MARITIME DECARBONISATION – DECARBONISATION THROUGH DIGITALISATION AND LOGISTICS OPTIMISATION USE-CASES

Prepared by	ESA
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1. INTRODUCTION

This document lists the use cases to be used as part of the 'DECARBONISATION THROUGH DIGITALISATION AND LOGISTICS OPTIMISATION' thematic area within the umbrella of the "Maritime Decarbonisation" thematic call for proposals.

The use cases presented result from the cooperation between the European Space Agency (ESA) and various stakeholders with interests in the domain of Maritime. It aims at developing sustainable services leveraging space assets and digital technologies in consort to address key challenges and opportunities.

When writing the initial proposal (APQ/APQ+/Outline proposal), the applicant shall make clear which use case(s) their solution will address, if chosen from those listed here.

2. ANNEX A: DECARBONISATION THROUGH DIGITALISATION AND LOGISTICS OPTIMISATION USE CASES

2.1. International Windship Association (IWSA)

The International Windship Association (IWSA) is a member driven, not-for-profit association made up of wind propulsion technology suppliers and ship development projects, shipping lines, shipbuilders, designers, naval architects, engineers, academics, NGO's and Class with the aim to facilitate and promote wind propulsion solutions for commercial shipping worldwide. The organisation aims to bring together maritime stakeholders in the adoption of this zero-emissions energy source and the necessary technologies to harness it through the support of research, education, network development, policy advocacy and project facilitation activities.

2.1.1. Voyage Optimisation for Wind Propulsion

Wind propulsion has the potential to deliver very significant reductions in fuel use and emissions however, to realise this potential a robust system of integrated voyage optimisation tools are required.

This integrated approach will harness four important elements, a weather/voyage routing software that includes wind, wave, current and other conditions that utilises hindcast data that is enhanced by real time digital feedback which will in turn enable improved forecasting of change (due to climate change etc.). This digital feedback also will feed into design and digital twin improvements in the technologies themselves. Weather forecasting and monitoring will be an important element enabling improved routing and planning and this is supplemented by real-time weather analysis from Lidar installations, technology sensors and weather stations aboard the vessel. With this integrated approach both manned and autonomous vessels in the future will be increasingly aligned with weather and operational conditions.

2.1.2. Green + Wind Corridors

Currently there are 'Green Corridors' under development however these have been almost exclusively following a 'fuel' focus. These corridors are being designed to lower emissions and facilitate infrastructure build however they neglect to integrate wind propulsion into the equation and also look primarily at existing routes rather than potentially highly attractive routes that utilise wind.

An overhaul of this approach requires three areas of focus.

a. The mapping of wind patterns overlayed onto proposed green corridors with an assessment and monitoring of the 'savings' from wind-assist and primary wind propulsion vessels operating on those.
b. The assessment of optimal trade wind and prevailing wind routes along with the monitoring of vessels using those routes and
c. The mapping of weather patterns and identifying routes in LDC (Least Developed Countries) and SIDS (Small Islands Developing States) areas in particular.

2.1.3. Integrated Small Vessel Network

There is great potential to lower emissions and generate a sustainable small vessel network that also creates sustainable livelihoods, regenerates small ports and regions and delivers trade and communication links between isolated or periphery communities. A significant barrier

to this is the lack of coordination of a dispersed fleet of small ships operated by multiple companies, island communities etc. moving lots of smaller cargo packages to multiple locations.

To dramatically improve both the efficiency and resilience of this network there is the need for a system that tracks both the ships and the cargo flows in real-time to enable the most efficient use of the system, develop trans-shipment hubs and best utilise the benefits of large emission reductions from maximising wind propulsion use for first/last mile delivery.

This network development will require the integrated use of vessel and cargo tracking, the monitoring of performance to ensure accurate emission reduction calculations and the utilisation of route planning and delivery timing thus enabling cargos and vessels to be appropriately matched, crews assigned and the reduction of waiting times and ‘just-in-time’ deliveries.

This system will also increase the efficiency of multi-modal shifts where goods/passengers are linked up with ongoing land based, zero-emissions transport too.

2.2. European Maritime Safety Agency (EMSA)

The European Maritime Safety Agency’s (EMSA) purpose is to ensure a high, uniform and effective level of maritime safety, maritime security, prevention of, and response to, pollution caused by ships as well as response to marine pollution caused by oil and gas installations and, where appropriate, to contribute to the overall efficiency of maritime traffic and maritime transport so as to facilitate the establishment of a European Maritime Transport Space without Barriers. EMSA’s mission is to serve EU maritime interests for a safe, secure, green and competitive maritime sector and act as a reliable and respected point of reference in the maritime sector in Europe and worldwide. EMSA works on maritime safety, security, climate, environment and single market issues and tasks, first as a service provider to EU Member States and the European Commission, but also as an innovative and reliable partner and knowledge hub for the European maritime cluster and potentially beyond as a reference internationally. EMSA supports the European Commission (EC) and the EU Member States with technical and technological means to guarantee a proper ship emission monitoring

strategy as well as to verify that the regulations are properly applied and positively impacting at mid- and long-term the environment and life quality of the European citizens.

2.2.1. Monitoring of carbon emissions under the Emission Trading System (ETS) and implementation of FuelEU Maritime Regulation.

The EU is committed to achieving ambitious decarbonisation targets in the maritime transport sector as part of its broader climate goals outlined in the European Green Deal. Under the "Fit-for-55" package of legislation, the EU has introduced comprehensive measures to significantly reduce emissions by 2030, including extending the EU Emission Trading System (ETS) to cover large ships entering European ports and adding the monitoring of other GHG gases (notably CH4 and N2O). This extension requires shipping companies to purchase and surrender emission allowances for their emissions.
Further to this, the FuelEU Maritime Regulation, effective from January 2025, mandates a progressive reduction in the greenhouse gas intensity of the energy used onboard ships, which aims at incentivising the uptake of renewable fuels as well as creating the demand for onshore power supply.

Within this context, advanced monitoring tools are increasingly necessary, not only to accurately address the dimension of the problem, but also to ensure widespread and robust implementation and enforcement of policies.

The integration of digital technologies, Internet of Things (IoT) solutions, and big data analytics can enable real-time monitoring of vessel emissions.

The high-level requirements include:

a. Development of an integrated monitoring infrastructure, for enhancing monitoring of the maritime transport sector GHG emissions (CO2, CH4 and N2O).
b. Utilisation of advanced technologies, including onboard monitoring and machine learning, to provide both real-time and predictive insights into maritime GHG emissions.

More specifically, for all vessels and voyages under the scope of ETS and FuelEU, develop novel solutions – including through onboard IoT technology - to measure, monitor and report in near-real time on:

a. Vessel GHG emissions, including CO2, CH4 slippage and N2O fugitive emissions, per voyage and annual basis.
b. Vessel voyage duration, distance travelled, time spent cruising, time spent manoeuvring and time spent hotelling, per voyage and annual basis.
c. Vessel fuel consumption, aggregated per fuel type used on board, per voyage and annual basis.
d. Engine load parameters of main and auxiliary engines, per voyage and annual basis.
e. Hull resistance, weather and sailing conditions, per voyage and annual basis.
f. Use and performance of alternative power solutions or abatement methods (e.g. wind propulsion, carbon capture), per voyage and annual basis.
g. Vessel GHG emissions while at berth, per port call and annual basis.
h. Use and performance of on board zero, or near zero-equivalent, emissions technologies (e.g. fuel cells) while at berth, per port call and annual basis.
i. Electricity consumption while at berth, per port call and annual basis.

2.3. Ocean Autonomy Cluster (Norway)/ Clarify

Clarify is a leading SaaS platform for operational intelligence, based in Norway. Clarify adds AI, automation, and analytics to any industrial asset, from single sensors to fleet and enterprise-wide adoption across tens of thousands of sensors and billions of data points in real time streams. We believe the key to improving operations and increasing sustainability for both maritime and land-based industries, is by combining data across systems, increasing quality, and enriching it with human insight and expertise. In turn making enriched data sets of the highest possible quality available for both human and machine analysis. With over a decade of experience from industrial digitalisation and customers across the globe and on the seven seas, we aim to become a global leader in operational AI. Clarify empowers frontline workers and specialists alike with the digital tools they need to transform data from manual burden into

operational advantage. Helping people apply their expertise and solve practical use cases, improving sustainability, operations, and innovate with data.

2.3.1. Digitalisation and operations optimisation

In order to succeed with digitalisation, operations optimisation, and sustainability use cases a flexible, powerful, and scalable data infrastructure must be in place. A platform to handle a diverse set of data sources and systems, capable of combining and making data available for solving a wide selection of use cases. Combining data from a multitude of sensors, from live vessel data to earth observations provided by satellites, is still not a solved problem. Demonstrate the feasibility of combining real time data streams from crewed and autonomous vessels, with satellite data, and static maritime sensor stations/buoys. Demonstrate how this combined data set can be easily made available for human and machine use cases through analytics and a unified API capable of serving both raw and aggregated time synchronised data across sources and formats. For both single and multiple vessels, with methods to filter and benchmark performance across vessels, vessel type, and accounting for external factors such as weather, current, wind, etc. Demonstrate how the combined and enriched data set can be used to train AI and automate dataflow to various analytics, visualisation, and other digital tools, both domain specific and general.

2.3.2. Satellite and vessel data fusion

Demonstrate the technical feasibility and pilot use cases for operational optimisation when combining onboard vessel data with satellite data, for both manual and autonomous optimisation. For example, compare onboard vessel performance data with earth observations covering currents, wind, and weather in general.

2.3.3. Sustainability estimation at vessel level

Demonstrate how onboard live data from manned and autonomous vessels can be combined with satellite data to estimate sustainability parameters in real time. For example, calculate and model emissions/engine load in real-time when accounting for earth observations. Explore possibility to forecast based on weather/ocean forecasts and observations ahead.

2.3.4. Green corridors/smart routing/alternative routes

Combine and crowdsource onboard data from autonomous and manned vessels and combine it with satellite data to provide a real-time map/overview of potential routes and caution areas to enable manual and automatic smart routing, present alternative routes, and potential green corridors. Utilise “vessels as a sensor” to build congestion maps ala Google Maps for “traffic congestion” and areas to seek out or avoid, based on live observations of vessel performance and external factors such as currents and wind. This can serve as the foundation for both manual and autonomous route optimisation.

2.3.5. Carbon trading/Sustainability/ESG

a. Demonstrate a service to calculate, estimate, and forecast ESG parameters based on real time onboard vessel data (communicated via satellite) in combination, enriched, and calibrated with data as observed from satellites such as: vessel speed and position, earth observations such as wind, current, temperature, etc. and in combination with other relevant APIs.
b. Combine with weather forecasts and observations ahead to enable optimal routing and thus improved sustainability.
c. Assess the feasibility to scale from individual vessels to fleet.

2.4. Grimaldi

Established in 1947, the Grimaldi group respectively Grimaldi Euromed S.p.A. is a fully integrated multi- national logistics company specialized in maritime transport of cars, rolling cargo, containers, and passengers. Grimaldi Euromed, one of the Group's most important companies has, since the mid-1990s, been at the center of remarkable development in the shipment of European finished vehicles and integrated logistics. The core elements of its services are high frequency maritime links, strict quality standards in terms of punctuality and procedures, and compliance with its zero- damage level target. Main research areas focus on the innovative fields of e.g. re-bulb, fuel cells, new exhaust gas treatment systems, waste heat

recovery systems, inverters, alternative fuels, LEDs and implementation of renewable energy on board as well as studying and developing futuristic new technologies in the naval sector.

Grimaldi group has provided the following use cases:

a. Upgrade to the digital fleet management systems using Artificial Intelligence and Machine Learning technologies.
b. Monitoring of vessel performance in real time by exchanging data between ship and shore with high accuracy for autonomous navigation.
c. E-maintenance, providing connection to several customers in order to prevent accidents and reduce maintenance costs.
d. Just-in-time service with dataset transfers between ships and ports.