MUSIC

Market Uptake Support for Intermediate Bioenergy Carriers

D2.3: EU and national regulatory framework: present and future developments
WP2: State-of-the-art, framework conditions and growth potential for IBC

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857806.

Project acronym:	MUSIC
Project title:	Market Uptake Support for Intermediate Bioenergy Carriers
Project no.	857806
Duration:	September 2019 – August 2022 (3 years)
Work Package:	WP2 State-of-the-art, framework conditions and growth potential for Intermediate Bioenergy Carriers
Work Package leader:	RE-CORD
Task:	T2.3 Assessment of the EU and national legislative, institutional, and political framework
Task leader:	RE-CORD
Deliverable title:	D2.3 EU and national regulatory framework: present and future developments
Due date of deliverable:	31.08.2020

Authors	Organization
Marco Buffi, marco.buffi@re-cord.org	*Renewable Energy Consortium for R&D (RE-CORD)*
Giacomo Talluri, giacomo.talluri@re-cord.org	
David Chiaramonti, david.chiaramonti@re-cord.org	
David Moosmann, david.moosmann@dbfz.de	*Deutsches Biomasseforschungszentrum (DBFZ)*
John Vos, vos@btgworld.com	*BTG Biomass Technology Group BV*
Kaisa Vikla, vikla@btgworld.com	
Patrick Reumerman, reumerman@btgworld.com	
Magnus Matisons, magnus.matisons@biofuelregion.se	*Biofuel Region (BFR)*
Myrsini Christou, mchrist@cres.gr	*Centre for Renewable Energy Sources and Saving (CRES)*
Cristina Calderón, calderon@bioenergyeurope.org *Giulia Laura Cancian, cancian@bioenergyeurope.org*	*International Biomass Torrefaction Council (IBTC/Bioenergy Europe)*
Wym Van Der stricht, wim.vanderstricht@arcelormittal.com	*Arcelor Mittal Belgium (AM)*
Vesa Kainulainen, vesa.kainulainen@greenfuelnordic.fi	*Green Fuel Nordic (GFN)*

Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, restricted under conditions set out in Model Grant Agreement	

Deliverable version	Date
Final Draft	August 21st, 2020
Final	August 31st, 2020

ACKNOWLEDGMENT & DISCLAIMER

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857806.

EXECUTIVE SUMMARY

MUSIC aims to improve logistics and trade of biomass and intermediate bioenergy carriers (IBCs). Furthermore, MUSIC targets to inform, engage, train and support consortium partners as well as (industrial, regional and other) stakeholders on this topic.

The object of the present document is to evaluate the current EU and national legislative, institutional, and political framework, in the target regions. Moreover, the economic, social, and regulatory implications, that are of key relevance for the market introduction and large-scale utilisation of IBC and respective technologies, are reported. National framework evaluations involve case study regions (Greece, Italy, Sweden, Finland, The Netherlands and Belgium).

Table of Contents

List of Figures

List of Tables

Background and introduction

The present report investigates the current EU and national regulatory framework for Intermediate Bioenergy Carriers. The main goal of this report is the assessment of how existing/forthcoming EU legislation serves as either an opportunity, or a barrier, to the introduction and deployment of IBCs. This report is intended as a guide for stakeholders involved into the value chains across IBCs.

The first chapter investigates the current EU policies of bioenergy and biofuels, placing the IBCs into the complex legislative framework. Special attention is given to sustainability aspects of the biomasses used to produce IBCs.

The second chapter shortly addresses recent events as European Green Deal and COVID-19 crisis.

The third chapter provides details about IBCs' situation at EU level, while the forth one investigated the national framework of each country considered within the project.

Recommendations have been provided in each section, with particular attention to the potential market uptake of the considered IBCs.

1 Current EU legislative framework for bioenergy sector

In the last years, the European Union (EU) made significant progress in boosting the internal market for electricity and gas, promoting energy efficiency actions, renewable energy deployment, greenhouse gas (GHG) emissions reduction and a stronger framework for carbon price signals. Bioenergy is considered as one of the main pillars in the EU' renewable energy growth, but it consists in an intricate and complicate framework of regulations due to complex value chains involved. Before starting the analysis of the current policy scenario together with implications that IBCs have into the EU- and National legislative frameworks, the present chapter reports the highlights of the main pillars of the current European bioenergy and biofuels legislation.

1.1 Brief history of EU climate and bioenergy policies

The history of EU climate policy started before the approval of Kyoto Protocol in 2000. EU set its first actions during 1990s limiting the quantity of pollution, a strategy preferred to impose a fixed tax on pollutions, which could have tremendous repercussions on the equilibrium created between Member States in that years. Given the huge task that the decarbonisation of Europe implied, several actions were taken. First, EU demonstrated that economic growth could be decoupled from GHG emissions: between 1990 and 2013, GDP of the 28 Member States increased by 45% while emissions were reduced by 19%. Then, the first market mechanisms to reduce emissions were developed, in particular by putting a price on carbon. The Emission Trading Scheme (ETS) mechanism is today one of the pillar of the upcoming GHGs mitigation strategies towards 2050. Third, EU took a strong position to support sustainability and GHGs mitigation, setting numerous actions and policies. Last, in order to maintain fixed rules for all potential stakeholders for the upcoming bioeconomy growth, EU set long-term targets to achieve the expected emissions targets.

Increasing the use of biomass in the EU can help diversify Europe's energy supply, create growth and jobs, and lower greenhouse gas emissions. In 2012, biomass and waste accounted for about two-thirds of all renewable energy consumption in the EU [1].

A very significant action in the promotion of renewable energies in Europe, including bioenergy, was the Renewable Energy Directive (RED) (Directive 2009/28/EC). Moreover, methods for land use impact of biomass have been established by ILUC Directive (Directive (EU) 2015/1513) that included a set of methodologies to assess the use of lands in the long debate between food vs fuel. The RED was re-casted in 2018 with the introduction of the Revised Renewable Energy Directive (RED II) (Directive (EU) 2018/2001). The RED II is part of the "Clean Energy for All Europeans Package" which is a package of all EU energy policy framework that aims to facilitate the transition away from fossil fuels towards cleaner energy and to deliver on the EU's Paris Agreement commitments for reducing greenhouse gas emissions [2].

Based on Commission proposals published in November 2016, the "Clean energy for all Europeans package" consists of eight legislative acts. Following the political agreement by the Council and the European Parliament (between May 2018 and May 2019) and the entry into force

of the different EU rules, EU countries have 1-2 years to transpose the new directives into national law.

Moreover, on 11 December 2019, the Commission presented its communication on the European Green Deal (EDG). The EDG is proposed as a new growth strategy for the EU [3], aiming to transform it into a climate-neutral economy towards 2050, building on 2030 targets.

Today, in the middle of the pandemic situation of COVID-19, which required further actions to relaunch the EU economy, EU launched a new program called "Recovery Plan". On 21st July 2020, EU Commission agreed on a €750 billion recovery effort, Next Generation EU, to help the EU tackle the crisis caused by the pandemic. Alongside the recovery package, EU leaders agreed on a €1,074 billion long-term EU budget for 2021-2027. Among others, the budget will support investment in digital and green transitions [4].

1.2 Current policy scenario of EU bioenergy sector

As reported in the last paragraph, currently EU is living a transition period where new actions will be implemented soon, probably late 2021. However, bioenergy sector has an already established legislative framework since several years, where the current regulation covers both supply and demand side of biomass and biofuels production and use. Table 1 resumes and reports the main regulatory pillars for bioenergy sector [5].

Table 1: Main EU regulation of bioenergy divided in supply and demand side.

	European regulation	Aim of the legislation/ bearings on the sector	Existent/upcoming	Useful keywords for links
Supply side	Common Agricultural Policy	The Common Agricultural Policy is a common policy for EU Member States. Managed and funded at European level with EU's budget it support farmers to improve agricultural productivity, ensuring a stable supply of affordable food. It also aims at helping tackling climate change Sustainability of farming is incentivized through the so called "green architecture". In Ecological Focus Areas (an area of land upon which farmers carry out agricultural practices that are beneficial for the climate and the environment) in most members states Short rotation coppice and agro forestry plantations are eligible. In few countries lignocellulosic grasses as miscanthus are eligible.	The framework post 2020 is currently under discussion. As the decision-making process was delayed by elections, discussions on the Multiannual Financial Framework and other factors, the European Commission has published a proposal for transitional measures to ensure continuity of the current legislative framework until adoption of the reformed CAP. The proposal of the CAP Strategic Plan (covering until 2027) includes a stress on performance and more responsibilities for the members states to manage the instrument (decentrali-	Common Agricultural Policy (Pillar 1, Pillar 2, Omnibus, Ecological Focus Areas) Transitional Measures proposal Common Agricultural Policy Strategic Plans Proposal

		Rural development measures with national and regional programmes to address the specific needs and challenges facing rural areas. These include support to improve the overall performance and sustainability of an agricultural holding; or co-operation among actors for sustainable provision of biomass. The latter measures is currently programmed in 24 Rural Development plans in 9 Member States.	sation). A system of enhanced conditionality is designed to make sure sustainable practices are preferred by farmers. Among the elements impacting the bioenergy sector: -A specific objective to contribute to climate change mitigation through generation of renewable energy - Among the sectors eligible for coupled support to "Non-food crops, excluding trees, used for the production of products that have the potential to substitute fossil materials". -Dedicated forestry measures under the Rural Development Fund	
	Land-use, land-use change and forestry regulation LULUCF	Member States must ensure that greenhouse gas emissions from land use, land use change or forestry are offset by at least an equivalent removal of CO_2 from the atmosphere in the period 2021 to 2030.	Adopted in May 2018	LULUCF Forest Reference Levels proposed by EU Member States
Demand side	**Energy efficiency directive**	The recently amended directive sets a headline energy efficiency target for 2030 of at least 32.5%. This means that energy consumption should be no more than 1273 Mtoe (million tonnes of equivalent) of primary energy and/or no more than 956 Mtoe of final energy. Important measures for the bioenergy sector are the revised Primary Energy Factor and the comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling. Member states have to have to identify current needs, forecast future ones and potential for high-efficiency cogeneration, including residential micro-cogeneration, and by district heating and cooling and refurbishing and new installations.	Review adopted in 2018 Targets will possibly be reviewed in 2021	Energy Efficiency Directive COMMISSION RECOMMENDATION on the content of the comprehensive assessment of the potential for efficient heating and cooling under Article 14 of Directive 2012/27/EU

		Members states need to submit their comprehensive assessment by 31 December 2020.		
	EU emissions trading system	The EU ETS is key EU tool for reducing greenhouse gas emissions, it is the world's largest carbon market. Under the EU ETS Monitor and reporting regulation compliance cycle biomass is Zero rated. This means that when using biomass, operators covered but the Emission trading Scheme do not need to surrender allowances. Sustainability criteria need to be fulfilled. This measure should work as an incentive to switch from fossil fuels to biomass use.	EU ETS was revised in early 2018 and will cover the trading period from 2021 to 2030.	EU ETS Phase IV Monitoring and Reporting Regulation
	Renewable Energy Directive (recast)	The Renewable Energy Directive: establishes a Common framework for the promotion of Renewable energy sources; sets a binding target for the overall minimum share of energy from renewable sources in EU gross final energy in 2030 (32%); sets a binding target for the share of renewable energy in transport at MSs level in 2030 (14%); defines caps, minimum shares, trajectories and calculation rules for the various considered sustainable biofuels; establishes sustainability and GHG emission saving criteria for biofuels, bioliquids and biomass fuels; regulates the financial support to renewable electricity, H&C and transport (however, specific support schemes are defined by MSs).	The renewable energy directive was recast in 2018 The new sustainability criteria for biomass will be implemented from July 2021. A Delegated Act specifying the methodology to determine the share of biofuel, and biogas for transport, resulting from biomass being processed with fossil fuels in a common process is due between the end of 2021 and the end of 2023 (Art 28,5). The target will be reviewed in 2021.	Renewable Energy Directive II ((EU) 2018/2001) and all the related Delegated and Implementing Acts

The main pillar for IBCs' collocation inside the intricate framework of EU bioenergy and biofuels policies is the RED II. It defines how each IBC (categorized by feedstock and end use) falls within the various targets, caps and requirements set for biomass contributions. Moreover, it defines several of the terms considered inside MUSIC' project. The most important definition regards

"advanced biofuels" production thanks to IBCs, i.e. fuels deriving 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, that have low CO_2 emission or high GHG reduction, and reach zero or low ILUC impact.

The main terms, caps and targets related to RED II for bioliquids, biofuels, solid and gaseous biomass fuels and advanced biofuels, are recapped in the following scheme.

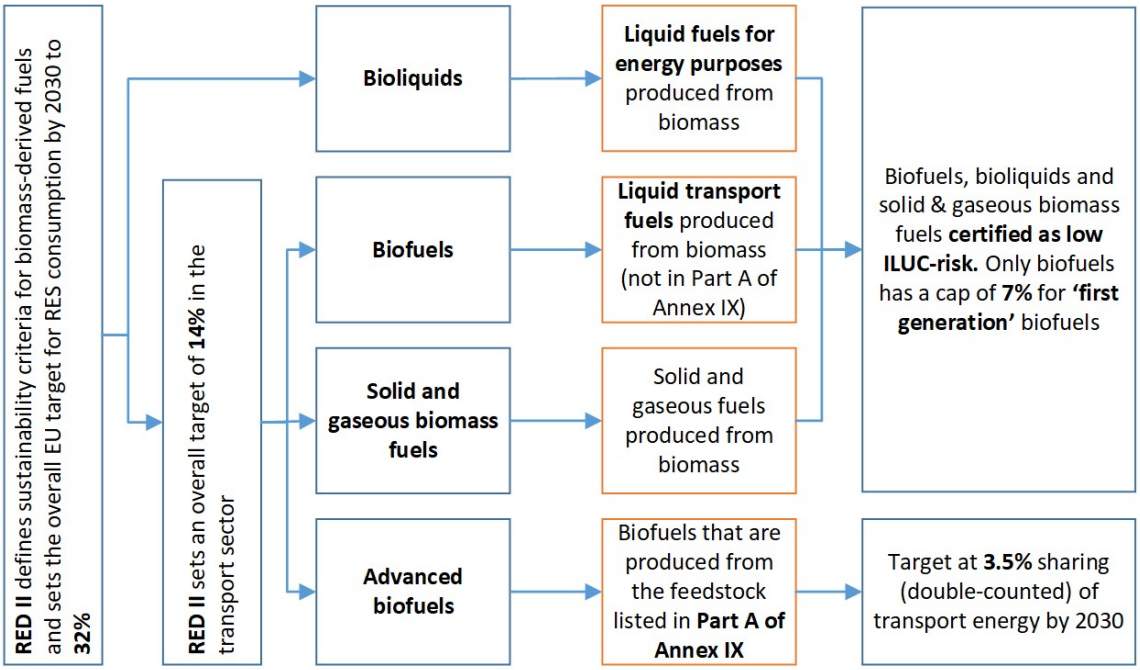

Figure 1: Main definitions and targets for bioenergy sector as regards RED II.

1.3 RED II and sustainability criteria

On a more general term, energy from biofuels, bioliquids and biomass fuels shall be taken into account for the following listed purposes only if they fulfil the sustainability criteria defined in Art 29 (2) to (7) paragraph and the GHG emissions saving criteria laid down in Art 29 (10), irrespectively of the geographical origin of the biomass[1]:

- contribution towards the overall 32% EU target set in Art. 3(1);
- contribution towards the 14% EU transport target set in Art. 25;
- eligibility for financial support.

[1] Anyway, Member States may establish additional sustainability criteria for biomass fuels.

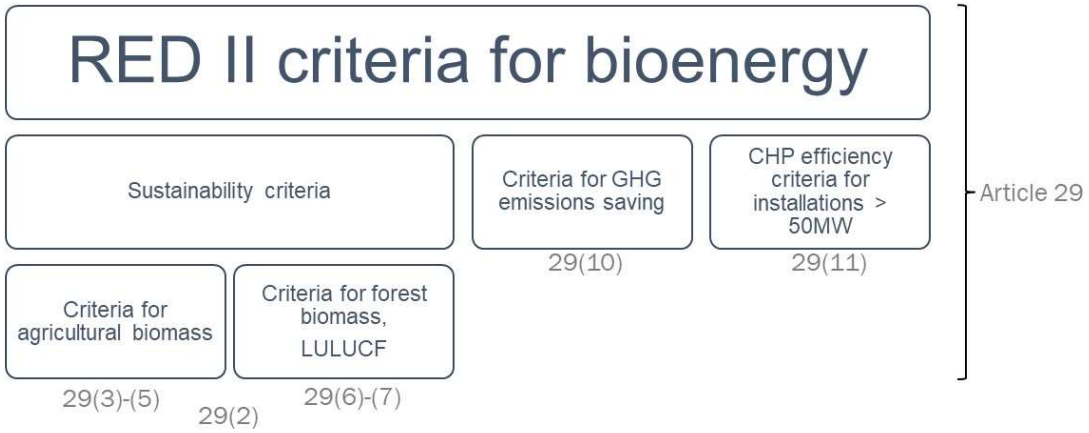

Figure 2: Overview of RED II criteria for bioenergy.

Then, a set of exceptions have been set and reported in the Appendix' section. For the above-mentioned purposes, biofuels, bioliquids and biomass fuels produced from waste and residues, other than agricultural, aquaculture, fisheries and forestry residues, are required to fulfil only the required GHG emission savings criteria.

Biomass fuels used in installations producing electricity, heating and cooling or fuels shall fulfil Art 29 (2) to (7) and Art 29 (10) criteria only if the plant surpasses a specific total rated thermal input threshold[2]. In this specific case, electricity from biomass fuels uses a slightly different total rated thermal input threshold[3] to decide if they shall fulfil Art 29 (2) to (7) and Art 29 (10) criteria; they are exempted to fulfil the criteria if biomass CCR (carbon capture and replacement) and CCS (carbon capture and storage) are applied.

1.4 Verification of RED II requirements

A certificate of a national or voluntary scheme demonstrates compliance with the requirements of the renewable energy directive. Within the scope of RED I, the EU Commission recognized a number of different schemes[4] for this purpose. This recognition is valid for five years. In order to enable voluntary schemes to become operational under the RED II, a recognition according to the new requirements is necessary. This process is not completed yet.

Operators seeking to become certified are free to choose one of the approved schemes. However, the schemes differ in geographic scope and applicable feedstock type. Besides, there are some schemes applicable to the entire supply chain, while others are limited to certain supply chain elements (e.g. biomass cultivation). In terms of the underlying principles and criteria, some of the schemes are more sophisticated. Hence, among them, there is a range between schemes covering only the criteria defined in the RED and others with higher ambition, covering

[2] 20 MW for solid biomass fuels, 2 MW for gaseous biomass fuels

[3] 50 MW, or 50 to 100 MW if it is produced applying high-efficiency cogeneration technology (for electricity-only installations, it must meet the energy efficiency level of the the best available techniques). Above 100 MW, it is produced applying high-efficiency cogeneration technology (for electricity-only installations, it must achieve an net-electrical efficiency of at least 36 %).

[4] https://ec.europa.eu/energy/topics/renewable-energy/biofuels/voluntary-schemes_en?redir=1

criteria sets beyond the RED criteria, targeting a more comprehensive consideration of the economic, social and environmental sustainability dimension.
Among the different actors involved in the implementation of the RED II sustainability requirements, there are control mechanisms in place to ensure reliability of the verification of the criteria (Figure 3). The EU Commission controls the certification schemes by the recognition based on the system documentation. Within the member states, the responsible national authority is reporting to the Commission. Moreover, with the national authority´s recognition, a certification body is permitted to offer a certification service to economic operators. Once an operator has applied for certification, an independent auditor conducts an initial audit for assessing compliance with the criteria of the chosen certification scheme. After successful completion of the audit, the operator eventually becomes certified. If so, he is authorized to trade material or products as sustainable. Information on the certification status is published on a public database operated by the certification scheme. To maintain certification, there will be a yearly surveillance audit. Auditors need to be qualified for the respective scheme´s criteria and rules and have to maintain the qualification by periodical re-recognition and training.

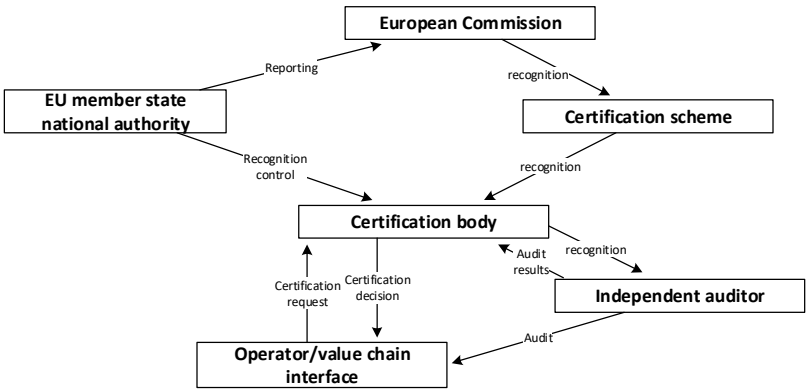

Figure 3: Involved parties and their roles in the verification of sustainability criteria for bioenergy in the EU.

To analyse how the RED II impacts specific bioenergy value chains, including IBCs, it is important to consider, that trading of RED II compliant biofuel or electricity and heat from biomass, requires the certification of the entire supply chain. Each supply chain element is subject to an individual certification, with an exception of the biomass cultivation, where biomass producers are mostly certified as a group of farmers and only a sample of the group is audited.
To comply with the GHG emission savings criteria, there are three options:

- use of default emission values for a defined value chain;
- individual calculation of the GHG emissions;
- use of a combination of disaggregated default values and individual calculation.

The disaggregated default values states the GHG emissions from one value chain element, while there are also default emission values for an entire value chain. Making use of default values is the most practicable way, as the emissions do not have to be actually calculated. The default values are given in RED II Annex V and VI. However, default values and disaggregated default values are only available for a limited number of value chains. In addition, the values are based on conservative assumptions. This means, that for cases in which no default value

exists or specific circumstances shall be reflected, GHG emissions have to be calculated individually. RED II Article 31 and Annex V and VI contain the equation and the basic methodological rules, which individual calculations have to be in line with. As illustrated in Figure 3, the GHG emission values are passed from one interface to the next interface throughout the supply chain. This enables the last interface to calculate the GHG emission savings against the applicable comparator for fossil fuels, specified in the RED II.

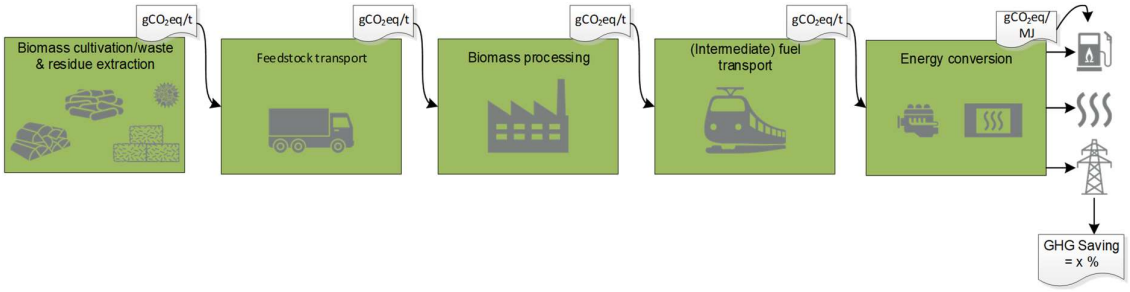

Figure 4: Exemplary bioenergy value chain with the flow of sustainability information by means of the GHG intensity.

1.5 Implications of sustainability into MUSIC case studies

With a view to the sustainability certification assessment of IBC value chains to be developed within this project, some aspects shall be highlighted in this section.

In this scenario the type of feedstock in use is crucial: RED II distinguishes between agricultural biomass, forest biomass and waste and residues. Differently than biomass, for waste and residues only the GHG emissions saving criteria are applied. Furthermore, emissions from feedstock production are not included in the GHG emissions calculation for this category. This means, the emissions up the feedstock transport are assumed equal to zero. This typically leads to high emission saving levels of the final bioenergy product.

RED II Annex IX provides a list of feedstock, which are eligible to be multiple counted (twice) their energy content for the minimum share of renewable energy in the transport sector (Article 25(1)). The list contains mostly lignocellulosic waste and residual feedstocks. Besides the multiple counting, biofuels produced from these feedstock stand out for a high GHG emission saving potential.

Which RED II requirements apply for a supply chain under investigation, largely depends on the products derived from the IBCs and their final use (transportation fuels, electricity, heat, cooling). This aspects is investigated in detail in the next chapter. Finally, in case of biomass fuels for electricity, heating and cooling, the capacity of the conversion plant decides about the value chain being suspect to RED II criteria or not.

Despite the RED II already entered into force, the requirements of the directive will become operational once implemented into national law of the MSs. At national level, there are still open rooms regarding the verification of the sustainability criteria for forest biomass. The new “risk based approach”, allows that criteria are verified on the country or regional level in which forest biomass harvest takes place. Verification on the level of the economic operators will only be necessary, in case regulatory frameworks do not already meet the requirements for forest

biomass harvesting. The details and especially the evidence to comply with the criteria will be specified by an implementing act on the operational guidance on forest biomass criteria. The EU Commission will publish the implementing act by 2021-01-31 (Article 29(8)).
Another fundamental aspect at national level is the application of the criteria for biomass fuels to installations with lower total rated thermal input (20MW for solid biomass and 2 MW for gaseous biomass) (Article 29(1)). In conclusion, each MS may establish additional criteria for biomass fuels (Article 20(14)).
The current status of MSs involved in MUSIC is investigated in Chapter 4.

2 EU Green Deal and COVID-19 impact on bioenergy legislation

As described in the first chapter, during 2019 the EU proposed the European Green Deal (EGD), a set of 50 actions for the coming five years across all sectors to prepare the EU economy for climate neutrality by 2050.

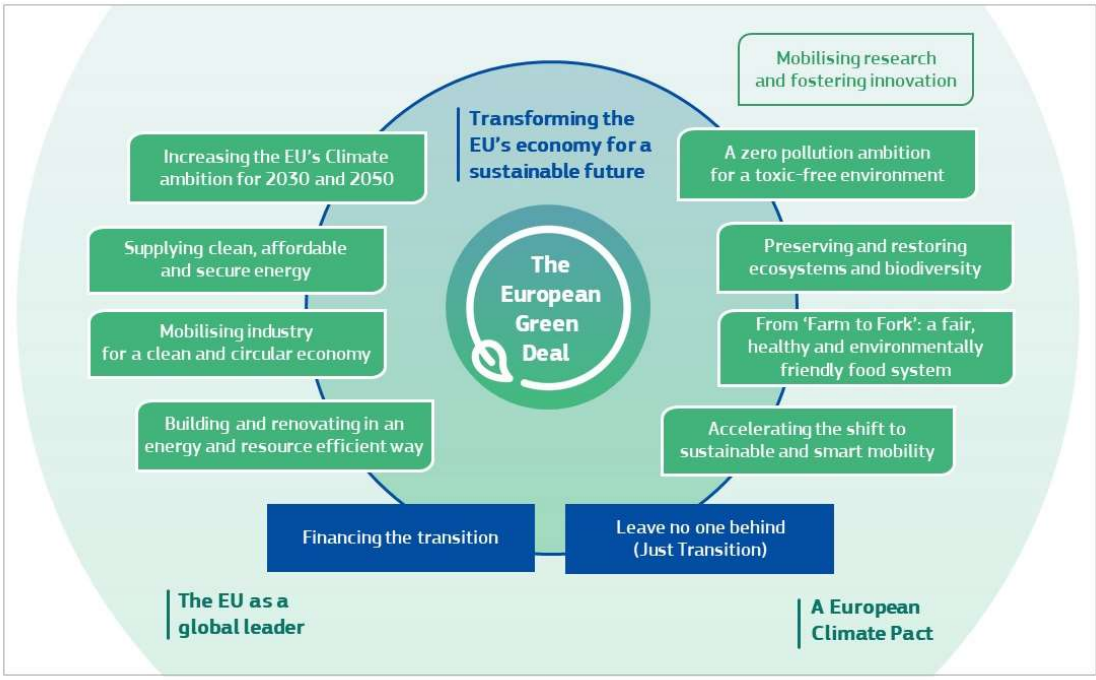

Figure 5: Main targets of the EDG[5].

Together with the European recovery plan and the EU budget, the EGD sets a framework for the EU to leverage short- and long-term actions for a green, resilient and expected recovery of the EU economy. The EGD has the potential to promote investments and technology progress needed for the long-term decarbonisation during the next years with targeted actions. Last but not least, the EGD is an opportunity for greater consistency of EU policies, to enable cost-effective, secure and guided transitions across the EU and across sectors beyond 2030 towards 2040 and 2050, within a common framework to promote industrial transformation, technology, and innovation leadership.

Since February 2020 the EU is affected by the world-wide pandemic of COVID-19. This crisis has effects on global (energy) markets and hence on the MUSIC project. Fuel demand has been reduced worldwide to unprecedented levels, with jet fuel demand being the most affected one. Oil price is at the lowest values recorded, reaching a negative price in the US for the first time ever on April 20th. While in the short-term low oil prices could be attractive, the long-term negative consequences could be very relevant, with significant associated costs for the EU economy and Member states (MS) related to the collapse of demand and to the socio-economic impacts.

[5] Available at: https://eur-lex.europa.eu/

Next paragraphs investigate how EGD and COVID-19 crisis affected bioenergy and biofuels sector, and consequently IBCs market uptake.

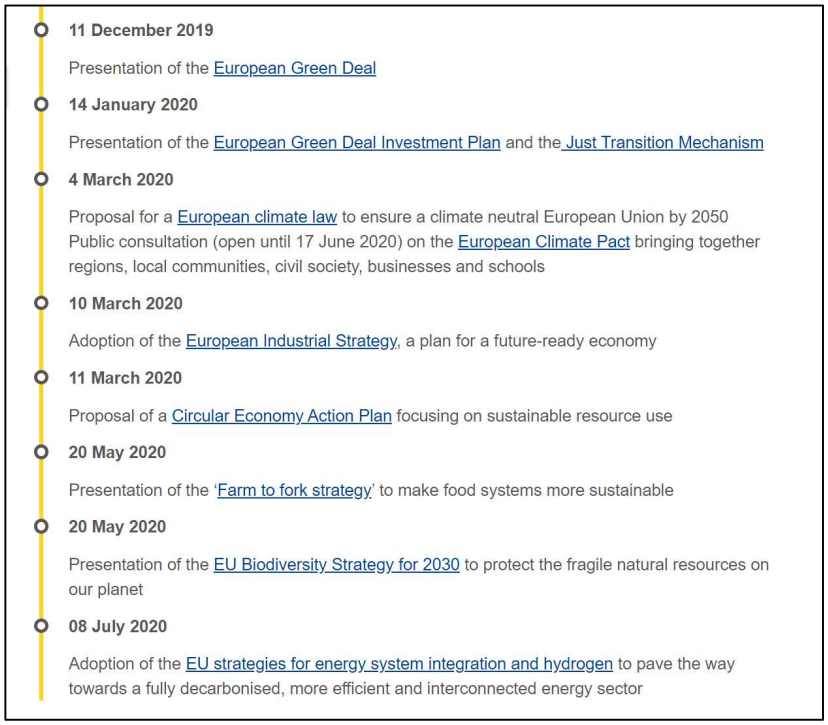

Figure 6: Recent EU actions against carbon emissions[6].

2.1 European Green Deal

The European Green Deal (EDG) will target the fight to climate change and the grow of EU Economy. In the new 2030 Biodiversity Strategy [6], the Commission recognised sustainable bioenergy as an important tool to fight climate change, identifying it as a priority along with wind and solar energy sources. The Energy System Integration Strategy [7] includes a separate chapter on unlocking the potential of renewable fuels produced from sustainable biomass and acknowledges biomass as an enabler of carbon capture, storage and use that can lead to "deep decarbonisation". However, bioenergy can be fully sustainable only when it meets the targets imposed by all sustainability criteria related to the use of soil.

EDG integrates the target of the Implementation Plan of Action 8 (IP8) - Bioenergy and Renewable Fuels for Sustainable Transport [8], to make a step change in the build-up of a cost-competitive bioenergy and renewable fuels market in the EU and globally. The plan details the European Research and Innovation activities required by 2030 to reach the strategic targets for this sector. Figure 7 highlights the most significant value chains involved into the "renewable fuels and bioenergy" plan.

[6] Extract from: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

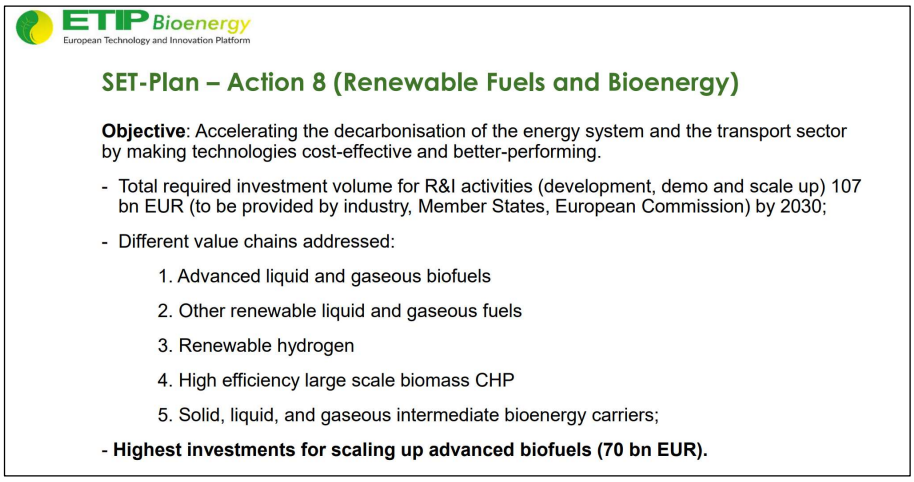

Figure 7: Recent slide of ETIP Bioenergy which highlights the updated SET-Plan targets at e-EUBCE2020 [9].

The main targets of the plan lay on improving the performance (yield and efficiency) of each value chain and the GHG saving of bioenergy technologies by 2030, whilst reducing their costs at the same time.

The action will develop a roadmap for funding and financing of the bioenergy projects and infrastructures included in the plan, innovation challenges to stimulate and encourage new business models, and an array of activities to bridge the gap between R&I results and industry application in SET Plan countries and globally.

In this context, IBCs play a significant role since they promote the green transition by substituting the fossil resources with bio-derived feedstock. They have been recognized as one of the main pillars of the energy transition, thus large investments that could promote actions such as MUSIC' case studies are expected. Their production favours growing business opportunities and promotes technology manufacturing and know-how in the EU as long as stable market and regulatory framework will be properly addressed.

In order to achieve these targets, biomass has undeniable strengths that mitigates carbon emissions, but it remains important to implement effective and efficient sustainability routes. RED II, agreed after lengthy political negotiations, establishes such sustainability criteria, effectively separating "sustainable" biomass from "unsustainable" biomass. It is important that the necessary implementing work goes on following this pathway. Ensuring that the sustainability criteria under RED II are fit for purpose, and work in practice will be essential in meeting the ambitious climate change targets set out by the EU and national governments.

2.1.1 Opportunities from EGD

A recent report by IEA [10] analysed the main opportunities that EGD can bring to the next future. Among pros, first, stimulus investments in energy efficiency are of primary importance. Equally, national fiscal stimulus programmes for home owners and builders can create a market for higher-efficiency products and services, with an additional benefit regarding the market uptake. Second, the period of low fuel prices represents an opportunity to promote low-carbon solutions, with incentives and taxation instruments. Third, investment in the digitalization of

the energy system introduce innovation and smart distribution of energy, very important for renewable energies. Fourth, together with the massive Next Generation programme of €750 billion, the target of the measures is the complete value chains, boosting energy research, development and demonstration as well as the proportion of a bioeconomy. Horizon Europe, the Innovation Fund, the Modernisation Fund, InvestEU and other measures take research to development and demonstration. EIB (European Investment Bank) is expected to play a major role in stimulating private-sector investment. The greater involvement of this action in earlier-stage and riskier energy projects compared to five years ago could generate additional resources. This will also be critical for the economic recovery – EIB has a critical role in supporting energy efficiency investment and more risky innovative projects, including by equity funding. The EU will evaluate the impact of EU energy RD&D funding, notably in the context of the EU economic recovery, ensuring the alignment of EU and national priorities (under the Strategic Energy Technology Plan) in the NECPs, and boosting private capital and innovation.
Despite the considerable challenge generated by COVID-19 pandemic, the European Commission continues to push towards the EDG targets. After the summer break, the Commission will present its 2030 Climate Target plan, explaining how it intends to increase ambition and raise 2030 emissions reduction targets.

2.2 COVID-19 pandemic crisis

COVID-19 affected hard on worldwide economy. As first, the effect of the generated economic crisis impacted on oil price. In particular, while in a short- to medium-term view the oil sector will require specific support measures to overcome the economic and physical shock brought in by the pandemic, in a medium to long-term perspective domestic sources such as EU biomass should be regarded as a way to secure energy supply, leading to significant technical and economic advantages. Thus, EU should allocate adequate resources in the post-COVID recovery plans to definitely allow the transition to renewable energy sources and particularly to bio-based economy and sustainable transport fuels.
A recent paper by Chiaramonti and Maniatis [11] evaluated the overall potential scenario ahead. Together with the lesson learnt during first year of MUSIC, biomass and IBCs play an important role to achieve a more independent energy system based on self-supported energy sources.
These targets could promote a real bioeconomy concept, stable and self-supported if immediate actions will be undertook. The recommended actions should cover:
• investment support to achieve short-medium term goals, which should address to assist EU large industrial companies to overcome the collapse of production demand and the economic shock, preserving EU direct and indirect jobs and business;
• investment support to achieve medium-long term goals, which should address to increase the ambition and promote bioenergy through incentives and taxation, injecting economic resources on the whole value chains.
The post-pandemic restart should be seen as an opportunity to steer the energy system to more resilient, secure, competitive and sustainable models, otherwise another very negative

consequence of COVID-19 will the represented by the missed opportunity to rethink our productive systems.

In conclusion, the post-COVID-19 period should not be considered only as a very difficult moment for renewables, but also as an opportunity, as never happened before, to support EU economic activities with sustainable resources. EU institutions should aim at strengthening the Energy Union aiming to ensure that Member States cannot take unilateral and disruptive decisions affecting the Single European Market.

3 Intermediate bioenergy carriers at EU level

This chapter analyses the interaction between IBCs and EU policies to place the MUSIC' case studies as well as other potential applications of IBCs into the current legislative framework. Recommendations and lesson learnt in the first year of MUSIC' project will be given in the last sections.

3.1 IBCs in the existing EU legislative framework

IBCs are intermediate products inside complex value chains, so their final use will drive a specific collocation of each of them inside the biomass, biofuel and bioenergy EU legislation. However, the initial feedstock to produce IBCs usually consists in lignocellulosic feedstock, both from residues, wastes and energy crops. In MUSIC, all IBCs derive from industrial or agricultural residues, thus they have to be compliant with sustainability criteria set by RED II (as reported in paragraph 1.5). The following flow chart provides a first summary based on end-uses.

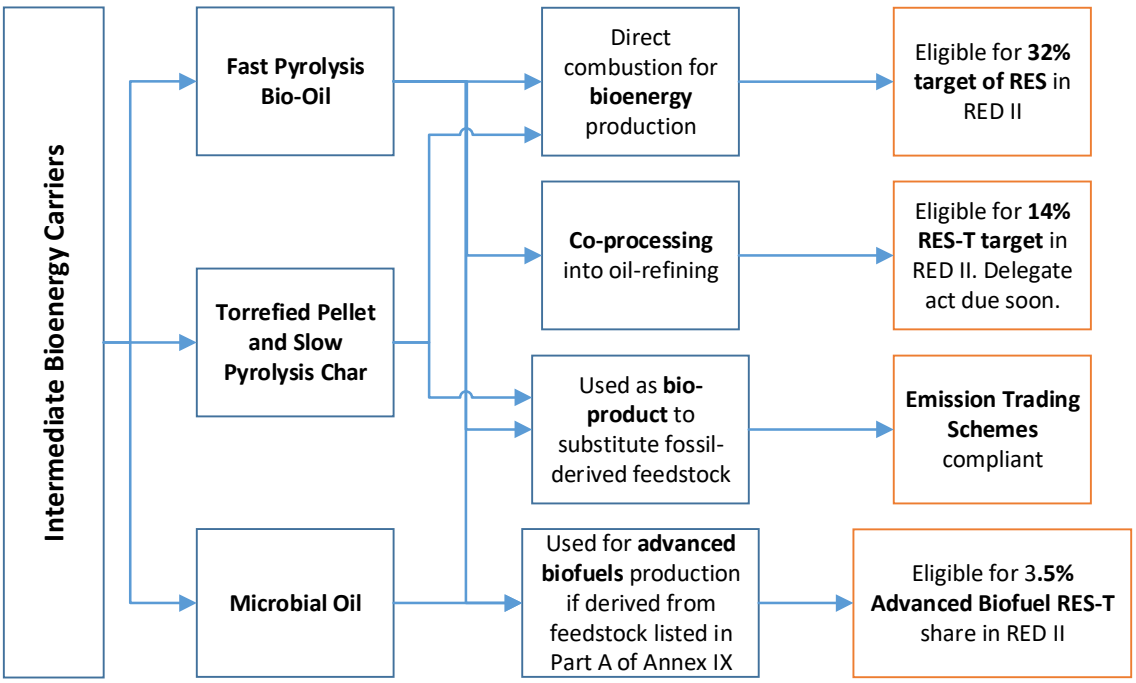

Figure 8: Collocation of each MUSIC' IBC according to its final use in the current legislative framework.

3.2 Fast Pyrolysis Bio-Oil

Fast Pyrolysis Bio-Oil (FPBO) is a dark brown, acid and viscous liquid derived from thermal liquefaction of biomass in absence of oxygen. As described in section 3.5.3, a lot of issues must be considered when this product is transported and stored. FPBO is an IBC that potentially can substitute petroleum oil or low quality fossil fuel, since it contains more than 50% of carbon and present a liquid form suitable for use in the existing oil refining' infrastructures. Depending on its final use, it can assume different collocation into the existing legislative framework. Here

below a brief list of the potential applications of FPBO into the current biofuel and bioenergy scenario.

- Bioliquid for energy purposes in burners, according to the standard reported in a recent report of H2020 Residue2Heat project [12]. In this case, once the bioliquid meets defined stardards, it can be stored, pumped and burned to provide domestic heat. This solution is included into the RED II targets regarding renewable energy target at 32%.
- Feedstock to be processed to advanced biofuels by means of hydrotreating (but this option is not commercial yet). In this case the final product is included into the RED II targets for advanced biofuels at 3.5% (generally double-counted, since it is produced from low-ILUC lignocellulosic biomass). The Hydrotreated Pyrolysis Oil (HPO) consists of a mixture of hydrocarbons, containing mainly aromatics: thus, its use as blending component has to be monitored. The recent webinar of MUSIC "Upgrading of Pyrolysis Oil" hold on Monday 8th June 2020 discussed in detail about these aspects. If used in aviation, it must be certified following ASTM D4054 [13], at a certain blending fraction according to ASTM D7566 [14]. In conclusion, the final blend must meet ASTM D1655 [15].
- Feedstock for co-processing with oil. Co-processing refers to the simultaneous transformation of biogenic feedstocks and intermediate petroleum distillates such as vacuum gas oil (VGO) in existing petroleum refinery process units to produce finished fuels. It involves cracking, hydrogenation, or other reformation of semi-processed biogenic oils in combination with petroleum intermediates to hydrocarbon fuels [16]. Semiprocessed biogenic feedstocks such as pyrolysis oil have been already identified as likely to be suitable for co-processing [17], such as other bio-derived feedstock as triglycerides (e.g. virgin vegetable oils, algae and other micro-organisms based oils, used cooking oil and fat-based oils. As depicted in Figure 8 it is part of the share of renewable energy within the transport sector at least 14% according to RED II. Work still needs to be done to determine the methodology to account the amount of carbon into the final product. The current (C14) methods may not always work to determine the renewable carbon quantities in 'green' refinery products, especially at low level of co-processed pyrolysis oil [17].
- Mechanisms of ETS. The use of FPBO could generate ETS in two different applications: industry and transport sector (excluding road vehicles but including electricity used in rail and road transports). In industry, the overall volume of greenhouse gases that can be emitted by power plants, factories and other fixed installations covered by the EU emissions trading system (EU ETS) is limited by a 'cap' on the number of emission allowances. If FPBO has been used into (e.g.) steel production, the industry sector is covered under the EU ETS with free allowances for those industries that are at risk of carbon leakage. Steel making industry (as the other industrial sectors) does not have any specific target for energy efficiency or renewables, and its inclusion under the EU ETS has not yielded substantial reductions in emissions. From 2013 to 2018, CO_2 emissions from industrial installations decreased by only 0.3%. EU should assess the allocation of allowances, investigate life-cycle approaches and review carbon leakage implications. In

2019, the EU saw a price for allowances at 28 €/ton, up from only EUR 8 €/ton in 2014. In 2020, the EU ETS withstood the oversupply from the COVID-19 crisis thanks to the Market Stability Reserve (MSR) [10]. CO_2 price at about 26 €/ton have been registered in August 2020[7], thus oil, gas and coal market might win back a competitive advantage that slow down low-carbon investments. The EU ETS cap for the aviation sector has been separately calculated. The Commission's 2012 initial proposal included aviation as a whole in the EU ETS while International Civil Aviation Organisation (ICAO) with CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) did not find yet a solution to equally manage this situation outside EU. Within the overall EU-wide cap, air companies receive or buy emission allowances, which they can trade as needed, but in any case the mechanism is a hindrance for them. Today EU aviation is currently the only sector subject to the European carbon market (EU ETS) whose emissions continue to increase. In 2018, aviation emissions subject to the EU ETS increased by 4% compared to 2017, reaching 67 million tons of CO_2 [18]. EGD allows for the revision of the EU ETS in 2021: the mechanism should be re-considered since intercontinental flights are excluded from the EU ETS system. The original scope of the EU ETS for aviation, i.e. covering the aviation sector as a whole, should remain, covering international flights, and probably other sectors such as maritime, according to EDG targets.

3.3 Torrefied pellets and slow pyrolysis char

Differently from other IBCs as FPBO, torrefied pellets and slow pyrolysis char are solid products. Thus, their use is not primarily intended for biofuel production. In the framework of MUSIC, they are assumed as feedstock for energy purposes (direct combustion), or in steel making plants as substituting product to fossil coal/coke. In the last option, TP/char (used as renewable carbon) consist in a mitigation strategy to carbon emissions. The mechanism generates tax detraction providing carbon credits to the plant owners: this mechanism is part of the EU ETS mechanisms. Limits and barriers of ETS have been already discussed in the previous paragraph. Moreover, no standards for char or torrefied material use in steel making sector still exist. However, the specific chemical and physical-mechanical requirements of the pellets made from thermally treated wood have been issued as international technical specification of ISO TS 17225-8: 2016 [19].

3.4 Microbial Oil

Microbial oil (MO) is produced from cellulosic sugars derived from lignocellulosic biomass, and it consists of 100% triglycerides (i.e. lipids) as conventional vegetable oils. Oleaginous yeasts accumulate lipids produced from sugars derived from lignocellulosic biomass, and the produced microbial oil can be used like conventional vegetable oils for biodiesel industry or biorefineries. They have potential advantages like faster growth rate, shorter life cycle, easier scale-

[7] https://ember-climate.org/carbon-price-viewer/

up, with no effects derived from seasonality and climate variation, and can serve as the excellent oil accumulating renewable feedstock [20]. However, the production technology is not fully commercial yet, but it is very similar to the one of cellulosic ethanol plants.
Microbial oil has a very similar collocation of FPBO into the current legislative framework (as shown in Figure 8), with the main difference that is easier to upgrade to biofuels. Today lipids are a consolidated feedstock for commercial HVO biorefineries; within MUSIC, the partner ENI is already operating two biorefineries to produce commercial green diesel. Whenever MO is used for this application and the initial feedstock is part of Annex IX part A, the produced green diesel is considered as an advanced biofuel. Today green diesel is blended with conventional diesel fuel up to 15% at the gas station (in Italy), and it consists of pure aliphatic hydrocarbons. Thus, the actual blending wall is far from the limit imposed for biodiesel according to CEN – European Committee of Standardization [21]. If MO is used to produce aviation and maritime renewable fuels, it can contribute to the 14% transport target but it is not subject to an obligation. The contribution of non-food renewable fuels supplied to these sectors will further count 1.2 times their energy content, toward the 14% transport target set by RED II.
Moreover, producing lipids from lignocellulosic material is becoming more interesting since the entry into force of the delegated acts on high ILUC-risk feedstocks and on the certification of low ILUC-risk biofuels, bioliquids and biomass fuels[8], as requested in RED II. In fact, the EU institutions agreed to reduce the consumption of high ILUC-risk feedstock to produce biofuels, as palm oil, starting in 2023 and reaching a complete phase out by 2030.

3.5 REACH regulation

Since 2007 the EU REACH Regulation (Regulation (EC) 1907/2006) deals with the Registration, Evaluation, Authorisation and Restriction of Chemicals. The overall objective of the Regulation is to ensure high levels of human health and environmental protection through the registration of chemical substances circulated in the EU and identification of their intrinsic properties [22]. The REACH Regulation requires registration of all the chemical products circulated in the EU market by EU situated manufacturers and importers, as well as non-EU companies exporting their products to the EU, in a central database managed by the European Chemicals Agency (ECHA). The REACH Regulation leaves the industry responsible for the management of the risks arising from chemicals and the provision of the corresponding measures for their safe handling. To complete the registration under REACH, different information requirements and deadlines apply depending on the volumes (tonnage) produced/imported and the hazard (carcinogenicity/toxicity) of the substance. Since 2018 manufacturers or importers of chemical substances need to register those substances when they are manufactured or imported in quantities of 1 tonne/year or more. The REACH regulation imposes very costly administrative burdens on these actors before they can please these chemical substances on the European market.

[8] COMMISSION DELEGATED REGULATION (EU) 2019/807 of 13 March 2019 supplementing Directive (EU) 2018/2001 of the European Parliament

Substances are registered for particular technical uses, which includes providing information on intrinsic properties and hazard of each substance, uses and safe way of handling as well as a risk assessment for human health and the environment.
Fuels are not exempt from REACH. Intermediate Bioenergy Carriers (IBCs) within the scope MUSIC enters into different REACH categories, which require independent analysis of REACH parameters as shown in the next paragraphs.

3.5.1 Char and Torrefied pellets

Char and torrefied pellets are product derived from slow pyrolysis (also known as carbonisation). Char produced from organic waste may be subject to constraints imposed by the REACH regulation, because the chemical composition of the biomass changes during pyrolysis. An exhaustive analysis of REACH regulations for char has been reported by Van Laer et al [23]. A REACH application for char and torrefied material is under preparation [24].

3.5.2 Vegetable oils and their derivate

Many vegetable and animal fats, oils and waxes are exempt from REACH [25]. Microbial oil, as well as other oil derived from micro-organisms (e.g. microalgae oil) and composed entirely by triglycerides are except from REACH. However, when biodiesel is produced from waste oil it must comply with REACH requirements.

3.5.3 Pyrolysis oil

In view of the production of large quantities of FPBO and their use in various applications, FPBO needs REACH registration. In 2013 a consortium led by Linnunmaa Oy (Finland) initiated the REACH registration process for FPBO. FPBO “used at industrial sites” is now registered (EC number: 692-061-0, CAS number 1207435-39-9).

3.6 Recommendations at EU-level

The present overview on the existing EU policies of bioenergy and biofuels showed that IBCs could play a crucial role in the promotion of a sustainable bioeconomy, being the first option to substitute fossil resources into the existing industrial infrastructures. However, barriers related to an intricate system of policies and high implementation costs (compared to fossil resources), in addition to an already absent biomass supply chain (production and logistics), still exist. Thus, first actions should go to boost all bio-based value chains towards RED II and the more ambitious EDG targets. A value chain approach with sector integration will allow to cover gaps and create new challenges across the supply chains, in particular when considering IBCs as element in the “middle” of a production pathway. Since today the biomass policy agenda has been based on specific targets such as CAPS and carbon reduction goals, value chains create multiple outputs that are clearly recognized to achieve sustainability and emission reduction targets. Each step of the entire value chains should now be involved in the process, to promoting a stable bioeconomy with clear roles and benefits for each involved stakeholder.
The new legislation has possibly to eliminate all uncertainties in order to facilitate bottom up decision making, which include future options that capitalize on local context and capacities, safeguard sustainability and facilitate resources efficiency. Restarting the fossil-based economy

with a bioeconomy based on short-chain production is the first measure to ensure the energy security in EU. This strategy needs urgent actions since EDG is the new umbrella to transit towards targets, which consider biomass as key-element into the transition (for instance circular economy, sustainability, energy security). Moreover, the reception of RED II within June 2021 at national level and the initiatives from NECP, play a crucial role in the next actions towards bioeconomy uptake. The next chapter shows the national situation for each country considered as part of MUSIC' case studies, highlighting the current potential at national level to boost the IBCs market uptake.

4 Intermediate bioenergy carriers at National level

The four case studies investigated in the framework of MUSIC involve six different regions. Each region is covered by a specific project partner, which has to deal with the national legislative framework of its specific country to implement the MUSIC' case study. The development IBCs market uptake is strictly connected to bioenergy and biofuels regulations that is under constant development, in particular at national level where the complex EU legislative framework has to be implemented. This chapter investigates the current national bioenergy policies of MUSIC' countries, including a brief analysis on barriers and constrains, as well as future recommendations, to promote IBCs' market development.

Country	Representative partner
Italy	RE-CORD
Sweden	BFR
Finland	GFN
The Netherlands	BTG
Belgium	ArcelorMittal
Greece	CRES

Finally, some specific recommendations at general level are provided by the MUSIC' country leaders to improve the current scenario.

4.1 Italy

The present paragraph addresses the use of biomass for energy in Italy, providing an assessment of the current status, as well as the expected future development. This paragraph reports the result of a recent analysis of RE-CORD for IEA [26].
In Italy, bioenergy represents the largest contributor among all RES, accounting for almost 50% of the total contribution, and approximately 9% of Italian Total Primary Energy Consumption.

4.1.1 Legislative framework for bioenergy

On the 31st of December 2018, the three Italian Ministries for Economy, Environment and Transport presented the Italian Proposal for a National Energy and Climate Plan, NECP [27] (in Italian: PNIEC, Piano Nazionale Integrato Energia e Clima dell'Italia), a ten-year strategy submitted to the EC. It has been reviewed in late 2019 and published in 2020.
The NECP 2019 lays its foundations on the previous 2017 National Energy Strategy [28] (NES 2017); both plans define a general policy framework and set several action priorities, among which:

- further promotion of RES penetration and integration;
- decarbonisation of the energy system;
- general increase in energy efficiency.

Specific targets for RES penetration in total energy consumption by 2030, as well as sub-targets for electricity, heat & cooling and transport are set in both plans, as reported in Table 2; NECP

2019 obviously mentions the RED II [29] objectives (32% for RES-Total and 14% for RES-T), that appear to be slightly different than its own ones.

Table 2: RES shares (total and sector-related) as set in NES 2017 and NECP 2019.

	NECP 2019		NES 2017
RES - Total (Bioenergy share)	30%	(3.7%)	28%
RES-E (Bioenergy share)	55.40%	(4.7%)	55%
RES-H&C (Bioenergy share)	33%	(16.3%)	30%
RES-T (Bioenergy share) [9]	21.60%	(14.4%)	21%

Bioenergy plays an important role in both National Plans, therefore policy context and corresponding sectorial usage scenarios are defined, as well as envisaged growth forecasts to 2030. As regards the power generation sector, a barrier of NES 2017 consisted in not recommending the installation of further bioenergy-powered capacity, due to high raw material costs and local pollution risk issues, especially in sensitive areas. Thus, it suggested reducing support schemes for existing bioenergy capacity and to raise installations efficiency. Only small to very small-scale plants should be subsidized, and only if powered by waste and residual biomass, meeting the cascading-use principle. The envisaged alternative conversion pathway is to bio-methane, to be used in the H&C or transport sector.

This vison is maintained also in the NECP 2019 that further defines solid biomass and biogas conversion technologies into electricity as fully developed, mature, yet still costly options. Auto-consumption is envisaged, especially in the agro-industrial sector, using CHP plants powered by production wastes and residues.

Both NES 2017 and NECP 2019 recognize the primary role of biomasses in the H&C sector, while pointing out the serious issue related to their polluting emission levels, which is mostly related to solid biomass and old equipment. More stringent performance requirements for heat generator are then expected to be set in order to obtain access to subsidies.

District heating potential is also evaluated; biomass is considered but with a smaller role, due to the already highlighted pollution issues.

NECP 2019 finally sets an ambitious 21.6% target for RES share in the transport sector, in which bioenergy weights for almost two-thirds of the total. In order to meet this objective, the largest shares of the proposed mix – again, around two-thirds of the total – are accounted to advanced bio-methane and multiple counting, non-advanced feedstocks (as defined in RED II Directive [29], Annex XI Part B).

4.1.2 Overview of the current supporting schemes

This chapter examines the Italian policy context related to bioenergy, separately reviewing the three main sectors of application: Electricity, H&C and Transport.

[9] Multipliers, as defined by RED II Directive, are implemented in the calculation

4.1.2.1 Electricity

At this time subsidies for non-PV RES-E, as defined by M.D. 06/07/2012 [30] and following M.D. 23/06/2016 [31] are no more available for new installation. A new decree is at draft level since August 2018, anyway it seems that support schemes for bioenergy are not to be included [32]. The only exception to this comes from the 2019 Budget Law (n.145, 30/12/2018), that extended the support schemes defined by M.D. 23/06/2016 to biogas-powered power plant up to 300kW, if owned by a farming or livestock business, that should use biomass produced on its premises to power the plant and self-consume the thermal energy produced.

Aside from that, bioenergy-powered power plant can access to a premium tariff called "Ritiro Dedicato" (put into force by S.I n. 387/03 and law n. 239/04), in which Renewable energy installations are promoted through a simplified purchase from GSE, who then sells the energy on the free market on their behalf. Producers (up to a specific power level) can decide whether they want to receive a Minimum Guaranteed Price (MGP) or the market price. In case the market price is higher than the MGP, the producer receives an annual adjustment.

The active power threshold is set to 1 MW for bioenergy-powered plants to access to MGP; prices are calculated and updated according to the formulas set in Art. 7.6, Annex A, AEEG 280/07 and updated every year.

Finally, S.I. n.387, 29/12/2003 simplifies grid access to RES-powered plants, by obliging the System Operator to provide the owner with solutions and cost estimations.

4.1.2.2 Heating & Cooling

The S.I. n. 28 03/03/2011, transposing RED Directive into National legislation, set a 50% RES share obligation for DHW and H&C needs for new or deeply renewed buildings, not to be obtained by only RES-E. In case the building belongs to the Public Authority, the share is raised to 60%. The M.D. 16/02/2016, referred to as "Conto Termico", updates the support scheme framework for, among the others, small scale, RES-powered thermal plants.

This support schemes are accessible to private individuals, as well as to Public Authorities and ESCo. Generally, subsidies are limited to 65% of total expenses; enterprises are subject to a further limit related to the maximum allowed aid intensity[10], which varies from 65% for Small enterprises to 45% for Large ones. Finally, a tax deduction scheme is in place for energy renovation of buildings, where some of the allowed interventions are bioenergy related [33].

4.1.2.3 Transport

In order to comply with the RES-T target set by RED Directive [34], Italy introduced, through the L. D. n. 28 03/03/2011 (modified by M.D. 10/10/2014 and by M.D. 2/3/2018) a quota obligation of biofuels for suppliers of petrol and diesel from fossil sources. The obligation can be met by obtaining the equivalent quota or the corresponding rights from others, buying so-called Biofuel Certificates (CICs); not complying with the obligation leads to a fee of €750 for every missing CIC in a certain year; anyway, an amount of CICs can be postponed to the next year (20% in 2018, 5% from 2019 onwards) [35].

[10] Expressed as the share of total aid over allowed costs.

Every CIC is set by M.D. 10/10/2014 to be equal to 10 Gcal (0.999933 toe), but advanced biofuels, UCO and animal fats[11] access to a double counting mechanism, so in that case a CIC is equal to 5 Gcal.
Together with the overall biofuels quota, an advanced biofuels quota has been introduced; [9] summarizes the implementation trajectories, as defined by the latest legislative intervention (M.D. 2/3/2018 "Biomethane Decree"). The same "Biomethane Decree" sets an obligation that the mandatory quota for advanced biofuels must be fulfilled for 75% by biomethane and for 25% by other advanced biofuels (the respective shares are to be reviewed every two years).

Table 3: Biofuels and adv. biofuels mandatory quota trajectories (as defined by M.D. 02/03/2018)

Year	Biofuels quota	Advanced biofuels quota
2015	5%	-
2016	5.5%	-
2017	6.5%	-
2018	7%	0,6%
2019	8%	0,8%
2020	9%	0,9%
2021	9%	1,5%
From 2022	9%	1,85%

Moreover, a National Registry of Guarantees of Origin for Biomethane is put in place by "Biomethane Decree" and managed by GSE.
Furthermore, all the biofuels released for consumption in Italy must comply with the sustainability criteria stated by the Renewable Energy Directive (2009/28/EC) and Fuel Quality Directive (2009/29/EC). These must be certified by specific certification bodies according to the National Certification Scheme (MD 23/01/2012), still in force but actually under revision [36].
Finally, Land Use, Land-Use Change and Forestry (LULUCF) regulations are taken into account by S.I. n.34 03/04/2018, that introduced the Consolidated Act for Forestry and Forest Industry (TUFF) which updates regulations in terms of Sustainable Forest Management.

4.1.3 Barriers and recommendations

Bioenergy in Italy needs larger incentive mechanisms in the heating and power sector, where significant environmental constraints and the absence of new supporting schemes limit this business development. In this scenario, the market uptake of IBCs such as microbial oil and slow pyrolysis char is limited by the absence of consolidated biomass supply chain.
Currently Italy is a large importer of solid biomass, which therefore requires strict control over sustainability of raw materials, as well as on statistics, to avoid opening the way to possible frauds and illegalities. Even if the current scenario is relevant, several opportunities still exist:

[11] More precisely, the list of feedstocks entitled to double counting mechanism is defined in Annex 3 Part A and Part B of M.D. 10/10/2014.

Italy presents a significant potential of lignocellulosic biomass availability, and an improvement of logistic infrastructure could bring to an increase in extraction rate, that in turn would lead to import reduction and to an increase of domestic energy security.

One of the current most relevant opportunities for bioenergy in Italy is represented by biomethane for transport: Italy has several competitive advantages already in place, such as the distribution infrastructure, a huge catchment area such as the CNG (and LNG) circulating fleet and the appropriate legislative framework as defined by "Biomethane Decree" and the ambitious target of 21.6% share of RES in Transport sector. The promotion of biomethane could favour in a second moment even the other IBCs since it allows the growth of a value chain based on agro- and forest- residues, thus promoting biomass wastes supply chains.

Bioeconomy could be further boosted by well-designed legislative acts aimed at defining reference standards to qualify sustainable bio-based products, as well as at encouraging a behavioural shift in consumers, fostering circular economy propositions.

Moreover, an adaptation of existing legislative measures, both at European and National level, could foster and financially support the Mediterranean marginal land recovery action that bioeconomy and bioenergy could put into place by using autochthonous feedstocks as an input for their processes.

An improvement of forestry logistic infrastructure, possibly fostered by specific support schemes and subsidies, would bring access to higher volumes of domestic solid biomass production and thus to a higher level of energy security.

Finally, maintaining the existing support schemes, and developing a clear and stable legislative framework for the bioenergy sector, would facilitate the investments, allowing to better plan a growth trajectory for the sector.

4.2 Sweden

4.2.1 Legislative framework for bioenergy

The use of bioenergy in Sweden has increased from 40 TWh/year in the 1970s to around 140 TWh/year today. Biomass has a dominant position in the Swedish heat market as a fuel for CHP for district heating. Very little fossil fuels are today used for heating. Biomass is also the main energy source for energy intense forest industries. Increased use of bioenergy is the main reason that Sweden has managed to decrease greenhouse gas emissions by 25% between 1990 and 2014. The main reason for this development is a broad political support for long term and stable energy policies starting with the introduction of carbon tax in 1991 and further developed with green electricity certificates introduced in in 2003.

4.2.2 Overview of the current supporting schemes

Investment support from the Swedish climate leap is available for investments in renewable energy.

4.2.2.1 Electricity

The most important measure regards green electricity certificates introduced in 2003. The system came in to force on the 1st of May 2003 and is intended to increase the production of

renewable electricity and make the production more cost-efficient. The system replaces earlier public grants and subsidy systems.
From 1st January 2012, Sweden and Norway have a common electricity certificate market. Over the period until 2020, the two countries aim to increase their production of electricity from renewable energy sources by 28.4 TWh. The joint market will permit trading in both Swedish and Norwegian certificates and receive certificates for renewable electricity production in either country.

4.2.2.2 Heating & cooling

Heating is not directly supported but as heat is produced in CHP plants it is indirectly supported by green electricity certificates.

4.2.2.3 Transport biofuels

In Sweden, the parliament has decided that the vehicle fleet should be fossil independent by 2030. In connection with the decision on the climate policy framework 2017, the parliament decided that greenhouse gas emissions from domestic transport should decrease by at least 70 percent by 2030 compared to 2010. In 2018, Sweden had the largest share of renewable fuels for transport in the EU with a 23 % share. The main driver for this development is the tax exemption that was introduced in 2007. However, the tax exemption has been questioned by EU as state subsidy and permission to extend it has been granted during this time period 7 times. This has not created the long term and stable energy policy landscape required for investments in domestic production of biofuels. In 2018, 85 % of the biofuels used in Sweden were imported and a reduction quota was introduced. The quota stipulates that the distributers of transport fuels are obliged to reduce the carbon footprint from the volumes sold by 19.3 % for diesel and by 2.6 % for gasoline. The reduction quota will step by step be increased until 2030. For the biofuels distributed as high blends (HVO 100, E85 and biogas), the tax exemption still remains may be removed soon. The past 5 years there has been a huge increase in the use of HVO based on a palm oil by product, PFAD (Palm Oil Fatty Acid Distillate). To deal with this problem, PFAD will be reclassified from waste to by product meaning that it must fulfil the same suitability criteria as other biofuels.
With the new quota in place, interest for domestic investments in biofuel production is on the rise. The quota for advanced biofuels within RED 2 is also a strong market driver. However, there're are still no plans to introduce a national quota for advanced biofuels. Investment support from the Swedish climate leap has been granted for production of PO in Kastet Sawmill in Gävle, now under construction. The climate leap budget has been increased this year and is likely to continue the coming years. Swedish oil refinery Preem has set up a company goal to produce and distribute at least 3 million cubic meters of renewable fuel by 2030 and are involved in several investment plans.

4.2.3 Barriers and recommendations

Even though Sweden has very good conditions for domestic production of biofuels, it still imports 85% of the biofuels used domestically. Polices has been too much focused on stimulation of consumption and the risk for investments in production of advanced biofuels has been and

still is high. Large imports of cheap biofuels especially palm oil is a barrier for domestic investments.

4.3 Finland

4.3.1 Legislative framework for bioenergy

Finnish situation of bioenergy is mainly based on increasing the biofuels since electricity and heating/cooling are well established due to the large amount of resources. In order to achieve the 30% biofuel target (as shown in Figure 9), the use of FPBO as feedstock for biorefinery to advanced biofuel production is perfectly in line with the national guidelines. Here following the targets towards 2030 of RES.

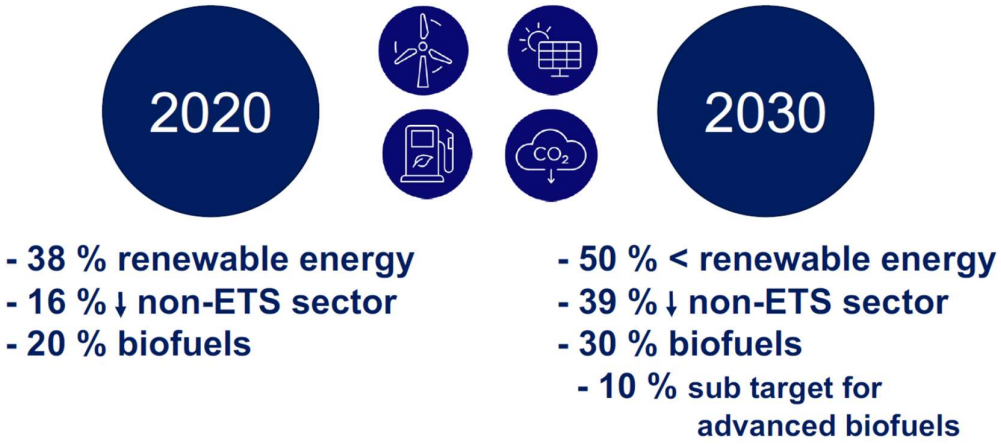

Figure 9: Renewable Energy targets in Finland from 2020 to 2030 [37].

4.3.2 Overview of the current supporting schemes

The main recent points regarding the national strategy for energy and climate as well as the main policies related to biofuels are reported here below:

Table 4: Current supporting schemes for bioenergy in Finland.

National Energy and Climate Strategy for 2030	Government of Finland issued year 2016	• Outlines the actions that will enable Finland to attain the targets specified in the Government Programme and adopted in the EU for 2030, and to systematically set the course for achieving an 80–95 per cent reduction in greenhouse gas emissions by 2050. • Finland will phase out the use of coal for energy. • The share of transport biofuels will be increased to 30 per cent • An obligation to blend light fuel oil used in machinery and heating with 10 per cent of bioliquids will be introduced. • The share of renewable energy in the end consumption will increase to approx. 50 per cent and the self-sufficiency in energy to 55 per cent. • Import of oil will be halved.

Act 446/2007		• The Act on the Promotion of Biofuels in Transport obliges vendors of petrol and diesel to fulfil a defined quota of biofuels. The amount of biofuels has to be increased year by year to make up 20% of the total sales by the year 2020 • Biofuels have to comply with the requirements defined in the Act on Biofuels and Bioliquids (§ 5 § 2 Act No. 446/2007, § 5, Act No. 393/2013) • Quota obligation 2011-2014 6.0 % 2015 8.0 % 2016 10.0 % 2017 12.0 % 2018 15.0 % 2019 18.0 % 2020 and afterwards 20.0 % • When biofuel is produced from waste, residues or inedible cellulose or lignocelluloses, its energy content is counted as double when calculating the final amount of biofuels (§5 Act No.446/2007). • If the retailer fails to fulfil the quota, a fine will follow. The penalty payment will be calculated based on the amount by which the retailer has failed to fulfil the quota, where each mega joule (MJ) is charged € 0.04 (§ 11 Act No. 446/2007).
Act 418/2019		• The Finnish Government decided on 6th February 2019 that coal-fired power and heating generation be banned as of 1 May 2029. The Government also decided measures to promote the use of transport biofuels and biofuel oil for heating and machinery. Government also decided fuel distribution obligations. • The obligation to distribute biofuels would be tightened gradually in the 2020s. • The obligation to distribute transport biofuels would be increased as of 2021, from 18% to 30% by 2029. • Similarly, the obligation to distribute advanced biofuels would be tightened from 2021 onwards, reaching 10 percentage points by 2030. • Obligation to distribute heating biofuels as of 2021, from 3% to 10% by 2028

4.3.3 Barriers and recommendations

Finland has ambitious energy and climate targets compared to other EU' countries. Targets for 2020 have been already exceeded and over 50 % renewable energy target are expected by 2030. The ambitious 30 % biofuel obligation, including 10 % sub-target for advanced biofuels, leads promising opportunities for the next future, in particular regarding the use of IBCs. Finally, since RED II implementation is due by end of June 2021, a lot of different delegated acts and implementing acts are coming. This will favour the promotion of new economic operators from biomass fuels and stable and long-term policies for industries.

4.4 The Netherlands

4.4.1 Legislative framework for bioenergy

The Netherlands in 2019 was far behind most other EU countries in the production of energy from renewable sources. In 2018, only 7.4 percent of the energy used in the Netherlands came from sustainable sources, according to figures by the European statistics agency Eurostat. (January 2020). As a result, the Netherlands is furthest from achieving the renewable energy individual targets for this year, since this share must be at least 14 percent by the end of 2020, according to the EU's rules.

Climate Agreement

To ensure targets are met the Dutch government in 2019 presented the Climate Agreement, with the key aspiration to reduce overall greenhouse gas emissions by 49% by 2030 (compared to 1990 emission levels).

In 2019, more than 100 parties (governments, the private and public sectors, NGOs) have made agreements on what measures they will adopt over the next ten years. Each sector sets its own targets and takes measures together to reduce CO_2 emissions. The sectors are electricity, industry, mobility, built environment, agriculture and land use. The government is also taking additional measures to ensure that the issue and the costs are shared fairly. For example:

- The tax on the energy bill of households with average consumption will be reduced by €100 in 2020. In subsequent years, the increase in the energy tax will be limited.
- Up to and including 2030, industry will contribute more to the so-called Storage of Renewable Energy (ODE) than it receives in subsidies from the SDE+. There will also be a CO_2 tax for the industry.
- The government wants to continue to stimulate electric driving with more charging stations and subsidies for electric cars.

The effects of the measures on CO_2 emissions and income effects are analyzed by the Netherlands Environmental Assessment Agency (Planbureau voor de Leefomgeving, PBL) and the Netherlands Bureau for Economic Policy Analysis (Centraal Planbureau).

The estimated emissions from transport in 2030 should be below the 25 Mtonne CO_2 target of the earlier Energy Agreement. The 2030 target stated in the Climate agreement will be partly filled in by the HBE system, a biofuel blending requirement. This system is aimed at companies that deliver fuels to the road transport sector in the Netherlands. In paragraph 4.4.2.2 this system is detailed.

Recent developments

The PBL published the *Climate and Energy Outlook (KEV)* in November 2019[12], which serves as the basic scenario for all analyses of energy and climate developments in the Netherlands up to 2030. The KEV takes into account all established and planned policies up to 1 May 2019.

[12] https://www.pbl.nl/publicaties/klimaat-en-energieverkenning-2019

Because the Climate Agreement was not published until the end of June, PBL considered in an additional 'Policy Letter' what the agreements would yield if they were all met.
The targets for 2020 in terms of energy conservation and renewable energy generation from the Energy Agreement, which is now incorporated into the Climate Agreement, have not yet been met. The target for renewable energy will probably be met in 2023. The target for 2030 is to achieve 49% less CO_2 emissions than in 1990. According to the KEV, all planned policies will lead to 35% fewer emissions. In the supplementary policy letter, PBL calculates that the latest agreements in the Climate Agreement add another 8 to 13%, which means that the 49% will not yet be achieved.
The SER – an influential advisory board of the Dutch government – published in July 2020 a report '*Biomassa in balans*' (Biomass in the balance) [38] In which the phasing out of biomass use for low-valued applications like heating was recommended. Biomass should only be used for high value applications like chemicals and materials, or in applications for which there are no other sustainable alternatives, like heavy transport or air traffic and marine applications.

4.4.2 Overview of the current supporting schemes

For now, bioenergy is still supported in the Netherlands, although there is a political discussion held on this (see the previous paragraph).
Besides many different forms of subsidy for innovative projects, there are several generic instruments that the Dutch government uses to stimulate bioenergy, that will be mentioned below. The focus has recently broadened from supporting renewable energy towards supporting actions that reduce emissions.

4.4.2.1 Electricity and heat and cooling

Energy Investment Deduction scheme

The Energy Investment Deduction (EIA) is a tax scheme through which the Dutch government supports investments in energy-saving assets and renewable energy in companies. EIA is a tax scheme that falls under the responsibility of the Ministers of Finance and Economic Affairs (EZ). The Tax and Customs Administration and the Government Agency for Enterprising Netherlands (RVO.nl), part of the Ministry of Economic Affairs, implement this scheme. The EIA offers tax advantages on investments in innovative techniques that save energy compared to a standard technique. With the EIA, the Ministry of Economic Affairs and Climate Change wants to give an impulse to investments in energy saving and sustainable economic growth. This is essential for achieving the energy transition targets.
EIA allows entrepreneurs to deduct 45% of the investment costs of energy-saving equipment from the taxable profit, in addition to the usual depreciation. As a result, they pay less income tax or corporation tax. In 2019, the EIA provided more opportunities in the context of the energy transition. These included investments to reduce natural gas consumption and CO2 emissions, but also to stimulate more electrification. As a result, the EIA will be further broadened to include the reduction of greenhouse gases.

Stimulation Sustainable Energy Transition grant (SDE++)

The Stimulation Sustainable Energy Transition (SDE++) provides grants for the use of techniques for renewable energy and other CO_2-reducing techniques. This grant is in the form of an exploitation subsidy, that provides a set amount of support per tonne of reduced CO_2.

For each technique, the 'unprofitable top' is subsidised. This is the difference between the cost price of the technique that reduces CO_2 (the 'base price') and the market value of the product produced by the technique (the 'correction price'). The base price is fixed for the entire duration of the subsidy, while the correction price is determined annually. If the market value increases, the unprofitable top decreases and so does the subsidy that companies receive. Organisations, in sectors such as industry, mobility, electricity, agriculture and the built environment that produce renewable energy or use CO_2-reducing techniques can apply for the SDE++. The SDE++ is a broadening of the former Sustainable Energy Production Incentive Scheme (SDE+). In addition to sustainable energy production, this new scheme also stimulates CO2 reduction. This makes the new SDE++ scheme considerably broader than the current SDE+ scheme. The scheme can thus make an important contribution to the objectives of the Climate Agreement. In addition, the government wants to ensure that the energy transition in the Netherlands remains feasible and affordable. The SDE++ is currently being developed, and will open in November 2020. After that it is expected that the SDE++ will open up again yearly, or biyearly in the next few years.

4.4.2.2 Support schemes for transport biofuels

Support schemes for transport biofuels fall outside of the scope of the SDE++, and are handled separately in the Dutch context. The Dutch biofuels policy is closely linked to the European policy and the Paris Climate Agreement. The Ministry of Infrastructure and Water Management is primarily responsible for the biofuels policy in the Netherlands. RED II requires EU Member States to impose an obligation on fuel suppliers to achieve a minimum of 14% renewable energy in transport by 2030. However, the Dutch Emissions Authority (NEa) is responsible for monitoring the RED II targets such as the cap on crop-based fuels by 7% and the obligation of 1% of advanced biofuels in 2020. The Netherlands steadily increases its share of renewable energy sources like biogas, biofuels and using green electricity[13].

Annual Energy Transport Obligation

A policy that supports the implementation of RED II is the Energy Transport Annual Commitment. The Annual Energy Transport Obligation obliges companies in the Netherlands that supply fuel to transport to have part of that fuel made from renewable energy. This concerns petrol and diesel for transport purposes for which a permit applies. These are, for example, road and rail vehicles, but also agricultural tractors and recreational vehicles. The Annual Energy Transport Obligation is used alongside other measures. Examples include increasing the efficiency of transport and stimulating electric driving. Renewable (bio)fuels are used where combustion engines are still necessary. The Dutch Climate Accord also sets additional targets to

[13] https://www.emissieautoriteit.nl/onderwerpen/algemeen-ev-2018/ontwikkelingen-ev

reduce CO_2 emissions and use more renewable fuels in the transport sector. Fuel suppliers have an obligation to reduce greenhouse gas emissions from transport fuels by 6%. In order to achieve these targets, the Annual Energy Transport Obligation will be adjusted on 1 January 2022. The Ministry of Infrastructure and Water Management is responsible for implementing the directive and RVO supports this[14].

Renewable Fuel Units (HBEs)

In the Netherlands, fuel suppliers must place a certain amount of biofuels on the Dutch market every year. Since 2015, they have indicated how much biofuels they have blended and how much electricity they have supplied for road transport. This is included in the Energy for Transport Register (REV) of the Dutch Emissions Authority (NEa). With the Energy for Transport implementation system, the Dutch government has introduced a trading system whereby companies can jointly supply their mandatory share of renewable energy in the most cost-effective manner. They can choose whether to supply and book renewable energy themselves, creating Renewable Fuel Units (HBEs), or buying HBEs to meet their obligations. An HBE stands for 1 gigajoule (GJ) of renewable energy supplied to the Dutch transport market. HBEs are obtained when renewable energy is registered in the Energy for Transport Register (REV). Companies need an account in the REV to hold and trade HBEs. But they can also buy HBEs to meet their obligation. Account holders in the REV can trade HBEs among themselves. Only companies with an obligation, bookers and other holders of an excise warehouse licence can have an account in the REV.

The Energy for Transport system follows the European directives but has been implemented in Dutch legislation and regulations. Companies cannot trade HBEs internationally or use them for legislation and regulations in other countries. Conversely, companies cannot transfer units from similar systems in other countries to the REV.

There are three types of HBE: HBE Advanced, HBE Conventional and HBE Other. The raw material of the entered renewable energy determines the type of HBE created. Companies with an annual obligation need a minimum share of HBE Advanced (HBE-G) and may use a maximum share of HBE Conventional (HBE-C). For the remainder of the annual commitment, HBE Other (HBE-O) is used. In the Climate Agreement it is stipulated that the amount of biofuels from food or feed crops will not rise after 2020.

Companies that do not meet the quantity receive a fine. This is stated in the Renewable Energy Transport Regulations. The NEa is required by law to publish several reports based on data from the REV. One of these reports is the HBE report. This report periodically provides information to support the market. The HBE report is published 5 times a year[15].

[14] https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/duurzame-energie-opwekken/bio-energie/beleid-bio-energie/beleid-biobrandstoffen

[15] https://www.emissieautoriteit.nl/onderwerpen/algemeen-ev-2018/hernieuwbare-brandstofeenheden

4.4.3 Barriers and recommendations

There are ample opportunities for the use of IBC's in the Netherlands, especially for production of advanced biofuels and chemicals/materials. Drawbacks with respect to the implementation of the RED II system for stimulating advanced biofuels are that the HBE units do not provide long term investment certainty for investors, and measures to alleviate that would be welcome. The recent movement in the Netherlands to high-value applications for biomass instead of e.g. heat can be beneficial for IBC developments and applications since the price of biomass could go down. As this change is however rather sudden, there is a longer term risk with the predictability of policy.

4.5 Belgium

Belgium has adopted the recently released RED II in the national climate action plan ('Belgisch geïntegreerd Nationaal Energie- en Klimaatplan 2021-2030'). Energy policy responsibility in Belgium is divided between the federal government and the three regions (Flanders, Wallonia, and Brussels), and more detail can be found at this link [39].

More details about recent news can be found on the official site of the National Energy and Climate Plan of Belgium [40].

4.6 Greece

4.6.1 Legislative framework for bioenergy

Today Greek energy market heavily depends on oil products. RES targets, as referred in the NCEP 2019[16], focus on biogas that provides in small part to electricity production. The use of bioenergy (primary solid biomass) will continue to make a significant contribution to heating and cooling, but without a significant increase until 2030, mainly due to the reduction of its use in the urban centres. As regards the transport sector, it is characterised by fast increase of the RES share, mainly due to the penetration of biofuels and the considerable contribution of RES electricity. The contribution of biofuels including multipliers related to the use of advanced biofuels, is increased by 5% from 2020 to 2030, while without the use of multipliers the increase is 3%.

A major item in the current energy scene of Greece is the 'lignite phase-out', which will lead all the lignite-fired thermal power plants to cease operation by 2023, which will put a complete end of the use of lignite for power generation in Greece by 2028. For this reason, the interest to replace lignite with torrefied pellet is of high interest. According to the NECP, several priority actions will be initiated in order to meet the national targets, such as the simplification and speeding up of the licensing procedures, the digitisation of the energy system, the enhancement and expansion of the energy infrastructures in order to allow maximum RES penetration in the power grid, whereas electro-mobility based on RES power generation is currently very high on the agenda.

[16] National Energy and Climate Plan. https://ec.europa.eu/energy/sites/ener/files/el_final_necp_main_en.pdf

4.6.2 Overview of the current supporting schemes

4.6.2.1 Electricity

The RES electricity market in Greece is currently well established and led by wind power and large hydro whereas photovoltaics are expected to grow faster after 2022. Biogas is the IBC that currently contributes to bioelectricity generation, mainly because of the high FiP it enjoys. The most important policy measure for electricity in Greece is the Guaranteed Price Support Scheme, which in conjunction with the Special Account for RES and High Efficiency Combined Heat and Power (HECHP) plants has ensured both the payments and viability of the support scheme.

Since the beginning of 2016, a new framework for the support of RES and HECHP was formed by Law No. 4447/2016[17] based on the operating aid in the form of either sliding Feed-in-Premium (FiP) or Fixed Price. This is expected to be the main policy measure for the strengthening of RES plants by the year 2030. In addition, a competitive process through tenders is established in the case of wind and photovoltaic units, which regulates the operational support of RES plants aiming to reduce costs for consumers.

The supporting schemes are summarised below:

- Premium tariff: A sliding feed-in premium (FiP), called "Operating support based on a differential compensation price" is awarded to RES and combined heat and power (CHP) plants connected to the power grid. FiP is calculated as the difference between the Reference Market Price and the Reference Tariffs for each technology and installed capacity, and is guaranteed for 20 years. FiP is supported by national Law No. 4447/2016.
- The New Development Law 4399/16 is the main financial tool for the support of the entire production process of enterprises. It covers investment plans of almost all sectors of the economy, including among others tourism, agricultural and animal primary sector and processing of agricultural and animal products, as well as energy production, distribution and infrastructure, etc.

  Through the Development Law, a number of Greek companies operating in all regions of Greece can be subsidized, under certain conditions, with rates that could reach the 55% of the investment. Eligible are building and infrastructure costs, production equipment, hotel equipment etc.

  Specific financial mechanisms are:
  - Tax regulation mechanism: The Development Law foresees support for CHP plants, small-scale hydro-power plants, and self-production using other RES in a form of an income tax relief and stabilisation of income tax coefficient.
  - Subsidies: The Development Law also foresees subsidies, leasing subsidies, and subsidies for the creation of new jobs for CHP plants, small-scale hydro-power plants, and self-production using other RES.

[17] All reported Greek laws available at: http://www.res-legal.eu/

- Net metering: The amendment of Law No. 3468/2006 introduces net metering for all RES for autonomous producers, while "virtual net metering" is applicable to PV and small wind power plants only in certain cases.

4.6.2.2 Heating & cooling

Heating and Cooling provisions mainly address energy efficiency in buildings[18]. The market is supported only by the Development Law, which foresees support for CHP plants and RES H&C plants (for self-consumption, but not only) in the form of income tax relief and a stabilisation of income tax coefficient for CHP and RES H&C plants. CHP plants and RES H&C plants can be substituted with other support mechanisms, i.e. subsidies, leasing subsidies, and subsidies for the creation of new jobs.

4.6.2.3 Supporting schemes for transport biofuels

Greece supports biofuels with a quota system, while there is also a tax regulation and a subsidy scheme available[19]. RED II has not been harmonised yet into the Greek legislation.

- Quota. Law No. 3054/2002 obliges producers and distributors of petrol and diesel to blend their fuels with a certain amount ("quota") of biofuels. The mandatory quota is set by ministerial resolution and is reviewed every year (art. 15A par. 3 Law No. 3054/2002). Max blending rate allowed by EN590 diesel standard is 7% by volume.
  Biodiesel mainly produced from sunflower oil is the only biofuel produced and distributed in the Greek territory.
  In 2020, 132,500 kilolitres of biodiesel will be distributed in the transport sector under the Quota system, being produced by 16 biodiesel production units and 5 importers. Domestic production of biodiesel corresponds to 99% of the total biodiesel production, amounting to 130,805 kilolitres and only 1% is imported. It is worth to mention that the domestic biodiesel production capacity exceeds by almost 5 times the biodiesel consumption under the quota system in the country.
  In terms of raw materials, about 60% of the biodiesel produced comes from oilseeds, 27% from used vegetable oils, frying oils, animal fats, while the rest is covered by cotton seed oils. Sunflower dominates with 210,000 tons that corresponds to 86% of the total amount of oilseeds, followed by rapeseed (10%) and soybeans (4%).

[18] -Law No. 2238/1994 (Law on the Income Tax)
-Law No. 3468/2006 (Generation of Electricity Using Renewable Energy Sources and High-Efficiency CHP of Electricity and Heat and Miscellaneous Provisions)
-Law No. 4399/2016 (Institutional framework for the establishment of Private Investment support scheme for environmental regional and economic development of the country – Establishment of the Development Council and other provisions (Development Law).
-Announcement of the "Energy Saving at Home II" programme to be implemented under the NSRF 2014-2020 - Programme Implementation Guide.

[19] -Law No. 3054/2002 (Organisation of the Oil market and Miscellaneous Provisions)
-FEK B 67/2010 (Joint Ministerial Decision on the Definition of the maximum biodiesel percentage in blends)
-FEK B 253/2013 (Definition of biodiesel criteria, distribution methodology and settlement of any relevant legal question in accordance with Art. 15A Par. 7 Law No. 3054/2002)

Law 4646/2018 introduced from the 1/1/19 bioethanol blends at a rate of 1% in gasoline for 2019 and 3.3% of the energy content of gasoline for the year 2020 and for the following years. However there is no local production of bioethanol for transport fuels as yet.

- The Development Law: as in the previous cases, the Development Law foresees tax regulation mechanisms to support for biofuels, in the form of income tax relief, stabilization of income tax coefficient, and subsidies, leasing subsidies and subsidies for the creation of new jobs.

4.6.3 Barriers and recommendations

The delignification of the country as well as the policy priorities as provided by the last National Energy and Climate Plan is expected to open new opportunities for biomass and IBC to increase their share in power, heating & cooling as well as in advanced biofuel production.

Table 5: Barriers and opportunities for bioenergy growth.

Barriers	Opportunities	New policy measures as reported in NECP
Electricity		
○ Complexity and delays in the licensing procedure, volatility of the existing legal framework and financing mechanisms, old and inefficiently maintained energy infrastructures hinder the further increase of RES - and consequently biomass - share in the electricity market. ○ Challenging biomass mobilisation and logistics for energy exploitation.	○ The Lignite phase-out. ○ The 'Just Transition support' Plan. ○ The special RES account ○ Other financial instruments.	○ Updating, simplification and optimisation of licensing framework (Regulatory measure). ○ Support for deployment of RES energy projects (incl. IBCs) by energy communities also through the use of specialised financing tools. ○ Reform of the electricity market regulatory framework as regards opportunities for the participation of decentralised energy schemes. ○ Development of supply chains for residual biomass/biodegradable matter and support for the development and implementation of optimal environmental and energy-efficient bioenergy applications. ○ Use of waste (agri-livestock units and industries, urban).
Heating & Cooling		

○ Lack of established heat prices, which are negotiated on the spot. ○ The energy exploitation of the residual biomass is still challenging as the biomass mobilisation and logistics are not yet well established. ○ Emission problems (microparticles) caused by the inefficient biomass combustion in open/free combustion spots and the absence of certification of the raw materials are the main obstacles to further promoting biomass for space heating, whereas corrective measures need to be adopted and regulatory tools need to be applied to mitigate the potential adverse environmental impact.	○ The lignite phase-out. ○ The 'Just Transition support' Plan. ○ The special RES account. ○ Other financial instruments. ○ The increased heating demands of the existing district heating plans, currently operated with the excess heat from the lignite-fired thermal power plants could urge the need for further biomass resources to be mobilised in the nearby agricultural areas of the region.	○ Support for deployment of RES energy projects (incl. IBCs) by energy communities also through the use of specialised financing tools. ○ Reform of the electricity market regulatory framework as regards opportunities for the participation of decentralised energy schemes. ○ Development of supply chains for residual biomass/biodegradable matter and support for the development and implementation of optimal environmental and energy-efficient bioenergy applications. ○ Utilisation of RES power generation for heating/cooling and transport as well as for the operation of storage systems. ○ Supply chain organisation. ○ Sustainable forest management. ○ Production of solid biofuels through the promotion of energy crops of woody biomass or coppice plantations. ○ Promotion of RES systems for heating and cooling.
Biofuels		
○ The current regulatory framework needs to be revised towards the promotion of advanced biofuels and the reduction of conventional biofuels in line with the requirements of the new Directive, which is not yet transposed. ○ As for electrification, the main barrier is the high initial cost of electric vehicles which has also undermined the sustainability of the required charging infrastructures.	○ Opportunities for future development of IBCs for the production of advanced biofuels lie in the high biofuels target (14%). ○ The electrification of transport, by means of using IBCs for electricity production.	○ Utilisation of RES power generation for heating/cooling and transport as well as for the operation of storage systems. ○ Pilot actions for the use of RES gaseous fuels in the transport sector. ○ Maintaining and extending the sustainability certification scheme for biofuels, bioliquids and solid fuels. ○ Boosting the consumption of biofuels.

More particularly, as refers to the opportunities raised:

a. 'Just Development Transition Master Plan'

According to NECP (2019) and as far as the Government's top priority for lignite phasing-out, a 'Just Development Transition Master Plan' have been presented in mid-2020. It consists in an integrated, multi-faceted and front-loaded plan that will serve as a Roadmap for the post-lignite era and include a set of measures and provisions to boost renewable energies.

b. National Energy and Climate Plan (NECP)

In addition, the National Energy and Climate Plan set policy priorities for the promotion of RES in the period 2021-2030.

Particular emphasis will be also placed in the next period on updating, simplifying and improving both the licensing and the physical planning framework for RES, that would include among others RES district heating networks and feeding biogas into the natural gas network.

Financing instruments will be designed to promote the most cost-effective RES systems per final consumer category, including the development of a scheme of special tax incentives for the installation of RES systems for heating and cooling in the domestic and tertiary sectors. These would also support RES district heating networks using solid biomass.

Specific market mechanisms will also be developed to support the use of biofuels, as well as the domestic production of advanced biofuels, through the development of a support scheme and/or specific financing tools, focusing on the production of biofuels with the highest domestic added value. Moreover, RES gaseous fuels for use in the transport sector will be supported through necessary regulatory framework, for example producing biomethane from organic waste and feeding it into the natural gas network or using it as fuel in vehicles. The environmental licensing procedure for biogas upgrading technologies will be accordingly developed, to allow for smoothly implementing the necessary investments.

To further promote bioenergy, specialized support programmes will be designed both for the development of efficient supply chains for residual biomass / biodegradable matter and for the support and implementation of optimal environmental and energy-efficient bioenergy applications.

Today the use of biomass for energy generation and/or fuel production in Greece is limited, due to availability of residual biomass and lack of efficient logistics. The basic principles of the agricultural sector in line with the Greek Rural Development Programme adopted by the European Commission for the period (2014-2020) include, in particular, enhancing the viability and competitiveness of agricultural holdings, maintaining and enhancing ecosystems and promoting local development in agricultural areas. Focus will be given in the following period on the transition from current conventional energy uses of biomass to more energy-efficient and cost-effective applications over the entire spectrum of the Greek economy, with emphasis placed on sustainability criteria and sustainable management.

4.7 Barriers and recommendations at national level

From the analysis of bioenergy policies at National level, different measures emerge in the investigated EU countries. Geography and political situation play fundamental roles for national policy makers to develop effective measures for the promotion of bioenergy sector. Despite the reception of RED II is close to being done for each MS, the current situation offer open rooms and potential opportunities for IBCs market uptake. As investigated at EU level, the promotion of policies targeting the whole value chain, from biomass to the end product (both for IBCs as well as for bioenergy, biofuels or bioproducts), could favour the bioeconomy growing, which is considered fundamental to achieve RED II and EDG targets.

5 Conclusions

This document reported the current national and international (at EU level) legislative framework of the IBCs, including recommendations related to their market introduction and large scale utilization. Definitions and collocations of MUSIC' IBCs into the RED II framework have been properly addressed. Depending on the final use of each IBC, the deliverable shows how different targets can be achieved according to the recent EU policies for biofuels, bioproducts and bioenergy. In particular, the document focused on the four MUSIC' case studies and their potential according to RED II targets, focusing on sustainability criteria implications. Moreover, recent events such as EDG and Covid-19' recovery measures have been investigated and evaluated in terms of opportunities for IBC' market uptake. This report also facilitates the work of WP3 and WP5 by addressing technologies, products and industries into the current EU legislative framework. In conclusion, this report is intended as an outline for the different stakeholder groups involved in the IBCs value chains, as well as a guideline for policy development in the mentioned countries.

References

[1] European Commission (EC), Biomass | Energy. Available at: https://ec.europa.eu/energy/topics/property-fieldtopicparent/biomass_en?redir=1 (accessed July 23, 2020).

[2] European Commission (EC), Clean energy for all Europeans package | Energy. Available at: https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en (accessed July 23, 2020).

[3] European Commission (EC), European Green Deal - Consilium. Available at: https://www.consilium.europa.eu/en/policies/green-deal/ (accessed July 23, 2020).

[4] European Commission (EC), A recovery plan for Europe - Consilium. Available at: https://www.consilium.europa.eu/en/policies/eu-recovery-plan/ (accessed July 23, 2020).

[5] European Commission, official website. Available at: https://ec.europa.eu/info/index_en (accessed August 18, 2020).

[6] Biodiversity Strategy - Environment - European Commission. Available at: https://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm (accessed August 19, 2020).

[7] EU strategy on energy system integration | Energy. Available at: https://ec.europa.eu/energy/topics/energy-system-integration/eu-strategy-energy-system-integration_en (accessed August 19, 2020).

[8] National representative countries, Stakeholders, DG Energy, ETIP Bioenergy, SET Plan Implementation Plan Action 8: Bioenergy and Renewable Fuels for Sustainable Transport, Brussels, Belgium, 2018. https://setis.ec.europa.eu/system/files/setplan_bioenergy_implementationplan.pdf (accessed July 28, 2020).

[9] P. Klintbom, EU Green Deal and SET Plan Updates for Cost-Competitive and Efficient Renewable Fuels and Bioenergy, in: ETIP Bioenergy Workshop at EEUBCE 2020, RISE, Sweden, 2020: pp. 1–9. https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6723 (accessed July 28, 2020).

[10] European Union 2020 – Analysis - IEA, (n.d.). https://www.iea.org/reports/european-union-2020#executive-summary (accessed July 23, 2020).

[11] D. Chiaramonti, K. Maniatis, Security of supply, strategic storage and Covid19: Which lessons learnt for renewable and recycled carbon fuels, and their future role in decarbonizing transport?, Applied Energy. 271 (2020) 115216. doi:10.1016/j.apenergy.2020.115216.

[12] E. Alakangas, A. Oasmaa, Production and standardization of FPBO - Public deliverable D3.13 of H2020 Residue2Heat project, Helsinki, Finland, 2010. doi:Artn 243107 Doi 10.1063/1.4729407.

[13] ASTM International, ASTM D4054-14, Standard Practice for Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives, 2014. doi:10.1520/D4054-14.

[14] ASTM International, ASTM D7566-15c, Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons, 2015. doi:10.1520/D7566-15C.

[15] ASTM International, ASTM D1655-15de1, Standard Specification for Aviation Turbine

Fuels, 2015. doi:10.1520/D1655-15DE01.
[16] M. Schimmel, G. Toop, S. Alberici, M. Koper, ECOFYS-A Navigant Company Determining the renewability of co-processed fuels Final report, Utrecht|, NL, 2018. http://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics (accessed July 30, 2020).
[17] D. Rutz, R. Janssen, N. van den Berg, J. Spekreijse, P. Reumerman, D. Bacovsky, M. Doris, A. Gröngröft, N. Dögnitz, K. Dimitrios-Sotirios, P. Grammelis, E. Karampinis, K. Koponen, H. Saastamoinen, E. Tsupari, I.A. Susmozas, R. Iglesias, M.B. Perdices, D. Johansson, G. Gustavsson, A. Kazagic, D. Trešnjo, A. Merzic, TECHNICAL OPTIONS FOR RETROFITTING INDUSTRIES WITH BIOENERGY: A HANDBOOK, Munich, Germany, 2020. https://www.biofit-h2020.eu/publications-reports/BioFitHandbook-2020-03-18.pdf (accessed July 30, 2020).
[18] K. Delli, Expanding the EU Emissions Trading Scheme - The European Files, MEP (The Greens/EFA) - Chair of the TRAN. (2020). https://www.europeanfiles.eu/climate/expanding-the-eu-emissions-trading-scheme (accessed July 31, 2020).
[19] ISO/TS 17225-8:2016 - Solid biofuels — Fuel specifications and classes — Part 8: Graded thermally treated and densified biomass fuels, (n.d.). https://www.iso.org/standard/71915.html (accessed August 20, 2020).
[20] A. Patel, N. Arora, K. Sartaj, V. Pruthi, P.A. Pruthi, Sustainable biodiesel production from oleaginous yeasts utilizing hydrolysates of various non-edible lignocellulosic biomasses, Renewable and Sustainable Energy Reviews. 62 (2016) 836–855. doi:10.1016/J.RSER.2016.05.014.
[21] CEN Website: European Fuel Labels. Available at: https://www.cen.eu/work/products/labels/pages/fuel.aspx (accessed August 20, 2020).
[22] EU-OSHA, Regulation (EC) No 1907/2006 - Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) - Safety and health at work, (n.d.). https://osha.europa.eu/legislation/directives/regulation-ec-no-1907-2006-of-the-european-parliament-and-of-the-council (accessed July 23, 2020).
[23] T. van Laer, P. de Smedt, F. Ronsse, G. Ruysschaert, P. Boeckx, W. Verstraete, J. Buysse, L.J. Lavrysen, Legal constraints and opportunities for biochar: A case analysis of EU law, GCB Bioenergy. 7 (2015) 14–24. doi:10.1111/gcbb.12114.
[24] W. Stelte, Best Practice Guideline - Storage and Handling of torrefied biomass, Aarhus (DK), 2015. https://www.teknologisk.dk/_/media/64590_Storage and Handling of torrefied biomass.pdf.
[25] European Chemicals Agency, Guidance for Annex V Exemptions from the obligation to register, Helsinki, Finland, 2012. doi:10.1007/s12562-010-0257-z.
[26] D. Chiaramonti, G. Talluri, Status and perspectives for bioenergy in Italy - IN PRESS, Florence (Italy), 2020.
[27] MISE, MATTM, MIT, Proposta di Piano Nazionale Integrato per l'Energia e il Clima, (2018) 238. Available at: https://www.mise.gov.it/images/stories/documenti/Proposta_di_Piano_Nazionale_Integrato_per_Energia_e_il_Clima_Italiano.pdf (accessed July 23, 2020).
[28] MISE, MATTM, Strategia Energetica Nazionale, (2017) 308. Available at: https://www.mise.gov.it/images/stories/documenti/Testo-integrale-SEN-2017.pdf (accessed July 23, 2020).
[29] The European Parliament, DIRECTIVE (EU) 2018/2001 on the promotion of the use of

energy from renewable sources (recast), OJ L 328 (2018). 82–209.
[30] MiSE, M.D. 06/07/2012, Gazzetta Ufficiale n.159, 10/07/2012. (n.d.) 1–65.
[31] MISE, MATTM, MIPAAF, M.D. 23/06/2016 Incentivazione dell'energia elettrica prodotta da fonti rinnovabili diverse dal fotovoltaico, Gazzetta Ufficiale n.150, 29/06/2016. (2016).
[32] MISE, M.D FER - Draft - 08/2018, (2018) 1–43.
[33] European Commission (EC), portal for EU national laws. Available at: RES-Legal.ue (accessed July 23, 2020).
[34] The European Parliament, DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5/6/2009. 2008 (2009) 16–62.
[35] MISE, GSE, Procedura Applicativa per i soggetti obbligati e i fornitori di GPL e Metano ai fini dell'autotrazione. Available at: https://www.gse.it/documenti_site/Documenti%20GSE/Servizi%20per%20te/BIOCARBURANTI/Regole%20e%20procedure/PROCEDURA+SOGGETTI+OBBLIGATI+E+PRODUTTORI.PDF (accessed July 23, 2020).
[36] A. Carettoni, CERTIFICAZIONE DI SOSTENIBILITA' DEI BIOCARBURANTI, in: Workshop Nuovo Decreto Biometano, Rome 10/05/2018, 2018.
[37] H. Haavisto, Policy Update Finland-Implementation of the RED II, in: 10th ISCC Global Sustainability Conference, Brussels, Belgium, 2020: p. 11. https://www.iscc-system.org/wp-content/uploads/2020/02/4_Haavisto_Policy_Update_Finland_REDII_Implementation_10th_ISCC_Sustainability_Conference_2020.pdf (accessed July 22, 2020).
[38] Socio-Economic Council (SER) - Dutch Government, Biomassa in balans - Een duurzaamheidskader van biogrondstoffen, LK Den Haag (The Netherlands), 2020.
[39] RES-LEGAL, Renewable energy policy database and support: Belgium. Available at: http://www.res-legal.eu/en/search-by-country/belgium/ (accessed July 24, 2020).
[40] Nationaalenergieklimaatplan, NEKP | Vlot en veilig mobiliteitssysteem. Available at: https://www.nationaalenergieklimaatplan.be/nl (accessed July 24, 2020).

Citation, Acknowledgement and Disclaimer

Marco Buffi, Giacomo Talluri, David Chiaramonti, John Vos, Kaisa Vikla, Patrick Reumerman, Magnus Matisons, David Moosmann, Myrsini Christou, Magnus Madison, Cristina Calderón, Wim Van Der Strincht, and Vesa Kainulainen, 2020
Market Uptake Support for Intermediate Bioenergy Carriers. MUSIC, Horizon 2020 project no. 857806, WP2, D2.3: EU and national regulatory framework: present and future developments. Lead: BTG Biomass Technology Group BV.
www.music-h2020.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 857806.

Annex

This section provides additional tables that investigated sustainability criteria of RED II (integrating Section 1.3).

Table 6: RED II sustainability and GHG emissions saving criteria for bioenergy.

	RED II Article	Criterion	Exceptions	Feedstock type and origin (Agriculture, forest)
Sustainability criteria	29(2)	For waste and residue based value chains, where raw material is derived from agricultural land, economic operators or national authorities shall have monitoring and management plans in place to address **impacts on soil quality and soil carbon**.	Electricity, heating, cooling and fuels from biomass fuels are excluded, if produced in installation with a total rated thermal input: - ≤ 20 MW (solid biomass fuels) - ≤ 2 MW (gaseous biomass fuels) (in the following referred to as "installations with low capacity")	Agricultural waste and residues
	29(3)	Exclusion of feedstock from land with **high biodiversity** (status in 2008 and thereafter), including: a) **Primary forest** b) **Highly biodiverse forest** c) **Designated areas** d) **Highly biodiverse grassland**	Installations with low capacity Waste and residues[20]	Agricultural biomass
	29(4)	Exclusion of feedstock from land with **high carbon stock** (status in 2008 and thereafter), including: a) **Wetlands** b) **Continuously forested areas** c) **Areas > 1 ha with trees > 5m and canopy cover 10-30%**	installations with low capacity Waste and residues[20]	Agricultural biomass

[20] Other than agricultural, aquaculture, fisheries and forestry residues

	29(5)	Exclusion of feedstock from land that was **peatland** in 2008	Evidence is provided that feedstock cultivation and harvesting does not involve drainage of previously undrained soil Small installations Waste and residues[20]	Agricultural biomass
	29(6)[21,22]	Criteria minimizing risk of the use of unsustainable forest biomass. **Management systems at sourcing area level** are in place, ensuring: a) **Legality of harvest** b) **Forest regeneration** c) **Protection of designated areas (incl. wetlands, peatlands)** d) **Minimum impact for soil quality and biodiversity** e) **Long-term forest production capacity is maintained or improved**	The country in which biomass harvest takes place has **national or subnational laws** in place, ensuring: a) **Legality of harvest** b) **Forest regeneration** c) **Protection of designated areas (incl. wetlands, peatlands)** d) **Minimum impact for soil quality and biodiversity** e) **Long-term forest production capacity is maintained or improved** Installations with low capacity Waste and residues[20]	Forest biomass

[21] The Commission will adopt implementing acts establishing the operational guidance on the evidence for demonstrating compliance with these criteria by 31 January 2021.
[22] The Commission will assess whether the criteria laid down in these Articles effectively minimize the risk of using forest biomass derived from unsustainable production and address LULUCF criteria, based on the available data by 31 December 2026.

LULUCF criteria	29(7)[23]	Forest biomass shall meet land use, land use change and forestry criteria: **Management systems at sourcing area level**, ensuring that carbon stocks and sinks levels in the forest are maintained, or strengthened over the long term	The **country or regional economic integration organisation** of origin of the forest biomass: a) **Is party to the Paris Agreement** b) **Has submitted a NDC[23] covering emissions and removals from agriculture, forestry and land use which ensures that changes in carbon stock associated with biomass harvest are accounted towards the country's commitment to reduce or limit greenhouse gas emissions as specified in the NDC; or:** c) **has national or sub-national laws in place, in accordance with Art 5 of the Paris Agreement, applicable in the area of harvest, to conserve and enhance carbon stocks and sinks, and providing evidence that reported LULUCF-sector emissions do not exceed removals** Installations with low capacity Waste and residues[20]	Forest biomass

[23] Nationally determined contribution

GHG emissions saving criteria	29(10)	The GHG emission savings from the use of biofuels, bioliquids and biomass fuels shall be: a) Consumption in the transport sector (biofuels, biogas/biomethane, bioliquids): - at least **50%** for installations in operation on or before 2015-10-05 - at least **60%** for installations starting operation between 2015-10-05 and 2020-12-31 - at least **65%** for installations starting operation from 2021-01-01 b) Consumption for electricity, heating and cooling (biomass fuels): - at least **70%** for installations starting operation from 2021-01-01 - at least **80%** for installation starting operation from 2026-01-01	Installations with low capacity	Agricultural biomass Forest biomass Waste & residues