MUSIC

Market Uptake Support for Intermediate Bioenergy Carriers

# D3.9: EU level strategies and recommendations



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## Executive Summary

The report summarizes results derived during work package 3 'stakeholder engagement and mobilisation' of the MUSIC project. During several stakeholder workshops, in expert interviews and by desk research, information and data about factors affecting value chains of intermediate bioenergy carriers (IBCs) were gathered and categorized to develop strategies and recommendations to support market uptake of IBCs in the EU. Some of these factors, regulatory framework and important strategic aspects related to the regional context, were described already in the D2.3 report on 'EU and national regulatory framework: present and future developments' (Buffi et al. 2020) and the D3.8 report on 'National Strategies and Recommendations' (Siegfried et al. 2023a) and in further deliverable reports of work package 7 of the MUSIC project (https://www.music-h2020.eu). The here presented contents are based on expert knowledge and suggestions of different groups of stakeholders which are involved in potential IBCs value chains (Figure 1). The findings and proposed strategies and recommendations of D3.9 are related to important influencing factors which may apply to many EU countries. Main challenges for IBCs market uptake are the frequently changing political EU regulations for renewable energies (REDII, EU 2018/2001, EU 2021) and the sustainability policy (EU 2018c) which limits usage of some important feedstocks for IBCs production. Although the currently applicable EU regulatory framework (RED II) has not yet been transposed into national law in many countries, new guidelines (REDIII) are already in the negotiation phase. Adding to that, guidelines for usage of biowaste and hybrid feedstocks are not uniform across EU member states which hampers EU wide implementation of value chain concepts and investment willingness.

International stakeholders and industry should form associations to promote forest and agri-residues as well as biowaste use for IBCs production and their subsequent upgrade to advanced biofuels. In this context, inter industrial sector communication should be accelerated. These association could also initiate platforms for estimation of biomass availability and trade. Agricultural and waste associations as well as municipalities should increasingly support business concepts for farmers and waste management to optimise logistics for IBCs production. EU markets will increasingly demand advanced fuels made from IBCs if national implementation of RED II and national sub-quota for advanced biofuels blending or minimum targets for IBCs shares are in place.

Widespread information campaigns across Europe should help to avoid misunderstandings about bioenergy applications with IBCs and demonstrate societal, economic and environmental benefits through the successful implementation of pilot projects.

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## Abbreviations

| | |
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| ASTM | American Society for Testing and Materials |
| CHP | Combined Heat and Power |
| CS | Case Study |
| Dx.x | Deliverable |
| EU | European Union |
| FPBO | Fast Pyrolysis Bio Oil |
| IBC | Intermediate Bioenergy Carrier |
| MS | Member State |
| MUSIC | Market Uptake Support for Intermediate Bioenergy Carriers |
| PESTEL+I | Political, Economic, Social, Technological, Environmental, Legal and Infrastructural |
| REDII | Renewable Energy Directive |
| SAF | Sustainable Aviation Fuel |
| Tx.x | Task |
| WPx | Work Package |
| WS | Workshop |

# 1 Introduction

In the last five years the EU strongly promoted bioenergy as an efficient alternative to fossil fuels and due to the outbreak of the Ukraine war in 2022 the EU is calling for a faster transition towards renewable energies (Zachmann et al. 2022). One major source of renewable energy could be biomass converted into Intermediate Bioenergy Carriers (IBCs), which can substitute fossil resources in several applications such as combined heat and power but also in important industrial processes such as steel making or cement production. "They are biomass that is processed to energetically denser materials, analogous to oil, coal and gaseous fossil energy carriers. This means they are easier to transport, store and use then raw biomass. The MUSIC project supports market uptake of three types of IBCs by developing concepts for feedstock mobilisation strategies, improved cost-effective logistics and trade centres. IBCs covered in MUSIC include pyrolysis bio oil, torrefied biomass and microbial oil. [...] They can be used directly for heat or power generation or further refined to final bioenergy or bio-based products. IBCs contribute to energy security, reduce greenhouse gas emissions and provide a sustainable alternative to fossil fuels in Europe." (WIP Munich 2021, Reumerman et al. 2021).

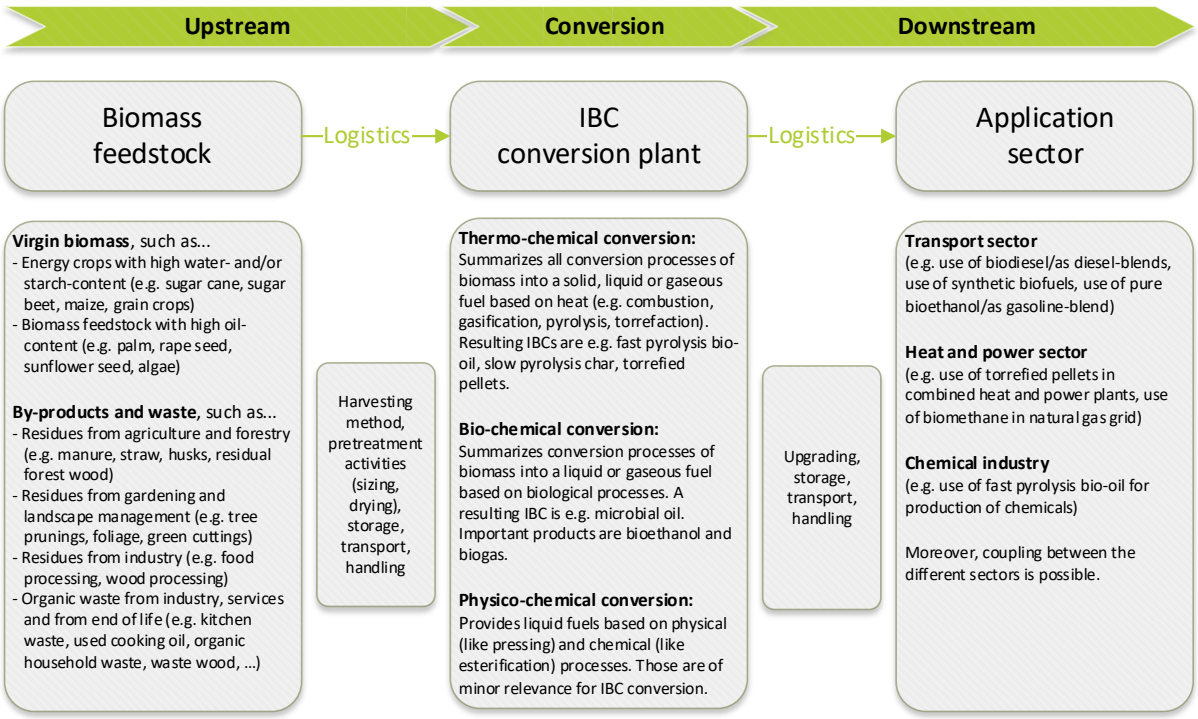


Figure 1. Generic biomass supply chain of IBCs, adapted from Blümel et al. 2023

The methodological framework applied to this report is the PESTEL+I analysis (Blümel et al. 2023) as well as SWOT/TOWS analysis. During the 3 years of project work, data was collected through stakeholder workshops, interviews and literature review (D3.6; Siegfried et al. 2023b). Data collected within WP 3 was analysed and categorized into a PESTEL+I analysis, which provided the baseline for determining and analysing hindrances and enablers that EU member

states might face in the implementation of IBCs value chains. Afterwards, hindrances and enablers were strategically combined in a SWOT and TOWS matrix to develop proposals for strategies and recommendations. Based on the collected data, strategies and recommendations for market uptake of IBCs at EU level are proposed in the following chapters.

# 2 Macro-environment PESTEL+I

In D3.8, tailored recommendations were proposed for each case study region in specific member states and regions of the EU, whereas this deliverable provides strategies and recommendations for the implementation of IBCs at the EU level (Siegfried et al. 2023a). It is worth mentioning that the revised EU directive on renewable energy (RED II, EU 2018/2001) and the forthcoming proposals for a RED III constitute a common legal and political framework crucial for the implementation of IBCs value chain in the four case study regions but also in all EU member states who might embark in the IBCs pathway. Therefore, the following RED II key-points are useful to understand the proposed strategic recommendations. First, the directive determines the target, caps, and requirements set for biomass contribution of each IBC, according to its feedstock and use. Second, each IBC should comply with specific GHG emission savings criteria. Third, once the EU directive entered into force, the directive requirements are only effective when member states transpose it into national law. In addition to the legal framework, many relevant macro-environmental factors depend on global political dynamics, as well as natural disasters and global market fluctuations. In the PESTEL+I analysis, such factors were classified as enablers (E) or hindrances (H) for the market uptake of IBCs in Europe (Table 1).

Table 1. Macro-environmental factors affecting IBCs value chains at the EU level (H - Hindrances, E - Enablers)

| PESTEL+I Category | EU level |
|---|---|
| **Political (P)** | A changing political environment worldwide marked by the COVID-19 pandemic and the outbreak of the Ukraine war, stresses the need towards a bioenergy transition while contributing to a more resource-independent Europe. (E)<br>In the EU REDII directive (EU 2018/2001) Annex IX Part A (o), advanced biofuels which are considered here to be produced from IBCs are considered double their energy content when counting towards the 14% minimum proportion of all renewable energy in the transport sector until 2030. (E)<br>The forthcoming REDIII or proposal for revision of REDII (EU 2021) sets more ambitious targets of a 28% share of renewables in the transport sector and a sub-target share for advanced biofuels of 2.2% without double counting. (E)<br>Some EU MS are rather slow to implement RED II into national law due to internal legislative and bureaucratic issues. (H)<br>EU sustainability policy (EU 2018c) limits the exploitation of forest residues. (H)<br>Uncertainty caused by a lagging RED II implementation at national level with an unclear outcome in terms of the detailed reinforcement measures in each EU member state. (H) |
| **Economic (E)** | Rising fossil fuel prices, legislative incentives such as rising $CO_2$ prices and an increasing quota for low carbon fuels in transport sectors in EU member states in the near future could close the price gap between fossils and advanced biofuels made from intermediate bioenergy carriers. (E)<br>The political instability in Europe leads to heavily fluctuating and rising biomass feedstock and material costs resulting in unstable biofuel market price developments. (H)<br>The implementation of IBCs value chain across EU MS could create economic value for local communities and specifically support rural development and resource independence in remote areas. (E)<br>With the increasing demand of woody residues for bioenergy and other applications (biochemicals), the price of woody biomass and forest residues might considerably increase in the next few years. (H)<br>Legal uncertainties and frequently changing guidelines/amendments about sustainability criteria for biomass feedstock (e.g. primary wood) might hinder investors in supporting the market uptake of IBCs. (H) |
| **Social (S)** | Supporting a self-sustained energy supply from own resources is a trend in society in view of recent political changes. (E)<br>Several NGOs and environmental protection lobbyists are strongly campaigning at an EU and MS level against the further exploitation of woody resources for energy application. (H)<br>Illegal activities (illegal logging) in some of the MS impede implementation of IBC value chains. (H) |
| **Technological (T)** | Mandatory cascading principles are challenging to implement in the framework of complex legislative bioenergy framework. (H)<br>Some of the biomass conversion technologies for IBC production can be considered to be TRL 8-9, which is a good level but also these technologies are currently stuck because further upgrading technology is at lower TRL level (e.g. FPBO upgrading to biodiesel). (H)<br>Uncertainties about regional biomass availability (quantities/qualities) and demand across EU MS. (H) |
| **Ecological (E)** | Use of primary biomass (especially woody) could threaten biodiversity conservation. (H)<br>Availability of unused or inefficiently used amount of feedstock from natural disasters (i.e. wood infested by the bark beetle, wood and hybrid waste from floods). (E)<br>Optimized management of forested lands and re-cultivation of marginal lands could lead to reduction of wildfires and improvement of water storage, biodiversity and climate change resilience (E) |
| **Legal (L)** | EU legislation is overlapping regarding sustainability criteria, i.e. taxonomy regulation, which describes a framework to classify sustainable economic activities in the EU, sets different sustainability criteria than RED II for biomass feedstock. (H)<br>RED II biomass sustainability criteria have not yet been fully implemented or assessed in MS, sometimes even ignored at regional policy level. (H)<br>Quotas are not efficient as they rely on the overall level of energy consumption and may be affected by market fluctuations. In some of the MS no quotas for advanced biofuels in place (B) |
| **Infrastructural (I)** | Concepts for collection and storage of biomass residues have been developed. (E)<br>Development of digital tools and platforms for biomass estimations is increasing. (E)<br>Missing infrastructure in remote regions, which needs to be built by skilled labour. (H)<br>Biomass storage centres are rather rare across Europe. (H)<br>Small and scattered farms make collection of biomass residues at scale difficult. (H) |

# 3 Strategies and Recommendations for Market Uptake of IBCs in the EU

Table 2. SWOT/TOWS Matrix

| INTERNAL FACTORS / EXTERNAL FACTORS | **S (Internal Strengths) – enablers:**<br>**S1:** Adding value to by-products and waste, creation of new value chains/economic opportunities, generating profit for rural areas, can extend farmers and foresters business opportunities<br>**S2:** Use of cheap or free of-cost residues as feedstock<br>**S3:** Production of 2nd generation fuels due to using residues and wastes instead of primary biomass (RED II Annex IX, Part A (o) | **W (Internal Weakness) – hindrances:**<br>**W1:** Limited amount of skilled labour is available in remote areas<br>**W2:** Missing infrastructure, which needs to be built by skilled labour<br>**W3:** Uncertainty about biomass availability (quantity, quality) across EU MS<br>**W4:** Feedstock is scattered and therefore difficult to collect all at once<br>**W5:** Financial and time constraints often hinder technological developments/investments as many small farmers cannot afford expensive new machines and extra labour efforts<br>**W6:** Extensive exploitation and removal of residues may lead to soil degradation |
|---|---|---|
| **O (External Opportunities) – enablers:**<br>**O1:** Changing politics support biofuels compensation of fossil imports<br>**O2:** Advanced biofuels counted double their energy content<br>**O3:** Rising fossil fuel prices, legislative incentives such as $CO_2$ tax, ETS system and blending quota or minimum target shares for advanced blended fuels in transport sectors will create markets<br>**O4:** Creation of regional employment opportunities, support rural development and local resources use<br>**O5**: Cascading use applications (depending on quality, added value and regional market-environment, should not be mandatory)<br>**O6**: Currently unused amounts of feedstock (e.g. waste wood type B and C) on the market<br>**O7**: Research on bioeconomy as transformation process allows establishment/development of digital tools to estimate biomass potentials (e.g. biomass dashboard, databases, e.g. lubey, binter), high expertise in industry and research landscape<br>**O8**: Increasing amounts of demolition waste (caused by natural disasters) | **Strategy 1:** International stakeholders and industry should form associations (IBC Hub) to promote forest and agricultural residues and hybrid waste use for IBCs and advanced biofuel production and support inter industrial sector communication and collaboration.<br>**Strategy 2:** EU markets will increasingly demand alternative fuels if blending quota or minimum target shares are implemented. This opportunity should be explored.<br>**Strategy 3**: A biomass purchasing platform should be invented to bring farmers (e.g. wine and olive oil producers), waste collectors/recycling and end users (biofuels and biochemicals industry, steel and cement industry, energy utilities) together.<br>**Strategy 4**: Promotion and use of renewable energy synergies and sector coupling, including green hydrogen | **Strategy 5:** Increase organisation of bilateral talks, workshops of feedstock providers and other stakeholders in specific IBCs value chains.<br>**Strategy 6**: Demonstrate and analyse economic viability in a real implementation case and include economic value of ecosystem function and services as well as societal benefit -> reduction of external resources imports and reduction of waste resources exports, reduction of emissions, increase efficiency of residues use, increase independence from external resources<br>**Strategy 7**: Need of exact definition of biomass potentials and determination of mobilisable technical biomass potentials (quantities and qualities) and actual and predicted demands of different industry players, knowledge transfer and use of expertise of biomass experts, applying dashboards and other digital tools for calculation of available biomass potentials dedicated for market players |
| **T (External Threats) – hindrances:**<br>**T1**: Political uncertainty: RED II and III adjustments and regulatory discontinuity of measures, slow or missing national implementation<br>**T2**: NGOs and environmental lobbyists campaigning against woody resources use for energy application<br>**T3**: Decreasing public appreciation of usage of woody feedstocks for biofuels, knowledge gap | **Strategy 8:** National implementation of RED II is key and has to be promoted as well as national sub-quota and/or minimum targets for biofuels blending or replacement of fossil fuels by IBCs/advanced biofuels.<br>**Strategy 9:** Creation of a long-term database, which continuously provides information about the availability of sustainable forestry feedstock, based on reliable data and controlled and certified by independent institutions. | **Strategy 14:** Further R&D activities on FPBO and torrefied biomass quality, adapt characteristics according to the requirements of the engines and other applications that represent the most promising and profitable application field (e.g. eliminate metal content in FPBO because already small contents are problematic for FCC units in refineries, create quality standards for torrefied biomass for steel making).<br>**Strategy 15:** FPBO quality determines application, always investigate the best fitting purpose in order to reach the highest value, clearer allocation |

| | | |
|---|---|---|
| **T4**: Using IBCs for energy depends on national legislation and more specifically on the implementation of the RED II directive and forthcoming REDIII<br>**T5** Political instability in Europe leads to heavily fluctuating and rising biomass feedstock and material costs resulting in unstable market price developments. This results in a low willingness to invest.<br>**T6**: Political uncertainty on European and national level (especially regarding steel making industry, waste utilisation, advanced biofuel classification acc. to RED II); Future use of municipal waste will rather be material instead of energetic use; EU sustainability policy limits exploration of forest residues, forest sector may be regulated by REDIII<br>**T7**: Only little cross-cutting communication and lack of information exchange between industrial sectors; not always willingness to collaborate in industry along the supply chain (waste management companies, torrefaction companies and steelmaking/cement/energy companies)<br>**T8**: Different declaration of waste wood across EU country legislations (e.g. split off B wood in B1 and B2, like in the Netherlands)<br>T9: Too much regulative pressure in the EU will force companies to produce abroad (e.g. in India)<br>**T9**: High number of small companies supplying and using waste feedstock, economy of scale not in place regionally (imports required) | **Strategy 10:** Prevailing misunderstanding of different biofuel generations should be avoided; campaigns are needed in which it is clarified that (a) advanced biofuels do not compete with food production chains, (b) feedstock used has to undergo certification processes, (c) assessment of the biofuels life cycle is made, (d) biodiversity issues are considered.<br>**Strategy 11**: Reduction of overall emissions and environmental damage by reintegrating waste feedstock into industrial processes, e.g. applying torrefied biomass (made from wood and hybrid waste) in steel material production as a carbon source<br>**Strategy 12**: Demonstration, correct communication and transparency of overall supply chain, especially feedstock sourcing process (using waste and residues, no use of logging/stem wood, no damage of biodiversity, fight against illegal logging and fake certifications)<br>**Strategy 13**: Uniform legislation on waste wood categorisation and permit to use dangerous waste (e.g. waste wood type C) across EU countries should facilitate reintegration of large volumes of waste feedstock in circular economy; associations and lobbyists need to consult policy makers and promote advantages of a uniform and long-lasting legislation because this will guide investment willingness. | of specific feedstock to specific applications/processes, e.g. lower quality FPBO could serve as a fuel for CHP plants in Sweden<br>**Strategy 16:** ASTM standardisation requirements, currently prevent the application of FPBO in SAF -> Further R&D activities on FPBO, adapt characteristics according to the requirements of plane engines.<br>**Strategy 17:** Further R&D activities on FPBO plant operation, which lead to an increase in the process efficiency and therefore, (a) makes the plant operation also profitable and economic at smaller scale (output less than 25,000 t/yr) and (b) converge prices for advanced biofuels and conventional fuels.<br>**Strategy 18**: Optimized management of forested lands and re-cultivation of marginal lands could lead to reduction of wildfires and supports biodiversity restoration, feedstock amounts that are currently burned could be used in IBC production. |

# 4 Conclusions and Outlook

Rising fossil fuel prices, legislative incentives such as $CO_2$ tax, ETS system and blending quota for advanced blended fuels in transport sectors will facilitate IBCs market uptake. Minimum targets for the use of IBCs or advanced biofuels instead of quota would create even stronger market incentives. Currently, EU directives guidelines on renewable energies (EU 2018/2001, EU 2021), waste (EU 2018a,b) and sustainability (EU2018c) are not yet transferred uniformly into national law. At the same time, work is already underway on revisions to existing regulations, e.g. emerging RED III.

In summary, this uncertain and constantly changing policy framework at the EU level, combined with the lack of implementation at the national level, is hindering the development and innovation of IBCs. As a result, there is a lack of investment and contractual security for the industry. The challenge is to consider regionally varying economic, societal and environmental conditions across the EU when implementing IBC value chains. National targets for related IBCs and advanced biofuels have to be adapted and adjusted accordingly. Cross-sectoral concepts for IBCs market uptake must be developed, especially in synergy with other renewable energy sources and also by the integration of the cascading principle for specific types of biomass and waste in a circular bio-economy. The cascading use should not be mandatory but may be applied if there is a demand under specific circumstances in regional markets.

Associations of feedstock providers (forestry, agriculture, waste/municipalities) and industry (transport, energy, steel and cement) must be created to support IBCs business cooperation and create biomass trade centres and regional innovation hubs. Further research and innovation activities as well as standardisation/certification activities can be supported and financed by members of the formed associations coming from all stakeholder groups. Finally, the associations can also push politics to create financial and regulatory incentives for stakeholders in the IBC value chain therewith supporting investments, resource independency, new regional developments, skilled labour and jobs across EU member states.

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