BL2F

Transforming Black Liquor to Biofuel

Research and Innovation Action

H2020-LC-SC3-2019-NZE-RES-CC

Policy & Stakeholder Assessment

WP6 - Task 6.1

September 2020 [M6]

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°884111.

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Document Information

Grant agreement	884111
Project title	Black Liquor to Fuel by Efficient Hydrothermal Application integrated to Pulp Mill
Project acronym	BL2F
Project coordinator	Prof. Dr. Tero Joronen
Project duration	1st April 2020 – 30th November 2023 (36 Months)
Related work package	WP 6 – Market potential and exploitation
Related task(s)	Task 6.1 – Policy mapping & stakeholder assessment
Lead organisation	LGI
Contributing partner(s)	SINTEF-ER
Due date	30-09-2020
Submission date	28-09-2020
Dissemination level	Public

History

Date	Version	Submitted by	Reviewed by	Comments
	N°1	September 14th	Joanne Schanté (LGI)	
	N°2	September 14th	Judit Sandquist (SINTEF-ER) & Tero Joronen (TAU), Noora Kaisalo (Neste)	
	N°3	September 30th	Arvid Løken, Avinor & Joanne Schanté (LGI)	

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Abbreviations and acronyms

Acronym	Description
ACI	Airports Council International
ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie *(Environment and Energy Management Agency)*
APEC	Asia-Pacific Economic Cooperation
ATAG	Air Transport Action Group
BL2F	Black liquor to fuel
CAN	Climate Action Network
CO_2	Carbon dioxide
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EASA	European Union Aviation Safety Agency
EBA	European Boatmen's Association
ECBF	European Circular Bioeconomy Fund
EEA	European Economic Area
EFTA	European Free Trade Association
ESPO	European Sea Ports Organisation
ETS	Emissions Trading Scheme
EU	European Union
FSC	Forest Stewardship Council

Acronym	Description
GHG	Greenhouse Gases
HFO	Heavy Fuel Oil
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ILUC	Indirect Land Use Change
IMO	International Maritime Organisation
MEPC	Marine European Protection Comity
NRA	National Research Agency
OECD	Organisation for Economic Co-operation and Development
PEFC	Programme de reconnaissance des certifications forestières *(Forest certification recognition program)*
RED	Renewable Energy Directive
RED II	The updated version of the Renewable Energy Directive
RFTO	Renewable Transport Fuel Obligation
RTK	Revenue-tonne-kilometre
SAF	Sustainable Aviation Biofuels
SOx	Sulphur oxides
TGAP	Taxe Générale sur les activités polluantes *(General tax on polluting activities)*
TRL	Technology Readiness Level

Acronym	Description
UCO	Used Cooking Oil
UK	United Kingdom
WP	Work Package

Executive Summary

This document is the deliverable D6.1 of the Black Liquor to Fuel H2020 Project and is part of the WP6 on Market Potential and Exploitation. The report presents the results of a policy and stakeholder assessment, analysing direct or indirect influences on the uptake of the "black liquor to fuel" technology (BL2F). It provides an overview of the policy framework at three levels of policy making: at a global scale, at the European level and a national level with focus on nine European countries (Denmark, Finland, France, Germany, Italy, Netherlands, Norway, United Kingdom and Sweden). The analysis of major EU directives and national policies allows for the identification of general regulatory trends concerning biofuels use and production.

At the international level, the decarbonization of aviation and shipping is supported through the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and the International Maritime Organization (IMO). CORSIA aims at stabilising flight emissions at 2020 levels, while the IMO aims at halving the maritime emission by 2050.

At the European level, aviation is part of the EU Emissions Trading System (EU ETS) for flights within the European Economic Area (EEA), and shipping is expected to integrate the EU ETS. Advanced biofuels in aviation & shipping are only supported through a very light incentive with Renewable Energy Directive II (RED II), where non-food-based biofuels can be counted 1.2 times their energy content. They can also opt in to contribute to the national target of 14% of renewables in transport by 2030.

At the national level, the nine European countries of the study are moving forward with policies enhancing the use of advanced biofuels, driven by the European directives such as the Indirect Land Use Change Directive and RED II. The main instruments used are advanced biofuel mandates: eight national advanced biofuel mandates in transportation were identified, including three of them in aviation or shipping. The number of advanced biofuels mandates have gradually been increasing with time, with more ambitious goals being set. Three countries stand out from the analysis for their progressive policies on advanced biofuels for aviation and shipping: United Kingdom, Norway and Denmark.

The report presents a set of recommendations for the industry of advanced biofuels for aviation and shipping on how to better benefit from existing policy mechanisms and facilitate the success of the BL2F technology:

- Benefit from funding opportunities to start industrial demonstration works,
- Network with other projects to further develop the technology,
- Focus on the shipping industry for a faster scale-up,
- Prioritise on the distribution of the technology on countries with ambitious targets in the aviation and shipping sectors,
- Benefit from diminishing allowance of EU ETS quotas to leverage advanced biofuels use,
- Develop cross-sectorial partnership opportunities to ensure fuel quality, secure resources, and guarantee a steady supply,
- Strengthen communication with relevant stakeholders to obtain their buy-in.

Keywords

Policy assessment, biofuels, aviation, shipping, advanced biofuels, black liquor, renewable energy

Glossary

Term	Definition
Biofuels	Fuels produced from biological raw materials. Four generations of biofuels are distinguished: • **First generation biofuels** are **crop-based** biofuels as they are commonly derived from food plants, such as biodiesel from oilseed rape and bioethanol from sugar. • **Second generation biofuels** are produced from lignocellulose materials derived from whole or parts of plants and trees that are not used for human consumption. These include all biofuels derived from wood and include **black liquor-based fuels**, lignocellulosic bioethanol and synthetic diesel produced by means of gasification or the Fischer-Tropsch process. • **Third generation biofuels** are those derived from aquatic biomass. • **Fourth generation biofuels,** so-called "electrofuels", include the use of renewable electricity and carbon dioxide as feedstock.[1] **Advanced Biofuels**, as defined by the European Technology and Innovation Platform, are those "(1) produced from lignocellulosic feedstocks (i.e. agricultural and forestry residues, e.g. wheat straw/corn stover/bagasse, wood based biomass), non-food crops (i.e. grasses, miscanthus, algae), or industrial waste and residue streams, (2) having low CO2 emission or high GHG reduction, and (3) reaching zero or low Indirect Land Use Change impact." [2]
Black liquor	A black liquid residue produced by the pulping of wood during the paper making process. Black liquor is highly concentrated in lignin and can be used as component of biofuel.

[1] (Sandquist, 2017)
[2] (ETIP, 2020)

Term	Definition
Drop-in Biofuels	Liquid bio-hydrocarbons that are functionally equivalent to petroleum fuels and are fully compatible with existing petroleum infrastructure.[3]
Indirect Land Use Change (ILUC)	Land-use change occurring when increasing demand for biofuels feedstocks leads to agricultural expansion and the conversion of natural lands, such as rainforests or grasslands. ILUC translates to a net increase in greenhouse gas emissions due to the removal of the carbon storage properties of natural lands.[4]

[3] (Dyk, 2019)
[4] (Scarlat & Dallemand, 2019)

1. Introduction

In Europe, the transport sector contributes to nearly 27% of greenhouse gas emissions and is the major cause of urban air pollution.[5] Compared to other sectors, the transport industry has not seen the same significant reduction in pollution since 1990, and still faces a constant growth. International aviation, although contributing to only a few percent of GHG emissions globally, is responsible for the highest percentage increase in greenhouse gas emissions of the last 30 years (+129 % from 1990 to 2017), followed by international shipping (+32 % in the same time period).[6] The decarbonisation of aviation is a challenge due to its projected growth (nearly 70% by 2050)[7], the attractive pricing of fossil fuels and the long replacement time of aircrafts.

Biofuels can help decarbonise the shipping and aviation industry and reduce dependence on fossil fuels. They present the advantage that they are compatible with the existing infrastructure – and are referred to as "drop-in biofuels" for this reason. At the same time, drop-in biofuels present high energy content, which allows them to be a major contributor to decarbonize long-distance transportation.

Biofuels are fuels made of biomass (living matter). This broad definition implies that there exist many kinds of biofuels. Depending of the nature of the biomass and the type of technology in use, there can be significant differences in sustainability and quality performances. In Europe, biofuels are categorized by the feedstock they were produced from. Conventional biofuels are based on mainly crop-based feedstock while advanced biofuels are made of feedstock listed in the annex IX of the Renewable Energy Directive II (RED II). All biofuels must meet the minimum sustainability criteria and their feedstock must be present on the list.

The BL2F process will convert black liquor into advanced biofuels. Black Liquor is an industrial side-stream produced by the chemical pulping industry. It appears on the RED II list and has no indirect land use change (ILUC). The pulp industry currently produces about 170 million tonnes of black liquor globally[8], representing a promising feedstock for sustainable biofuel production. Its current sustainability performance will be calculated later in the BL2F project.

The technology developed in the BL2F project could produce more than 50 billion litres of sustainable advanced biofuels by 2050, meeting the EU demand for advanced biofuels for aviation and shipping. The process produces an intermediate that can be upgraded in a conventional oil refinery or a biorefinery to ensure true drop-in fuel quality.

[5] (EEA, 2019)
[6] (EEA, 2019)
[7] (ICAO, 2016)
[8] (IEA Bioenergy, 2007)

2. Objectives and structure of the report

The goal of this report is to highlight key policy trends, assess policy interventions and suggest recommendations to enhance the potential of a successful market uptake of the BL2F technology based on the policy landscape analysed.

This report will not cover the elaboration of scenarios on the demand for biofuels in 2040 nor the market potential of the BL2F technology, which will be analysed respectively in the following deliverables D6.2 and D6.3.

This report presents the results of the policy mapping, at international, European and national levels. At each level, an analysis is presented on existing policies promoting renewables, biofuels, advanced biofuels, and advanced biofuels in aviation and shipping. The first section presents the main EU directives. The second section focuses on the national level, covering specific measures by national states. A final section presents policy recommendations to facilitate the use of the BL2F technology based on observations from the policy analysis.

3. Methodology

This section presents the methodology used in this study to analyse the existing policies that can directly or indirectly influence the use of advanced biofuels in aviation and shipping.

The methodology consists of defining the scope of policies sourcing, mapping the stakeholders behind the policies, and classifying policy interventions.

The impact of the adoption of the technology is defined at 5 levels:

- measures that set a global framework for aviation and shipping
- measures that promote renewable energies
- measures promoting biofuels
- measures promoting advanced biofuels
- measures promoting advanced biofuels for aviation and shipping

Following the analysis, opportunities and risks are assessed to deploy the technology. Finally, recommendations are provided to facilitate the use of the BL2F technology and enhance its economic value.

3.1. Scope of policy sourcing

The methodology that is used for this research is structured into four different steps, as seen in Figure 1. The first step consists in desktop research with the objective of sourcing as many measures as possible, on International, European and National levels. This first step results in the creation of a database of policies.

1. The second step consists in the classification of policies.
2. Then, the policies identified and classified are analysed for Europe and every individual country.
3. Lastly, findings and conclusions are drawn from the analysis.

Figure 1. Research methodology in four steps

In line with the objective of this study, the scope of this research is limited to a focus on European and National policies, with a focus on nine countries regarding national policies. Global regulations that have a role in aviation and shipping are also studied.

The national policies analysis was made with a focus on nine European countries: Denmark, Norway, Sweden, Germany, Finland, France, Italy, United Kingdom (UK) and the Netherlands.

The country selection was made based on the following methodology:

Firstly, the 16 countries with the highest GDP per capita in Europe were mapped in Table 1.

In the second place, the countries with a population inferior to 5 million inhabitants were not selected in order to focus on countries with a more sizable population. Luxembourg, Ireland, Iceland and Malta were therefore removed.

Finally, a preliminary policy assessment in the twelve remaining countries was performed in order to identify the countries that have the most relevant measures to support biofuels and advanced biofuels. Switzerland, Austria and Belgium were removed in order to narrow down the scope of the study to a limited number of countries that had more relevant and ambitious measures in place.

The nine countries highlighted in green on the table hereafter were therefore selected to carry out a deeper policy analysis. The decision was made to include two non-EU member states (Norway and UK), because these two nations had some of the most relevant policies regarding advanced biofuels in aviation.

Countries	Europe rank GDP per capita PPP[9]
Luxembourg	1
Ireland	2
Switzerland	3
Norway	4
Denmark	5
Netherlands	6
Austria	7
Iceland	8
Germany	9
Sweden	10
Belgium	11
Finland	12
United Kingdom	13
France	14
Malta	15
Italy	16

Table 1. Selection of countries

[9] (Trading Economics, 2019)

3.2. Selection of stakeholders

Stakeholders behind the existing policies are assessed on International, European and National levels. Decision makers, civil society, science & research, the aviation and shipping industry, their associations, and their end-users are analysed.

Desktop research allows to map stakeholders who are linked to policies impacting the BL2F project.

3.3. Level of impact on the adoption of the BL2F technology

Measures are classified according to the level of impact they may have on the adoption of the BL2F process in aviation and shipping.

This study focused on measures related to biofuels. The analysis is carried out on measures that can have a direct or indirect impact on the adoption of biofuels produced by the BL2F technology.

To estimate the extent to which existing policies influence the use of the BL2F technology, all measures are classified between those that have a direct link and an indirect link with the project.

As shown the Table 2, measures are studied at different levels of impact. In Figure 2, the different levels and their connections appear.

Level 1 policies specifically address the technology deployed by the BL2F project and therefore have the highest impact on their adoption while Level 4 and 5 policies have a more limited impact due to their more generic nature.

Impact of policies and interventions on the adoption of the BL2F technology	**Level**	Type of measure
Direct link with the BL2F technology	*Level 1*	Measures that are specifically beneficial to the BL2F technology: promotion of advanced biofuels for aviation and/or shipping
Direct or indirect link with the BL2F technology	*Level 2*	Measures that promote advanced biofuels
	Level 3	Measures that promote biofuels
Indirect link with the BL2F technology	*Level 4*	Measures that promote renewable energies
Transversal link with the BL2F technology	*Level 5*	Measures that set a framework for the BL2F technology in aviation & shipping

Table 2. Levels of study for the policy mapping

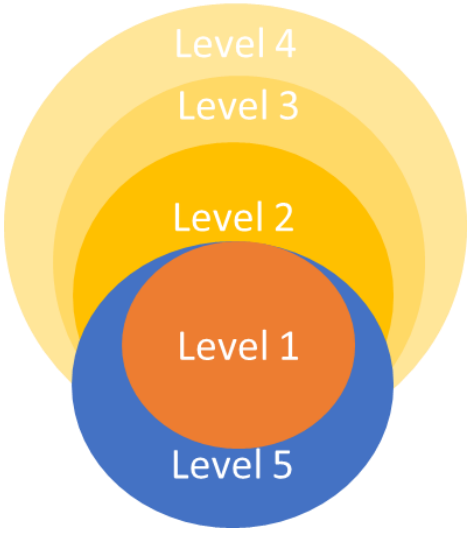

Figure 2. Levels in studying the policies

3.4. Assessing the influence of policies on the market uptake of the BL2F technology

The analysis of European and national policies is undertaken by focusing on their significant influence on the market uptake of the BL2F technology. The policies analysed in this document can affect this uptake by:

- Supporting to R&D and innovation deployment,
- Setting competitive pricing of biofuels compared to fossil fuels,
- Sustaining growth along the value chain (creating jobs, contributing to a competitive pulp industry, fuels, aviation etc),
- Establishing enforcement instruments to engage stakeholders (incentives, penalties...),
- And/or contributing to the domestic production and consumption of biofuels within the European Union.

3.5. Opportunities, risks, and policy recommendations

Following the policy mapping at each level, risks and opportunities for the BL2F deployment are analysed. They aim at suggesting what solutions could be brought to enhance the economic value of the BL2F process for the partners.

Taking current policies into consideration, final recommendations for policy interventions and measures are then provided for future biofuels as it relates to aviation and shipping.

We then extrapolate from the analysis what policy measures and interventions could facilitate the use of biofuels deployed by the BL2F technology at this day.

4. Assessment of stakeholders relevant to the BL2F project

For a better understanding of the BL2F project's ecosystem, the main stakeholders were mapped through desktop research on the visual below (Figure 3).

The categories of stakeholders relevant to the BL2F project are decision-makers, civil society members, science and research institutes, end-users, industrial actors and industrial associations.

Decision makers & international forums

- EU institutions establish a common legal ground for renewable energies,
- National authorities contribute to the development of renewable energies, and securing their sources of energy, decreasing their dependence to fossil fuels,
- The International Marine Organisation (IMO) and the International Civil Aviation Organization (ICAO) have a stake by, for example, seeking to decrease the CO_2 emissions of aviation and shipping,
- The European Union Aviation Safety Agency (EASA) is the European Union's body to set and monitor safety standard and performances. It certifies products before they are adopted for commercial exploitation.

Civil society

- Passengers of airlines & shipping companies: an opportunity like fuels produced by the BL2F technology to decrease carbon emissions in travelling might allow companies to decrease their carbon emissions and project a better image of their services to clients.
- Environmental NGOs might see biofuels as a promising technology to decarbonise shipping and aviation. Moreover, NGOs that fought against first-generation biofuels (land use, food competition, CO_2 emissions) might consider the next generation of biofuels an interesting alternative. However, some environmental NGOs might keep their disapproving stance to biofuels and advanced biofuels.

Science & Research

- Research and academic institutes will gain knowledge from the results of the BL2F technology on biomass conversion processes. They might also develop skills in new areas that are applicable to the BL2F technology, such as converting other feedstocks to HTL fuel intermediate.

Industry & Industry associations

- Industry representatives

The Forest industry, the Pulp & Paper Industry, Process suppliers, Logistics, Oil refiners, Chemical Catalyst Providers might want to showcase a novel cost-effective process to produce biofuel in a sustainable manner. Additionally, they will have the opportunity to lower their GHG emissions along the value chain and ensure the sustainability of their business.

Forest owners and forestry companies might see an increased volume of business and enhanced local welfare.

Associations such as the EU refining forum, the European Biomass association, and the European waste-to-advanced biofuels association are active in leading the next generation of biofuels.

- **End users' representatives**

In the aviation sector, aircraft manufacturers, airlines and logistics companies might want to demonstrate that there is a willingness to demonstrate actions to increase the production of advanced biofuel in order to decrease CO_2 emissions.

Public transport, air force and navy might want to inform on alternative biofuels to reduce fleet's GHG emissions.

Some active associations would be the Aviation Manufacturers Association, the European Association of Internal Combustion Engine Manufacturers and the General Aviation Manufacturers Association, the International Air Transport Association (IATA), the Air Transport Action Group (ATAG), and the Airports Council International (ACI).

In the shipping sector, the shipbuilders, engine manufacturers, and logistics might also want to show that they are willing to decrease their CO_2 emissions. The maritime shipping seems to be represented by numerous trade associations such as the European Sea Ports Organisation (ESPO) or the European Boatmen's Association (EBA).

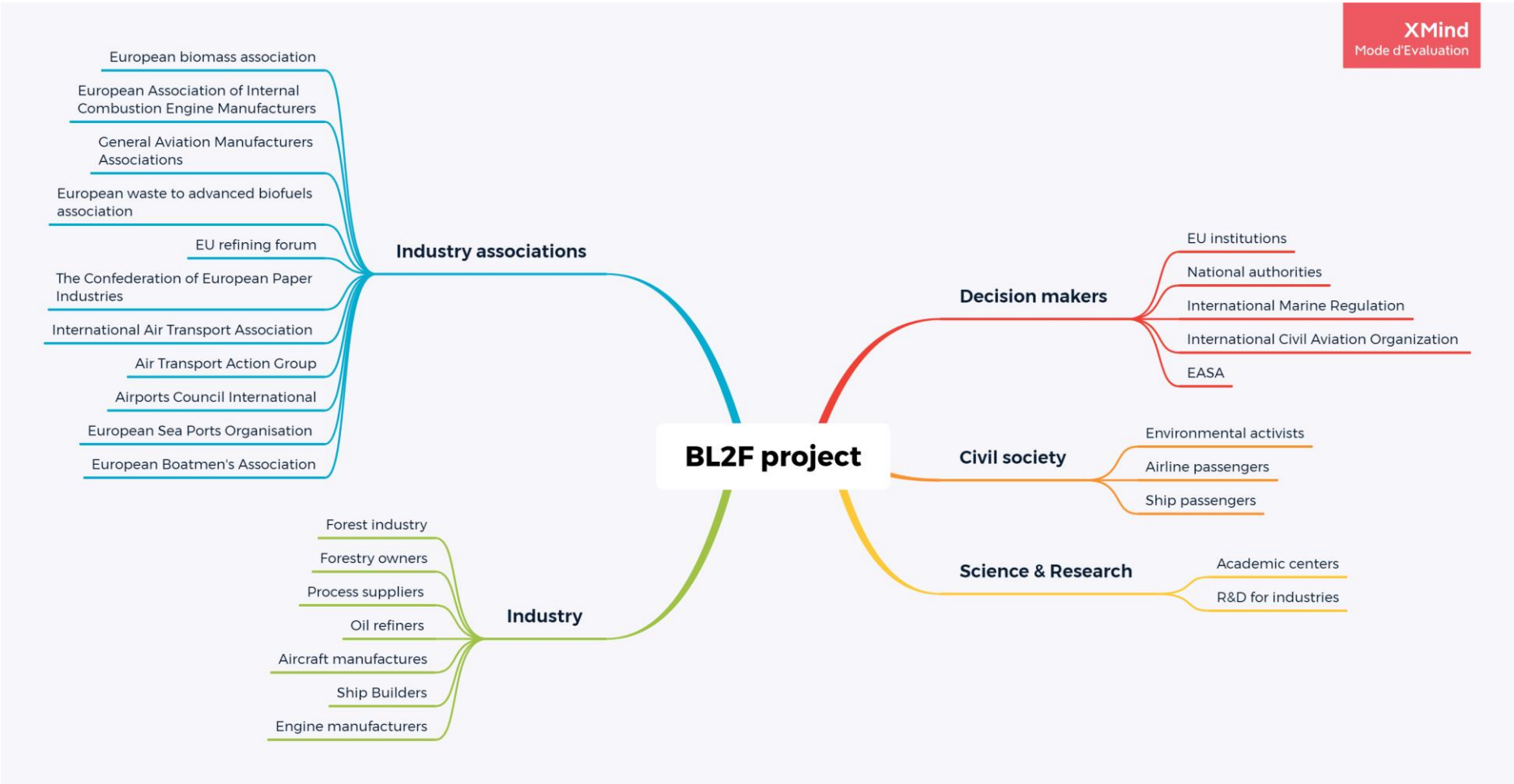

Figure 3. Stakeholders relevant to the BL2F project

5. International rules for aviation & shipping

This section presents the international rules for aviation and shipping that set a framework for European and national policies. It aims at presenting the decarbonisation strategies of both industries on the international scene.

5.1. International rules for Aviation

The aviation industry's direct emissions represent about 3% of the EU's total greenhouse gas emissions and more than 2% of global emissions[10]. Aviation CO_2 emissions are constantly and rapidly growing. If no action is taken, the UN International Civil Aviation Organisation (ICAO) foresees a 300% growth from 2020 to 2050[11].

In 2010, **ICAO adopted a goal of carbon-neutral growth[12] from 2020 onward**. In October 2016, the organisation adopted **a global market-based measure to address worldwide CO_2 emissions** by enacting the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The aim with **CORSIA is to stabilise CO_2 emissions from 2021 at 2020 levels.**

However, due to the Covid-19 outbreak, the 2020 emissions dropped significantly, which would result in having a very low-level baseline. In a position paper[13], IATA argues in favour of setting the baseline level at the 2019 emission level rather than taking 2020 in account. The goal from 2021 to 2035 will be to **offset around 80% of emissions above 2020 (or 2019) levels**.

CORSIA consists of three phases: pilot 2021-2023, first phase 2024-2026 and a second phase 2027-2035, where the participation in the pilot and first phases are voluntary. In 2019[14], **80 States,** representing almost 80% of international aviation revenue-tonne-kilometres (RTK) and **including all EU countries, indicated their participation to the scheme from the start.**[15]

Airlines will have to monitor emissions on all international routes and offset emissions from routes included in the scheme by purchasing eligible emission units. Following this voluntary participation of the EU, using biofuels from the BL2F technology in Europe can be a pathway to decarbonizing aviation, since it aims at reducing carbon emissions by 83%.

5.2. International rules for Shipping

The International Maritime Organisation (IMO) states that maritime transport emits about 1 billion tons of CO_2 each year, which represents about 3% of global greenhouse gas emissions.[16]

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[10] (European Commission, no date)
[11] (European Commission, no date
[12] Carbon-neutral growth: C02 emissions do not grow despite an increase in demand and supply.
[13] (International Air Transport Association, 2020)
[14] (CORSIA, 2019)
[15] (European Commission, no date)
[16] (International Maritime Organization, 2014)

According to the IMO, without any action, these emissions could increase between 50% and 250% by 2050.

The IMO is the special agency of the United Nations in charge of **creating a regulatory framework** for safety, security and **prevention of marine and atmospheric pollutions** to be adopted and **implemented universally by ships**. As 174 countries are members of the IMO including EU Member States, the objectives of decarbonisation set a framework for European regulations in shipping.

The IMO has committed to reduce **its carbon emissions by 40% by 2030**, and to **halve the total emissions (reference 2008) by 2050**[17]. It also strives towards full decarbonisation within this century, as soon as possible. These measures will be revised in 2023.

The IMO has also committed to **reducing sulphur oxides (SO_x) emissions** affecting air pollution.[18] SO_x is an atmospheric pollutant which, unlike CO_2, is not classified as GHG. Since January 2020, the IMO requires to reduce the **global sulphur cap of fuels** from **3.5% to 0.5% in the revised MARPOL Annex VI**.[19] As a result, CO_2 emissions from ships are expected to increase or decrease, depending on the existing technologies which contribute to lowering the sulphur content. Scrubbers are the most economical solution however, as they consume energy, CO_2 emissions are 2% higher than systems without scrubbers.[20] Another solution consists in using low-sulphur fossil fuels (marine diesel oil, marine gas oil and desulfurized HFO) which emit equivalent CO_2 or shift towards natural gas which allow to reduce CO_2 emissions by 20%. In the future, all types of **biofuels could replace heavy fuel oil as they respect this 0.5% sulphur cap and are less carbon intense.**

The **revised MARPOL Annex VI might affect the implementation of the IMO decarbonisation strategy**. All mature solutions to reduce the sulphur content in fuels are more costly to the shipping industry. Since this measure entered into force on January 1st, 2020, the current impacts on costs might not be visible yet. If costs are bearable for the shipping industry, the IMO will be credible to enforce its decarbonization strategy. If costs become too high and cannot be shared along the value chain of the shipping industry, the IMO will have more difficulties to enforce the decrease of GHG emissions. Moreover, in the **current Covid-19 situation**, the shipping industry is already affected economically, which might add up to the **cost-related uncertainties**.

[17] (IMO, 2018)
[18] (IMO, 2020)
[19] (IMO, 2020)
[20] (Den Boer & Hoen, 2015)

6. Assessment of the European policy framework

First, European measures with an impact on the decarbonisation of aviation and shipping are assessed. Several regulations applicable in all 27 EU member states are studied: policies that promote renewables, policies that promote biofuels, and policies that promote advanced biofuels. All of them have an indirect link with the future use of the BL2F technology. The last category focuses on the policies on advanced biofuels for aviation and shipping.

6.1. Measures that promote the reduction of CO_2 emissions in aviation and shipping

6.1.1. CO_2 emissions accounting in Europe

The European Union **Emissions Trading Scheme** (ETS) is the main instrument used to record and cap GHG emissions in the region across all its industries and to enable trading of corresponding allowances. It was launched in 2005 to support the commitment made under the Kyoto Protocol agreed in 1997.[21]

Its scope initially governed CO_2 emissions mainly from the energy and several raw materials manufacturing sectors but has been gradually expanded since to include additional harmful gases, additional countries outside the EU (Norway, Iceland, Liechtenstein) and additional industry sectors.

6.1.2. European measures regarding aviation

CO_2 emissions from aviation are included in the **EU ETS** since 2012[22]. All airlines operating in Europe must monitor, report and verify their emissions. Since 2016 and until 31 December 2023, CO_2 emissions in **EU ETS** are **limited to flights with the EEA, which gathers the EU member states, Iceland, Liechtenstein and Norway**[23]. The results of the EU ETS published in an annual report, states that the intra-EEA flights emitted 67 million tonnes of CO_2 equivalent emissions in 2018, representing a 4% increase from the previous year. [24].

The limitation of the EU ETS for the aviation sector, to flights to and from EEA countries was initially set to be applied until 2016, at which point flights to and from non-EEA countries would also become subject to the EU ETS regulations. However, as stated in 5.1, the ICAO launched CORSIA in 2016. The EU submitted a proposal for **amendment of the EU ETS for aviation on July 3rd, 2020,** for implementation in Q2 2021. The goal was to **facilitate the implementation of CORSIA in the EU** in a way that is consistent with both organizations' objectives. However, it is important to note that the ultimate objectives of CORSIA and the EU ETS are different. The

[21] (European Commission, no date)
[22] (European Commission, no date)
[23] (European Commission, no date)
[24] (European Commission, 2020)

EU ETS objective is to achieve a net reduction of CO_2 emissions of 43% compared to 2005 levels[25], applicable across all sectors under the ETS. As stated in 5.1, CORSIA's objective is to offset emissions from the industry's growth from 2021.

Additionally, in August 2020, the European Union is considering the **use of quotas** to compel airlines to use more sustainable aviation fuel, along with an obligation for the fuel industry to generate a **minimum share of SAF** in the objective of reducing aviation carbon emissions.[26]

6.1.3. European policies regarding shipping

The EU uses the **MRV REGULATION** as an accounting tool for the CO_2 emissions from the shipping industry. It captures **travel routes between two ports, of which one is in the EU**, operated by ships larger than 5,000GT[27]. The report from 2019 states that more than 138 million tonnes of CO_2 have been emitted, of which 62% of CO2 emissions originated from extra EEA traveling.[28]

In 2013, the European Commission implemented a **strategy to integrate maritime GHG emissions into the EU climate policy**[29], relying on three steps:

- Monitor, report and verify CO_2 emissions from the shipping industry
- Define Greenhouse gas reduction targets for the sector
- Develop market-based measures, in the medium and long term

As a first step towards the implementation of this strategy, the European Parliament and the council adopted **Regulation (EU) 2015/757[30]** as a first step on the monitoring, reporting and verification of the CO_2 emissions in shipping.

In 2019, the Commission presented the upcoming **Green Deal**[31] to make Europe the first carbon-neutral economy by 2050. The agreement tackles the shipping industry, hinting towards regulations accelerating solutions for controlling and limiting emissions.

International emissions from shipping are currently **not part of the Paris Agreement**[32]. **Domestic navigation emissions and emissions from inland waterways** are included in the Effort Sharing Regulation, through mitigation measures.[33] However, the European Parliament recently voted in favour of a proposal to **include shipping in the EU ETS** and to impose a 2030 40% carbon intensity target on big ships calling at EEA ports.[34] This decision is still under negotiation as of September 2020.

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[25] (European Commission, no date)
[26] (Biofuels International, 2020)
[27] (DNV.GL, 2017)
[28] (European Commission, 2020)
[29] (European Commission, 2020)
[30] (The European Parliament and the council of the European Union, 2015)
[31] (Novéthic, 2020)
[32] (Novéthic, 2020)
[33] (European Commission, 2020)
[34] (Lloyd's List Maritime Intelligence, 2020)

6.2. Measures promoting renewable energies

To respect the hierarchy of law, the analysis begins with the presentation of measures on European level. We focus on policies that promote renewable energies and have an indirect impact on the adoption of advanced biofuels in aviation and shipping, such as the technology developed by the BL2F project.

6.2.1. European policies promoting renewable energies

From 2015 to 2020, there have been increasingly more policies on renewable energies. Their goals are more ambitious than ever, with more binding targets. Figure 4 presents several measures tackling the promotion of renewables in Europe from 2009 to 2020:

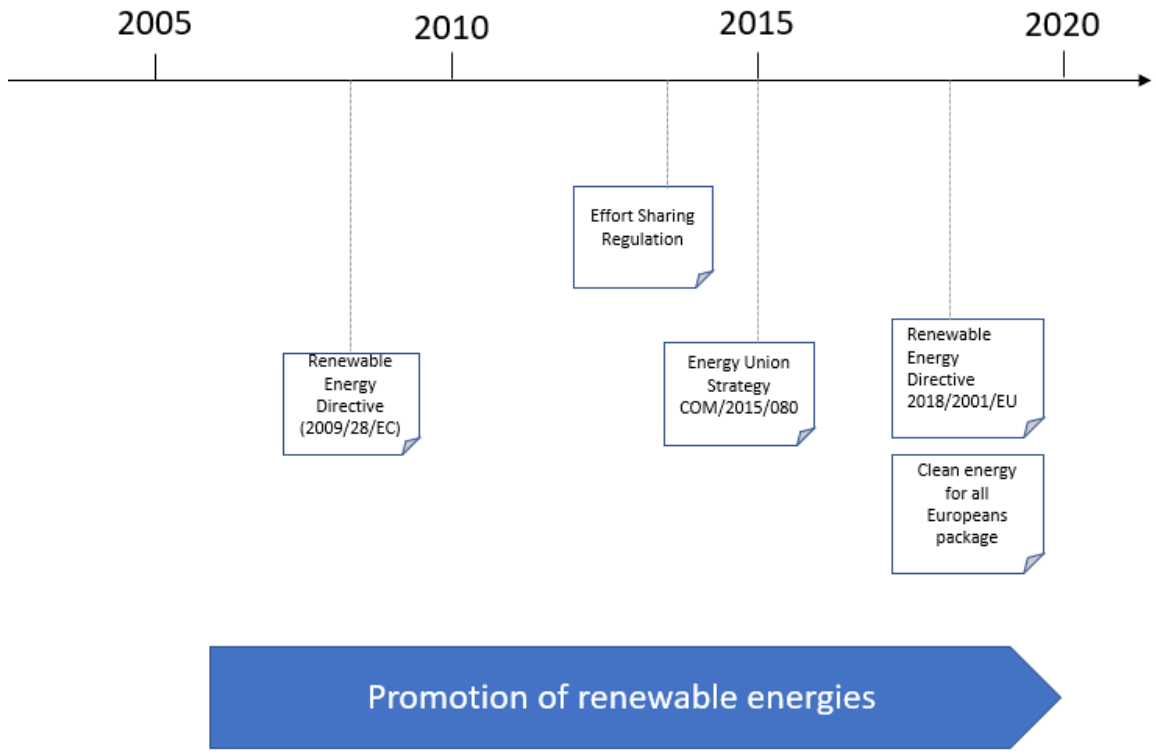

Figure 4. Timeline of appearance of measures promoting renewable energies in Europe

The Effort Sharing Regulation

Key elements for renewable energies

The Effort Sharing Regulation 2021-2030[35] was decided in 2014 by EU leaders and adopted on May 14th, 2018.

The regulation sets **binding greenhouse gas emissions targets for 2021-2030** for the sectors of the economy that are not covered by the EU ETS (transport, buildings, non-ETS

[35] (The European Parliament and the council of the European Union, 2018)

industry, waste). The policy specifies that **non-ETS sectors should reduce emissions by 30% by 2030** (base 2005).[36]

Additional targets to cut carbon emissions were also decided for national states, according to their gross domestic product per capita (GDP.) The national targets are spread from **0% to 40%, compared to 2005.**[37]

The Energy Union Strategy

Key elements for renewable energies

The **Energy Union Strategy** (COM/2015/080)[38] enables the transition towards renewable energies, in order to meet the Paris Agreement commitments, and is the main instrument to achieve the transformations set by the **Green Deal**.[39] The five challenges addressed by the strategy are: energy security, solidarity and trust; **the internal energy market**; energy efficiency as a contribution to the moderation of energy demand; **decarbonisation of the economy**; and **research, innovation and competitiveness**.

Clean energy for all Europeans package

Key elements for renewable energies

Based on proposals published in 2016, The **Clean energy for all Europeans package** is an agreement set by the Council and the European Parliament that was adopted between 2018 and 2019 and is seen as a milestone towards the implementation of the Energy Union Strategy.[40] It is composed of eight legislative acts, of which the recast Renewable Energy Directive (2018/2001/EU).

EU countries have 1-2 years to transpose new directives into their national laws.

Renewable Energy Directive (2018/2001/EU) (RED II)

Key elements for renewable energies

The original **Renewable Energy Directive** (2009/28/EC) (RED I) mandated **20% of renewables in the EU by 2020**, along with a 10% renewables target in transport.

The **Renewable Energy Directive** (2018/2001/EU) (RED II), revises the 2009 text and sets the **binding target of 32% share of renewables in the EU energy mix by 2030** with a clause

[36] (The European Parliament and the council of the European Union, 2018)
[37] (The European Parliament and the council of the European Union, 2018)
[38] (European Commission, 2020)
[39] (European Commission, 2020)
[40] (European Commission, 2020)

for a possible revision by 2023. EU members also must ensure that at least **14% of their transport fuels come from renewable sources by 2030[41].**

In RED II, **Biofuels and bioliquids are recognised as instrumental** in helping EU countries meet their 14% renewables target in transport.

Companies can show they comply with the criteria through national based schemes. Under the new regulation, **every member state must transpose the directive**'s new elements into national law and draft **10-year National Energy & Climate Plans** (NECPs) **for 2021-2030**. The transpositions will have a direct impact on the market for renewable energies and biofuels.

6.2.2. Analysis of policies that support renewable energies

All identified policies supporting renewables aim at reducing CO_2 emissions, in compliance with the Paris Agreement. Most of them involve binding targets and their classification may vary. They also drive **R&D and innovation deployment** in renewable energies rather than fossil fuels, by creating a predictable policy framework over the next years.

The **Energy Union Strategy**, **RED II and** the **Clean energy for all Europeans package** are all **enablers of the diversification of energy and the increase of renewables in the energy mix**. The **Effort Sharing Regulation** is a measure of **coercion and restriction for CO_2 emissions.**

RED II is a key directive to enforce the Energy Union Strategy, invest in renewables, enhance cross-border connections between EU countries and generate economic growth. Biofuels markets are directly impacted by the transposition of RED II into national law. If a member state fails to transpose the directive into its national jurisdiction, it may be the subject of an infringement procedure launched by the Union which can ultimately end with significant financial penalties.

The **Effort Sharing Regulation** is unique as it sets additional targets for national states, and objectives for the non-EU ETS sectors.

The effects of recent European policies will be seen in the long run. Some outcomes will become visible once directives are transposed into national laws. The economic uncertainties generated by measures targeting the **Covid-19 pandemic** might however postpone the implementation of the policies in some countries.

6.3. Measures promoting biofuels & advanced biofuels

In this section, the focus is on European policies promoting biofuels use and/or production that have an indirect impact on the adoption of advanced biofuels in aviation and shipping,

[41] Calculation rules regarding the minimum shares of renewable energy in the transport sector are defined in Article 27.

such as the biofuels developed by the BL2F technology. Policies are detailed with their impact on biofuels and advanced biofuels use and/or production, following with an analysis.

6.3.1. European measures promoting biofuels and advanced biofuels

Figure 5 presents several measures tackling the promotion of biofuels and advanced biofuels in Europe from 2009 to 2020. From 2003 to 2009, four policy measures were taken on biofuels at EU level: The **Biofuels directive,** the **Biomass Action Plan**, **the Fuel Quality Directive**, and the **Renewable Energy Directive RED** (2009/28/EC). They all applied to the use of biofuels in road transport, and the Renewable Energy Directive RED (2009/28/EC) also applies to rail.

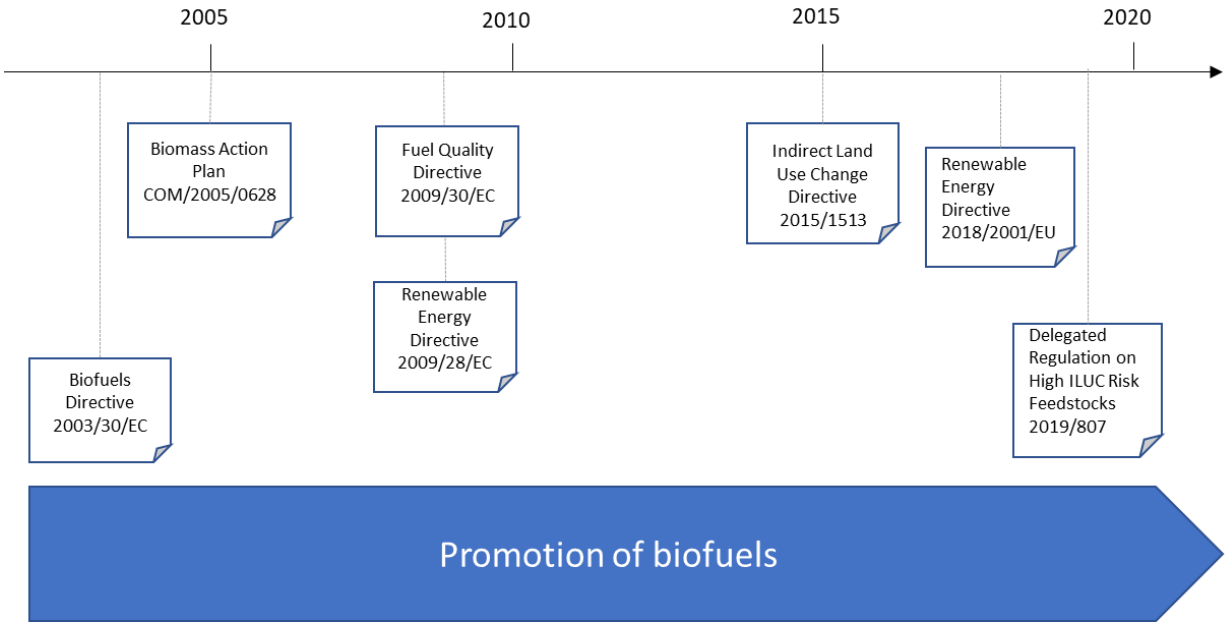

Figure 5. Timeline of European measures promoting biofuels

In 2003, the **Biofuels directive** (2003/30/EC) set out an indicative **biofuel target** of 2% for road transport by 2005, and 5.75% by the end of 2010.[42] The **Biomass Action Plan** (COM/2005/0628) aimed at diversifying EU energy supply for road transport, by increasing the use of energy from **agriculture, forestry and waste**.[43] It was seen as a lever to lower greenhouse gas emissions. **Fuel Quality Directive** (2009/30/EC) was amended in 2009 and required the reduction of **GHG intensity by 6%** of fuels for road transportation.[44] In 2009, the **Renewable Energy Directive RED** (2009/28/EC) set out a target to produce **20% of**

[42] (The European Parliamant and the Council, 2005)
[43] (Commission of the European Communities, 2005)
[44] (The European Parliament and the Council, 2009)

renewables by 2020, including at least 10% of all energy in road and rail transport.[45] This directive was updated in 2018 with RED II.

From 2015 to 2020, three European policies came into force to address the sustainability issues of crop-based biofuels, favouring the use of advanced biofuels : the **ILUC Directive** (EU) 2015/1513, the **Renewable Energy Directive** (2018/2001/EU), and the **Delegated Regulation on High ILUC risk Feedstocks** (2019/807). Since these three policies are the most recent with RED II being a major framework, a focus is made in the next section.

Indirect Land Use Change Directive (EU) 2015/1513[46]

Key elements for biofuels & advanced biofuels use

The **Indirect Land Use Change Directive** (EU) 2015/1513 limits environmental impacts related to the conversion of land to produce biofuels. A limited surface of land is available for agriculture, and natural land (forests, grasslands among others) has been converted to produce biofuels to satisfy the growing demand of biofuels. This indirect land use change has led to higher CO_2 emissions by using crop-based biofuels than fossil fuels.

The **ILUC Directive** (EU) 2015/1513 limits the **crop-based biofuels share** to a maximum of **7% of the final energy consumption in transport**.[47]

Key elements for advanced biofuels use

The **ILUC Directive** (EU) 2015/1513 includes an **indicative target of 0.5% for advanced biofuels.** [48]

Renewable Energy Directive (2018/2001/EU) (RED II)[49]

Key elements for biofuels use & production

The **updated version of the Renewable Energy Directive** (RED II) sets out a requirement on fuel suppliers from EU member states to ensure that the **share of renewables supplied for final consumption in the road and rail transport sector is more than 14% by 2030**. This share is calculated as the sum of all biofuels, biomass fuels and gaseous transport fuels of non-biological origin used in the transport sector.[50]

RED II lays out a **sustainability and GHG emission criteria for all biofuels** produced or consumed in the EU.[51]

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[45] (The European Parliament and the Council of the European Union, 2009)
[46] (The European Parliament and the Council of the European Union, 2015)
[47] (The European Parliament and the Council of the European Union, 2015)
[48] (The European Parliament and the Council of the European Union, 2015)
[49] (The European Parliament and the council of the European Union, 2018)
[50] (IEA Bioenergy, 2020)
[51] Sustainability criteria are defined in Article 29(2) to (7) of the RED II.

RED II sets limits on crop-based biofuels with high ILUC risk. Members are still able to use and import high ILUC risk biofuels however, they must limit how they are counted in their renewable share. These limits are the 2019 levels for the 2021-2023 period and are gradually decreasing from 2023 to zero by 2030. RED II also introduces an exemption for crop-based fuels that can be certified as low ILUC-risk biofuels.

RED II has also prepared the Delegated Regulation on high ILUC risk feedstocks which will define high ILUC risk feedstocks.

Key elements for advanced biofuels use

Advanced biofuels are defined as biofuels from **feedstocks listed in Part A of Annex IX** of the directive. Most feedstocks were lignocellulosic and included **black liquor**.

The contribution of **advanced biofuels** coming from these listed feedstocks will amount to **3.5% of the total rail and road energy demand by 2030**[52]. Targets are set to 0.2% by 2022, and 1% by 2025.

The **contribution of advanced biofuels will be counted twice their energy content**, so the real target in 2030 would be 1.75%.[53]

Key elements for advanced biofuels use in aviation and shipping

Biofuels which do not come from food nor crops can be **counted 1.2 times their energy content** when they are used in aviation and shipping.

Fuels used in aviation and shipping **can be included in the national transport target** (**14%**).

Delegated Regulation on high ILUC risk feedstocks (2019/807)[54]

Key elements for biofuels use

The Delegated Regulation on high ILUC risk feedstocks sets **limits on high ILUC risk feedstocks for biofuels**[55] production**.** It is a first step towards the implementation of RED II.

This regulation is set to address the public debate regarding the sustainability of biofuels, including the use of palm oil.

A criterion is defined for the characterisation of the high ILUC risk feedstocks, defined as having "a significant expansion of the production area into land with high-carbon stock is observed".

[52] (IEA Bioenergy, 2020)
[53] (IEA Bioenergy, 2020)
[54] (The European Commission, 2019)
[55] (European Commission, 2019)

6.3.2. Analysis of European policies promoting biofuels and advanced biofuels

A recent framework on biofuels with RED II as the most important element

The **ILUC Directive** (EU) 2015/1513, the **Renewable Energy Directive** (2018/2001/EU), and the **Delegated Regulation on High ILUC risk Feedstocks** (2019/807) which promote specifically the use of biofuels were identified.

The three policies encourage investments towards biofuels and advanced biofuels: the ILUC Directive stimulates less investments towards crop-based biofuels, RED II constitutes a predictable framework to 2030 and the Delegated Regulation on High ILUC risk Feedstocks shows a better image of biofuels and advanced biofuels. As the framework is quite recent, some uncertainties remain, leading to reluctances to invest in biofuels.

RED II establishes renewable energies targets, and even though it has a target for advanced biofuels, it has **no specific targets for the share of biofuels in renewables.** Policies have mandatory targets regarding renewables consumption for road and rail transport.

Palm oil imports at the heart of controversies towards biofuels

Biofuels can be very different in terms of impact on indirect land use change, which can be high depending on the type and source for the biofuel. **Biofuels from palm oil** are the **most emitting biofuels, followed by soybean oil**.[56] High ILUC risks biofuels might be more emissive than fossil fuels which is contradictory to the European regulatory framework that aims at applying the Paris Agreement and decreasing carbon emissions.

The certification of low-ILUC-risk biofuels and the **phase out of high ILUC feedstock by 2030** can be seen a first step towards **more sustainable feedstocks**.[57] However, the long-term effects on the market will be seen in the following years but might not encourage sustainable domestic production. One of the effects is the controversies around the **consumption of Used Cooking Oil (UCO)**, classified as advanced biofuels in RED II. In 2019, more than half of the UCO was imported (1.5 million tonnes out of 2.8 million tonnes[58]) and mostly came from China, Malaysia and Indonesia, the biggest palm oil producers in the world. As RED II does not distinguish collected oils from the one imported from countries that are palm oil producers, there are **suspicions of fraud**. The UK and the Netherlands suspect that the imported **UCO contains palm oil**.[59]

However, there is **no limitation on importing biofuel from high ILUC risk feedstock**. The only limit is the accounted share in the national target in renewables, which should be equal to 0 by 2030. This means that during the next 10 years, high ILUC risk biofuels will still be accounted for in the national share of renewables, although at a decreasing rate.

[56] (Le Monde, 2016)
[57] (ETIP Bioenergy, 2019)
[58] (EURACTIVE, 2020)
[59] (Euractiv, 2020)

6.3.3. Analysis of measures promoting advanced biofuels

Limited framework for advanced biofuels in aviation and shipping

A major finding of the research reveals that no other European policy than RED II specifically addresses the use of advanced biofuels in the aviation and shipping industries. The impact of RED II is limited since there is **no double counting nor mandatory target** for both industries.

More stringent policies promote advanced biofuels use

As policies are more stringent towards high ILUC risk feedstocks and crop-based biofuels, biofuels must diversify and shift towards more advanced biofuels. The **3.5% RED II target** for advanced biofuels will stimulate their use, requiring about 10,000 ttoe. However, this quantity represents the current production of conventional biofuels, which requires investments regarding domestic plants, and possible sourcing from outside the EU[60].

Double-counting stimulates advanced biofuels

Double-counting measures are enablers for advanced biofuels, reducing barriers to compliance to the quota and acting as a **strong support tool** to their **democratization**. However, these measures also represent **business risks** due to the instability of regulations and possible changes that may be brought. Companies are indeed not willing to develop a technology that is only feasible due to subsidies.

6.4. Risks and Opportunities for the BL2F technology related to European policies

A lack of framework prioritising the usage of black liquor

The regulations identified for renewable energies do not specify what to do in case of **resource competition** for different usages. As biomass is a limited resource, support is needed to choose between energy and non-energy markets. Black liquor is currently burnt to produce **electricity** in paper mills, whereas it could be used to make **chemicals** instead of biofuels in the future with technologies such as in the BL2F project.

In the future, if a regulation was to **prioritise the usage of biomass** towards electricity rather than biofuels, it would have an enormous impact on the commercialization of the advanced biofuels generated by the BL2F process. This risk will be studied in deliverable D6.2, Identification of major trends in future biofuel demand.

[60] (ETIP Bioenergy, 2019)

A lack of framework enabling a competitive pricing of biofuels

Overall, no policy enables to bridge the price gap between fossil fuels and biofuels. Until this is developed, biofuels deployment will be based on fossil fuels prices. If **fossil fuels prices remain very low**, using fossil fuels and buying new EU ETS allowances would still be cheaper than buying biofuels.

A solution for aviation and shipping to decrease carbon emissions

Aviation is currently part of the **EU ETS**, while **shipping** isn't but is **expected** to be integrated in the same scheme. There are also discussions about possible upcoming regulations setting **SAF targets** at the European level. In this context, companies within the aviation and shipping industry will need more sustainable solutions to comply to their diminishing carbon allowance.

Currently, both industries are more and more interested in **compensation systems** that are numerous, and price competitive. In compliance with the principles "Avoid, Reduce, Offset", the products developed by the BL2F technology are a more sustainable solution than carbon offsets as they directly reduce carbon emissions. Their market competitivity will be analysed in deliverable D6.3.

RED II, a recent but predictable support towards advanced biofuels until 2030

The policy framework supporting advanced biofuels is recent, which leads to reluctances to invest, but is predictable until 2030. The solution deployed by the BL2F technology is mainly driven by RED II for several reasons.

First, RED II defines **black liquor in the list of feedstocks** for advanced biofuels, in Part A of Annex IX. Second, RED II sets the target to incorporate 3,5% of advanced biofuels by 2030 of the total rail and road energy demand, and this is double counted.

Moreover, the target to phase out high ILUC risk feedstock by 2030 allows investors to shift from crop-based biofuels to advanced biofuels such as the one produced by the BL2F technology. Advanced Biofuels from black liquor have a **low risk of causing indirect land use change**, and they do not compete with agricultural land for the food production. However, the impact of the phase out of high ILUC risk biofuels will be seen in the next years as it can foster the use of UCO more than lignocellulosic biofuels.

Finally, even if the impact is limited, **advanced biofuels used in aviation and shipping can opt in the national transport targets** and be multiple counted (x1.2).

7. Assessment of national policies and regulations

As stated previously in part 6, the EU directives must be implemented through national legislation. Therefore, EU countries will take their own measures and use a variety of policy instruments in order to meet the objectives imposed by the EU directives. In this section, the focus has been put on **nine European countries: Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden and the United Kingdom.** The country selection process is described in the methodology page 17.

First, a policy assessment highlights the relevant regulations and most common policy instruments in the nine selected countries. Second, an analysis of these policies is performed by level of relevance, based on criteria described in the methodology.

7.1. National policy assessment per country

7.1.1. Denmark

Denmark

Measures promoting renewables

Denmark imposes a **carbon tax on fossil GHG emissions, supporting biofuels through tax exemptions and direct subsidies.** In 2018, the value of the carbon tax was equal to 173 DKK per ton CO_{2eq} (23.2€/ton CO_2).[61]

Liquid biofuels, which will include biofuels from the BL2F technology, are exempted from this carbon tax as well as other energy taxes. Moreover, Denmark places specific emphasis on transportation: **The average tax rates are higher on transport fuels** than on fuels used for heating and process purposes or electricity generation (respectively 13.46€/GJ, 2.2€/GJ and 7.12€/GJ).[62]

Measures promoting advanced biofuels use

Denmark implemented in 2009 a **biofuel mandate for transport fuels**. The law includes road and rail transportation, but also **mentions waterway navigation vessel and recreational vessels**. Currently, fuel suppliers are obliged to blend fuels with at least 5.75% biofuels (in energy content). [63] A supplier that fails to fulfil a quota obligation shall pay a penalty, which is fixed by the national court. Only biofuels that comply with the requirements for the sustainability of biofuels can be included: biofuels made from waste, residues, non-food cellulosic materials and lignocellulose to be twice the contribution of other biofuels. [64] Denmark therefore **promotes advanced biofuels by double counting**.

[61] (World Bank, 2020)
[62] (OECD, 2019)
[63](Retsinformation, 2019)
[64] (Retsinformation, 2009)

The ILUC Directive was transposed in 2016, introducing a 0.9% blending target for advanced biofuels in transportation, starting in 2020.[65]

7.1.2. Finland

Finland

Measures promoting renewables

Finland was the **first country to introduce carbon tax** as an instrument to mitigate climate change. Implemented in 1990 at 1.12€/ton CO_2, it was raised to reach the current rate of 66.2€/ton CO_2. It initially only covered heat and electricity production but was later expanded to cover transportation and heating fuels.[66]

Measures promoting advanced biofuels use

In 2020, according the Finnish **biofuel mandate**, a 20% minimum of biofuels is required based on a total energy content of petrol and diesel. The regulation provides that **advanced biofuels** made from waste or remains, or inedible cellulose or **lignocellulose materials are eligible for double counting.** Moreover, a **0.5% target of advanced biofuels** in transport energy must be met by 2020.[67]

Moreover, in 2019, the Finnish Parliament approved a law that sets a gradually increasing 30% biofuels target for 2035.[68]

7.1.3. France

France

Measures promoting renewables

In France, a **carbon tax** was introduced in 2014 at the initial rate of 7€/ton CO_2 (excluding VAT) and increased each year to reach 65.4€/ton CO_2. It is expected to grow at 86.2€/ton CO_2 in 2022.[69] This tax **penalizes fossil fuels and aims to encourage the transition to low-carbon energies.** Part of the revenue from the tax (1.7 billion euros in 2017) is allocated to the financing of renewable energies.

Measures promoting biofuels use

The **Incentive tax relative to biofuels incorporation** (TGAP), first introduced in 2005 as part of the Finance law, sets an objective of **biofuels incorporation in the energy mix**, and penalizes fuel operators that do not respect it. Originally at 7% for both diesel and gasoline

[65] (Retsinformation, 2017)
[66] (Carbontax.org)
[67] (UPEi, 2018)
[68] (Biofuels International, 2019)
[69] (French Ministry of Ecological Transition, 2017)

supply, the biofuels objective has been raised from 7.7% in 2014, to the current rate: 7.9% in 2019. [70]

Measures promoting advanced biofuels use

Article 43 of the 2015 Energy Transition Act for Green Growth ambitions to prioritize the **development of advanced biofuels** while preserving investments made in the conventional biofuel production chain. The targets for the incorporation of advanced biofuels in the fuel mix provide the inclusion of 3.8% advanced biofuels (from straw or forest waste) into petrol and 2.8% into diesel by 2028. This objective is applicable to **road and air transport.**[71]

7.1.4. Germany

Germany

Measures promoting advanced biofuels use

In 2009, Germany implemented a **biofuel mandate** with a 6.25% target in road and rail transport. In 2017, **a sub-target was introduced for advanced biofuels**. The rate in 2020 is 0.05% and is expected to grow up to 0.5% for all suppliers by 2025.[72]

7.1.5. Italy

Italy

Measures promoting advanced biofuels use & production

Italy is an interesting case as it became in 2014 the first EU member State to **mandate the use of advanced biofuels in the transport sector**.[73] Since 2006, the legislation imposes that fossil fuel producers should annually supply a minimum quota of biofuels based on the total amount of fuel supplied. Italy has reduced palm-based biofuel consumption in favour of **biofuels produced from wastes and residues, which can be double-counted for the compliance with the quota.**[74]

The original mandate underwent multiple amendments in the last decade. The last in date was published in March 2018: the new decree set the biofuel mandate to 9% by 2020, including an obligation for advanced biofuels starting at 0.6% in 2018 and rising to 1.85% in 2022. 75% of the advanced biofuels target must be met with advanced biomethane and 25% with other advanced biofuels. [75] Figure 6 hereafter indicates the minimum requirements for advanced biofuels in the fuel mix between the 2018-2022 period.

[70] (French Ministry of Ecological Transition, 2020)
[71] (French Ministry of Ecological Transition, 2020)
[72] (German Federal Ministry of Justice, 2020)
[73] (ETIP Bioenergy, 2020)
[74] (GSE - Energy Service Management)
[75] (Gazzetta ufficiale della repubblica Italiana, 2018)

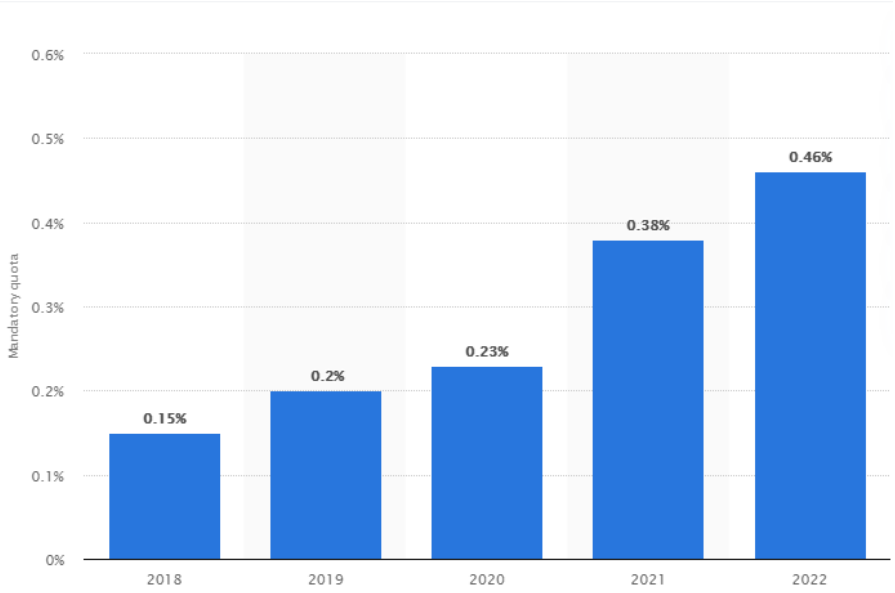

Figure 6. Mandatory quota for advanced biofuels in the total fuel mix in Italy (2018-2022)[76]

Producers of biofuels are assigned **Emission Certificates** (Certificati di Immissione in Consumo or CIC) which can be traded and sold to suppliers and can be used by authorities to verify compliance with the obligation. One CIC is assigned for each 10 Giga calorie (GCal) of conventional biofuels supplied and for each 5 GCal of advanced biofuels.[77] There is a 750€ fee per missing certificate for suppliers that do not comply with the mandate; this is equivalent to 2.7 EUR/litre of diesel equivalent for conventional biofuels and 5.4 EUR/litre of diesel equivalent for advanced biofuels. However, **aviation biofuels cannot opt into the mandate and are not eligible to receive CICs, and the shipping sector is not mentioned either**. [78]

7.1.6. Netherlands

Netherlands

Measures promoting advanced biofuels use

The Dutch government first implemented **renewable energy obligations on fuel suppliers for transport** in 2007. The mandate was then updated in 2011 to grow from 4.25% to 10% in 2020, in line with the RED target.[79] In 2017, advanced biofuels accounted for 0.1% of the transportation energy and 1.6% of all biofuels delivered.

[76] (Statista, 2020)

[77] (GSE – Energy Service Management)

[78] (GSE – Energy Service Management)

[79] (Official Gazette of the Kingdom of the Netherlands, 2011)

In 2018, Netherlands raised the **biofuel mandate** to 16.4% by 2020, including double counting. The **advanced biofuels mandate** was increased from 0.6% in 2018 to 1% by 2020.[80] The remaining quota of the mandate is expected to be filled by double-counted biofuels.

7.1.7. Norway

Norway

Measures promoting renewables

The Norwegian **carbon tax** has been implemented since 1991. Approximately 80 % of greenhouse gas emissions in Norway are taxed and/or regulated through the emissions trading system (EU ETS), **applied predominantly to fossil energy sources emissions**. The petroleum sector and domestic aviation sector are required to pay the tax, at a rate of about NOK 500 per tonne of CO_2 (46.7€/ton CO_2).[81]

Measures promoting advanced biofuels use

Norway requires a minimum of 22.3 vol% biofuels in road transportation from July 1st, 2020.[82] The minimum amount of advanced biofuels required in the fuel mix is 6.1 vol%, single counted.[83] Yet, just like in Denmark, **only biofuels that comply with the requirements for the sustainability of biofuels can be included.**

In September 2020, the Norwegian Government has decided to increase the biofuel minimum in road transportation to 24,5% starting 2021, and 9% advanced biofuels double counted.[84]

In 2018, the Norwegian government introduced a **quota requirement of 0.5% of (single-counted) advanced biofuel in aviation from 2020**, proposed to increase to 30% by 2030.[85]

7.1.8. Sweden

Sweden

Measures promoting renewables

In Sweden, **the carbon tax**, which applies to fossil fuels, exempts biofuels. The carbon tax was introduced in 1991 at a rate corresponding to 250 SEK (23€/ton CO_2), and has gradually been

[80] (Official Gazette of the Kingdom of the Netherlands, 2018)
[81] (Energy Facts Norway, 2017)
[82] (NRK, 2019)
[83] (Lovdata, 2020)
[84] (Rehjeringa.no, 2020)
[85] (Norwegian Environment Agency, 2018)

increased to 1190 SEK (110€/ton CO_2) in 2020.[86] **The Swedish carbon tax is today by far the highest in the world.[87]**

Measures promoting biofuels use

In 2018, a **mandate on fuel distributors** was introduced to **reduce GHG emissions of the diesel and gasoline fuel mix supply**.[88] This mandate requires fuel distributors to decrease GHG emissions by 21% in the diesel supply and 4.2% in the gasoline supply by 2020. [89] The measure is coercive, imposing a non-compliance penalty of 476€/ton CO_2 for petrol and 380€/ton CO_2 for diesel.

By 2030, Sweden targets a fuel mix that would achieve a GHG reduction of about 40%, corresponding to around 50% of biofuels blending.[90]

7.1.9. United Kingdom

United Kingdom

Measures promoting advanced biofuels use

The UK transposed the EU ILUC Directive in 2018 and amended the 2008 RTFO (Renewable Transport Fuel Obligation), which was aiming to delivering reductions of GHG emissions from the road transport sector by encouraging the supply of renewable fuels.[91] **The biofuel mandate** was extended, increasing the biofuel volume target from 9,75% in 2020 to 12,4% in 2032[92]. Another key change is the **additional target for advanced waste-based renewable fuels** starting at 0.1% in 2019 and rising to 2.8% in 2032. **Renewable aviation fuels and renewable fuels of non-biological origin were added in the mandate.**

The UK also created a 22 million pounds (more than 24 million euros) of **government funding to develop waste-based advanced fuels in the UK for aviation and freight**.[93]

7.2. Analysis of national policies

Following the policy assessment for each of the nine countries selected for the study, the national policies were analysed based on their level of relevance regarding the BL2F technology. Figure 7 summarises the main take-aways from the national policy assessment.

[86] (Government Offices of Sweden, 2020)
[87] (Carbon pricing leadership, 2019)
[88] (Swedish Parliament, 2018)
[89] (Energy Authority Sweden, 2018)
[90] (Energy Authority Sweden, 2020)
[91] (UK Department for Transport, 2018)
[92] (The Government of UK, 2018)
[93] (The Government of UK, 2018)

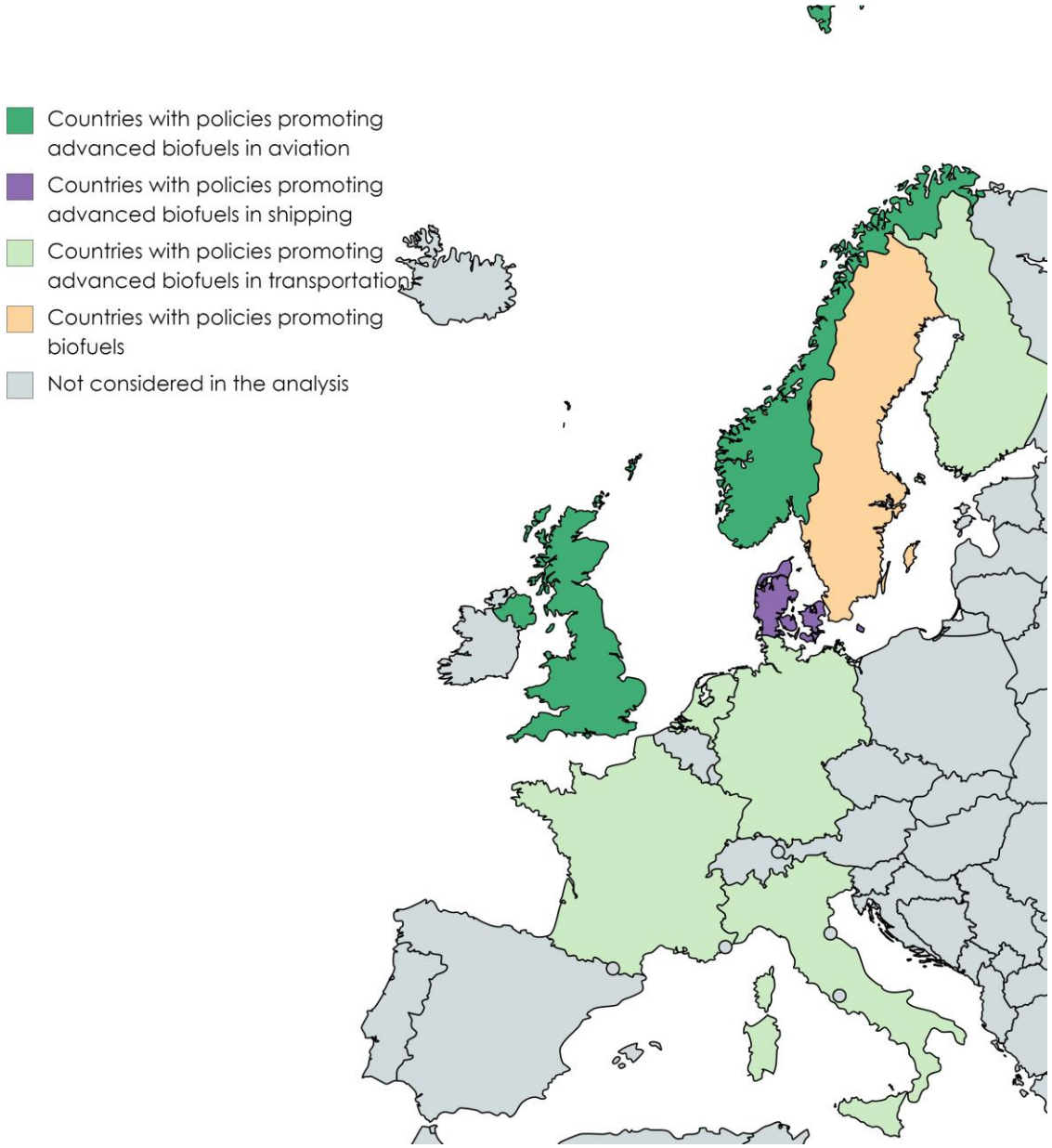

Figure 7. Advanced biofuels policies in European countries as of September 10th, 2020

7.2.1. Analysis of national measures promoting renewable energies

In this section, the focus was made on **carbon tax mechanisms.** It is however important to note that measures that promote renewable energies however do not uniquely consist in carbon taxes. As shown in Table 3, carbon tax regulations were identified in five countries, **Denmark, Finland, France, Norway and Sweden.** Other countries with lower carbon rates than 23 euros/ton were not considered.

Country	Policy	Year of implementation	Original rate	Current rate	Evolution
Denmark	Carbon tax	1992	6€/ton CO2	23€/ton CO_2	*3.8
Finland	Carbon tax	1990	1.12€/ton CO2	66.2€/ton CO_2	*59
France	Carbon tax	2014	7€/ton CO2	86.2€/ton CO_2	*12.3
Norway	Carbon tax	1991	17€/ton CO2	46.7€/ton CO_2	*2.7
Sweden	Carbon tax	1991	23€/ton CO2	110€/ton CO_2	*4.7

Table 3. Carbon tax instruments in the countries of the study

Carbon taxing, a limited instrument to move away from fossil fuels

In these five countries, **the stringency of the carbon tax regulation was gradually and constantly increased over time**. The exemption of renewable fuels and biofuels from the financial burden encourages distributors to **shift towards more sustainable fuels in the long run**. On the other hand, **carbon tax rates, despite their constant evolution still seem to be insufficient.** A much greater scale of intervention would be needed to bridge the price gap between renewable and fossil fuels. According to the 2019 OECD Taxing Energy Use report, only 18% of emissions outside the road sector across the globe are sufficiently taxed to address the climate crisis. Moreover, emissions from international aviation and shipping are not taxed at all.[94]

7.2.2. Analysis of national measures promoting biofuels and advanced biofuels

National Policies set up more biofuels blending targets and advanced biofuels incorporation

Figure 8 illustrates the appearance of relevant national policies regarding the promotion of biofuels and advanced biofuels. The first policies promoting renewables (here, carbon taxes) were implemented in the 1990's. Then the first policies regarding biofuels emerged in the mid to late 2000's, and began implementing advanced biofuels sub-targets starting mid-2010's. In

[94] (OECD, 2019)

parallel, the ILUC Directive and the RED II (quoted in part 6) were a **massive push to the growth of biofuel blending targets and incorporation of advanced biofuels**.

Sweden has regulations promoting biofuels, whereas Finland, France, Italy, Germany and the Netherlands have policies promoting biofuels and advanced biofuels.

Higher biofuels blending objectives in road and rail fosters innovation

Biofuels and advanced biofuels mandates are working towards their higher incorporation in the energy mix. Indirectly, biofuels promotion in road and rail transport can foster R&D and innovation deployment on biofuels, that could be **later used for aviation and shipping**. Regulators typically stiffen the stringency of the regulation further as soon as the industry complies, setting biofuels blending objectives higher overtime.

Penalties and emissions certificates foster the production of advanced biofuels

Most measures enhancing the use of advanced biofuels in the transportation sector are relatively recent (2010's) and often result from a prior policy promoting the use of biofuels in the form of **sub-targets for advanced biofuels.** Sweden, France and Italy have **financial penalties**, which constrains fossil fuel producers to leave more space to the **production of advanced biofuels.**

In parallel, **advanced biofuel producers** are benefitting from the use of emissions certificates in the Italian case. Policies stay flexible, allowing fossil fuel producers to adapt freely to the change, instead of imposing specific processes or technologies.

The minimum obligation of advanced biofuels remains too low

Such policies represent opportunities for the use of advanced biofuels, and therefore the BL2F technology, especially in Italy, Denmark and Norway, where **advanced biofuels produced from wastes and residues are particularly enhanced.** On the other hand, despite their constant growth, the minimum obligation of advanced biofuels on the total fuel mix remains too low, leaving space for fossil fuels to continue developing further. Their volumes are marginal compared to the fossil fuel production. In Italy, Germany, Netherlands, and Denmark, the advanced biofuels obligation is only under 1% as of now.

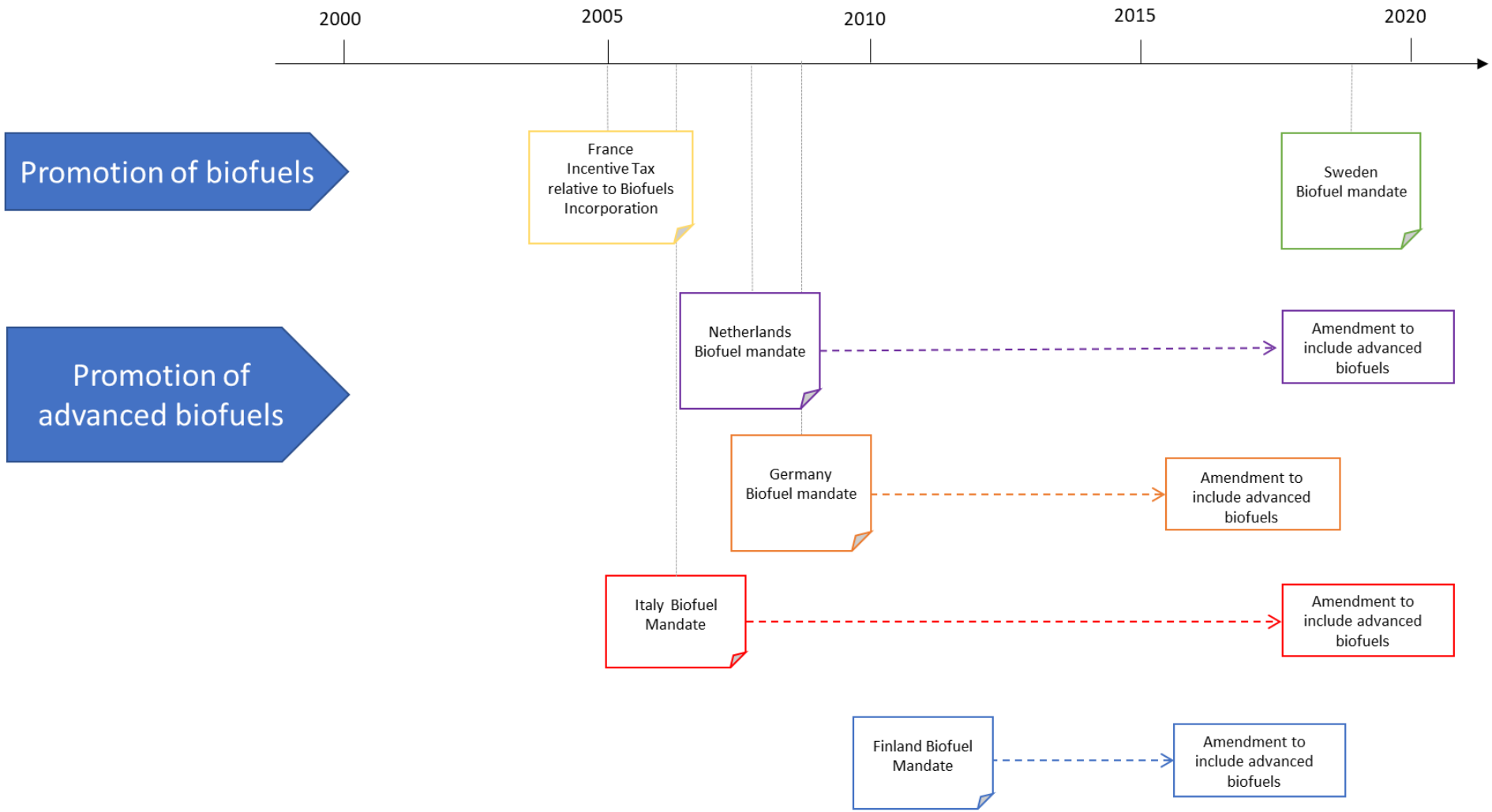

Figure 8. Timeline of countries promoting biofuels and advanced biofuels

7.2.3. Analysis of national measures promoting advanced biofuels in aviation or shipping

UK, Norway, and Denmark support advanced biofuels in aviation and shipping

An important highlight of this research's findings is that National policies consists generally in **financial coercion measures against fossil fuels** and/or in **enablement measures for biofuels and advanced biofuels** (Table 6, page 60). Only the United Kingdom, Norway and Denmark were listed as part of the countries in which policies enhance advanced biofuels in aviation or shipping.

The transposition of RED II will lead to more advanced biofuels targets in aviation and shipping

By 2021, June 30th, all the EU member states will have to transpose the **RED II Directive**, described in the part 6. **A spread of such policies is therefore expected by 2030.** In other EU member states, some additional policies are currently being studied or implemented to promote biofuels.

- As of mid-September, specific measures to enhance aviation biofuels have been in consideration by the Swedish Government since 2019. The biofuels for the proposed mandate could be **derived from the forest and paper industry residues**.[95]
- Similarly, in 2019, the Finnish government has introduced a Government Programme, which includes the ambitious **target of 30% biofuels share in aviation**, which will be achieved through a blending obligation.[96]
- In France, the Ministries of Ecological and Solidarity Transition, Economy and Agriculture have defined a national roadmap, which includes a **short-term trajectory for the substitution of fossil kerosene by sustainable biofuels** of 2% in 2025 and 5% in 2030.[97]

7.3. Risks and Opportunities of national policies to the BL2F technology

A gap between the permanent fossil fuel subsidies and the support of renewable energies

In European countries, **fossil fuel subsidies** are still undermining efforts to promote renewable energies sources and mitigate climate change. According to Climate Action Network Europe (CAN Europe), any form of government action which lowers the cost of fossil fuel energy

[95] (Biofuels Flighpaths, 2019)

[96] (Biofuels International, 2019)

[97] (French Ministries of Ecological and Solidarity Transition, Economy and Agriculture, 2020)

production or consumption can be defined as a fossil fuel subsidy. This includes **direct funding** (e.g. for coal mine operations) and **tax exemptions** (e.g. on diesel fuel), preferential loans and guarantees from public banks, and the grant of favourable access to resources, infrastructure and land.

In 2009, many governments members from the G20 and of the Asia-Pacific Economic Cooperation (APEC) committed to "*rationalise and phase out over the medium-term inefficient fossil fuel subsidies that encourage wasteful consumption*."[98] However, the 2017 report from the Overseas Development Institute and Climate Action Network claims that European governments and the EU Commission are handing out more than 112 billion euros each year to support the production and consumption of fossil fuels.[99]

Fossil fuel subsidies vary in their form across different EU Member States.

- In **France**, the **tax breaks for aviation** represent in total about 3.12 billion euros per year.[100] Domestic and international flights operated by commercial air carriers are exempted from the energy tax that usually applies to the **consumption fossil fuels** like kerosene.
- A similar **aviation tax break** is also in force in **Italy, the Netherlands, Germany** and the **United Kingdom**, representing each year respectively 1551 M€, 2154 M€, 7539 M€ and 6379 M€ through VAT exemptions.[101]
- In **Italy and the Netherlands**, **fuel tax exemptions** are also used in **shipping**. Waterway transportation is exempt from the energy tax that normally applies to the consumption of fossil fuels. The amount is approximatively 548 M€ a year in Italy and 1369 M€ a year in the Netherlands.[102]

These fossil fuel subsidies undermine efforts to shift from fossil fuels to biofuels, using advanced biofuels from the BL2F technology.

The increase of carbon tax could foster the use of advanced biofuels

If carbon rates increase more, carbon tax could be a lever to shift towards low-carbon advanced biofuels. Because **financial costs are major drivers for change** by incentivizing fossil fuel distributors to seek more affordable alternatives, the **BL2F technology will provide a more affordable option**. The BL2F technology aims for a competitive production cost of 0.90€/L, instead of 1.00 to 1.50€/L for other sustainable aviation fuels, according to data provided by the grant agreement. The impact of carbon tax on the market will be detailed in deliverable D6.3.

[98] (OECD, 2009)

[99] (Overseas Development Institute and Climate Action Network, 2017)

[100] (OECD 2017)

[101] (OECD, 2017)

[102] (OECD, 2017)

Forerunner countries are attractive for the development of advanced biofuels in aviation & shipping

Denmark, Norway and the UK currently represent opportunities for the development of the BL2F technology on national scales as they have advanced biofuels targets in aviation and/or shipping. Moreover, since **Sweden and France** are also considering the inclusion of advanced biofuels in aviation and shipping, they **can lead the path** towards the adoption of similar policies in **other countries.**

A strong support for circular economy in national policies

The supportive regulations for circular economy indirectly affect the BL2F technology positively, as the technology implements a circular economy process at industrial level. In eight countries of the study, policies are supporting the development of circular economy, setting out the direction and ambition for a long-term and sustainable transition: **Circular economy roadmaps** are in force in France[103], Finland[104] and Sweden[105]. In the UK[106], Norway[107], Denmark[108] and Netherlands[109], a **national strategy for a circular economy** has been implemented in the last ten years. The circular economy action plans notably include the **creation of sustainable jobs.** This criterion is indeed a key point for the EU to achieve world leadership in renewables. These national policies could provide financial benefits to produce biofuels resulting from the BL2F process, improving its cost competitiveness.

National impulses for R&D and innovation efforts in the biofuel industry

Some countries are willing to encourage R&D efforts in companies and incite them to innovate through specific innovation policies targeted towards the industry. Through different types of **programs and grants initiated by the government**, research on the second generation of advanced biofuels shall be encouraged. This is the case for France. In France, the National Research Agency (NRA) has implemented the Bioenergies 2010 Program[110], which notably targets the **development of biodiesel from lignocellulosic biomass**, as well as the Bioeconomy Comity, created in 2017.[111] The French government has entrusted ADEME, the Agency for the Environment and Energy Management, with the management of a fund to support research in the various fields of new energy technologies. In this context, the agency

[103] (French Ministry of Ecological Transition, 2019)
[104] (Ministry of the Environment, 2018)
[105] (Government Offices of Sweden, 2020)
[106] (Government of the United Kingdom, 2020)
[107] (Norwegian Agency for Environment, 2020)
[108] (Danish Government, 2018)
[109] (Government of the Netherlands)
[110] (ANR National Research Agency)
[111] (French Ministry of Agriculture and Food)

has launched a call for expressions of interest (*AMI or Appel à manifestation d'intérêt*) on second-generation biofuels.[112]

Potential for the domestic production of biofuels produced by the BL2F technology

Europe is a major player in the pulp and paper industry on a global scale, representing 25% of the global production. Sweden and Finland are the top pulp producers in Europe, with a total production estimated at about 11 million tons each year for each country.[113] While it is important to note that policies do not particularly encourage domestic energy production, this performance still represents an opportunity to **retain black liquor's production in Europe**, rather than resorting to imports from outside the EU. North America and Asia (mainly China and Japan) represent respectively 35% and 22% of the pulp production worldwide.[114]

As the largest producer of renewable diesel and jet fuel in the world, and therefore a major player on the Finnish market, the Finnish company **Neste[115] will also be able to provide already-existing distribution lines for aviation biofuel.**

Germany, France, Finland and Sweden, may also leverage their **strong existing forestry industries.**[116] The location of advanced biofuel plants near to sources of waste or residue feedstocks will contribute to the reduction of costs and GHG emissions.

The high dependency of EU nations on fossil fuel imports from outside EU can push the adoption of domestic renewable alternatives

The nine countries of the study are dependent on fossil fuel imports from outside the EU, and therefore becoming increasingly reliant on non-domestic supplies. While Italy has seen the development of policies willing to reduce energy imports to promote domestic energy production, the **lack of incentives for domestic production and uptake of domestic energy** is highlighted in most EU member states, as seen regarding European regulations in part 6. In 2018, Italy's dependency rate was still a little below 80%, and around 60% in Germany.[117]

These rates demonstrate **the high reliance of countries on imports** in order to meet their energy needs. This challenge can be addressed through the promotion of domestic energy, and more precisely, domestic biofuels, to decrease the use of imported energy and resort to domestic renewables instead. This could become an **opportunity to relocate energy production in the EU and develop the production and use of domestic advanced biofuels.**

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[112] (French ecological transition Ministry, 2020)
[113] (World Paper Mill, 2019)
[114] (Statista, 2017)
[115] Neste is the world's largest producer of renewable diesel and renewable jet fuel refined from waste and residues introducing renewable solutions also to the polymers and chemicals industries. It is one of the partners from the BL2F project consortium.
[116] (Eurostat, 2016)
[117] (European Commission, 2020)

8. Policy recommendations to leverage the BL2F technology

This section includes recommendations on how the industry can use existing and desirable policy mechanisms to facilitate the use of the BL2F technology and enhance its economic value after 2030.

Benefit from funding opportunities to start industrial demonstration works

The TRL of the BL2F technology is currently at 3 at the start of the project in 2020 and aims to reach TRL 5 by the project end in 2023. By 2029, the advanced biofuels from Black Liquor are expected to be commercialized, as described in Figure 9 below.

The research phase will last for 3 years and will be followed by an industrial demonstration to increase the industrial readiness (from 2023 to 2025, reaching TRL 7). Two years later will come the first commercial plant (from 2026 to 2027, TRL 8) with one year of additional testing. The complete commercialization is targeted for 2029.

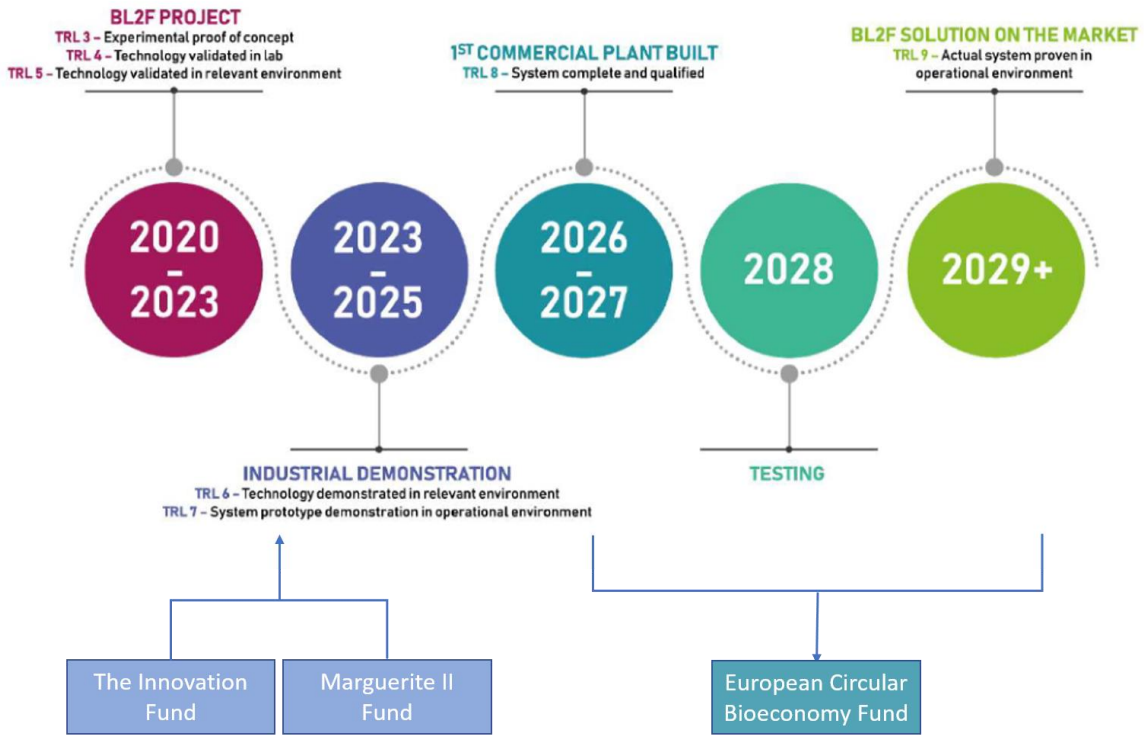

Figure 9. Funding opportunities to scale up the BL2F technology

Beyond the H2020 project duration, once the technology has reached a TRL 5 (between 2023 and 2025), the BL2F technology may take the opportunity to benefit from European funding programs in order to fund the industrial demonstration phase and scale up the technology : the **Innovation Fund** and the **Marguerite II Fund.**

The Innovation Fund is one of the world's largest funding programmes for demonstration of innovative low-carbon technologies, including renewable energy solutions. The revenues from the fund are provided by the EU ETS from the auctioning of €450 million allowances from 2020 to 2030. The Innovation Fund focuses on highly innovative technologies and big flagship projects with European added value that can bring on significant emission reductions. It aims to share the risk with project promoters by supporting the demonstration of highly innovative, pioneering projects.

The Marguerite II Fund, which was previously named the "2020 European Fund for Energy, Climate Change & Infrastructure", is an equity fund which aims to act as a catalyst for infrastructure investments in renewables, energy, transport and digital infrastructure, implementing key EU policies in the areas of climate change, energy security, digital agenda and trans-European networks.

At the late stage of the project, from TRL 6 to TRL 9 (from 2026 to 2029), investment opportunities are also provided by the **European Circular Bioeconomy Fund** (ECBF) which is a dedicated fund to invest in the Circular and Bio-based Industries in Europe. Opportunities for growth in late stage projects with higher capital needs are offered.

Network with other projects to further develop the technology

To reach TRL 5 and get more funding opportunities to reach TRL 9, the BL2F project needs to connect with national or international projects. The BL2F technology will be strengthened by connecting with national and international activities during the project phase. A non-exhaustive list, coming from the Grant Agreement, is available in the Appendix 5.

Focus on the shipping industry for a faster scale-up

In terms of processes, the shipping industry is more accessible for the advanced biofuels developed by the BL2F technology. In the BL2F process, the production of drop-in marine fuels is an intermediary stage to the production of drop-in aviation fuels (See Appendix 6).

The aviation fuel standards are more stringent and require more work for the BL2F technology to comply, compared to shipping. It is however important to note that regarding the policies factor only, the aviation policies are currently more open to the inclusion of advanced biofuels in the fuel mix compared to the shipping policies.

Prioritise on the distribution of the technology on countries with ambitious targets in the aviation and shipping sectors

The distribution of advanced biofuels could be initiated in European nations where policies are the most progressive regarding the incorporation of advanced biofuels. **The United Kingdom[118] and Norway are pioneers in aviation regulations while Denmark is leading**

[118] The current negotiations with Brexit might change the policy framework and thus change our recommendations.

the way in shipping. Currently, these countries offer the best support for the development of the BL2F technology.

In the UK, the fuel produced by the BL2F technology may benefit from the advanced waste-based renewable fuels mandate as part of the RFTO, as well as the government grant for waste-based advanced fuels for aviation and shipping. Similarly, in Norway the advanced biofuel mandate in aviation creates a favourable context for the BL2F technology. Moreover, in Denmark, the advanced biofuel mandate will favour the development of the technology for waterway navigation vessel and recreational vessels.

The analysis of the potential of these countries regarding their infrastructure and production in volumes will be deepened and further analysed in the D6.3 deliverable on market potential.

Benefit from diminishing allowance of EU ETS quotas to leverage advanced biofuels use

The BL2F technology produces advanced biofuels that may be a solution to the decarbonization of both aviation and shipping industries in a context of continuous reinforcement of allowances of EU ETS quotas.

The fuel produced by the BL2F process is expected to decrease CO_2 emissions by 83% compared to fossil fuels, and this data that will be further assessed by the end of the project. The technology allows airlines and ships to reduce their emissions and comply with their diminishing EU ETS allowance. Aviation is already part of the EU ETS, and shipping is expected to join the system soon.

The industry may however be tempted to choose carbon offsets that are more competitive over buying advanced biofuels. The cost competitiveness of advanced biofuels will be further studied in the market analysis (Deliverable D6.3).

Develop cross-sectorial partnership opportunities to ensure fuel quality, secure resources, and guarantee a steady supply

To ensure the quality and the supply of the advanced biofuels, it is also important to strengthen partnerships and co-operation between **pulp mills**, **fuel upgrading companies** and **fuel distribution.**

There is a lack of regulatory framework on the prioritization of resources. As black liquor can be used in **electricity** and **biochemical** applications, it is critical to **cooperate** with pulp mills to secure the resource for the transport sector and ensure a viable supply. As biomass is a limited resource, the market analysis (Deliverable 6.3) will assess the market potential of Black Liquor for biofuels, as opposed to the current market for electricity.

Moreover, it is important that partners ensure a robust and sustainable supply chain for the new technology. Biofuels from high ILUC risk feedstocks will be completely phased out by 2030, and there might be more stringent upcoming regulations regarding sustainable forest management. Regarding the feedstock, the technology should scale up with a **proper traceability of wood origin.**

Strengthen communication with relevant stakeholders to obtain their buy-in

The BL2F project can raise awareness on public acceptance of advanced biofuels, connect with other projects, and network with industry players and industry associations that appear on Figure 3 page 21, through active communication and dissemination during the project.

First, policies have been highly controversial due to changes regarding food-based biofuels, feedstock sustainability criteria, and indirect promotion of importations rather than support for domestic biofuel generation. The BL2F project can raise **general public awareness** on advanced biofuels from Black Liquor to prepare acceptance of these alternative fuels by the civil society, as they represent the end users. Moreover, once the BL2F technology is commercialized, it is important to emphasise that the products are made in Europe.

Additionally, the BL2F project needs to **communicate to industries** and **industry associations** to obtain their buy-in, which is key for the uptake of the technology. It is important to leverage that black liquor can be used to decarbonise aviation and shipping through innovative advanced biofuels.

Finally, in line with the Energy Union Strategy (COM/2015/080) which aims to support domestic job creation and reduce dependency on energy imports, it is important to communicate to forest owners and forestry companies that the technology will **promote jobs in Europe,** especially in rural areas. The use of biomass should be monitored carefully so that it is used in a sustainable manner.

For further dissemination & communication activities, please refer to the deliverable D7.1.

Conclusion

The international framework drives decarbonization in aviation and shipping

Decarbonization of aviation and shipping is pushed at the international level through different organizations. CORSIA aims at stabilizing aviation at 2020 levels, and EU members are volunteering to implement the first phases. In the shipping industry, the IMO has set objectives to halve CO_2 emissions by 2050. Biofuels are an opportunity since they are less carbon intensive and can help achieve their reduced sulphur cap. Moreover, they can be used in current ships while other solutions require new fleet.

In Europe, aviation is part of the EU ETS, and shipping is expected to be as well soon

There are also decarbonization strategies in aviation & shipping at the European level. Aviation is more ambitious than shipping, as it is part of EU ETS for flights within the EEA, while only domestic navigation emissions and emissions from inland waterways are currently included in EU ETS for shipping. However, a proposal was approved by the European Parliament in September 2020 to fully integrate shipping in the EU ETS.

RED II sets a 3.5% target on advanced biofuels for 2030, aviation and shipping can opt in the renewable share target

At the European level, advanced biofuels in aviation & shipping are only supported through a very light incentive with RED II, where biofuels which do not come from food nor crops can be multiple counted (x1.2) when they are used in aviation and shipping. Production of advanced biofuels for other sectors is supported overall in RED II which gives a predictable support towards advanced biofuels production until 2030. Feedstocks listed in Part A of Annex IX shall be equal to 3.5% of the total rail and road energy demand by 2030, where the contribution of advanced biofuels will be double counted.

Advanced biofuels may benefit from the phase out of high ILUC risk feedstocks by 2030

Moreover, other frameworks ensure that advanced biofuels are prioritised over biofuels causing ILUC emissions. The 2015 ILUC Directive has limited the use of first-generation biofuels to 7% of the final energy consumption in transportation. The Delegated Regulation on high ILUC risk feedstocks (EU) 2019/807 sets a criterion for characterisation of the high ILUC risk feedstock and for certifying low ILUC-risk biofuels. In 2030, high ILUC risk biofuels will not be accounted in the national renewable share of EU countries but will still be importable.

The transposition of RED II by member states is leading to a rise of biofuel mandates

European members states must take their own measures and instruments to transpose EU directives, especially the ILUC and RED II, in order to meet the imposed objectives. A variety of instruments is used, from carbon taxes to promote the use of renewable energies instead of fossil energy, to mandates working towards a higher incorporation of biofuels and, more recently since the mid-2010's, advanced biofuels in the fuel mix. The policy framework is heading towards the right way for the BL2F technology. While road and railroad transportation are generally the main targeted sectors, aviation and shipping are getting more and more

included in the national policies, and a further push is expected from European countries in the next years.

UK, Denmark and Norway have promising policies with advanced biofuels targets for aviation and shipping

The national context indeed offers potential opportunities for the development of the BL2F technology, especially in the UK, Denmark and Norway, where policies are the most progressive regarding the incorporation of advanced biofuels in aviation or shipping. A strong policy support for the circular economy is also highlighted in different European countries, as well as national impulses for R&D and innovation efforts in the advanced biofuels industry.

Based on the analysis, the recommendations for the industry of advanced biofuels for aviation and shipping on how to better benefit from existing policy mechanisms and facilitate the successful uptake of the BL2F technology are the following:

- Benefit from funding opportunities to start industrial demonstration works,
- Network with other projects to further develop the technology,
- Focus on the shipping industry for a faster scale-up,
- Prioritise on the distribution of the technology on countries with ambitious targets in the aviation and shipping sectors,
- Benefit from diminishing allowance of EU ETS quotas to leverage advanced biofuels use,
- Develop cross-sectorial partnership opportunities to ensure fuel quality, secure resources, and guarantee a steady supply,
- Strengthen communication with relevant stakeholders to obtain their buy-in.

Next steps: A first milestone towards the elaboration of scenarios for biofuel demand in 2040

This Policy mapping & Stakeholder assessment will be updated when necessary through short publications on policy changes. Following this deliverable, the identification of major trends in future biofuel demand will be assessed through the representation of factors and the elaboration of scenarios of the demand for biofuels in 2040 (deliverable D6.2). Based on each scenario, the market potential of the BL2F technology will be analysed (deliverable D6.3).

Appendix

Appendix 1. ANNEX IX of RED II Part A.

"Feedstocks and fuels, the contribution of which towards the target referred to in the first subparagraph of Article 3(4) **shall be twice their energy content**:

a) Algae if cultivated on land in ponds or photobioreactors.

b) Biomass fraction of mixed municipal waste, but not separated household waste subject to recycling targets under point (a) of Article 11(2) of Directive 2008/98/EC.

c) Bio-waste as defined in Article 3(4) of Directive 2008/98/EC from private households subject to separate collection as defined in Article 3(11) of that Directive.

d) Biomass fraction of industrial waste not fit for use in the food or feed chain, including material from retail and wholesale and the agro-food and fish and aquaculture industry, and excluding feedstocks listed in part B of this Annex.

e) Straw.

f) Animal manure and sewage sludge.

g) Palm oil mill effluent and empty palm fruit bunches.

h) Tall oil pitch.

i) Crude glycerine.

j) Bagasse. 85

k) Grape marks and wine lees.

l) Nut shells.

m) Husks.

n) Cobs cleaned of kernels of corn.

o) **Biomass fraction of wastes and residues from forestry and forest-based industries, i.e. bark, branches, pre- commercial thinning, leaves, needles, treetops, saw dust, cutter shavings, black liquor, brown liquor, fibre sludge, lignin and tall oil.**

p) Other non-food cellulosic material as defined in point (s) of the second paragraph of Article2.

q) Other ligno-cellulosic material as defined in point (r) of the second paragraph of Article 2 except saw logs and veneer logs.

r) Renewable liquid and gaseous transport fuels of non-biological origin.

s) Carbon capture and utilisation for transport purposes, if the energy source is renewable in accordance with point (a) of the second paragraph of Article 2.

t) Bacteria, if the energy source is renewable in accordance with point (a) of the second paragraph of Article 2."

Appendix 2. Summary tables of European policies

Policies	Classification	Type	Market Impact
The Effort Sharing Regulation	Coercion of CO_2 emissions Restriction of CO_2 emissions	Regulation	• Support towards R&D and innovation deployment to cut carbon emissions. • Enforcement instruments for stakeholder engagement
Energy Union Strategy	Enablement for the diversification of energy Environmental restructuring: support for the implementation of major infrastructure project that aim to integrating renewables	Regulation	• Support R&D and innovation deployment in renewable energies • Growth along the value chain
Clean Energy for all Europeans package	Enablement for the diversification of energy Environmental restructuring: - support for R&D innovation for clean energy - securing energy - improving cross-border connections within the EU	Legislation	• Support R&D and innovation deployment in renewable energies[119] • Growth along the value chain • Contributing to the domestic consumption of biofuels within the European Union

[119] (EU publications, 2019)

Policies	Classification	Type	Market Impact
Renewable Energy Directive (2018/2001/EU) (RED II)[120]	Enablement for: - the diversification of energy, - biofuels, - advanced biofuels, - biofuels in aviation and shipping	Legislation	• Support R&D and innovation deployment in renewable energies • Growth along the value chain • Enforcement instruments for stakeholder engagement • Contributing to the domestic consumption of biofuels within the European Union
Indirect Land Use Change Directive (EU) 2015/1513[121]	Restriction of CO2 emissions Enablement for advanced biofuels	Legislation	• Enforcement instruments for stakeholder engagement
Delegated Regulation on high ILUC risk feedstocks (2019/807)[122]	Restriction of CO2 emissions Enablement for advanced biofuels	Legislation	• Enforcement instruments for stakeholder engagement

Table 4. Analysis of European Policies

[120] (The European Parliament and the council of the European Union, 2018)
[121] (The European Parliament and the Council of the European Union, 2015)
[122] (The European Commission, 2019)

Appendix 3. Summary tables of national policies

Country	Policy	Year of implementation	Original rate	Current rate	Evolution	BL2F analysis
Denmark	Carbon tax	1992	6€/ton CO2	23€/ton CO2	*3.8	•Competitive pricing compared to fossil fuels •Enforcement instruments to engage stakeholders
Finland	Carbon tax	1990	1.12€/ton CO2	66.2€/ton CO2	*59	•Competitive pricing compared to fossil fuels •Enforcement instruments to engage stakeholders
France	Carbon tax	2014	7€/ton CO2	86.2€/ton CO2	*12.3	•Competitive pricing compared to fossil fuels •Enforcement instruments to engage stakeholders
Norway	Carbon tax	1991	17€/ton CO2	46.7€/ton CO2	*2.7	•Competitive pricing compared to fossil fuels •Enforcement instruments to engage stakeholders
Sweden	Carbon tax	1991	23€/ton CO2	110€/ton CO2	*4.7	•Competitive pricing compared to fossil fuels •Enforcement instruments to engage stakeholders

Table 5. Carbon tax measures in selected countries

Appendix 4. Policies promoting biofuels

Country	Link with the BL2F project	Policy	Year of implementation	Penalty	Current biofuels blending targets in the fuel mix	Current advanced biofuels blending targets in the biofuels mix
Sweden	Measures promoting biofuels	Biofuel Mandate	2018	476€/ton CO2 petrol; 380€/ ton CO2 gasoline	50% by 2030	/
France	Measures promoting biofuels	Incentivising Tax relative to Biofuels Incorporation	2005	0.98€/L	7.9% in 2019	/
Italy	Measures promoting advanced biofuels	Advanced biofuels mandate	2006 legislation amended in 2018	2.7 EUR/litre of diesel equivalent for conventional biofuels and 5.4 EUR/litre of diesel equivalent for advanced biofuels	9% by 2020	1.85% in 2022
Germany	Measures promoting advanced biofuels	Biofuel Mandate	2009 mandate amended in 2017	/	6.5% (in transportation energy mix)	up to 0.5% by 2025
Netherlands	Measures promoting advanced biofuels	Biofuel Mandate	2007 mandate amended in 2018	/	16.4% by 2020	1% in 2020
France	Measures promoting advanced biofuels	Article 43 of the 2015 Energy Transition Act for Green	2015	/	/	3.8% into petrol; 2.8% into diesel by 2028
Finland	Measures promoting advanced biofuels	Biofuel Mandate	NA	/	20% in 2020	0.5% in 2020
UK	Measures promoting advanced biofuels for aviation or shipping	RFTO amendment	2008 obligation amended in 2018	/	12.4% by 2032	2.8% in 2032
Norway	Measures promoting advanced biofuels for aviation or shipping	Biofuel Mandate	ND	/	22.3% in 2020	0.5% in 2020
Denmark	Measures promoting advanced biofuels for aviation or shipping	Sustainable biofuels Act	2009	/	5.75%	0.9% starting 2020

Table 6. Policies promoting biofuels in selected countries

Appendix 5. Suggested networking opportunities

List of activities involving BL2F partners	Type of project	Main contents and relation to the BL2F project
Pulp and Fuel Pulp and Paper Industry Wastes to Fuel	EU HORIZON 2020 RIA 2018-2022, SINTEF TRL 3-4 – TRL 5	• **Feedstock**: Black liquor and sludge • **Technology**: Combination of super critical water gasification (wet gasification) and fixed bed gasification (dry gasification); integration of the process on a pulp mill. • **Other**: The yield of biofuels will be increased to 28 % and production costs below 1€/l. • **Link to the BL2F project**: BL knowledge can be utilized. Different conversion technologies (gasification vs. HTL).
WASTE2ROAD Biofuels from WASTE TO ROAD transport	EU HORIZON 2020 RIA 2018-2022, VTT, SINTEF TRL 3-4 – TRL 5	• **Feedstock**: Low-cost biogenic residues and waste fractions • **Technology**: fast pyrolysis and hydrothermal liquefaction • **Other**: High overall carbon yields > 45% can be obtained while reducing greenhouse gases emissions > 80 %. • **Link to the BL2F project:** Emphasis not on the solving the challenges of BL. HTL involved as one of the cases handled in the project. Possibility to utilize the knowledge of HTL.
HyFlexFuel Hydrothermal liquefaction: Enhanced performance and feedstock flexibility for efficient biofuel production	EU HORIZON 2020 RIA 2017-2020, PSI TRL 2-4 – TRL 5	• **Feedstock:** Lignin-rich underutilized feed • **Technology:** Hydrothermal liquefaction, inorganic salts recovery, catalytic hydrothermal gasification, biocrude upgrading • **Other**: The goal is to develop flexible technologies for the hydrothermal liquefaction and biocrude upgrading of diverse advanced biomass feedstock to drop-in jet fuel. • **Link to the BL2F project:** Emphasis not on black liquor as HTL feedstock. Understanding relation between feedstock and process conditions vs. oil yield and quality. Biocrude upgrading (ash removal, HDO, HDN). There are some similar features that gather information relevant also to BL2F.

List of activities involving BL2F partners	Type of project	Main contents and relation to the BL2F project
BioMates Reliable Bio-based Refinery Intermediates	EU HORIZON 2020 RIA 2016-2020, RANIDO TRL 3-4 – TRL 5	• **Feedstock:** Straw and miscanthus • **Technology:** Ablative fast pyrolysis, catalytic hydrotreating, renewable H2-production, optimal energy integration. • **Other:** The hydrogen required for HDO process is produced from • hydrocarbons dissolved in the aqueous phase by gasification. HDO catalysts are developed, current catalyst's lifetime is short due to cooking. • **Link to the BL2F project:** Different feedstock and conversion technology. Knowledge of the catalyst development is relevant to BL2F
COMSYN Compact Gasification and Synthesis process for Transport Fuels	EU HORIZON 2020 RIA 2017-2021, VTT TRL 3-4 – TRL 4-5	• **Feedstock:** Biomass and waste-derived materials. • **Technology**: Biomass feedstock is converted by gasification and Fischer-Tropsch synthesis into FT-wax that upgraded into biofuel at an existing refinery. • Other: Goals are to reduce biofuel production cost 35 % cheaper compared to alternative routes and production cost for diesel is <0.80 €/l. • **Link to the BL2F project**: Different conversion technologies. Technology benchmarking available. Similar distribution value chain gives knowledge.
4REFINERY Scenarios for integration of bioliquids in existing REFINERY processes	EU HORIZON 2020 RIA 2017-2021, SINTEF, VTT TRL 3-4 – TRL 4-5	• **Feedstock:** Biomass • **Technology:** Fast pyrolysis and hydrothermal liquefaction • **Other:** Goal is to achieve overall carbon yields of > 45 %. • **Link to the BL2F project:** Focus on the upgrading of bio-oils from fast pyrolysis and HTL. Provides significant understanding of the refining of bioliquids. Products of fast pyrolysis are currently not accepted by oil refineries for upgrading to biofuels due to low quality of the products.
BRISK2	Biofuels Research Infrastructure Funded by EU Horizon 2020, RIA, grant agreement 731101	• **Feedstocks:** Wood, Miscanthus, Straw • **Technology:** Pyrolysis, Roasting, HTL, Gasification • **Other:** Transnational access to experimental facilities and advanced analytical methods for BL2F partners (HTL and hydrogenation)

List of activities involving BL2F partners	Type of project	Main contents and relation to the BL2F project
		• **Link to the BL2F project**: Access to equipment and analytical tool in addition to those activities contained in the tasks of BL2F.
NextGenRoadFuels Sustainable Drop-In Transport fuels from Hydrothermal Liquefaction of Low Value Urban Feedstocks	EU HORIZON 2020 RIA 2018-2022, STEEPER ENERGY TRL 3-4 – TRL 5	• **Feedstock:** sewage sludge, food waste and construction wood waste • **Technology:** Modification of the highly efficient and validated baseline HTL designed for lignocellulosics to process new feedstocks from urban activity. • **Other**: Aim is to demonstrate the potential to convert more than 100 M tons urban feedstock per year, at a cost of approximately 0.5-0.6 €/l. • **Link to the BL2F project**: Different feedstocks. Public results can be used to define detail engineering flow sheets for the HTL system. The knowledge of upgrading is relevant.
FlexJet Sustainable Jet Fuel from Flexible Waste Biomass	EU HORIZON 2020 IA 2018-2022, TRL 5 – TRL 7	• **Feedstock:** waste vegetable oil (cooking oils) and organic solid waste biomass (food waste) • **Technology**: SABR-TCR technology (traditional transesterification and Thermo-Catalytic Reforming). • **Other:** a pre-commercial demonstration plant to produce advanced aviation biofuel (jet fuel, 1,200 ton/year) The produced jet fuel is planned to be used by commercial flights of British Airways. • **Link to the BL2F project**: Different feedstocks and conversion technologies. Business case interesting on the distribution.
Bio4A Advanced sustainable Biofuels for Aviation TRL 6 – TRL 7	EU HORIZON 2020 IA 2018-2022,	• **Feedstock**: Wastes (residual lipids) • **Technology**: Hydro-processing of esters and fatty acids (HEFA) from wastes • **Other**: production target is 5,000 tons of HEFA in the new TOTAL's La Mède biorefinery in France, where a commercial technology is first time utilized at an industrial scale. Offtake agreements have been signed with KLM and Air France. • **Link to the BL2F project:** Different feedstocks and conversion technologies. Distribution knowledge useful.
Heat-to-Fuel Biorefinery combining HTL and FT for 2nd generation biofuels	EU HORIZON 2020 RIA 2017-2021 TRL 3-4 – TRL 4-5	• **Feedstock**: Dry and wet biomass • **Technology:** Combined gasification, FT and HTL processes. • **Other**: Targets are to gain a carbon conversion efficiency of 50% and the biofuel cost below 1€/l. • **Link to the BL2F project:** Different feedstocks and conversion technologies. General knowledge of HTL is useful in BL2F.

Table 7. Related activities

Appendix 6. The BL2F concept as a whole

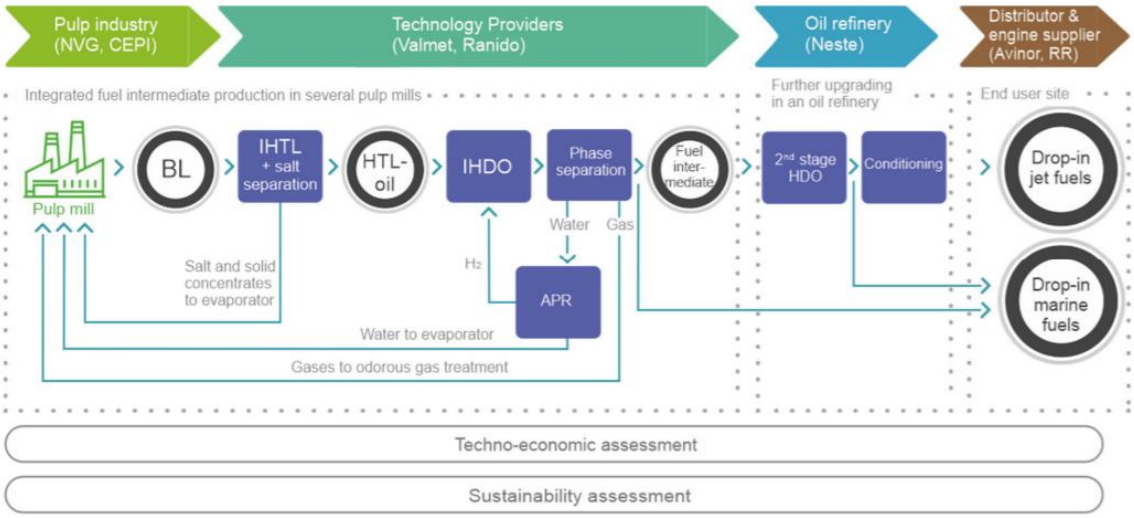

Figure 10. The BL2F concept as a whole

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