D10.3 Exploitation Plan

Sustainable Energy and Alternative Fuels from Advanced Intermediate Renewable Energy carrieR technology

Seafairer

Seafairer-project.eu

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Seafairer

Document control sheet

The project	**SEAFAIRER:** Sustainable Energy and Alternative Fuels from Advanced Intermediate Renewable Energy carrieR technology
Grant Agreement n°	101173002
Call identifier	HORIZON-CL5-2024-D3-01
Type of action	HORIZON-IA
Coordinator	DANMARKS TEKNISKE UNIVERSITET (DTU)
Project start date	1 September 2024
Project duration	48 months
Work package n° and title	10 - Dissemination, exploitation and communication (part I)
Work package leader	ETA - ENERGIA, TRASPORTI, AGRICOLTURA SRL (ETA)
Dissemination level	PU - Public
Lead Beneficiary	KPMG & ASSOCIADOS SOCIEDADE DE REVISORES OFICIAS DE CONTAS SA (KPMG)
Author	Afonso Florim, Marta Belinha, Marta Godinho, Dulce Varandas, Olívia Rocha
Reviewer(s)	Jan Wilske, Daniel Pichler (DTU)
Review date	14 February 2025; 2nd review: 17 March 2025
Due Date	28 February 2025 (M6)

This project has used a standard methodology already developed in FUEL-UP (Grant Agreement number: 101136123), REFOLUTION (Grant Agreement number: 101096780) and Bin2Bean (Grant Agreement number: 101113011) projects, following EU recommendations. Ad hoc modifications were added to comply with the Grant Agreement conditions for SEAFAIRER (Grant Agreement number: 101173002).

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Seafairer

ROLE	NAME
COO	DTU - DANMARKS TEKNISKE UNIVERSITET
BEN	UABIO - BIOENERGY ASSOCIATION OF UKRAINE
BEN	ETA - ENERGIA, TRASPORTI, AGRICOLTURA SRL
BEN	FVTR - FORSCHUNGSZENTRUM FUR VERBRENNUNGSMOTOREN UND THERMODYNAMIK ROSTOCK GMBH
BEN	FRAUNHOFER - FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV
BEN	FVP - FUNDACION DE LA COMUNIDAD VALENCIANA PARA LA INVESTIGACION, PROMOCION Y ESTUDIOS COMERCIALES DE VALENCIAPORT
BEN	KPMG - KPMG & ASSOCIADOS SOCIEDADE DE REVISORES OFICIAS DE CONTAS SA
BEN	PETROGAL - PETROGAL SA
BEN	SAGAVA - TERGY SAGAVA - BIOENERGIAS, UNIPESSOAL LDA
AP	CMM - Centro Mario Molina para Estudios Estrategicos sobre Energia y Medio Ambiente AC

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Seafairer

Index

Index of Figures

Index of Tables

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Seafairer

Disclaimer

The SEAFAIRER project is funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Seafairer

Executive summary

SEAFAIRER project (**S**ustainable **E**nergy and **A**lternative **F**uels from **A**dvanced **I**ntermediate **R**enewable **E**nergy Carrie**R** technology), funded through the Horizon Europe programme, aims to develop sustainable biofuels for maritime shipping. Led by DTU and supported by nine additional partners, SEAFAIRER focuses on reducing shipping related greenhouse gas (GHG) emissions by advancing a biofuel production system that integrates seamlessly into existing maritime infrastructure. SEAFAIRER pioneers the VINTER technology - a novel thermochemical conversion process - to transform agricultural residues and biowaste into three valuable outputs: bio-oil, biochar, and syngas, each playing a key role in the process. The bio-oil serves as an advanced intermediate biofuel with potential for direct maritime use, biochar provides carbon sequestration benefits with economic value through carbon removal credits, and syngas supports energy self-sufficiency while offering e.g., pathways for hydrogen production or combined heat and power generation. This approach positions SEAFAIRER as the *first-of-its-kind* at pilot scale, demonstrating the viability of maritime biofuels while minimising waste and emissions. To ensure a clear path and transition from research to commercialisation, SEAFAIRER has identified key exploitable results (KERs), such as the VINTER demonstration unit, the digital twin for process optimisation, standardised fuel and engine testing protocols, the value-chain simulation tool to assess supply chain feasibility, and the EU Roadmap for deployment. The project follows a structured exploitation strategy, leveraging IP management, market analysis, and spin-off development to better position its results for future commercial adoption and scale-up, with SAGAVA as a technology licensing vehicle. Following the climate change reality and the susbsequent tightening of EU regulations, the demand for sustainable maritime fuels is growing. Moreover, SEAFAIRER aligns closely with the European Green Deal, the FuelEU Maritime initiative, and the decarbonisation targets of the International Maritime Organization (IMO), reinforcing its potential as a long-term solution for the reduction of shipping related emissions. With pilot deployments in Germany, Spain and Mexico set to validate the biofuel in real-world conditions, SEAFAIRER is poised for scalable implementation, with ambitions to establish its technology in key European and global maritime hubs by 2035. The project's long-term vision includes a widespread rollout of VINTER units across strategic locations, significantly contributing to the EU's target of an 80% reduction in shipping emissions by 2050. By bridging scientific innovation with industry adoption, SEAFAIRER is not only contributing to a new generation of maritime biofuels but also shaping the future of sustainable shipping, ensuring that renewable energy solutions become a cornerstone of global maritime decarbonisation.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

1.0 Introduction

This Deliverable is the first version of the **SEAFAIRER Exploitation Plan (EP) (Deliverable 10.3)**, which aims to define a **sustainability and exploitation** strategy encompassing the identification, development, and description of the **Key Exploitable Results** (KERs; *cf. 3.0 Key Exploitable Results (KERs)*, its owners and post-project exploitation plans. Exploitable results are considered **intellectual property (IP)** and therefore require careful management and protection. This has been agreed upon by the SEAFAIRER consortium as part of both the **Grant Agreement** (Intellectual Property Rights (IPR) – Background and Results – Access rights and rights of use, Article 16) and the **Consortium Agreement**. Accompanying the progress of the project and its results, this first version of the EP will be updated throughout the project duration, with foreseen re-submissions by Month 35 (M35) (*cf. Deliverable 11.4*) and M48 (*cf. Deliverable 12.3*), providing a more advanced outlook on the post-project exploitation opportunities, based on the data, results, and insights collected throughout the project lifetime. By establishing close links with other tasks, the EP will incorporate key research findings, stakeholder insights, and market intelligence to ensure the seamless uptake of project results.

The first update (*cf. Deliverable 11.4*), due by M35, will assess the progress of Task 11.4 and will integrate findings from an exploitation workshop, to be organised simultaneously with a consortium meeting between M19 and M34. This workshop will serve as a key opportunity to review IP rights, refine ownership structures, and assess market intelligence, while also fostering critical discussions with stakeholders for scaling SEAFAIRER beyond its initial scope. This update will be deeply intertwined with tasks related to innovation and IP management (*cf. Task 1.3*), stakeholder mapping (*cf. Task 2.1*), development of communities of practice (*cf. Task 2.3*), market and implementation studies (*cf. Tasks 8.6, 8.7, 9.1*), and cooperation with external initiatives (*cf. Tasks 11.2, 11.3*). The final version of the EP (*cf. Deliverable 12.3*), delivered in M48, under Task T12.4, will integrate comprehensive evaluations from the entire project lifecycle, serving as the definitive roadmap for ensuring SEAFAIRER's transition from research to market. This final version will be informed by market trends, business viability, and long-term investment opportunities, incorporating results from business modelling (*cf. Task 9.4*), market studies (*cf. Task 9.3*), deployment roadmaps (*cf. Task 9.5*), and engagement events (*cf. Task 12.2*). Additionally, a second exploitation workshop will be organised as part of Task 12.2 during a consortium meeting at EUBCE, as a parallel event in collaboration with SEAFAIRER sister projects, between M36 and M48. Through this approach, the final version will not only validate SEAFAIRER's commercial and regulatory pathways but also provide a blueprint for scaling its impact across the EU and beyond.

In its scope, the SEAFAIRER EP is driven by the potential **scientific and industrial/commercial exploitation of project results,** focusing on the advanced biofuel production technology (VINTER) at its core, as well as its products: **bio-oil (advanced biofuel), biochar, syngas,** and the **carbon removal credits** obtained from the biochar's carbon sink effect.

The EP is driven by the future commercial and scientific exploitation of results, valorising the intermediate biofuel in particular, as well as, the biochar, syngas, and the resulting carbon credits. The goal is to define a common EP while safeguarding the individual interests of each partner. By focusing on profit maximisation, minimising environmental impacts, enhancing social benefits, fostering technological innovation, and aligning with sustainable development goals (SDG), the plan can effectively contribute to a sustainable and economically viable biofuel industry. This EP will address **five specific objectives**, directly linked with a critical step for successful market implementation:

1. Technological innovation – Scale-up VINTER technology validation. Taking into consideration advancements through *demand-pull* and *technology-push* activities. Focus on the development and commercial viability maritime biofuels, with demonstrated higher sustainability potential;
2. Economic viability - Explore strategies to maximise industrial investment on VINTER technology (including applicable carbon removal credits), enabling industrial-scale adoption and commercial viability of its intermediate and drop-in biofuels. Foreseeing the economic value across the value chain, regarding bio-oil, biochar and syngas products, these fuels will be integrated into existing

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

shipping infrastructure, offering a scalable and commercially viable solution to maritime decarbonisation. A continuous viability check will help to overcome medium-term economic barriers through the design of financial and market-based strategies to reduce economic barriers and enhance the commercialisation of SEAFAIRER biofuel production system and its products;

3. Social impact – Modernise industries within the biofuels supply chain and boost talent upskilling and reskilling, promoting job creation, and enhancing social welfare. Improve the portfolio of products offered by different industries, promoting symbiotic cooperation between industrial ecosystems, resulting in more engaged local communities, particularly those dependent on agriculture;
4. Environmental sustainability - SEAFAIRER hub-and-spoke model will not only create direct and indirect jobs but also establish a sustainable economic framework, ensuring that maritime decarbonisation remains both a technological advancement and a driver for long-term industry transformation. Focus on reducing GHG emissions through optimised production processes, aligned with the EU Green Deal by enhancing sustainability and energy security. Evaluate the framework for maritime sustainable biofuel production ensuring that it does not adversely affect biodiversity and ecosystems;
5. Alignment with SDGs - Ensure that biofuel production aligns with and contributes to achieving SDGs, particularly those related to climate action and clean energy.

Through structured updates and integration efforts, the SEAFAIRER EP will remain dynamic, actionable, and deeply embedded within the project's broader objectives. By engaging key stakeholders at every stage, the plan will ensure that SEAFAIRER's innovations are not only validated and scalable, but also actively shaping the future of maritime biofuels as a sustainable, investment-ready solution.

SEAFAIRER's EP has **five main pillars**:

1. **Exploitation workshops** that will focus on the management of IPR and the drafting of a results' ownership list;
2. **Business intelligence activities** encompassing a market and technology watch to have the most comprehensive understanding of market trends, the competitive environment and potential barriers hindering uptake of results. This is key since the market for renewable fuels is a fast-evolving field that needs to be closely monitored;
3. **Business modelling** workshops that will be organised to identify and characterise value to be created based on the project results and to develop initial business plans serving as a strategic roadmap;
4. **Business and market facilitation activities** intended to support the exploitation of results by connecting SEAFAIRER with the main target groups, namely investors, to initiate new value chain development projects in Europe and leverage public and private funding;
5. **Funding opportunities**: a workshop dedicated specifically to exploring synergies with additional funding - sources, with a scope of biomass valorisation and production of advanced biofuel for maritime shipping, biochar with agricultural applications (e.g., soil improver, fertilizer, carbon sink), and syngas with several possible industrial application (e.g., Combined Heat and Power plant).

For the purpose of the present deliverable, a first approach on Pillars 2., 4. and 5 is provided, considering the available data at this stage of project implementation. Pillars 1 and 3 are also addressed aiming to provide a baseline for the preparation of future exploitation and business modelling workshops. A comprehensive overview of SEAFAIRER's KERs is provided, detailing their ownership, potential end users, and strategic exploitation pathways. These pathways outline how the results will be leveraged within the consortium and extended to external stakeholders, ensuring widespread adoption beyond the project's lifetime.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

2.0 Target market and insights

2.1 The advanced biofuel market

The adoption of bio-based fuels, which have a lower environmental impact throughout their life cycle, is a strategic priority for SEAFAIRER EP. Furthermore, facilitating the market uptake of eco-efficient maritime transport strategies through biofuels aligns perfectly with major European and international policies. These include the European Green Deal, the EU Emissions Trading System, the FuelEU Maritime (part of the Fit fot 55 measures), and international frameworks such as the International Maritime Organization's (IMO) strategy, and the ReFuelEU Initiative. SEAFAIRER´s key global targets include **(i)** carbon intensity reduction, achieving at least 40% reduction through the use of low-carbon fuels by 2030 and 70% reduction by 2050, in line with the IMO strategy; **(ii)** CO_2 emissions control, supporting compliance with Regulation (EU) 2015/757 of the European Parliament and Council which mandates monitoring, reporting, and verification of maritime transport emissions.; **(iii)** market-based carbon incentives, promoting mechanisms such as carbon removal credits (obtained from the biochar's carbon sink effect), as outlined in the ReFuelEU Initiative and the 'Fit for 55' package; and **(iv)** GHG emissions reduction, contributing to the goal of cutting total GHG emissions by 50% by 2050.

According to Global Markets and Insights' published data, in 2024, the global **advanced biofuel market** was valued at approximately EUR 1.34 billion and is projected to grow at a compound annual growth rate **(CAGR) of 13.9% from 2025 to 2034**. Advanced biofuels, derived from non-food feedstocks such as agricultural and forestry residues, algae, and waste materials, are gaining momentum. Unlike conventional biofuels - such as ethanol from corn or sugarcane - these alternatives have a lower carbon footprint and do not compete with food production, making them a more sustainable and environmentally friendly option. The increasing focus on reducing dependence on foreign oil and enhancing energy security is driving demand, particularly in nations seeking a diversified energy portfolio and a more resilient energy system. The adoption of biofuels with lower GHG emissions and environmental benefits is accelerating market expansion.

Technological advancements in advanced biofuel production, including cellulosic ethanol, algae-based biofuels, and renewable diesel, are helping improve cost competitiveness with traditional fuels. Additionally, innovations in catalytic processes, such as hydrothermal liquefaction, are enhancing biofuel efficiency and scalability, further strengthening industry prospects. Government policies and incentives are playing a crucial role in promoting advanced biofuels. Key initiatives include the Renewable Energy Directive (RED) in the EU, and tax benefits such as the Investment Tax Credit (ITC) and Production Tax Credit (PTC). These measures are stimulating investment and fostering research and development in the biofuel sector. Moreover, the rising emphasis on reducing emissions from the transportation and aviation industries is further driving demand for sustainable biofuel solutions.

2.2 Biochar – soil improver and carbon sink

According to thr 2024 Outlook for the Global Biochar Market (MSCI Carbon Markets), biochar generates carbon credits by effectively sequestering carbon in the soil. Without this conversion, the same biomass would naturally decompose or be burned, releasing methane or carbon dioxide into the atmosphere, contributing to greenhouse gas emissions.

Interest in biochar within the voluntary carbon market has surged significantly in the 2020s. In 2020, fewer than 1,000 tonnes of carbon credits were linked to biochar projects. However, corporate purchases increased to 34,000 tonnes CO_2e in 2022 and further to 65,000 tonnes in 2023, according to MSCI Carbon Markets. To date, two-thirds of all biochar credits issued have come from projects in the United States, although in 2023, most newly issued credits originated from major projected in Brazil (Aperam BioEnergia Biochar Project and

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

French company NetZero[1]). Several major corporations, including Microsoft Corp., JPMorgan Chase & Co., and Swiss Re Group, have purchased biochar credits. Some transactions have recorded prices as high as EUR 184 per tonne of CO_2 equivalent, with the 2023 average at approximately EUR 138. This is significantly higher than the EUR 5.30 average price for voluntary carbon credits overall in 2023, though biochar credit transactions tend to be smaller in volume.

While biochar projects offer several advantages, they face competition from other carbon removal technologies. Additionally, they must compete for feedstock, particularly with the biofuel sector and the sustainable maritime fuel industry. To help achieve its net zero ambitions, the EU actively promotes renewable and zero carbon fuels and uses onshore power at berth for ships over 5000 GT. This is part of its plan to reduce annual GHG intensity from shipping by 80% by 2050, against a 2020 baseline[2].

In terms of pricing, biochar credits have followed an upward trend over the past two years, often trading within the EUR 92-EUR 184 (USD 100-200) range. This premium pricing reflects the permanence of biochar-based carbon removal compared to nature-based solutions like afforestation and mangrove restoration. However, the sustainability of these high prices remains uncertain. According to MSCI Carbon Market projections, rising competition and tighter margins could lead to a price decline before 2026, with a potential rebound by 2035.

2.3 Valorisation of syngas

Syngas plays a pivotal role in the SEAFAIRER project as a hydrogen-rich product gas generated during the VINTER reactor's intermediate pyrolysis process. Comprising approximately 40% hydrogen, 15% carbon monoxide, 25% carbon dioxide, 8% methane, and other hydrocarbons, its effective utilisation is essential for optimising energy efficiency and exploring multiple economic pathways for the project's outputs.

One primary application of syngas within SEAFAIRER is process **heat generation**. A portion of the syngas will be combusted to supply the necessary heat for the VINTER reactor's pyrolysis operations, making the process energy self-sufficient.

Additionally, syngas is utilised in **Combined Heat and Power (CHP) systems to generate both electricity and heat**. The electricity generated from syngas combustion contributes to on-site energy generation, supporting various processes within the SEAFAIRER system. The generated heat is employed for feedstock drying and other ancillary processes, further optimising energy use within the facility. Beyond these primary applications, syngas holds significant potential for **hydrogen production**[3]. Given its substantial hydrogen content, syngas can serve as a feedstock for hydrogen extraction processes, which can then be utilised in various applications, including fuel cells and as a reactant in refining processes to upgrade bio-oils into high-quality fuels. The global hydrogen generation market was valued at approximately EUR 177.96 billion in 2024 and is projected to reach EUR 302.85 billion by 2030, growing at a CAGR of 9.3%[4], emphasising the strategic importance of syngas as a key contributor to the hydrogen economy. Another promising pathway is **synthetic fuel production**[5] which aligns with EU mandates on reducing fossil fuel reliance and integrating sustainable drop-in fuels. The global synthetic fuel market size was valued at EUR 5.98 billion in 2024 and is expected to expand at a CAGR of 22.40% from 2024 to 2034[6], driven by the push for low-carbon energy solutions and regulatory incentives such as the Renewable Energy Directive (RED II) and the FuelEU Maritime regulation. Furthermore, syngas has **industrial applications**, particularly in chemical manufacturing, where it serves as a precursor for **methanol and ammonia production**. Methanol, widely used as a fuel additive and in the chemical industry, aligns with the EU's push for cleaner marine fuels, while ammonia is critical for fertilizer production. The global methanol market was valued at EUR 29.83 billion in 2023 and is anticipated to reach EUR 44.20 billion by 2032, registering a CAGR of 4.5%[7], while the global ammonia market was valued at EUR 63.94 billion in 2020 and is projected to reach

[1] https://carboncredits.com/netzero-raises-over-19m-for-biochar-expansion-in-brazil/ (Accessed on: 05/03/2025)
[2] https://www.lr.org/en/services/statutory-compliance/fueleu-regulation/ (Accessed on: 05/03/2025)
[3] https://doi.org/10.1016/B978-0-323-91878-7.00019-8
[4] https://www.grandviewresearch.com/industry-analysis/hydrogen-generation-market (Accessed on: 05/03/2025)
[5] https://www.mdpi.com/2073-4344/11/6/752
[6] https://www.precedenceresearch.com/synthetic-fuel-market (Accessed on: 05/03/2025)
[7] https://www.fortunebusinessinsights.com/industry-reports/methanol-market-101552 (Accessed on: 05/03/2025)

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

EUR 105.93 billion by 2028, growing at a CAGR of 6.4% during the forecast period[8]. Studies have shown that renewable syngas can effectively replace fossil-fuel-based syngas in these applications, thereby playing an essential role in the decarbonisation of the industry[9]. Additionally, the transition from fossil-based to renewable syngas in ammonia and methanol production aligns with EU decarbonisation policies and could create opportunities for carbon credit generation under the European Emissions Trading System (ETS).

The aforementioned pathways for the valorization of the generated syngas can be further developed and integrated into SEAFAIRER's maritime sector presenting an even better opportunity due to the project's industry engagement. Hydrogen recovery from syngas is particularly relevant for the maritime industry as shipping companies accelerate their transition to fuel cell-powered vessels. The deployment of hydrogen fuel cells in auxiliary and main propulsion systems is being actively explored as part of decarbonisation strategies, with projects such as the sHYpS (Sustainable HYdrogen powered Shipping)[10] demonstrating the feasibility of this transition. By supplying syngas-derived hydrogen, SEAFAIRER can contribute to a growing market where hydrogen-powered vessels operate with significantly lower emissions than conventional marine fuel alternatives. Other explorable pathway is the conversion of syngas to synthetic hydrocarbons, enabling existing vessels to reduce their carbon footprint. As shipping operators navigate increasingly stringent IMO GHG reduction targets, synthetic fuels represent a practical pathway toward gradual decarbonisation, ensuring compliance with upcoming emission reduction milestones. One final integration of syngas exploitation pathways into the maritime sector and market relates to two widely discussed next-generation maritime fuels, methanol and ammonia[11]. The production of methanol from renewable syngas not only enhances its sustainability credentials but also aligns with the European Union's Fit for 55 targets[12], ensuring that SEAFAIRER's technological developments contribute directly to greener fuel alternatives for shipping. Ammonia is also gaining significant traction as a maritime fuel due to its carbon-free combustion properties, positioning it as a long-term solution for deep-sea shipping. Studies have highlighted ammonia's potential to reduce greenhouse gas emissions in the maritime sector[13], with various projects underway to develop ammonia-fueled vessels and the necessary bunkering infrastructure. By utilizing syngas as a feedstock for ammonia synthesis, SEAFAIRER taps into a growing market that aligns with the broader ambitions of maritime decarbonisation.

The global syngas market was valued at EUR 54 292 million in 2024 and is projected to grow to EUR 86 868 million by 2033[14], driven by increased adoption in energy and industrial applications. SEAFAIRER's strategic positioning within this evolving market is reinforced by major industry players such as Air Products and Chemicals, Linde, Air Liquide, Technip Energies, and Maire Tecnimont, all of whom are actively investing in syngas technology development and commercialisation. The EU regulatory framework further strengthens the potential for syngas-based technologies, with policies like RED, the European Green Deal, and the FuelEU Maritime Initiative creating a clear market pull for sustainable fuels.

By integrating syngas valorization across multiple pathways - process heat, CHP, hydrogen recovery, synthetic fuel production, and other industrial applications - SEAFAIRER ensures that this valuable byproduct contributes to both project sustainability and economic feasibility, while aligning with EU decarbonisation goals.

2.4 The three SEAFAIRER case studies

The **three selected feedstocks** (rice husk, biowaste sieving material, and agave bagasse) address different challenges in biofuel production. These include (i) energy-intensive separation and carbonization processes -

[8] https://www.fortunebusinessinsights.com/industry-reports/ammonia-market-101716 (Accessed on: 05/03/2025)
[9] https://doi.org/10.1002/cssc.202400059
[10] https://www.shyps.eu/the-project/ (Accessed on: 05/03/2025)
[11] https://www.offshore-energy.biz/23-methanol-powered-ships-ordered-since-the-start-of-2024/ (Accessed on: 05/03/2025)
[12] https://www.consilium.europa.eu/en/policies/fit-for-55/ (Accessed on: 05/03/2025)
[13] https://www.emsa.europa.eu/publications/reports/item/4833-potential-of-ammonia-as-fuel-in-shipping.html (Accessed on: 05/03/2025)
[14] https://straitsresearch.com/report/syngas-market (Accessed on: 05/03/2025)

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

rice husks, while abundant, require efficient conversion technologies to offset energy losses during processing[15], (ii) low silica yields from some feedstocks - agro-industrial wastes like sugarcane bagasse and corn stalk present disposal challenges but offer potential for silica-derived materials with advanced properties[16], and (iii) limited bio-coal yield from agro residues - bio-coal production from these feedstocks shows promise for partially replacing coal in steel industries, potentially reducing CO2 emissions by 18-40%[17]. However, large-scale production remains challenging, necessitating new technologies to boost biofuel production and meet energy needs[18]. Overcoming these obstacles is crucial for sustainable biofuel production from agricultural waste materials.

In **Germany**, SEAFAIRER focuses on a case study on the biowaste sector. The average green waste per capita generation and collection in the EU28 is 59 kg per year or a total of approx. 30 million tons. In Germany alone, the green waste collection in 2021 was of 5.19 million tons. This waste is sieved before its further treatment in composting or biogas plants. The sieve overflow is composed of relatively large woody particles. Currently this waste fraction is useless and needs to be disposed in incineration plants carrying significant disposal costs of about 70 EUR/t. The water content of the biowaste sieving material is approx. 50 wt-%. This means it needs to be dried before entering the VINTER reactor. On a commercial scale the drying must be done using residual heat i.e., from a biogas CHP or directly from the VINTER reactor. The main composition of the biowaste sieving material is wood mixed with some organic wastes. The resulting biochar can be inserted to the market together with other compost products as soil amendment, with adequate European Biochar Certification (e.g., EBC AgroOrganic, EBC Agro). For the SEAFAIRER activities, biowaste sieving material will be supplied by BENC Bio Energie Centrum in Mertingen, Bavaria, who is expected to be represented in the Advisory Board.

In **Spain**, SEAFAIRER focuses on rice husk from the *Comunidad Valenciana*, the region around the city of Valencia. The area surrounding the Albufera lake is a traditional rice agricultural region with a current productive area of about 17,000 ha. Rice husk is in principle a residue but its availability applications, as *i.e.* bedding material for livestock is gaining popularity. Limitations of availability will be assessed in WP8 by a field study as well as interviews with farmers and rice mills and local agricultural experts. Rice husk shows excellent feedstock properties for the VINTER technology since it has a defined particle size and form, very low water content (< 12 wt-%); and, since the VINTER reactor works at relatively low temperature (about 650°C), there is no risk of ash melting problems. Additionally, by operating the VINTER plant near to the rice mill, the residual heat can be used for rice drying. Surplus electricity from the CHP can be also supplied to the rice mill, improving their carbon footprint. Depending on its final quality, the produced biochar can be used as livestock feed additive (EBC Feed) or can be returned to the rice fields or to other agricultural fields with higher need of soil amendment such as citric fruits or vineyards (e.g., EBC Agro-Organic; EBC Agro). Initial samples of rice husk were sourced from a local supplier; for larger volumes SEAFAIRER has liaised with *La Unió de Llauradors*; a farmers' union in this rice growing region, which will be represented in the Advisory Board by their Director of Innovation, Pepe Castro.

In **Mexico**, SEAFAIRER presents a case study based on the tequila and mezcal industry as a showcase for the technology export potential outside Europe as well as the provision of sustainable marine biofuels in the American continent, since SEAFAIRER undertakes a global approach. In the last five years (2019-2023), tequila production has been approximately 450 million liters per year. The total yearly agave bagasse generation is about 1.26 million tons, which is considered a residue besides exceptional cases. In most of those cases the agave bagasse is composted and returned to the fields without energy utilization. The agave bagasse is a fibrous material with a water content of approx. 55 wt-% as generated in tequila production. Before entering the VINTER reactor the bagasse needs to be dried. The drying process can be natural (sun and wind) or using the residual heat of the VINTER plant. Surplus electricity from VINTER can be supplied to the tequila factory.

[15] https://doi.org/10.1002/gch2.202300112
[16] https://doi.org/10.1016/j.envres.2023.116002
[17] https://doi.org/10.1016/j.cej.2023.145340
[18] https://doi.org/10.1016/j.rser.2024.114535

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Depending on its final quality, the biochar produced can be used as livestock feed additive (EBC Feed) or can return to the agave fields (EBC Agro-Organic, EBC Agro). For the SEAFAIRER activities, Associated Partner Centro Mário Molina, and the Community of Practice members of the Tequila Regulatory Council (*Centro Regulador del Tequila*), will support the supply of agave bagasse.

The feedstock availability in Europe and worldwide for the three selected feedstocks, as well as the potential marine biofuel production with commercial-scale VINTER units by 2050 is presented in **Table 1**. It is important to highlight that these three feedstocks alone could potentially deliver more than 5% of the EU's industrial maritime shipping fuel demand, with a potential production volume greater than 1.7 million tons per year.

Table 1 - Feedstock availability and potential biofuel production

First three feedstocks		Availability in Europe		Availability worldwide		Market share by 2050	Availability as VINTER feedstock	VINTER units by 2050	Marine fuel output	EU demand covered
Feedstock	*LHV (GJ/t)*	*Mt/a*	*TJ/a*	*Mt/a*	*TJ/a*	*Mt/a*	*Mt/a*	*#*	*t/a*	*%*
Rice husk	15	0.34	5.1	103.6	1,544	5.18	5.18	648	1,554,000	4.44%
Biowaste sieving material	10	3.6	36.2	n/a	n/a	1.45	3.62	76	173,998	0.50%
Agave bagasse	8	n/a	n/a	1.26	10.1	0.378	0.8505	21	39,690	0.11%

2.5 "Push" and "Pull" factors

The three possible use case implementations present different barriers and incentives when exploited in the maritime transport sector. The transition to biofuels in maritime shipping is driven by regulatory mandates, environmental concerns, and technological advancements. However, economic barriers, feedstock competition, and policy uncertainty continue to slow adoption. By addressing these challenges through strategic policy interventions, infrastructure investments, and industry-wide cooperation, biofuels can play a transformative role in achieving the shipping sector's decarbonisation goals[19].

Table 2 - Push-pull overview on Marine biofuel produced from SEAFAIRER primary feedstocks.

Feedstock origin		Push factors		Pull factors	
Feedstock	*Geography*	*Barriers*	*Incentives*	*Barriers*	*Incentives*
Biowaste sieving material	Germany	**Sustainability and environmental concerns**	**Regulatory and policy pressure**	**Feedstock availability and competition** *Limited biomass resources to	**Boosting innovation in biofuel for maritime transport**

[19] https://doi.org/10.1016/j.rser.2024.114427

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Rice husk	Spain	*Reducing GHG emissions; *Regulatory compliance for shipping companies; *Air quality near ports and coastal communities and public health benefits; *Technological readiness and infrastructure compatibility *Advancements in feedstock processing.	*IMO decarbonisation goals; *The FuelEU Maritime initiative and the expansion of the EU ETS; *Increasing carbon levies make biofuels a cost-effective alternative in the long term;	meet demands of transport sector (road, aviation and maritime); *Land use and sustainability concerns; *Geographical disparities in feedstock production; *High production costs *Uncertain long-term price stability; *Lack of large-scale production infrastructure	*Scaling up production and infrastructure *Biofuel production, food security, and ecosystem preservation; *Strengthening policy incentives; *Partnerships between shipping companies, fuel producers, and policymakers; *Dynamic carbon taxation
Agave bagasse	Mexico				

One of the strongest biofuel adoption drivers in shipping is the **increasing regulatory pressure from international and regional bodies.** The International Maritime Organization (IMO) has set ambitious targets, including a 20% reduction in emissions by 2030 and a commitment to reach net-zero emissions by 2050. At the same time, the European Union has introduced stricter policies through the FuelEU Maritime Initiative – an element of the "Fit for 55" package - and the expansion of the EU Emissions Trading System (EU ETS) to shipping, creating financial incentives for cleaner fuels. FuelEU Maritime entered in force on January 1, 2025, and the EU ETS will be applied fully from January 1, 2026. Therefore, **the intra-EU maritime shipping market**, *i.e.,* shipowners sailing between EU ports, will be exposed to the **highest need to pay** for biofuels.

Beyond regulations, environmental concerns are another major factor accelerating the shift toward biofuels. The need to reduce greenhouse gas emissions is critical, and biofuels derived from waste-based and non-food feedstock offer an immediate and scalable pathway to decarbonisation. Additionally, the transition away from high-sulfur fuels can significantly improve air quality, benefiting both the environment and public health in coastal and port areas, which can be explored in SEAFAIRER, **in the Port of Valencia**.

Despite these positive developments, several challenges continue to hinder the widespread adoption of biofuels in shipping. One of the primary concerns is **the availability of sustainable biomass feedstocks**. The shipping industry competes with other bio-based sectors, including road transport and the growing demand for sustainable aviation fuel, which could limit the supply of biomass for maritime use.

While carbon pricing mechanisms and regulatory incentives aim to close this gap, uncertainty in long-term pricing and market stability continues to deter investment. To meet these challenges, SEAFAIRER will exploit the connections to the port authority, the infrastructure, and its operators by leveraging the presence of Fundación Valenciaport in the consortium, as well as the Portuguese refinery Galp, which operates refinery and fuel storage facilities that will be instrumental in testing the integration of SEAFAIRER's intermediate biofuels into existing maritime fuel supply chains. The industry's hesitation to commit to biofuels is also driven by concerns about fuel supply stability and whether biofuels can remain a cost-effective solution in the long run. To accelerate the integration of biofuels into the maritime sector, several key actions must be taken.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Investment in large-scale biofuel production infrastructure is crucial to ensuring a stable and sustainable fuel supply. At the same time, policymakers must establish clear long-term regulations and incentives that provide certainty for investors and shipping companies. Ensuring sustainable feedstock supply while avoiding competition with food production and environmental degradation is essential for long-term success. Greater collaboration between shipping companies, fuel producers, and governments will also be necessary to address existing bottlenecks and drive technological advancements. Furthermore, refining carbon pricing mechanisms will help create a financial environment that favors the adoption of biofuels without compromising economic viability.

2.6 Additional feedstocks and use cases

One of the activities foreseen is the identification and sourcing of additional feedstocks, which will be tested at Fraunhofer UMSICHT in the pilot-scale VINTER unit. As the exploration of these feedstocks is still ongoing, the outcomes of this work will be assessed in due course. Once sufficient data and insights have been gathered, they will be integrated into a future version of the Exploitation Plan to ensure it accurately reflects the feasibility and potential applications of these feedstocks within the project, namely the potential use of **rice straw, digestate from biogas plants, forestry residues (wood), among others**.

3.0 Key Exploitable Results (KERs)

To ensure that SEAFAIRER's innovations extend beyond the project's lifetime, the consortium has identified a set of KERs that form the foundation for long-term industry impact, commercialisation, and knowledge transfer. These KERs represent the most strategically significant technological and methodological advancements within the project, each playing a crucial role in facilitating the transition toward sustainable marine biofuels.

By defining clear ownership structures, IP protection measures, and commercialisation pathways, SEAFAIRER ensures that its results are not just scientific achievements but tangible assets for industry adoption. The following KERs have been selected based on their technological maturity, market potential, and ability to drive biofuel integration into existing maritime infrastructure. A Key Exploitable Result is "a significant and noteworthy outcome due to its high potential to be utilised and generate benefits further down the value chain of a product, process, or solution. It can also serve as a crucial input for policymaking, further research, or educational purposes."[20].

SEAFAIRER will generate different types of exploitable results, which are tangible or intangible outputs, such as data, knowledge, and information. Due to the nature of this Innovation Action, exploitable results can be generated beyond the end of the project, as the pilot sites in the project can transition from demonstration to full commercial operation beyond the end of the project.

The SEAFAIRER consortium is committed to ensuring that its technological developments translate into real-world impact. At this early stage, the exploitation strategy focuses on positioning SEAFAIRER's KERs for market readiness, leveraging the expertise of different partners, and establishing clear pathways for commercialisation and industrial integration. While several business models and licensing approaches are being explored, final commercialisation strategies will evolve as the project progresses.

Each partner within the consortium plays a distinct role in defining how the project's results will be exploited. SEAFAIRER's exploitation approach considers various IP protection mechanisms, reflecting the fact that a significant portion of the project's deliverables are classified as confidential or restricted. The description of each KER provided below reinforces this, detailing ownership rights, target end-users, and post-project

[20] https://intellectual-property-helpdesk.ec.europa.eu/system/files/2022-02/HEU%20Results%20platform.pdf (Accessed on: 05/03/2025)

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

exploitation strategies. SEAFAIRER's technologies are being considered for different commercialisation pathways. The Digital Twin of the VINTER Demo Unit, led by UMSICHT, is currently under evaluation for patentability, with potential licensing opportunities being explored for research institutions and industrial biofuel producers. The Feedstock-to-Fuel Demo Plant, co-developed by SAGAVA and UMSICHT, is expected to advance towards TRL 8, and discussions on licensing and technology scale-up are anticipated as the project progresses. Similarly, the Fuel and Engine Testing Protocols, developed by FVTR, PETROGAL, and UMSICHT will be validated in real maritime conditions and could provide a regulatory framework for future fuel adoption in shipping. Meanwhile, the Value Chain Simulation Tool, developed by DTU and KPMG, is being positioned as a tool to support stakeholders in assessing the economic and environmental viability of biofuel supply chains.

Beyond technology transfer, SEAFAIRER's EP actively supports spin-offs and potential joint ventures. One existing example is SAGAVA, which has been actively involved in the project. While other potential spin-offs or joint ventures may emerge, these will be shaped by ongoing market assessments and business modeling activities led by KPMG and SAGAVA, particularly within Business Modelling and Spin-Off Development (*cf. Task 9.4*), Market Potential of VINTER Technology for the Maritime Sector (*cf. Task 9.3*), and Market potential study of feedstock conversion using VINTER (*cf. Task 9.1*).To strengthen the internal capacity of the consortium, SEAFAIRER will also implement workshops and knowledge transfer initiatives. These efforts meet the objectives in "Innovation and IP Management" (*cf. Task 1.3*), where DTU, KPMG, and FRAUNHOFER will guide the partners on IP rights management, licensing considerations, and commercialisation pathways. Additional capacity-building efforts will be tied to Techno-Economic Assessment and Life-Cycle Costing (*cf. Task 8.1*) and Industrialisation Plan for Technology Replicability and Scale-Up (*cf. Task 9.2*), ensuring that SEAFAIRER's innovations align with market needs and investment opportunities.

This multi-faceted approach- combining IP protection, licensing opportunities, spin-off potential, and internal knowledge transfer- ensures that SEAFAIRER's results will be positioned not just as research outputs but as strategic assets with clear pathways toward industrial adoption. While specific commercialisation strategies are still being refined, the consortium's collective expertise in business modeling, regulatory engagement, and market analysis ensures that SEAFAIRER's technologies remain aligned with industry demands and investment-ready by the project's later stages. SEAFAIRER's exploitation strategy is built on a proactive approach to market intelligence, regulatory monitoring, and stakeholder engagement to position its results effectively within the maritime biofuel sector. Given the rapidly evolving regulatory landscape and competitive environment, the project integrates business intelligence efforts with targeted industry outreach, ensuring that its innovations are aligned with both market needs and policy frameworks.

A key component of SEAFAIRER's strategy involves continuous market and competitive analysis, conducted primarily within Work Packages 8 and 9, which focus on techno-economic assessments, market potential studies, and industrialization strategies. These efforts will help assess SEAFAIRER's positioning within the biofuels sector, identifying competitive advantages, potential adopters, and commercialisation pathways. Regulatory monitoring is also a fundamental part of SEAFAIRER's exploitation activities. As maritime fuel policies evolve under FuelEU Maritime, IMO decarbonisation targets, and ISO 8217 fuel standards, SEAFAIRER will track these developments to ensure its technologies remain compliant and commercially viable. While no formal regulatory advisory board is currently planned, the project will engage directly with policymakers and standardization bodies through Development of European Implementation Studies (*cf. Task 8.6*) and EU Roadmap for Deployment of the VINTER Ecosystem (*cf. Task 9.5*), providing insights into how SEAFAIRER fuels can integrate into existing and future maritime regulations.

Stakeholder engagement plays a central role in the project's exploitation efforts. Through a combination of workshops, trade fairs, and industry forums, SEAFAIRER will engage with key players, including policy makers, energy providers, maritime shipping alliances, and biofuel industry leaders. Planned dissemination events at major ports such as Sines, and Valencia will help demonstrate the viability of SEAFAIRER's biofuels in real-world maritime operations. Additionally, SEAFAIRER will participate in major industry conferences, such as the

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

European Maritime Forum and the European Biomass Conference, to increase its visibility and attract potential collaborators. The current Advisory Board provides a foundation for these discussions, offering guidance from industry experts across different areas of the biofuel value chain. Moreover, SEAFAIRER is establishing Communities of Practice (COPs) in Denmark, Spain, and Mexico to facilitate regional knowledge exchange and policy discussions. Through this combination of business intelligence, regulatory engagement, and active industry outreach, SEAFAIRER is ensuring that its innovations are positioned for long-term success. By continuously monitoring the market landscape, engaging with key industry players, and aligning with regulatory trends, the project is building a foundation for widespread adoption and commercialisation of its biofuel technologies.

A crucial aspect of SEAFAIRER's exploitation strategy is ensuring that its biofuel technology and supporting tools attract investment and market interest. Given the complexity of scaling the production of advanced maritime biofuels, the project aims to create financially viable pathways that will support commercialisation, facilitate partnerships, and enable long-term market adoption. While SEAFAIRER does not yet have a fully developed investment plan, the project has identified key financing opportunities and stakeholder engagement strategies that will be further refined as the project progresses. SEAFAIRER recognizes that securing investment requires engagement with both public and private funding sources. The project will explore opportunities through the European Investment Bank (EIB) and the Innovation Fund, both of which have been identified as potential sources of CAPEX financing for the biofuel sector. Additionally, SEAFAIRER is considering funding avenues through the EIC Accelerator, which supports breakthrough innovations with high market potential, and the European Regional Development Fund, particularly for the scale-up of biofuel production and industrial applications. These financing mechanisms will play an essential role in expanding SEAFAIRER's reach, ensuring that its technologies progress beyond the research phase into real-world applications.

To attract potential investors, SEAFAIRER must establish credibility through results-driven demonstrations and strategic industry engagement. A key approach is leveraging the project's three pilot cases in Germany, Spain, and Mexico, which serve as proof-of-concept demonstrations for the viability of SEAFAIRER's biofuels in different geographical and industrial contexts. By providing real-world data on performance, emissions reductions, and cost-effectiveness, these pilot cases will serve as a foundation for investment discussions with industrial partners, shipping companies, and energy providers.

The project will also build credibility through investment pitch decks, financial modeling, and business case development, which are integrated into SEAFAIRER's business modeling tasks in Work Package 9. Specifically, Business Modelling and Spin-Off Strategy (*cf. Task 9.4*) and Market Potential of VINTER Technology for the European Port Maritime Sector (*cf. Task 9.3*) will help define scalable business cases, revenue models, and investor engagement strategies. This work will be supported by investment-focused workshops where partners can refine their commercialisation strategies and establish direct connections with potential financial backers. The project is also exploring early adopters within its consortium, with several partners playing a critical role in scaling SEAFAIRER's technologies. PETROGAL, a key consortium member, is well-positioned to integrate SEAFAIRER's biofuels into refinery operations, serving as a potential first adopter for industrial-scale applications. Other partners, such as SAGAVA, could facilitate further commercialisation through licensing agreements or joint ventures. While early discussions are ongoing, these existing industrial relationships will provide an initial market entry point for SEAFAIRER's technologies.

Finally, to ensure that commercial feasibility is demonstrated effectively, SEAFAIRER is integrating pilot deployments and technology showcases into its exploitation strategy. The three case studies - using rice husk in Valencia, biowaste sieving material in Bavaria, and agave bagasse in Mexico - serve as initial demonstration sites, providing data-driven evidence for investment discussions. These deployments will be used to refine cost-benefit calculations, assess return on investment (ROI), and validate business models before scaling SEAFAIRER's biofuel production technologies.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Through this multi-faceted approach- leveraging funding sources, refining investment models, engaging with key stakeholders, and demonstrating commercial viability- SEAFAIRER is laying the groundwork for long-term financial sustainability and large-scale adoption. While many aspects of this strategy are still being refined, the project is committed to securing the necessary resources and partnerships to ensure that its biofuel innovations transition from research to industrial reality.

3.1 VINTER demo unit

Description: This KER, also referred to as "Feedstock-to-fuel demo plant", describes the VINTER reactor, which at project start had a processing capacity of 80 kg/h. During SEAFAIRER, VINTER will be scaled up to at least 250 kg/h, or approx. 6 tonnes/day, which translates to an approximate advanced biofuel production capacity of approx. 600 kg per day, per VINTER unit.

End users: The operators (users) of a commercial-scale VINTER reactor can be (advanced) biofuel production companies, refineries, port operators, fuel bunkering companies, agricultural companies, as well as any state grid or private energy production entities.

Post-project exploitation: Towards the end of SEAFAIRER, it is expected to implement the scaled-up demonstration unit at a local/regional biomass provider, which would result in the first commercial use case. Currently, conversations are ongoing between SAGAVA and feedstock suppliers in Germany and Mexico.

Intellectual Property Rights: The VINTER process is fully patent protected under WO2023118213A1. The expected outcome is SAGAVA taking over the implementation and commercialisation of VINTER technology, based on an exclusive licensing agreement with UMSICHT (*cf. Task 9.4*). A freedom-to-operate (FtO) analysis will be performed prior to commercialising VINTER; this will entail a tender offer to specialized patent attorneys and related law offices. The FtO comprises: (i) An evaluation of the patentability of WO2023118213A1; (ii) FtO analysis based on prior art and granted patent rights from patent documents; (iii) A search for additional patent rights executed based on defined patent classification and keywords in both German and English language. Resulting in a list of identified documents, which will further undergo an analysis, summarising contents (especially patent claims) of the identified patents and the risk of infringement, thus strengthening the technology's IP protection and enabling its commercial rollout.

Additional funding opportunities: Additional funding opportunities for VINTER, as an advanced biofuel technology, can be summarized in two categories: **research-driven and industry-/commercially-driven** funding. For **research purposes**, Horizon Europe calls such as the Research Innovation Action for the "Development of smart concepts of integrated energy driven bio-refineries for co-production of advanced biofuels, bio-chemicals and biomaterials"[21], provide an opportunity to focus on e.g., how to further valorise the effluents of the VINTER process, namely the hydrogen-rich process gas (syngas) and the process water for e.g., ammonia-based salts which can replace conventional fertilisers. Similarly, the EIC Pathfinder and Marie Skłodowska-Curie Actions (MSCA), such as Doctoral Networks, can be viable options to integrate e.g., DTU and UMSICHT as partners hosting PhDs working *e.g.* on new knowledge of advanced biomass conversion technologies, CO_2/syngas valorisation, process water treatment, and biochar applications and activation. **For commercial purposes**, a collaboration with SAGAVA for deployment and commercialisation of VINTER, also provides a broad spectrum of funding opportunities. Specifically, the **EIC Accelerator** is an exceptional instrument to conclude the final development stages of VINTER and finance its scale-up; at a more advanced phase with sufficient market proof, the **Innovation Fund** can potentially be pursued.

3.2 Digital twin of the VINTER unit

Description: The digital twin will replicate the demo VINTER unit, which will have a processing capacity of at least 250 kg/h. The objective of the digital twin is to map out the thermodynamic, catalytic and energetic phenomena occurring inside the reactor throughout the entire residence time of the feedstock; from the sluice system to the moment in which the last products leave the reactor for the condensation unit (bio-oil, syngas)

[21] https://circular-cities-and-regions.ec.europa.eu/support-materials/funding-and-financing/horizon-cl5-2024-d3-02-03-development-smart-concepts#:~:text=Proposals%20should%20develop%20zero-waste%20and%20neutral%20or%20negative,through%20co-production%20of%20added-value%20bio-based%20products%20and%20bioenergy. (Accessed on: 05/03/2025)

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

and the carbonisate (biochar) has been captured. This will be performed by developed Computational Flow Dynamics (CFD) models, in addition to basic and detailed engineering activities (*cf. Task 4.1 – Lead: UMSICHT)* to model the mass and energy balances and be able to have an accurate 3D model of the demo unit and its components. Therefore, the digital twin will serve as a tool for the investigation of performance-improving strategies for the VINTER technology and provide data for the techno-economic and life-cycle assessment (*cf. Task 8.1 and 8.2 – Lead: DTU*). The software used is expected to be Aspen Plus Dynamics, along with Aveva.
End users: Academic/scientific community, as well as the VINTER licensees implementing the technology commercially. Due to the sensitivity of the digital twin in relation to the VINTER technology/unit, it is expected that the only an anonymized, adapted version of the data corpus of the digital twin is made available for research and teaching purposes.
Post-project exploitation: The digital twin will be primarily of interest to calculate different scenarios for different customers and use cases.
Intellectual Property Rights: The patentability of the digital twin will be formally reviewed, as well as an option to have it as a license-based digital option for VINTER licensees, such as SAGAVA. Copyright protection will be evaluated to safeguard the proprietary software code and any original content generated during its operation. Access will be controlled through secure authentication and authorization protocols, with strong encryption applied to data at rest and in transit. Discussions with third parties will require non-disclosure agreements (NDAs) to maintain confidentiality and protect intellectual property. Plans also include licensing the software to third parties for broader industry applications. Clear terms of use, including licensing agreements or end-user license agreements (EULAs), will be established to govern usage and protect intellectual property.
Additional funding opportunities: We do not foresee additional funding opportunities for the digital twin as a standalone element, but rather integrated within applied research projects; *e.g.* PhDs performing research on VINTER as an advanced biofuel production technology and collecting data on feedstock conversion campaigns using the digital twin.

3.3 Fuel and engine testing protocols

Description: This KER encompasses all fuel and engine testing protocols performed on the VINTER bio-oil (advanced biofuel). This includes information on the specifications and properties of VINTER bio-oil (*cf. Task 7.1 – Lead: FVTR*), the necessary boundary conditions and limits for any blends, including possible shares of bio-components in the blends. This also comprehends compatibility tests with existing engine materials and infrastructure (e.g., elastomer-based seals; O-rings) used on marine vessels and ports (*e.g.*, fuel storage units). This will deliver a range of possible blend ratios forms the basis for developing the final boundary conditions of the test matrix for the following tasks of experimental validation of the product with VINTER at demonstration scale.
End users: Academic/scientific community, as well as the VINTER licensees implementing the technology commercially.
Post-project exploitation: The fuel and engine testing protocols will serve both research and industrial/commercial interests. Certain results or protocols will be used for research purposes, *e.g.* including EU training initiatives on advanced biofuel production technology, as well as subsequent research by UMSICHT. These fuel and engine testing protocols will also provide the necessary validation for the commercialisation of VINTER bio-oil as an advanced biofuel. For SAGAVA as the expected implementation partner and VINTER licensee, the validation of different fuel blends and blending parameters allows for a commercial exploitation of so-called “designer fuels”; *i.e.*, the possibility of blending VINTER biofuel in accordance to offtakers’ needs and quality thresholds.
Intellectual Property Rights: The patentability of certain fuel blending parameters will be formally reviewed by the expected commercial licensee of VINTER technology, SAGAVA. These are expected to be protected as trade secrets and, where applicable, through patents. Confidentiality agreements (NDAs) will be required for employees and partners accessing these protocols to safeguard competitive advantages. Data and protocol access will be restricted through secure authentication systems and permissions management to ensure controlled usage.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

Additional funding opportunities: We do not foresee additional funding opportunities for the fuel and engine testing protocols as a standalone element, but rather integrated within applied research projects, *e.g.* PhDs performing research on VINTER as an advanced biofuel production technology and collecting data on feedstock conversion campaigns using fuel and engine testing protocols.

3.4 Value chain simulation tool

Description: This KER refers to a digital simulation tool that models the biofuel production and distribution value chain, providing data to optimise logistics and supply chain strategies. Its overarching objective is to assist stakeholders in identifying the most cost-effective biofuel supply chain strategies, supporting decision-making by providing comprehensive economic and environmental impact assessments based on the the techno-economic and life-cycle assessment (*cf. Task 8.1 and 8.2 – Lead: DTU*).

End users: Academic/scientific community, as well as the VINTER licensees implementing the technology commercially.

Post-project exploitation: The Value Chain Simulation Tool will be developed into a market-ready software. It may be bundled with the VINTER reactor as a decision-support tool for clients. To enhance usability, partners may expand its data libraries, including feedstock and vessel´s databases, improving simulation accuracy for maritime biofuel logistics. Beyond biofuels, the tool's versatility could be suitable for applications in agriculture and waste management, positioning it as a key platform for sustainable value chain analysis.

Intellectual Property Rights: The tool's source code, user interface design, and accompanying documentation – created by each of the contributing partners – will be copyrighted to protect IP. Patents may be pursued for unique algorithms or methodologies embedded within the tool. Additionally, trademarks for the tool's name, logo, and branding elements will secure its market identity and differentiate it from competitors. Both partners involved in the development of the value chain simulation tool will share the copyright. Copyright grants the owners of intellectual creations in the literary, scientific, and artistic fields the exclusive right to dispose of their work and use it, or authorize its use by third parties, in whole or in part. In this way, all involved partners aim to ensure that the reproduction, distribution, exhibition, performance, or adaptation of the KER does not occur without their consent. Without copyright protection, the KER could be misused or commercially exploited without the Consortium's permission. This may include uses that misrepresent the original meaning of the KER or damage the reputation of the Consortium.

Additional funding opportunities: We do not foresee additional funding opportunities for the value chain simulation as a standalone element, but rather integrated within applied research projects, e.g. PhDs performing research on VINTER as an advanced biofuel production technology and utilising data from the value chain simulation tool.

3.5 EU roadmap for deployment

Description: This KER refers to a strategic roadmap detailing pathways for large-scale deployment of VINTER as an advanced biofuel technology in Europe and beyond. Its overarching objective is to provide a framework guiding policymakers in biofuel adoption and showcasing the results and outcomes obtained in SEAFAIRER. It should also facilitate investment opportunities by outlining market readiness and regulatory incentives to implement advanced biofuel production value chains.

End users: Industrial stakeholders engaged in the project, second Tier stakeholders that directly benefit from SEAFAIRER industrial value chain ecosystem, research driven entities, policymakers and public institutions such as CINEA.

Post-project exploitation: The EU roadmap for deployment will serve both research and industrial/commercial interests. It will be published as a free resource for EU-wide impact; the overarching objective is to:

- Enable a strategy for funding future investments by SEAFAIRER industrial partners;
- Fast track technology market implementation of biofuels by serving the commercial interest of VINTER licensees by providing a knowledge basis for the expansion and wider deployment of VINTER units, identifying viable target markets, feedstocks, and other parameters conducive to a successful value chain implementation;

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

- Contribute to future policy on biofuel integration and maritime decarbonisation, through policy briefs and regulatory reviews.

Intellectual Property Rights: It should be noted that this document will be policy-oriented and intended for strategic dissemination. All partners involved in the development of the roadmap for deployment will share the copyright with the lead partner of this KER, FVP. Copyright grants the owners of intellectual creations in the literary, scientific, and artistic fields the exclusive right to dispose of their work and use it, or authorize its use by third parties, in whole or in part. In this way, all involved partners aim to ensure that the reproduction, distribution, exhibition, performance, or adaptation of the KER does not occur without their consent. Without copyright protection, the KER could be misused or commercially exploited without the Consortium's permission. This may include uses that misrepresent the original meaning of the KER or damage the reputation of the Consortium.

Additional funding opportunities: We do not foresee additional funding opportunities for the EU roadmap for deployment as a standalone element.

4.0 Monitoring and future work

The SEAFAIRER EP is designed to be adaptive and continuously informed by project developments. As key work packages (WP8 & WP9) progress, their findings will be systematically integrated into the evolution of the exploitation strategy, ensuring that commercialisation, market positioning, and investment readiness are refined in alignment with real-world data.

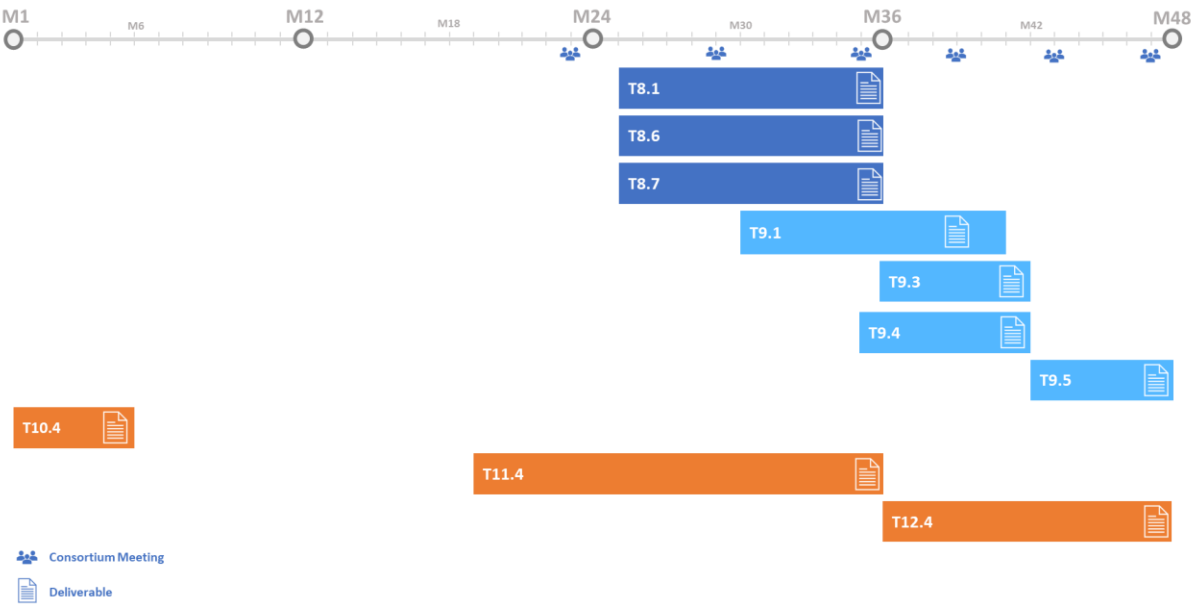

Figure 1 - Exploitation Plan Timeline

The GANTT chart above (Figure 1) outlines how crucial exploitation-related activities (Tasks and Deliverables) align with consortium meetings, which will serve as pivotal moments for knowledge exchange, stakeholder engagement, and other dissemination and communication activities. Planned exploitation workshops will allow the consortium to translate project findings, especially information derived from the reports produced in WP8 and WP9, into business intelligence insights, regulatory strategies, and commercialisation pathways, ensuring that SEAFAIRER's results are market-ready and investor-attractive oriented.

The structured integration of findings from WP8 and WP9 into SEAFAIRER's exploitation strategy ensures that the project's commercialisation pathways remain grounded in real-world data. The first exploitation workshop (cf. Task 11.4) is planned to be held at the Consortium Meeting in Sines, Portugal, hosted by PETROGAL at

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

around M23; the second exploitation workshop (*cf. Task 12.3*) is planned to be held at the last Consortium Meeting in Valencia, Spain, hosted by Fundación Valenciaport at around M47. At every such exploitation workshop, DTU as coordinators, and the respective partners (co-) owning the IP being discussed, will deliver information and updates on every KER, and structure these in **KER flashcards** (Table 3).

Table 3 - KER flashcards

Question / Area	Description
Description of KER (one line)	Short description of the exploitable result
Business model	Short description of business model for exploitable result (if applicable); does not apply to *e.g.*, KERs of academic/scientific exploitability only.
Preliminary cost-benefit analysis	For commercially relevant KERs: what are the expected costs and benefits of implementation? The analysis must indicate profitability indices, such as Net Present Value (NPV), Internal Rate of Return (IRR), Return on Investment (ROI) and/or payback period.
Investment	How much capital expenditure is required and what are recommended funding sources.
IP ownership	Who is expected to have IPR on the KER and in which form (e.g., patent, licensing agreement, trade secret). What are the updates/new elements and/or deviations from what has originally been defined in the Grant Agreement.
Multipliers	Who are the stakeholders expected to be involved in the exploitation of this KER and what are their roles and contributions.

At this stage, SEAFAIRER will have:

- Preliminary insights from the techno-economic assessment of VINTER technology as well as life-cycle costing, offering a clearer understanding of the cost-effectiveness and scalability of SEAFAIRER's biofuels.
- Findings from European and intercontinental implementation studies, identifying key opportunities and challenges for market deployment.
- The launch of the market potential study, marking the beginning of in-depth industry analyses that will inform commercialisation strategies.

By aligning the exploitation workshop with these milestones, SEAFAIRER creates a two-way exchange that will take into consideration the workshop benefits from WP8's findings, while simultaneously feeding critical input into WP8 and WP9, ensuring that business modeling efforts reflect real market conditions.

The next phase of integration occurs in the lead-up to M36, when SEAFAIRER will finalize its first major EP update (*cf. Deliverable 11.4*). This period will see the consolidation of findings from the techno-economic assessment and life-cycle costing study (*cf. Task 8.1*), as well as European and intercontinental implementation studies (*cf. Tasks 8.6 and 8.7*).

These efforts will provide a comprehensive evaluation of SEAFAIRER's economic viability, scalability, and real-world deployment potential, shaping a structured commercialisation roadmap. The consortium meeting at M35 will serve as a key checkpoint, allowing partners to refine market positioning strategies and identify key conditions for successful adoption, ensuring that SEAFAIRER's biofuel solutions are aligned with both regional and global maritime industry needs.

As SEAFAIRER moves into its last full year (M36 - M48), the focus shifts towards ensuring full-scale commercial deployment and regulatory alignment. The results from WP9, particularly findings from the market potential study (*cf. Task 9.1*), market potential of VINTER biofuels (*cf. Task 9.3*), business modelling and spin-off (*cf. Task*

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

9.4), and the EU roadmap for deployment (*cf. Task 9.5*), will form the backbone of the final version of the EP (*cf. Deliverable 12.3*, due M48).
By M39, preliminary market and business model findings will be discussed in a consortium meeting, ensuring that SEAFAIRER's technologies are positioned for industrial adoption. This will be followed by an exploitation workshop at M43, where partners will refine the business cases, investment models, and deployment pathways based on insights from the finalized market potential studies (*cf. Tasks 9.1 and 9.3*) and commercialisation strategies (*cf. Task 9.4*).
The final consortium meeting at M47 will serve as the last strategic checkpoint before the submission of the final EP (*cf. Deliverable 12.3*), ensuring that the EP reflects a fully integrated, investment-ready roadmap for SEAFAIRER's biofuel solutions. Findings from the EU roadmap for deployment (*cf. Task 9.5*) will play a central role in shaping the long-term policy, industrial scaling strategies, and investment engagement efforts required to establish SEAFAIRER's technologies as a market-standard solution for maritime decarbonisation.
By synchronizing the exploitation strategy with key findings from WP8 and WP9, SEAFAIRER ensures that its business models, investment strategies, and commercialisation pathways remain adaptable, data-driven, and positioned for long-term success.

4.1 Funding roadmap

The coordination team at DTU, together with KPMG, SAGAVA and UMSICHT has identified a preliminary list of funding opportunities that could further support the research and innovation activities in SEAFAIRER. The rationale is that, while SEAFAIRER – as an Innovation Action – focuses on the final development steps of VINTER to reach TRL 7 and prepare its commercialisation, there are additional areas of research that can be singled out from the project's core concept. For instance, VINTER generates both gaseous (syngas) and liquid (process water) effluents, which could be further valorised, by utilising e.g., Pressure Swing Adsorption technology to extract green hydrogen from syngas, or wet oxidation to treat the process water and potentially extract ammonia salts, which provide a viable alternative to conventional fertilizers. As such, SEAFAIRER is understood not as a static, standalone project, but as a potential research and innovation basis for several other projects leveraging SEAFAIRER's outcomes and results.

Based on this understanding, Table 4 provides an overview of the preliminary list of funding opportunities identified. These are European (Horizon Europe) opportunities only.

Table 4 - Overview of the preliminary list of funding opportunities

Instrument	Short description / Call Name	Indicative Budget & Best-Fits
Horizon Europe	Cluster 4 (Industry, Materials & Circular Economy), Cluster 5 (Energy, Mobility) and Cluster 6 (Bioeconomy, Environment) – RIAs/IAs. Development of smart concepts of integrated energy-driven bio-refineries for co-production of advanced biofuels, bio-chemicals, and biomaterials.	EUR 3.5M per project. Best suited for R&D institutions and industry consortia.
	EIC Accelerator (Open & Challenges): Supports deep-tech start-ups and SMEs developing breakthrough technologies. Provides blended finance (grants + equity).	EUR 0.5M- EUR 15M+ per project. Best suited for innovative SMEs and start-ups, particularly for SAGAVA's commercialisation efforts.
	EIC Pathfinder (Open & Challenges): Funding for high-risk, high-gain research to develop radically new technologies emerging from SEAFAIRER.	Up to EUR 3M per project. Best suited for research institutions like DTU, FVTR, and UMSICHT.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

	MSCA Doctoral Networks: Funds doctoral training through international, interdisciplinary, and intersectoral collaborations	Up to EUR 4M per project. Best suited for universities and research institutions (e.g., DTU, UMSICHT).
Innovation Fund	Funding for projects focused on innovative low-carbon technologies, including CAPEX investments for VINTER technology implementation.	EUR 2.5M- EUR 7.5M per project. Best suited for industrial-scale technology deployment.
LIFE Programme	Co-funds environmental, climate action, and clean energy projects. Focus on implementation studies for expansion required for the Port of Valencia.	EUR 1M- EUR 20M per project. Best suited for infrastructure-related developments (e.g., Fundación Valenciaport, PETROGAL).
Interregional Innovation Investments (I3)	Funds regional strategies for the implementation of VINTER technology and biomass utilization.	EUR 2M- EUR 8M per project. Best suited for regional partnerships and industrial clusters.
European Investment Bank / InvestEU	Provides loans, guarantees, and equity investments for projects in sustainable infrastructure and biofuel scale-up.	Variable. Best suited for large-scale investments in scaling biofuel production and commercialisation.
Venture capital	Private and institutional investors funding high-risk, high-reward start-ups in deep-tech, clean tech, and biofuels.	Variable. Best suited for SAGAVA's commercialisation efforts and biofuel-related start-ups.
EU Catalyst Partnership	Supports industrial-scale demonstration projects in clean energy and climate technologies, co-funded by Breakthrough Energy and the European Commission.	EUR 10M-EUR 40M per project. Best suited for large-scale hydrogen and synthetic fuels projects.
European Regional Development Fund (ERDF) & National Grants	Country-level funding for industrial decarbonisation & R&D. Each partner entity will seek national grants to finance their respective technologies.	Variable. Funding to be determined by country. Best suited for SMEs, regional clusters, and public institutions

4.2 Communities of Practice

A community of practice refers to a collective of individuals who are united by a shared interest, concern, or set of challenges within a particular field. These individuals engage with one another to pursue both personal and collective objectives. Such communities are typically centered around the exchange of expertise and the co-creation of knowledge, all aimed at enhancing a specific area of professional practice. Regular interaction plays a crucial role in sustaining the community, fostering deeper connections and continuous learning. To support their activities and maintain communication, many communities of practice utilize a mix of in-person gatherings and online collaborative platforms[22].

Based on this understanding, Communities of Practice (CoP) strategy will be implemented to widen the spectrum of knowledge of the consortium, to maximise the insights shared, boosting collaborative networks to drive innovation, exchange knowledge, and validate strategic roadmaps. In particular, the goal is to identify problems that they are trying to solve, identify the level of detail they need and the upscaling strategy that is

[22] Wenger, E. (2011). Communities of practice: A brief introduction.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

expected to be used[23]. Three CoPs were initially planned to be implemented in SEAFAIRER - one in Copenhagen, led by DTU, another in Valencia, directed by FVP, and one in Mexico, led by Centro Mário Molina (CMM).
Stakeholder engagement was identified as crucial from the very beginning. DTU, in collaboration with partners FVP and KPMG, commit themselves to implement a thorough mapping of significant stakeholders and the requirements of the value chain (*cf. Task 2.1*). This initiative is framed by two critical workshops. The initial workshop occurred during project's kick-off meeting and was prepared to obtain a collective understanding of the value chain, uniting various perspectives to pinpoint key participants and existing connections. The subsequent workshop will be conducted online by ETA at M9.

At the one-year milestone, it will focus on refining strategies and aligning all stakeholders towards a cohesive vision for the success of VINTER. These two COPs will be a catalyzer to explore how biofuels can be effectively integrated into existing maritime fleets and port infrastructures, ultimately aiding in the development of an EU roadmap (*cf. Task 9.4*) that will facilitate the wider adoption of biofuels across Europe.
Additionally, communication initiatives will be implemented to ensure the ongoing dissemination of insights and findings, thereby integrating CoP activities into the project's comprehensive outreach strategy. For further details please consult the current Dissemination and Communication Plan (*cf. Deliverable 10.1*).
To guarantee lasting impact, robust monitoring and evaluation mechanisms will be established. Activities of the CoPs will be monitored, stakeholder engagement will be evaluated, and all results will be compiled into the final exploitation plan (*cf. Deliverable 12.3*). By adhering to an iterative learning process, the SEAFAIRER project will enhance its strategies and optimize the effectiveness of biofuel adoption.
As next steps, a strategy to implement a communication plan for CoPs will be prepared. It is identified as crucial to ensure the success of SEAFAIRER among stakeholders and biofuel value chain players, that a structured and topic focused plan is implemented until the updated SEAFAIRER EP.

5.0 Conclusions and next steps

The SEAFAIRER EP provides a strategic roadmap to maximise the impact of the project's innovations, bridging cutting-edge technological developments with market readiness. It outlines how SEAFAIRER's KERs will achieve long-term viability in the biofuel and maritime sectors through targeted commercialisation strategies, alignment with policy frameworks, and proactive stakeholder engagement. The exploitation strategy underscores sustainability, directly contributing to maritime decarbonisation goals by delivering environmental and economic benefits that support the EU's long-term climate targets. Early market feedback has been encouraging - for instance, industry partners like BENC Biomüll GmbH have already expressed interest in deploying a commercial-scale VINTER unit- indicating growing market traction for SEAFAIRER's innovations.
Despite these positive developments, the plan is candid about remaining challenges and uncertainties. Widespread adoption of advanced biofuels faces hurdles, such as limited sustainable biomass feedstock supply (given competition with other sectors), higher production costs compared to fossil fuels, and ongoing policy and regulatory uncertainties in the maritime fuel domain. These risks highlight the need for continued innovation and validation to ensure SEAFAIRER's solutions can fully meet industry needs.
Certain aspects of the project require further verification – for example, the performance of additional feedstocks is still being evaluated, and the insights gained will be integrated into future versions of the exploitation plan once sufficient data is available. By acknowledging these challenges, SEAFAIRER's exploitation strategy will remain balanced and realistic. It pairs its ambitious technological and market objectives with a flexible, iterative approach to implementation, ensuring that the strategy can be adapted as new findings emerge. Indeed, the exploitation plan is conceived as a living document that will be revisited and refined, allowing the consortium to incorporate stakeholder feedback and address real-world challenges as they arise. The first major update of the exploitation plan (*cf. Deliverable D11.4*) is scheduled for M35 (end of project year

[23] https://doi.org/10.1177/0018726716661040

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

3). This interim update will assimilate mid-project findings and commercial insights gathered to that point, providing an opportunity to refine SEAFAIRER's market entry strategy. In particular, it will integrate the outcomes of a dedicated exploitation workshop – focused on IPR, ownership arrangements, and market intelligence – as well as initial techno-economic and market studies. This checkpoint will allow the consortium to adjust the exploitation strategy based on real-world feedback and emerging data, ensuring the project's biofuel solutions remain aligned with current market conditions and stakeholder expectations.

Funded by the European Union

Funded by the European Union under Grant Agreement No. 101173002. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.