【欧州】【海事】

Maritime Issues - Introduction of alternative fuel vessels: Towards the use of sustainable fuels and alternative propulsion in maritime transport - CINEA presents EU funded projects in the area of green shipping

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【概要：Summary】

Maritime transport is a vital part of global trade and commerce, but it is also a significant contributor to GHG emissions, although it is one of the climate friendlier transport modes, especially in comparison to freight transport on roads. In 2018, maritime transport generated around 3-4% of the EU 's total CO_2 emissions. Based on the European Green Deal (COM/2019/640 final), the decarbonisation of the European transport sector is a key target and its GHG emissions should be reduced by 90% by 2050, based on 1990 levels. Therefore, also maritime transport will have to be decarbonised to contribute to this target.

To reduce GHG emissions in maritime transport, the "Fit for 55" package not only includes a proposal to cover the maritime transport's GHG emissions in the EU-ETS (COM(2021) 551 final). It also includes a proposal on the FuelEU Maritime initiative (COM(2021) 562 final), to increase the demand for sustainable alternative fuels in maritime transport. The FuelEU Maritime initiative will require ships to progressively switch to sustainable marine fuels and it is expected to stimulate demand for low and zero-carbon marine fuels. Regarding alternative propulsion in maritime transport, there are basically three alternative fuel options under consideration, including biomass-derived fuels, hydrogen, and synthetic non-carbon fuels, like ammonia. Moreover, also electric propulsion can play a role in certain environments.

However, hydrogen and ammonia, although both are considered promising alternative fuels in maritime transport, they will need special safety measures and related legislation, as well as extended testing.

The testing of alternative fuels and propulsion systems in maritime transport are key to individualise the most practicable solutions and their feasibility as propulsion systems and alternative fuels for vessels. The European Climate Infrastructure and Environment Executive Agency (CINEA) has showcased some selected CINEA EU funded projects in the area of green shipping towards the decarbonisation of the shipping sector and has made related presentations available. These green shipping projects show different approaches regarding the application of alternative ship propulsion systems and fuel alternatives in maritime transport.

【記事：Article】

1. “Fit for 55“ package: The extension of the EU-ETS to maritime transport

Maritime transport is an essential element of global trade and almost 90% of the global freight is seaborne. 75% of the EU’s external trade and 36% of intra-EU trade of freight is shipped by maritime transport (SWD(2022) 214 final). In 2019, the EU Maritime sector generated a Gross Value Added of EUR 34.3 billion (CINEA 2023). Furthermore, more than 400 million passengers each year use ferries at EU ports. Considering the distance and weight carried, maritime transport is one of the transport modes with low CO_2 emissions, in particular in comparison to freight transport on roads. Nevertheless, maritime transport generated around 3-4% of the EU‘s total CO_2 emissions in 2018 (around 140 million tonnes of CO_2) and 13.5% of the transport sector’s GHG emissions (EEA/EMSA 2021a). As reported in EMSA’s THETIS-MRV database, in 2020, almost 11,700 ships with more than 5,000 GT emitted around 126.1 million tonnes of CO_2 within the scope of the EU Maritime MRV Regulation (EMSA 2022, SWD(2022) 214 final).

Considering the targets set in the European Climate law and in the European Green Deal, to reach a general reduction of GHG emissions of 55% by 2030 and by 90% for the transport sector by 2050, also maritime transport needs to shift towards sustainable alternative fuels to contribute its share to achieve these targets (European Commission 2022). The decarbonisation of maritime transport will play a pivotal role in the years ahead, also due to the alarming projections of an estimated increase of +250% of GHG emissions by 2050 (European Commission 2022). Therefore, to mitigate GHG emissions in maritime transport, the “Fit for 55“ legislative package of 14 July 2021 also contains proposal COM (2021) 551 final on the revision of the EU-ETS with an extension of the EU-ETS to maritime transport (European Commission 2021, European Parliament n.d.a). The EU-ETS will be extended to cover GHG emissions from ships with a gross tonnage of over 5,000t calling at EU ports for voyages on intra-European routes as of 2024 and 50% of GHG emissions from extra-European routes to and from the EU as of 2024 until end of 2026, and emissions that occur when ships are at berth in EU ports (European Parliament n.d.a, European Parliament n.d.b). From 2027 onward, 100% of GHG emissions from all trips should be covered with possible derogations for non-EU countries where coverage could continue to be reduced to 50%, subject to certain conditions (European Parliament 2022a, European Parliament 2022c). Thereby, the GHG emissions from maritime transport will be included in the existing EU-ETS, based on the proposal COM (2021) 551 final (COM (2021) 551 final, Erbach 2023). A reporting and review clause is proposed to monitor the implementation of the applicable rules and to take account of relevant decisions by the International Maritime Organisation (IMO) (European Parliament n.d.b).

2. Towards the use of sustainable fuels in maritime transport: The FuelEU Maritime proposal (COM(2021) 562 final)

At present, the maritime transport sector relies almost entirely on fossil fuels, mainly heavy fuel oil and it generated 2.9% of global anthropogenic CO_2 emissions in 2018 (COM(2021) 562 final). To change this situation, the “Fit for 55“ package of legislative proposals also includes the Fuel EU Maritime Initiative (COM(2021) 562 final) on the use of renewable and low-carbon fuels in maritime transport to reduce GHG emissions in maritime transport (CINEA 2023). The main target is to increase consistent use of renewable and low carbon fuels in maritime transport across the EU, in line with the EU’s objective of reaching climate neutrality at the latest by 2050 and the goals of the Paris Agreement (European Parliament 2022b).

The proposal (COM(2021) 562) supports the shift towards low carbon maritime fuels by changing the approach from using heavy fuel oil to the use of sustainable, renewable, and low-carbon fuels in the fuel mix of international maritime transport without creating barriers to the single market (COM (2021) 0562). The proposal also mandates the use of onshore power supply (OPS) in EU ports for ships at berth. From January 2030, freight and passenger ships staying at berth at EU ports for more than two hours will have to connect to shore-side electricity supply (OPS) (COM (2021) 0562, Kiss 2022). Until the end of 2034, exemptions would be allowed for cases when ships cannot connect to OPS due to unavailable connection points in port or because the port installation is not compatible with the on-board OPS equipment (COM (2021) 0562).

The increasing demand for and consistent use of renewable and low-carbon fuels in the maritime sector in the EU is expected to drive the maritime transport sector's decarbonization and sustainability (COM (2021) 562 final). Given the range of technologies used in the maritime sector, also the Council underlined the importance of technology neutrality and therefore to focus on fuel demand to meet the EU's 2030 and 2050 climate targets (Council of the European Union 2022). While the Council of the European Union adopted its position for negotiations in June 2022, the European Parliament adopted the report in Plenary with 451 votes to 137, with 54 abstentions, amendments to the proposal on 19 October 2022 (Soone 2023). A dedicated Ocean Fund should be established to improve the energy efficiency of ships and support investment aimed at helping decarbonise maritime transport.

The proposed Regulation should apply to all ships above a gross tonnage of 5000 and encompasses 100% of their intra-EU voyages and 50% of their voyages between EU ports and ports located in third countries (European Parliament 2022b).

Currently, the FuelEU Maritime proposal is still on its way through the adoption procedure and trilogue negotiations.

3. Possible alternative fuel options in maritime transport

Regarding alternative propulsion in maritime transport, there are mainly three alternative fuel options under consideration, including biomass-derived fuels, hydrogen, and synthetic non-carbon fuels, like ammonia. Each of these alternative fuels has its challenges, but hydrogen and other synthetic non-carbon fuels like ammonia seem to have the highest potential as an alternative fuel solution for maritime transport and they are currently the most discussed potential alternative fuels that the shipping industry could switch to in medium and long-term.

In maritime transport, the European Commission has so far pointed out the important role of LNG as alternative maritime fuel and LNG at maritime ports should be available by 2025. However, the European Parliament also considers to improving the role of hydrogen and ammonia. Although they admitted that "…in the short term, LNG is likely to play a transitional role in maritime transport", "the sustained use of liquefied natural gas (LNG) is not compatible with the Union's climate neutrality objective…Therefore, LNG in maritime transport should be phased out as soon as possible and substituted by more sustainable alternatives." (European Parliament 2022d). This MEPs' viewpoint has gained more supporters with the Russian war in Ukraine and its consequences for energy security in the EU.

In 2022, the European Maritime Safety Agency (EMSA) released two reports, analysing alternative fuels in maritime transport, including biofuels and ammonia to support the European Commission in the ongoing work on the FuelEU Maritime proposal.

The EMSA report on biofuels entitled "Update on potential of biofuels in shipping" examines all types of biofuels and their potential for the maritime sector. The EMSA study identifies the key advantages of biofuels in shipping and the remaining challenges, technology, and regulatory gaps (EMSA 2022b). Biofuels produced from biomass could in theory be considered carbon neutral. Marine biofuels may be produced using existing biofuel technologies that are technically compatible with marine engines (EEA/EMSA 2021b). The EMSA report concludes that while the current use of biofuels in marine-engine applications is very limited, biofuels have significant potential for biofuels to capture a larger share of the total maritime fuel consumption and to achieve GHG emission reductions in the maritime industry (EMSA 2022a).

Ammonia is another alternative fuel, considered suitable for maritime transport. Although ammonia presents certain technical challenges, in comparison to hydrogen, it requires less complex storage and transport solutions. Its widespread use in industrial and agricultural processes could also facilitate its distribution, using the existing infrastructure and supply chains (EEA/EMSA 2021b). The EMSA report on the alternative fuel ammonia, entitled "Potential of Ammonia as Fuel in Shipping", underlines that green ammonia is likely to make the transition to a marine fuel, which could offer a zero or near-zero carbon solution (EMSA 2022a, EMSA 2022c). The EMSA's report identifies several advantages that ammonia would have over other low-flashpoint fuels or gases, but technology and regulatory gaps prevent its immediate application (EMSA 2022c). On board ships, NH_3 could be used in combination with internal combustion engines and fuel cells (EEA/EMSA 2021b). The main challenges for ammonia are its flammability and toxicity. However, EMSA considers the related risks as "significant while manageable" (EMSA 2022c). Another challenge for ammonia as a marine fuel is the lack of a commercial technology and the need to develop large-scale production infrastructures for green or blue ammonia (EEA/EMSA 2021b).

The EMSA report concludes that ammonia has advantages, which make it a promising alternative fuel to support the decarbonisation of shipping (EMSA 2022c). To realise the large-scale production of "green ammonia" for maritime shipping, its production capacity, along with that of renewable electricity and green hydrogen, would need to grow tremendously. According to EMSA (2022c), ammonia shows promising potential and challenges would be manageable.

Regarding the utilisation of hydrogen (H_2), one of the major obstacles to the wider implementation of fuel cells in the marine sector is the hydrogen supply infrastructure (EEA/EMSA 2021b). Finally, commercially viable vessel designs have yet to emerge and considering the lifetime of vessels of 25 to 30 years, the new generation of vessels that utilises hydrogen or other CO_2 emission neutral fuels need to be developed now to be available for deployment by 2030 and to achieve the 2050 targets in GHG emission reduction.

4. CINEA presents experiences from EU funded projects for green shipping

Considering the wide range of technologies, and the need to further decarbonise maritime transport, there are several different approaches in new projects in maritime transport for testing alternative fuels or ship propulsion technologies. On 8 December 2022, European Climate Infrastructure and Environment Executive Agency (CINEA) organised a workshop to showcase EU funded projects in the area of green shipping to discuss the contribution of some selected EU funded projects to the decarbonisation of the shipping sector (CINEA 2022). The workshop was an opportunity for sharing knowledge between

organisations implementing solutions for green shipping, and EU policy makers CINEA (2022). The presented projects are funded under EMFF, Horizon 2020, CEF Transport and the Innovation Fund as EU initiatives addressing green shipping and most recently, CINEA published presentations on these EU funded green shipping projects (CINEA 2023).

The first example for a green shipping project is called ENGIMMONIA, with the full title "Sustainable technologies for future long-distance shipping towards complete decarbonisation". The project scope is to investigate the use of ammonia as a carbon-neutral fuel for the marine sector (Wieland n.d.). It received funding under the EU's Horizon programme H2020-EU.3.4. SOCIETAL CHALLENGES - Smart, Green And Integrated Transport. The total project budget is EUR 9,500,000 with an EU contribution of EUR 9,500,000, covering the whole project budget (Wieland n.d.). The project duration is from 1st of May 2021 to 30th of April 2025. The project investigates the use of ammonia (NH3) as energy vector in 2-stroke and 4-stroke engines. Supply of NH3 is less energy intense when compared to carbon-based fuels and therefore, the technology will be applied in large-scale engines. The challenges are that during high combustion temperature, NOx species can be formed, which contribute to global warming and impact the acid dew point. Flue gas cleaning and abatement strategies of engine operation and flue gas treatment is important based on research on potential catalysts for flue gas aftertreatment. Furthermore, Clean Energy Technologies are integrated to demonstrate existing clean-tech solutions on board (Wieland n.d.). The use of waste heat and solar is investigated. The technology will be applied to VLCC, Ferry and Container ship. Modular approaches allow seamless scale-up and down-sizing, as well as adaption to actual potential (Wieland n.d.). The second challenge regards the technology qualification, including the complex interactions between class society, technology providers and vessel owners for demonstrators. Therefore, close interaction with all partners and regular meetings and workshops between partners are important for the approval procedure and for capacity built-up (Wieland n.d.). The third challenge is the implementation of the technology, as the installation timeslots on vessels is very narrow, depending on dry dock periods, while dry dock can be at various worldwide locations. Turn-key solutions for vessels as retro-fit measure are almost impossible (Wieland n.d.).

The second project example is the FirstBio2Shipping low-carbon LNG for the marine industry (FirstBio2shipping, FB2S) project. It is the first Bio-LNG production plant for marine shipping (Gooren n.d.). The project received EUR 4.3 million under the EU Small Scale Innovation fund programme, out of the total project budget of EUR 7.2 million.

The project started on 1st January 2022 and the operational production is expected to start in March 2024. With the FirstBio2Shipping project, partners Attero, Nordsol and Titan aim to decarbonize the maritime sector by demonstrating the first industrial plant producing renewable, low-carbon bio-LNG in a standardised and scalable fashion, enabling a cost-effective substitution of heavy fuel oil (HFO) (Nordsol n.d.). It is expected to reach a GHG emission avoidance of 92% with an absolute GHG avoidance over 10 years of 87.764 tons (Gooren n.d.). The project solutions are expected to contribute to climate neutrality. A more energy efficient process to convert biogas into bio-LNG has been developed (Gooren n.d.).

The third project example is called TrAM - Transport - Advanced and Modular on electrically powered vessels. The project received EU funding under the Horizon 2020 programme. The project duration was from September 2018 to February 2023. Out of the total project budget of EUR 15 million the EU contribution was EUR 11 million. The project's contribution to climate neutrality is

related to energy-, cost- and time-efficiency and design and production methods. It is the world's first fully electrical fast ferry, based on renewable energy supply. It cuts CO_2 emissions by 1500t/year and will be transferable to other short-sea segments (Tvedte n.d.). TrAM's main challenges are related to balancing research and industry. Furthermore, the design basis for the vessel needed early conclusion. The technology is challenging as weight is key on fast ferries. At the same time, the project experienced challenges due to the pandemic-related supply chain problems, delays, and lockdowns (Tvedte n.d.). However, the project was a successful European collaboration and the world's first zero-emission fast ferry is in operation from September 2022. The technology won an award as Ship of the year 2022 at SMM Hamburg (Shipbuilding, machinery & technology international trade fair Hamburg) and Best climate action 2022 at the Zero Conference Oslo, among others (Tvedte n.d.).

The fourth project example represents a low-cost wind propulsion system Aspiring Wingsails - Aspiring Wingsails for the fishing and maritime transport sectors. ASPIRING WINGSAILS, is a full-scale demonstration project of a wing sail solution, which reduces fuel use and pollutant emissions in maritime transport through wind-energy co-propulsion (Aleixendri n.d.). The duration of the project was from October 2019 to May 2022. The Aspiring Wingsails for the fishing and maritime transport sectors project was co-funded by the EU with a 65% contribution of EUR 647,138 of the overall budget of EUR 995,598 (Aleixendri n.d.). Regarding the specific objectives, these were the design of an up-scale, customised full-scale demonstration eSAIL system and its construction. The turn-key solution had to be standardised and internationalised (Aleixendri n.d.). The system uses wind to propel the ship, thereby reducing fuel consumption and pollutant emissions. The specific objective of the project was to provide the fishing and the maritime sectors with a novel Aspiring Wingsail solution, suitable for vessels, which do not require a foldable solution, while offering up to 30% savings in fuel use, reducing hardware costs and thereby making the solution accessible to more vessels (Aleixendri n.d.).

The fifth project example, outlined by CINEA is the project entitled On-shore power supply TWIN-PORT III - Infrastructure developments on Tallinn-Helsinki maritime link TWIN-PORT (Mürk n.d.). The aim is to reduce the environmental impact of ferry traffic and to improve the Helsinki-Tallinn transport connection. The project duration is from 2018 to 2023 with a total budget of EUR 49 million, and the EU contributed EUR 14.7 million (Mürk n.d.). The aim is to convert two existing vessels Silja Europa and Megastar for port electricity and construction of one new generation LNG vessel (My Star) with On-shore power supply (OPS) capability (Mürk n.d.). The technology is the 11kV high-voltage shore connection switchboard with high-voltage power connector, a 11kV high-voltage shore connection breaker field at propulsion switchboard, a 11kV main cabling and control cabling between switchboards and remote and local connection operations with necessary interlocking and synchronization functionality (Mürk n.d.). The results are a CO_2 emission reduction of 230 tons month/per vessel (6h/per day), fuel economy of 15%-16% fuel reduction, an improvement of air quality in ports, which suits all vessel types. The main challenges, solution and lessons learned of the project were that the retrofit with this technology is nearly twice as expensive as a new built solution. There is also a need to check the capacity of onshore grid power with the power network operator. Another challenge is that the onshore voltage fluctuation amplitude could be higher (+ - 10%) than tolerable onboard (Max 2-3%). Moreover, the port grid up-grade must be made first, and a well experienced high voltage electricity company needed to do works (Mürk

n.d.). While the legal issues were no problem, positive enabling conditions like a "green thinking" port management is a necessary precondition to facilitate such a project (Mürk n.d.).

5. Conclusion

The maritime transport was responsible for around 3-4% of the EU 's total CO_2 emissions in 2018 and 13.5% of the transport sector' s GHG emissions. At the same time, the decarbonisation of the maritime transport sector is more difficult than in other sectors like in road transport as it will need alternative fuels and propulsion systems that go beyond the replacement of internal combustion engines with electric engines, as in case of passenger cars.

Biofuels, hydrogen, and ammonia, as well as electric propulsion for certain tasks are considered alternative solutions, suitable in maritime transport. However, they will need significant preparation work like the introduction of legislation, safety measures, as well as testing and introduction of new propulsion systems. Commercially viable vessel designs for hydrogen or ammonia powered vessels have yet to emerge and considering the long lifetime of vessels of 25 to 30 years, the new generation of vessels that utilises those alternative fuels or propulsion systems need to be developed in the next years to be available for deployment by 2030 and to achieve the European Green Deals 2050 target of reaching net-zero GHG emissions. Therefore, it is important to test now different approaches for propulsion systems and alternative fuels in maritime transport.

The CINEA workshop on green shipping was an opportunity to exchange experience and knowledge between organisations, implementing solutions for green shipping, and EU policy makers.

The presentations of EU funded projects in green shipping share knowledge on some technologies and solutions toward decarbonising maritime transport (CINEA 2022).

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