricity, heating and cooling and **transport** sector;
- ✓ Estimated trajectories per renewable energy technology to achieve the overall and sectoral trajectories for renewable energy from 2021 to 2030, including total expected gross final energy consumption per technology and sector in Mtoe ant total planned installed capacity per technology and sector in MW;
- ✓ Trajectories on bioenergy demand, separated by heat, electricity and **transport** and on biomass supply, by feedstock and origin (distinguishing between domestic production and imports). In case of the forest biomass, this shall have an assessment of its source and impact on the LULUCF sink;

Implementation of the following policies and measures:

- ✓ Implemented, adopted and planned policies and measures to achieve the national contribution to the 2030 binding Union target for renewable energy, including sector and technology-specific measures;
- ✓ Specific measures for regional cooperation where available;
- ✓ Specific measures on financial support, including Union support and the use of Union funds for the promotion of the use of energy from renewable sources in electricity, heating and cooling, and **transport;**
- ✓ Measures in place to increase the share of renewable energy in the heating and cooling and **transport** sector;

In addition, the following additional reporting obligations in the area of renewable energy specifically applicable to transport (and thus including SAF) are provided:

a) amounts of biofuels, biogas renewable **transport** fuels of non-biological origin, recycled carbon fuels and renewable electricity consumed in the **transport** sector and, where relevant, their greenhouse saving performance, distinguishing between fuels produced from different types of food and feed crops and each type of feedstock listed in Annex IX to Directive (EU) 2018/2001;

b) the technological development and deployment of biofuels made from feedstocks listed in Annex IX to Directive (EU) 2018/2001;

c) where available, the estimated impact of the production or use of biofuels, bioliquids and biomass fuels on biodiversity, water resources, water availability and quality, soils and air quality within the Member State;
d) observed cases of fraud in the chain of custody of biofuels, bioliquids and biomass fuels;

The reporting on the 2020 targets is made by providing the following information:

a) the sectoral (electricity, heating and cooling, and **transport**) and overall shares of energy from renewable sources in 2020;
b) the measures taken to achieve the 2020 national renewable energy targets, including measures related to support schemes, guarantees of origin and simplification of administrative procedures;
c) the share of energy from biofuels and bioliquids produced from cereal and other starch-rich crops, sugars and oil crops in energy consumption in **transport**;
d) the share of energy from biofuels and biogas for **transport** produced from feedstocks and of other fuels listed in Part A of Annex IX to Directive 2009/28/EC in the version in force on 31 December 2020 in energy consumption in **transport**.

A **Template[102] for the Member States** progress reports under the Directive 2009/28/EC is also available. The purpose of the template is to help ensure that Member State reports are complete, cover all the requirements laid down in the Article 22 of Directive and are comparable with each other, over time and with National Renewable Energy Action Plans submitted by Member States in 2010. Much of the template draws on the template for the National Renewable Energy Action Plans. The following tables show the sections of the template targeting the renewable energy use in the transport sector are shown:

***Table 1*:**
The sectoral (electricity, heating and cooling, and transport) and overall shares of energy from renewable sources[103]

	Year n-2	Year n-1
RES-H&C[104] (%)		
RES-E[105] (%)		
RES-T[106] (%)		
Overall RES share[107] (%)		
Of which from cooperation mechanism[108] (%)		
Surplus for cooperation mechanism[109] (%)		

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[102] https://ec.europa.eu/energy/en/topics/renewable-energy/progress-reports
[103] Facilitates comparison with Table 3 and Table 4a of the NREAPs.
[104] Share of renewable energy in heating and cooling: gross final consumption of energy from renewable sources for heating and cooling (as defined in Articles 5(1)b) and 5(4) of Directive 2009/28/EC divided by gross final consumption of energy for heating and cooling. The same methodology as in Table 3 of NREAPs applies.
[105] Share of renewable energy in electricity: gross final consumption of electricity from renewable sources for electricity (as defined in Articles 5(1)a) and 5(3) of Directive 2009/28/ECdivided by total gross final consumption of electricity. The same methodology as in Table 3 of NREAPs applies.
[106] Share of renewable energy in transport: final energy from renewable sources consumed in transport (cf. Article 5(1)c) and 5(5)of Directive 2009/28/EC divided by the consumption in transport of 1) petrol; 2) diesel; 3) biofuels used in road and rail transport and 4) electricity in land transport (as reflected in row 3 of Table 1). The same methodology as in Table 3 of NREAPs applies.
[107] Share of renewable energy in gross final energy consumption. The same methodology as in Table 3 of NREAPs applies.
[108] In percentage point of overall RES share.
[109] In percentage point of overall RES share.

In the previous table, "RES-T" refers to: "*Share of renewable energy in transport: final energy from renewable sources consumed in* ***transport*** *(cf. Article 5(1)c) and 5(5)of Directive 2009/28/EC divided by the consumption in* ***transport*** *of 1) petrol; 2) diesel; 3) biofuels used in road and rail* ***transport*** *and 4) electricity in land* ***transport*** *(as reflected in row 3 of Table 1). The same methodology as in Table 3 of NREAPs applies."*

Table 1a:
Calculation table for the renewable energy contribution of each sector to final energy consumption (ktoe)[110]

	Year n-2	Year n-1
(A) Gross final consumption of RES for heating and cooling		
(B) Gross final consumption of electricity from RES		
(C) Gross final consumption of energy from RES in **transport**		
(D) Gross total RES consumption[111]		
(E) Transfer of RES to other Member States		
(F) Transfer of RES from other Member States and 3rd countries		
(G) RES consumption adjusted for target (D)-(E)+(F)		

Table 1d:
Total actual contribution from each renewable energy technology in [Member State] to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in the transport sector (ktoe)[112],[113]

	Year n-2	Year n-1
- Bioethanol		
- Biodiesel (FAME)		
- Hydrotreated Vegetable Oil (HVO)		
- Biomethane		
- Fischer-Tropsch diesel		
- Bio-ETBE		
- Bio MTBE		
- Bio-DME		
- Bio-TAEE		
Biobutanol		
- Biomethanol		
- Pure vegetable oil		
Total sustainable biofuels		
Of which		
sustainable biofuels produced from feedstock listed in Annex IX Part A		
other sustainable biofuels eligible for the target set out in Article 3(4)e		
sustainable biofuels produced from feedstock listed in Annex IX Part B		

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[110] Facilitates comparison with Table 4a of the NREAPs

[111] According to Art.5(1)of Directive 2009/28/EC gas, electricity and hydrogen from renewable energy sources shall only be considered once. No double counting is allowed.

[112] For biofuels take into account only those compliant with the sustainability criteria, cf. Article 5(1) last subparagraph.

[113] Facilitates comparison with Table 12 of the NREAPs.

sustainable biofuels for which the contribution towards the renewable energy target is limited according to Article 3(4)d		
Imported from third countries		
Hydrogen from renewables		
Renewable electricity		
Of which		
consumed in road **transport**		
consumed in rail **transport**		
consumed in other **transport** sectors		
others (Please specify)		
others (Please specify)		

Table 3:
Support schemes for renewable energy

RES support schemes year n (e.g. 2011)			**Per unit support**	**Total (M€)***
[(sub) category of specific technology or fuel]				
Instrument (provide data as relevant)	Obligation/quota (%)			
	Penalty/Buy out option/ Buy out price (€/unit)			
	Average certificate price			
	Tax exemption/refund			
	Investment subsidies (capital grants or loans) (€/unit)			
	Production incentives			
		Feed-in tariff		
		Feed-in premiums		
		Tendering		
Total annual estimated support in the electricity sector				
Total annual estimated support in the heating sector				
Total annual estimated support in the **transport** sector				

***** The quantity of energy supported by the per unit support gives an indication of the effectiveness of the support for each type of technology

Table 4:
Biomass supply for energy use

	Amount of domestic raw material (*)		**Primary energy in domestic raw material (ktoe)**		**Amount of imported raw material from EU (*)**		**Primary energy in amount of imported raw material from EU (ktoe)**		**Amount of imported raw material from non EU(*)**		**Primary energy in amount of imported raw material from non EU (ktoe)**	
	Year n-2	**Year n-1**	**Year n-2**	**Year n-1**	**Year n-2**	**Year n-1**	**Year n-2**	**Year n-1**	**Year n-2**	**Year n-1**	**Year n-2**	**Year n-1**
Biomass supply for heating and electricity:												
Direct supply of wood biomass from forests and other wooded land energy generation (fellings etc.)**												
Indirect supply of wood biomass (residues and co-products from												

wood industry etc.)**												
Agricultural by-products / processed residues and fishery by-products **												
Biomass from waste (municipal, industrial etc.) **												
Energy crops (grasses, etc.) and short rotation trees (please specify)												
Others (please specify)												
Biomass supply for transport:												
Common arable crops for biofuels (please specify main types*)*												
Energy crops (grasses,etc.) and short rotation trees for biofuels (please specify main types)												
Others (please specify)												

* Amount of raw material if possible in **m3 for biomass from forestry** and in **tonnes for biomass from agriculture and fishery and biomass from waste**

** The definition of this biomass category should be understood in line with table 7 of part 4.6.1 of Commission Decision C (2009) 5174 final establishing a template for National Renewable Energy Action Plans under Directive 2009/28/EC

Table 6:
Estimated GHG emission savings from the use of renewable energy (t CO_2eq)

Environmental aspects	**Year n-2**	**Year n-1**
Total estimated net GHG emission saving from using renewable energy[114]		
- Estimated net GHG saving from the use of renewable electricity		
- Estimated net GHG saving from the use of renewable energy in heating and cooling		
- Estimated net GHG saving from the use of renewable energy in **transport**		

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[114] The contribution of gas, electricity and hydrogen from renewable energy sources should be reported depending on the final use (electricity, heating and cooling or transport) and only be counted once towards the total estimated net GHG savings.

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