Journal of Sailing Technology 2025, volume 10, issue 1, pp. 389 – 406.
The Society of Naval Architects and Marine Engineers.

WHISPER Project: Energy Transition from Wind and Solar Energy

Fabio Pili
Stirling Design International, France.

Thibaut Tincelin
Stirling Design International, France, tincelin@stirlingdesign.fr.

Romain Grandsart
OceanWings, France.

Jure Rogelja
Marfin Management, Monaco.

Manuscript received October 6, 2025; revision received November 10, 2025; accepted November 20, 2025.

Abstract. This paper presents the latest merchant ship concepts developed by the WHISPER Project Consortium under the Horizon Europe framework. The project is managed by Verkis and technically led by Stirling Design International (SDI), a naval architecture firm. It showcases innovative Panamax bulk carrier and container feeder designs, achieving up to 30% fuel consumption reduction through the integration of cutting-edge technologies, including OceanWings wingsails, Solbian solar panels, and Sidewind turbines. The paper provides a detailed analysis of the performance prediction, operational challenges, and associated risks. Mitigation strategies employed within the WHISPER Project will also be discussed. One key innovation is the integration of six tiltable OceanWings wingsails, each 363 m², into a Panamax bulk carrier, based on insights from Ant Topic and Marfin Management ship owners. Additionally, the paper presents the integration of two OceanWings wingsails with elevator platform on a container feeder with an innovative hull design, highlighting results on ship commercial capacity and performance as informed by Samskip and Nav-Tech ship owners. Both designs developed by SDI are practical examples of how renewable wind and solar energy technologies can be effectively incorporated into the shipbuilding and ship repair sectors, offering substantial potential for sustainable maritime operations.

Keywords: wind propulsion; bulk carrier; wing sail; naval architecture.

NOMENCLATURE

C_x	Aerodynamic force coefficient in the x-direction [-]
C_y	Aerodynamic force coefficient in the y-direction [-]
N'_{HULL}	Hull's yaw moment coefficient [-]
N'_v	Non-dimensional derivative of hull's yaw moment coefficient [-]
v'	Non-dimensional drift speed [-]
$W(z)$	True wind speed computed at the vertical coordinate z [m/s]
W_r	Reference true wind speed at 10 m height above the sea level [m/s]
X'_{HULL}	Hull's longitudinal force coefficient [-]
X'_{vv}	Non-dimensional second derivative of hull's longitudinal force coefficient [-]
Y'_{HULL}	Hull's side force coefficient [-]

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

Y'_v Non-dimensional derivative of hull's side force coefficient [-]
z Vertical coordinate [m]
z_r Reference height which is 10 m in this study [m]

σ Wind shear factor [-]

AWA Apparent Wind Angle
CAPEX Capital Expenditure
CFD Computational Fluid Dynamics
CII Carbon Intensity Index
DOF Degree of Freedom
ECN Ecole Centrale Nantes
EEDI Energy Efficiency Design Index
EEXI Energy Efficiency Existing ship Index
ETA Estimated Time of Arrival
ETS Emission Trading System
GT Gross Tonnage
OPEX Operational Expenditure
OW OceanWings
PV Photovoltaic
PPP Power Prediction Program
SDI Stirling Design International
SEEMP Ship Energy Efficiency Management Plan
TEU Twenty Foot Equivalent Unit
VPP Velocity Prediction Programme
WAPS Wind-Assisted Propulsion Systems

1. INTRODUCTION

Global shipping is a large contributor to climate change by emitting for approximately 3 % of global CO_2 emissions. To mitigate its consequences, it is essential to drastically reduce these emissions and limit the increase in global temperature below 2°C, as recommended by the *IPCC (2018).* Consequently, the shipping industry faces increasing pressures to reduce GHG emissions. In response, IMO introduced energy efficiency regulations in 2013, such as the Energy Efficiency Design Index (EEDI) or the Ship Energy Efficiency Management Plan (SEEMP). These were the first global measures encouraging the integration of carbon reduction technologies on both retrofit and newbuilding projects. In 2023, IMO introduced stricter short-term regulations such as the Energy Efficiency Existing ship Index (EEXI) and Carbon Intensity Index (CII), aiming to reduce the carbon intensity of the international shipping industry by at least 30% by 2030 (relative to the 2008 levels) with the ambition of achieving near to zero net GHG emissions by the end of the century.

Such a decrease in emissions cannot be achieved by relying solely on conventional propulsion systems. In the last decade, alternative propulsion systems have been identified, with wind-assisted propulsion systems (WAPS) emerging as a promising solution to reduce fuel consumption. These technologies include soft sails, wingsails, Flettner rotors, kite or suction wings that have been developed and tested on commercial vessels. Figure 1 presents an inventory of existing and on-order ships equipped with WAPS, showing that while Flettner rotors currently dominate the market, rigid wingsails and suction sails are closing the gap with an increasing number of orders.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

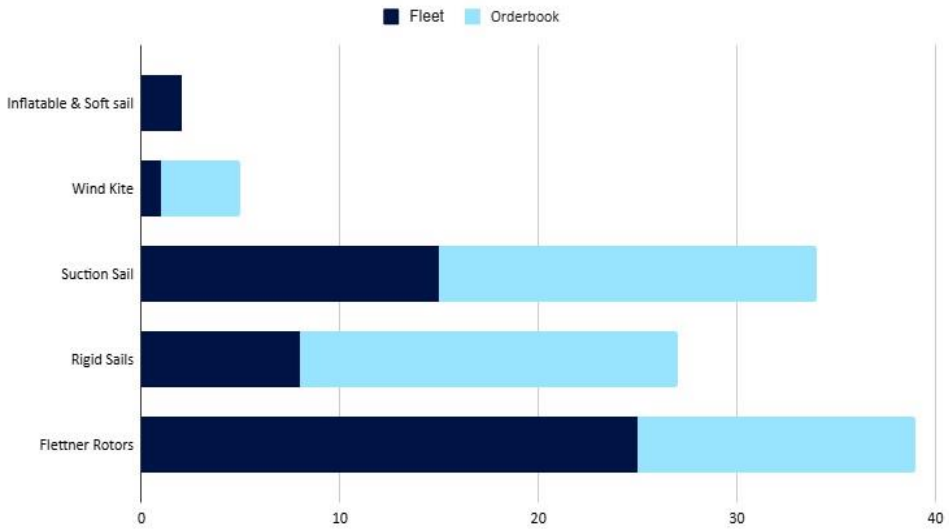


Figure 1. Global WAPS ship fleet data (DNV 2024).

Fuel savings from WAPS equipped vessels can be significant, ranging from 5% to 25% under average wind conditions according to ship operators, provided that enough systems are installed. However, these systems alone cannot completely replace conventional propulsion, additional onboard energy sources are required to meet auxiliary power demands. In this regard, renewable energy devices can be investigated such as solar photovoltaic panels to reduce the auxiliary engine loads during operations. Relevant examples are the 60,000 Gross Tonnage (GT) Auriga Leader built by NYK Line Company in 2011, Figure 2, and a 100-passengers ferry Solar Sailor built by OCIUS Technology, Figure 3.



Figure 2. Auriga Leader Ropax ship.



Figure 3. Solar Sailor ferry ship.

The main challenges addressed by the integration of these carbon reduction technologies into a merchant ship design are the economic viability, compliance with the CII, operational efficiency and safety with regards to ship stability requirements, since additional air drafts are induced by WAPS. WAPS performance evaluation is a key factor influencing ship owners' decisions, whether for retrofit projects or newbuilds. WAPS performance relies on hydrodynamic and aerodynamic balance analyses, based on empirical methods for evaluating ship manoeuvrability, especially for ships sailing at a drift angle (Viola et al., 2015; Tillig and Ringsberg, 2020; Kramer and Steen, 2022). Their performance can also be evaluated through Computational Fluid Dynamics (CFD) analysis or model test results using standard series hulls (Hopes et al., 2021, Kramer and Steen, 2022; Van der Kolk et al., 2022). This matter can also be addressed by Dynamic Velocity Prediction program DVPP (Kerdraon et al., 2019), in an unsteady environment. However, these methods, in the case of a WAPS ship in leeway, are computationally expensive.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

Other methods are more cost-effective. For example, a system-based approach to study the behaviour of wind-propelled ships with 6 Degrees of Freedom (DOF) has been developed by Ecole Centrale Nantes (ECN). This method works as a Power Prediction Program (PPP) or as a Velocity Prediction Program (VPP) and has been implemented into the open source xWASP_CN model (Charlou et al., 2023). Comparisons by Charlou et al. (2023) of the numerical results, and a model scale unit of an 18 ft catamaran equipped with a Flettner rotor, showed good agreement for steadystate results. Another 6 DOF PPP, developed by DNV (Reche-Vilanova et al., 2023), leverages semiempirical methods and WAPS aerodynamic database from scientific literature for rotor sails, rigid wingsails and DynaRigs. The study reveals good agreement between simulations and the sea trials. This work has been extended to a Capesize bulk carrier to assess both its performances and economic viability (Hansen et al., 2025). This work concluded that the economical speed for this vessel is 14 knots and highlighted the importance of the weather routing potential (Mason, 2021), for both carbon savings and cost reductions.

Beyond wind propulsion, hybrid solutions integrating both wind and solar power have also been explored. A performance study on a HandySize bulk carrier incorporating both technologies demonstrated a potential CO_2 reduction of 36 % at a service speed of 13 knots (Nyanya et al., 2021). However, the study did not consider the added resistance due to leeway, which can increase total resistance by up to 18%, nor the effect of waves, which can further raise this resistance to 33% (Kramer and Steen, 2022).

Despite these advancements, the previous studies have overlooked key operational challenges associated with hybrid wind-solar merchant ships, such as design integration, leeway induced drag on hull and rudder, and aerodynamic interactions between sails. This study aims to bridge these gaps by presenting the methodology to develop fuel efficient merchant ship concepts within the framework of the EU-funded WHISPER project.

The project's objective is to develop, design, manufacture, and test wind-solar hybrid power systems and wind-assisted propulsion systems (WAPS) solutions to improve fuel efficiency of merchant ships, specifically targeting bulk carriers and container feeder ships. This paper presents numerical performance predictions for two merchant ship concept designs, assessing their impact on both propulsion and auxiliary consumption. The ship designs, developed by SDI and supported by WHISPER consortium, are based on:

- A Panamax bulk carrier, designed with insights from Ant Topic and Marfin Management
- A 1,000 TEU container feeder ship, developed with insights from Samskip and Nav-Tech

The following fuel-saving technologies are integrated into these designs:

- Rigid wingsails provided by OceanWings (https://www.oceanwings.com/)
- Photovoltaic (PV) panels provided by Solbian (https://solbian.solar/en/)
- Horizontal axis Savonius wind turbine provided by Sidewind (https://www.sidewind.is/)

Numerical simulations are conducted using X-WASP PPP. The questions addressed in this study are the following:

- What are expected power savings for wind-solar assisted bulk carriers and container feeder ships?
- How does wing integration impact ship operation at sea and in port?
- What are the most effective sail configurations in terms of power savings in terms of carbon reduction?

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

2. WHISPER SHIP CONCEPTS

This section introduces the two ship designs under consideration and outlines their operational and technical constraints. The WHISPER project aims to ensure that these ship designs achieve power savings of 30% for the bulk carrier and 15% for the container feeder ship.

2.1. Panamax Bulk Carrier

2.1.1. Main Characteristics and Operational Profile

For this study, a Panamax bulk carrier, with dimensions given in Table 1, was designed by naval architect SDI, incorporating insights from ship owner Ant Topic and Marfin Management. This vessel type is particularly well suited WAPS installation as it is gearless with the absence of onboard cranes, unlike smaller bulk carrier such as Ultramax vessels. The absence of cargo-handling equipment facilitates loading and unloading operations, ensuring the WAPS are not interfering with onboard gears, thus enhancing operational efficiency.

Table 1. WHISPER Panamax bulk carrier ship: main characteristics.

Service Speed [kn]	12.0
Length overall [m]	225.0
Moulded depth [m]	18.6
Breadth [m]	32.2
Deadweight [T]	75 000

Table 2 presents the carbon reduction technologies installed onboard, which includes 6 tiltable rigid wingsails of 363 m² each, provided by OceanWings, 1456 m² of PV panels from Solbian and 5 wind turbines housed in a 20’ container, provided by Sidewind.

Table 2. Carbon reduction technologies onboard Panamax bulk carrier concept.

	Quantity
OceanWings OW363 [units]	6
Solbian solar panels [m²]	1 456
20' container - Sidewind Turbines [units]	5

The operational profile of such ship is shown in Table 3 for a service speed of 12 knots.

Table 3. Panamax bulk carrier operational profile.

	Main Engine Mean Power [kW]	**Aux. Engine Mean Power [kW]**	**Days**	**Total energy [MWh / year]**
At sea (service speed)	4 692	480	210	26 067
At anchorage	0	480	50	576
At port	0	1 160	105	2 923
			Total	29 566

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

2.1.2. General Arrangements

Figure 4 and Figure 5 illustrate the concept design developed by the WHISPER consortium. This design includes six tiltable rigid wingsails provided by OceanWings with their compact design, light weight and limited power supply need, allowing for an integration on complex deck arrangements. This design also includes solar panels from Solbian which are installed on top of the hatch covers, while Sidewind turbines are positioned between them.



Figure 4. WHISPER concept: rendered view of the Panamax Bulk carrier (© SDI).

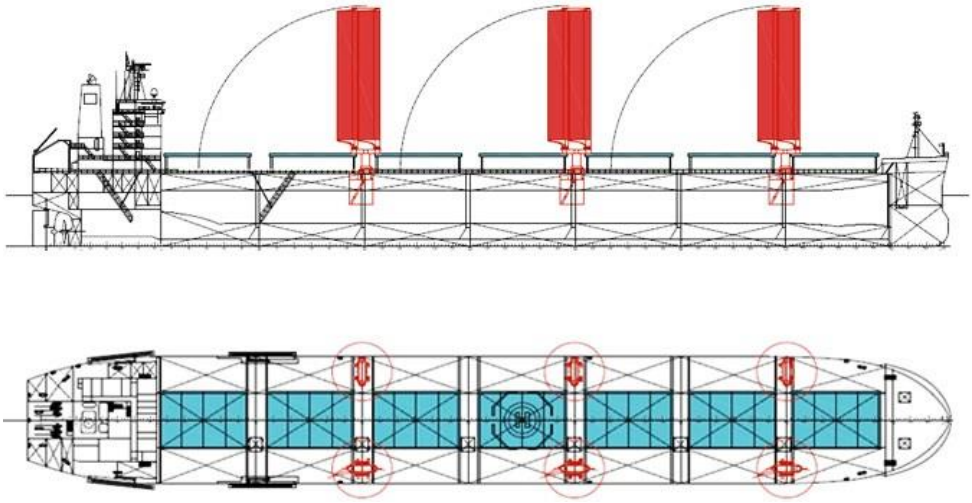


Figure 5. General arrangement: WHISPER Panamax Bulk carrier hosting 6 OW wingsails (© SDI).

The 6-wingsails configuration has been selected as the most favourable arrangement to reach the performance objectives described in this paper. In addition, impact of wingsail integration on ship operation at sea and in port has been minimized by a novel bulk carrier arrangement allowing tiltable wingsails on both ship sides to be stored bellow the sliding hatch covers. This arrangement offers unique protection of the wingsails during port operation, and minimum interference between the wings and harbour cranes for Panamax bulk carrier loading and unloading. Refer to Figure 6. It will be interesting for the reader to note that this wingsails configuration with this specific storing arrangement below the sliding hatch covers remains compatible with other types of bulk carriers, including Kamsarmax.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026



Figure 6. WHISPER Panamax Bulk: storage arrangement of wingsails for port operation (© SDI).

2.2. Container Feeder Ship

2.2.1. Main Characteristics and Operational Profile

For this study, a container feeder ship concept has been designed by naval architect SDI, incorporating insights from Samskip and Nav-Tech. Its main characteristics are presented in Table 4. This concept includes two rigid elevator wingsails of 363 m² each, provided by OceanWings, along with a series of Sidewind containers positioned on the highest container rows.

Table 4. WHISPER container feeder ship: main characteristics.

Service Speed [kn]	16.5
Length overall [m]	147.7
Moulded depth [m]	12.3
Breadth [m]	21.3
Deadweight [T]	1 029

Table 5 presents the carbon reduction technologies integrated on board, including two rigid wingsails, each measuring 363 m², which are mounted on an elevator system allowing them to slide inside the ship. Additionally, 255 m² of Solbian PV panels are installed on 24 Sidewind containers.

Table 5. Carbon reduction technologies inside WHISPER container feeder ship concept.

	Quantity
OceanWings OW363 [units]	2
Solbian solar panels [m²]	255
20' container - Sidewind Turbines [units]	24

Table 6 describes the operational profile of the container feeder ship for a service speed of 16.5 knots.

Table 6. Container feeder ship operational profile.

	Main Engine Mean Power [kW]	**Aux. Engine Mean Power [kW]**	**Days**	**Total energy [MWh / year]**
At sea (service speed)	5 424	950	265	40 539
At port	0	1 200	100	2 880
			Total	43 419

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

2.2.2. General Arrangement

Figure 7 and Figure 8 illustrate the container feeder ship concept design developed by the WHISPER consortium, showcasing its general arrangements. In this design, the wings are positioned behind the wheelhouse, ensuring clear visibility and compliance with SOLAS regulations.



Figure 7. WHISPER concept: rendered view of the 1029 TEU container feeder ship with 2 OW363 and three 40” Sidewind containers (© SDI).

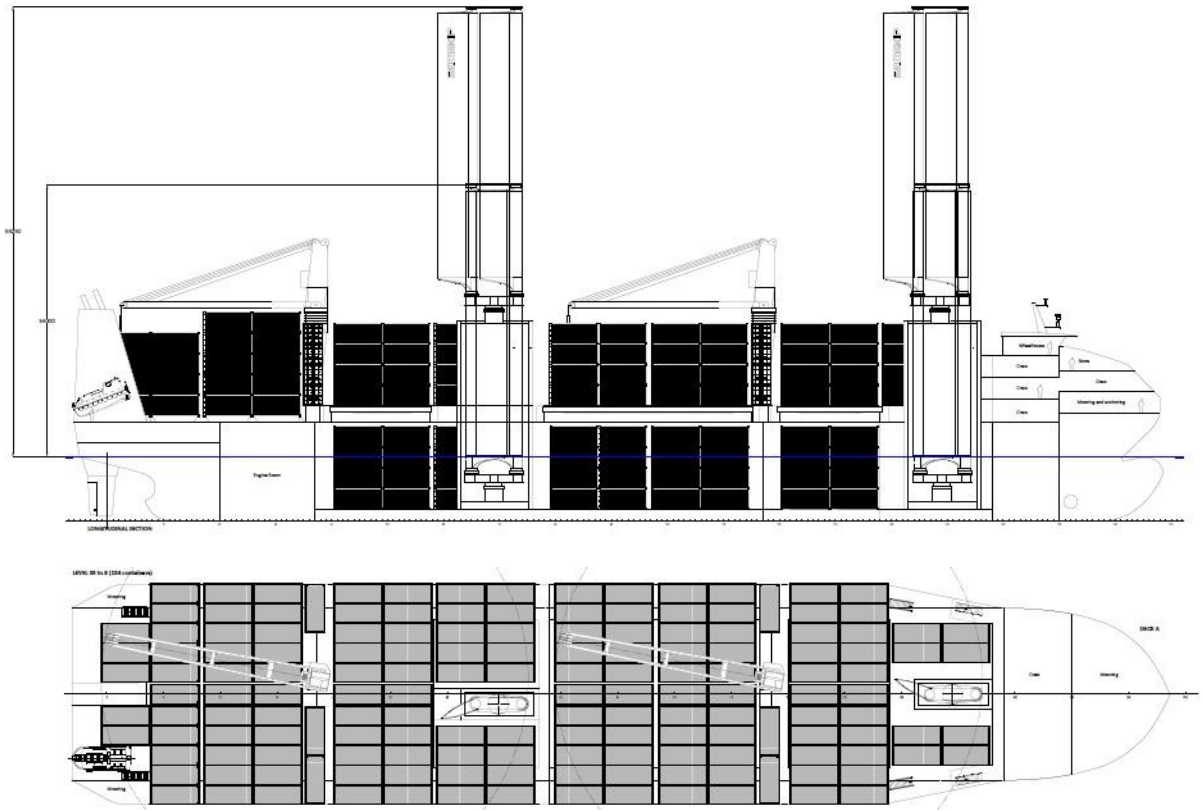


Figure 8. WHISPER container feeder concept hosting 2 OW363 rigid elevator wingsails (© SDI).

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

2.3. Operational and Technical Limitations

2.3.1 Bulk Carriers

The integration of sails on bulk carriers imposes significant limitations. During cargo operations, the rigid wingsails must be safeguarded against potential accidents or falling cargo. Additionally, integrating carbon-saving technologies in the bulk carrier impacts both cargo and ballast capacity, as the tilting penetration mechanism of the rigid wingsails beneath the deck will reduce the available top side tank space. Furthermore, the rigid wingsails must be positioned to minimise the interferences with ship operations during loading and unloading phases.

2.3.2 Container Ships

For container feeder ships, integrating rigid wingsails is more complex than for bulk carriers. In addition to ship stability issues resulting from ballast reduction or an increased vertical aerodynamic centre of effort, containers loss due to wingsail integration must also be considered. For this design and such high-speed commercial vessel, the inclusion of two rigid elevator OceanWings wingsails was the best compromise in terms of cargo-carrying capacity and fuel saving performances due to their low structural weigth and optimised aerodynamic characteristics.

3. PERFORMANCE PREDICTION METHODOLOGY

As mentioned in the introduction, performance assessment on WAPS-equipped ships relies on hydrodynamic and aerodynamic balance analysis. The present section focuses on the aerodynamic modelling, dealing with environmental data characterisation and aerodynamic performances of the rigid wingsails.

3.1. Environmental and Aerodynamic Modelling

3.1.1. Global Wind Chart

A normalized global wind chart has been developed by IMO 2021 regulation MEPC.1/Circ.896, illustrating the probability of wind conditions in relation to the ship's heading along major global trade routes. The trade routes are shown in Figure 9. The ships operated by Ant Topic have an operational profile very similar to the standard shipping routes studies by IMO, unlike Samskip's ships which follow very specific routes, as illustrated in Figure 10.

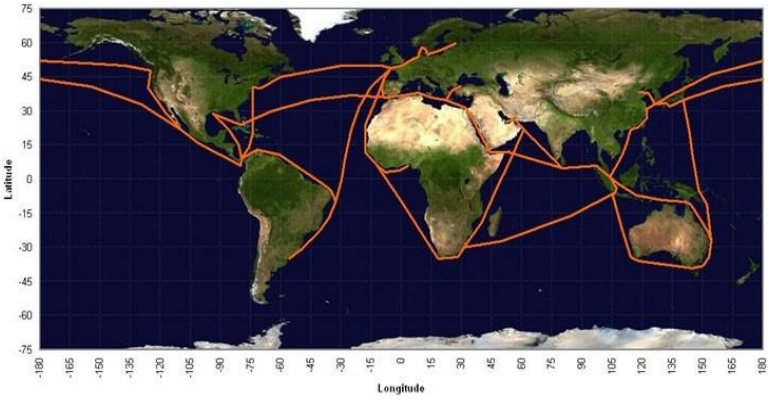


Figure 9. Global shipping routes used for wind chart calculation (IMO 2021).



Figure 10. Iceland Samskip's ship routes (Samskip 2025).

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

Based on IMO considerations, the average true wind speed encountered by ships operated on international trading route is 14.4 knots at a height of 10 m above sea level. For Samskip's specific routes, wind statistics have been established based on a 1-year measurement from one of their vessels. Note that the wind statistics from IMO are provided for a reference height of 10 m above the sea level and could be applied if we consider that the wind profile is uniform. However, a more accurate representation considers wind shear, which is modelled using a power law wind profile expressed as:

$$W(z) = W_r \left(\frac{z}{z_r}\right)^{\sigma}, \tag{1}$$

where $W(z)$ is the true wind speed computed at the vertical coordinate z with respect to the sea surface, W_r is the reference true wind speed at 10 m height above the sea level, z_r is the reference height which is 10 m in this study. The wind shear exponent σ takes the value 0.14 for normal wind conditions according to the BV regulation norm NR206, and to Touma (1977).

For Samskip specific routes, wind data was measured on board container feeder Arnarfell vessel at a wind sensor height higher than 10 m. The data was recalibrated using the wind power law from equation 1 to match the same reference height, resulting into an average true wind speed of 14.3 knots. Wind distributions for both IMO trading routes and Samskip specific routes are presented in Figure 11 at a reference height of 10 m. In use cases, a uniform distribution of true wind direction was considered. Wind speed distributions given in Figure 11 have been used for performance prediction of both use cases described below.

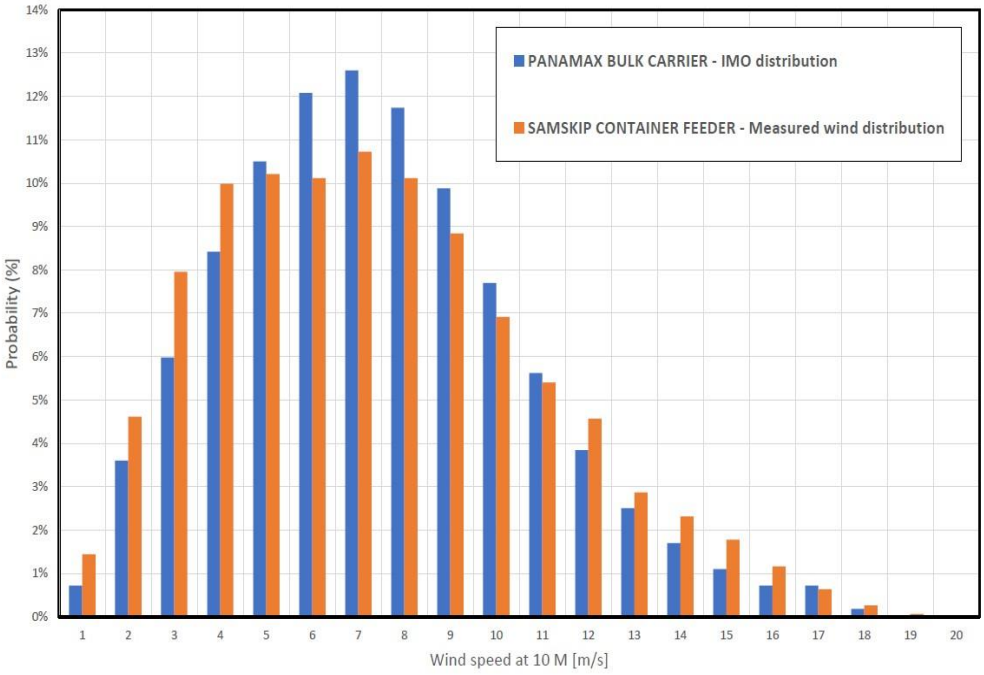


Figure 11. True wind speed distribution at 10 m from sea level according to standard IMO 2021 regulation MEPC.1/Circ.896 and custom measurements on ARNARFELL vessel.

To account for realistic operating conditions, the IMO analysed the probability of occurrence of various wind speeds from different directions. While their full wind matrix considers each combination separately, we adopted a simplified approach. For the purpose of this study, we computed the savings for each combination of true wind speed and true wind direction, assuming a uniform distribution of wind direction and the specified distribution of wind speed.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

3.1.2. Rigid wingsails

For this study, aerodynamic lift and drag coefficients, as well as aerodynamic interaction between wingsails and between wingsails and superstructure were computed by OceanWings, using CFD on a reference ship of similar length and similar wingsail arrangement to the designs examined in this article. This reference design included six rigid wingsails arranged in two rows (see Figure 5).

Horizontal visualisation of normalized wind speed flow around the wings of the reference vessel at various height are provided in Figure 12. Ship superstructure was considered too in these CFD simulations so that computed aerodynamic coefficients do include both effects of interactions between wings and interaction with the hull.

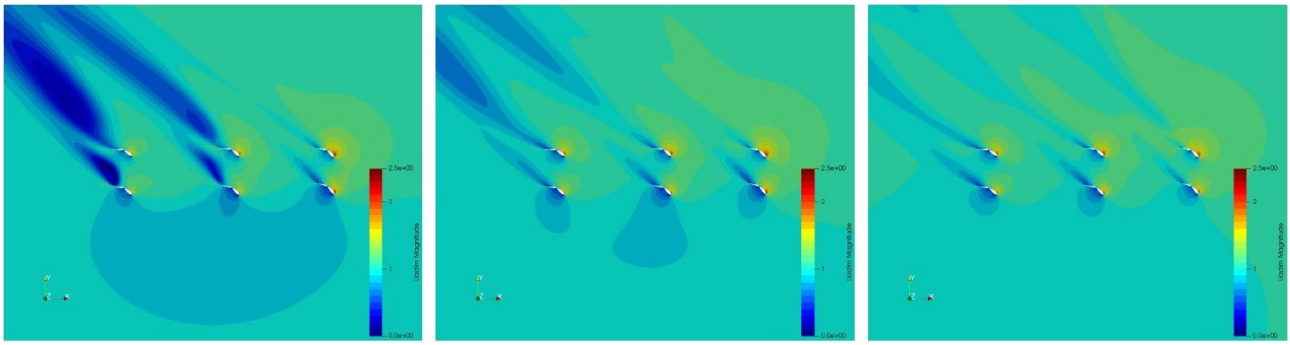


Figure 12. Normalized wind speed flow around the wings of reference vessel (OCEANWINGS, CFD Runs - Simulation Synthesis, May 2024)

This arrangement with 6 OceanWings of 363 m² per unit (OW363) proved to be the most relevant configuration in terms of performance and ship integration compared to alternative arrangements (refer to Section 4 of this paper).

For each apparent wind angle (AWA), it was assumed that the sails operate at their optimal thrust coefficient $C_{x,}$ which can differ from maximum thrust particularly in close hauled conditions. Indeed, in these conditions, high C_x values correspond to high values of side forces C_y and leeway, which penalizes hydrodynamic performance by increasing induced drag (Kramer and Steen, 2022). This hydrodynamic penalty is taken into account in OceanWings trimming strategy to determine the optimal 'net' thrust in each wind condition. To find the optimal trimming, each wingsail is trimmed independently.

Regarding sail performance, the lift and drag coefficients are of the same order of magnitude as those of a typical asymmetric air foil (e.g., NACA 4412) or symmetric air foil (e.g, NACA 0015) equipped with a flap.

3.2. Hydrodynamic Modelling

In this present study, X-WASP PPP is used to evaluate the WAPS ship performances. It is a system-based 6-DoFs Dynamic Velocity/Power Prediction Program approach. The propulsion problem is related to the forward motion of the ship, associated with the forces along the longitudinal axis of the ship. It finds the system states η that corresponds to a static equilibrium, solving the following equations.

$$\begin{cases} \sum \vec{F}(\eta) = \vec{0} \\ \sum \overrightarrow{M_G}(\eta) = \vec{0} \end{cases} \quad (2)$$

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

It presents the key advantage of being simple to implement and computationally efficient. Additionally, it is a modular approach, as each sub-system can be described by its own force model. However, its main limitation is that it does not take into account interactions between the different sub-systems. For instance, interactions between the hull and the propellers, as well as the hull and its appendages, are not explicitly modelled; only semi empirical corrections are applied to account for these effects. For this study, according to this second method, the main manoeuvring coefficient calculations have been based on following simplified governing equations:

$$X'_{HULL} = X'_{vv} v'^2, \tag{3}$$

$$Y'_{HULL} = Y'_v v', \tag{4}$$

$$N'_{HULL} = N'_v v', \tag{5}$$

where X'_{HULL}, Y'_{HULL} and N'_{HULL} are, respectively, the normalized hull's longitudinal forces, side forces and yaw moment and the right-hand side terms correspond to the hydrodynamic derivatives. Such equation is similar to the MMG rule (Yasukawa and Yoshimura, 2015).

As an illustration key manoeuvring coefficient $Y'_v = -0.015$ has been calculated and used in this study. Furthermore, in addition to the dynamic forces of the ship in longitudinal direction, the static part, i.e. the ship's resistance curve, is given by Holtrop's method (Holtrop and Mennen, 1982; Holtrop, 1984).

3.3. Weather Routing

If weather routing is considered, each individual sail setup can provide increased power savings, up to 60% according to data from scientific literature. Mason (2021) demonstrated that weather routing optimisation on globally distributed routes used by Panamax bulk carriers increases carbon savings of the wind-assisted Panamax ship by 62 % compared to the carbon savings of the wind-assisted ship alone. Dupuy et al. (2023) demonstrated 73 % additional weather routing benefit on a roundtrip Santos-Qingdao for a bulk carrier equipped with 6 wingsails. Accordingly, a weather routing benefit of 60% has been considered for this study for the bulk carrier and 15% for the container ship, due to its shorter routes.

4. RESULTS

4.1. Panamax Bulk Carrier

This section presents the overall power savings on the Panamax bulk carrier at a service speed of 12 knots. Several wingsails configurations were analysed, including two types of rigid wingsails with surface areas of 363 m² (OW363) and 588 m² (OW588). Figure 13 presents the power savings expressed as a function of the total sail area for different configurations.

4.1.1. Power Savings for a New Build Panamax Bulk Carrier

Figure 13 shows the impact of each wingsail configuration on the overall performance of the newbuild project. The WHISPER project targets power savings of at least 30% on bulk carriers. The configuration that comes closest to this target, when weather routing is included, is a setup with six OW363 wingsails. However, adding more wingsails beyond this point is not feasible for either retrofits or newbuilds, due to the limited available deck space on this type of vessel. Assuming wingsail-to-wingsail interactions and a 60% positive effect from weather routing, the six OW363 configuration delivers a 28% power reduction.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

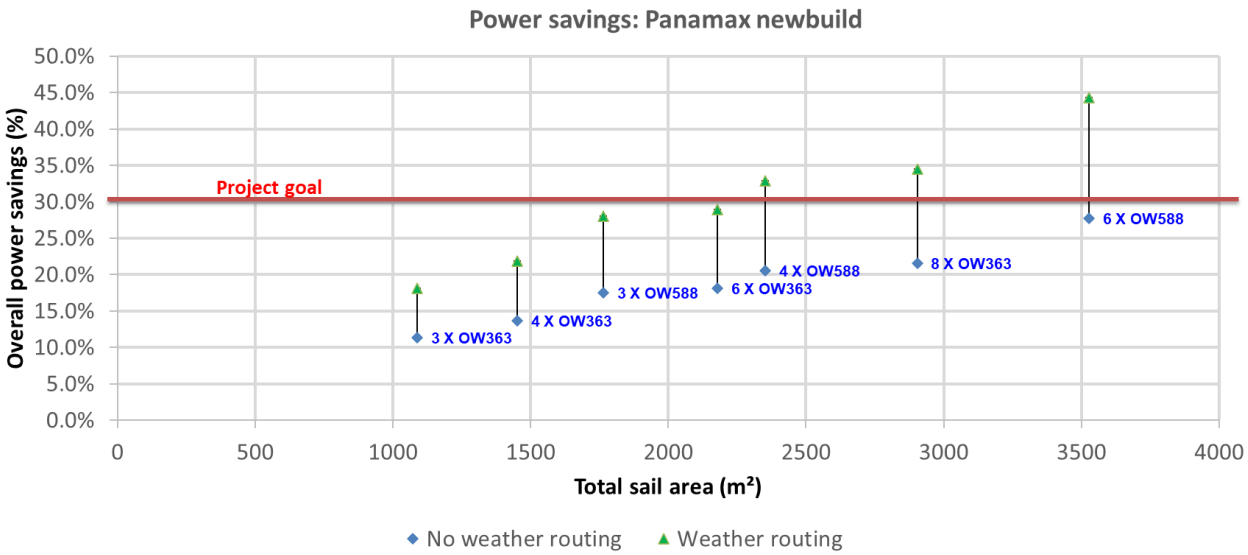


Figure 13. Power savings for the WHISPER Panamax bulk carrier concept at 12 knots.

These results are associated to a slow steaming speed of 12 knots. To account for this effect, power savings on the 6 OW363 wingsail setup have been calculated at service speeds of 10, 11, 12, 13 and 14 knots using the same assumptions as in Figure 13. Results, presented in Figure 14 indicate that power savings improve as service speed decreases, reaching up to more than 35% at a service speed of 10 knots when both wingsail-to-wingsail interactions and weather routing are considered. With 60% weather routing coefficient, the overall power savings at 10 knots increase from 22% to 35%.

The economical speed of a ship must be determined at the fleet level, as reducing a single vessel's speed requires increasing the fleet size to maintain service frequency and compensate for longer estimated times of arrival (ETA). According to the WHISPER consortium, a service speed of 12 knots is economically viable, whereas further speed reductions are not acceptable at the fleet scale for economic reasons.

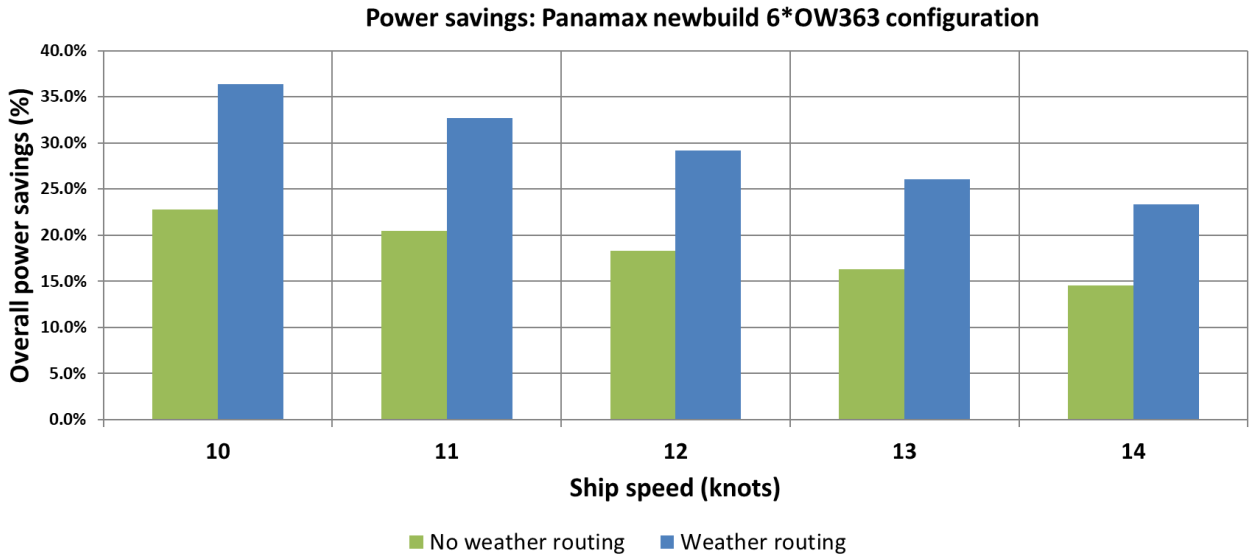


Figure 14. Power savings on WHISPER Panamax bulk carrier concept.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

4.1.2. Gain assessment for 6 OW 363 at 12 knots

Gain assessment induced by WHISPER technologies are presented in Table 7, showing the updated operational profile with active WAPS. For this setup and this service speed, overall savings of 28.2% are expected, with 26.6 % contribution from WAPS and 1.6% from PV panels and wind turbines.

Table 7. WHISPER gain assessment for the 6 OW363 setup at a service speed of 12 knots, under the assumption of weather routing and interactions between wingsails.

	Main Engine Mean Power [kW]	Aux. Engine Mean Power [kW]	Days	Total energy [MWh / year]
At sea (service speed)	3 131	425	210	17 925
At anchorage	0	425	50	510
At port	0	1 105	105	2 785
		Total		21 220
		Total power savings		28.2 %
		Sails energy		7 866
		Total sail coverage		26.6 %

4.2. Container Feeder Ship

This section presents the overall power savings newbuilding concepts of a container feeder ship based on the insights of ship owner Samskip and Nav-tech. Fuel consumption has been estimated for the following service speeds of respectively: 12.5, 14.5, 16.5 and 18 knots. Several wingsails setups have been considered; one does not include any wingsail and includes 24 Sidewind containers. Other configurations include two rigid elevator wingsails and three wingsails.

4.2.1 Power Savings for a New Build Container Feeder Ship

To choose the best configuration, relative daily fuel consumption normalized by the total number of containers has been estimated for all the configurations above mentioned, with the reference chosen as the configuration operating at its service speed of 16.5 knots without any WAPS or wind turbine integrated (corresponding to the label “No wingsails”). Figure 15 shows that the best performing configuration, in terms of daily fuel consumption per containers, is the one including 2 rigid elevator wingsails, for all the considered service speeds.

Consequently, absolute power savings calculations have been carried out for the same range of service speeds for the “no wingsails” configuration and the new build concept including 2 elevator rigid wingsails. It should be noted that, in the “No wingsails” configuration, power savings are solely attributed to the 24 containers equipped with SideWind turbines and solar panels. Results are shown in Figure 16, showing approximately 3% power savings for “No wingsails” configuration and approximately up to 18% for the 2 OW363 configuration at a service speed of 12.5 kn, under the assumption of a 15% positive effect of weather routing optimisation. However, the 3% power savings from the SideWind turbines are to be confirmed, as further CFD studies on turbine performance are still in progress.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

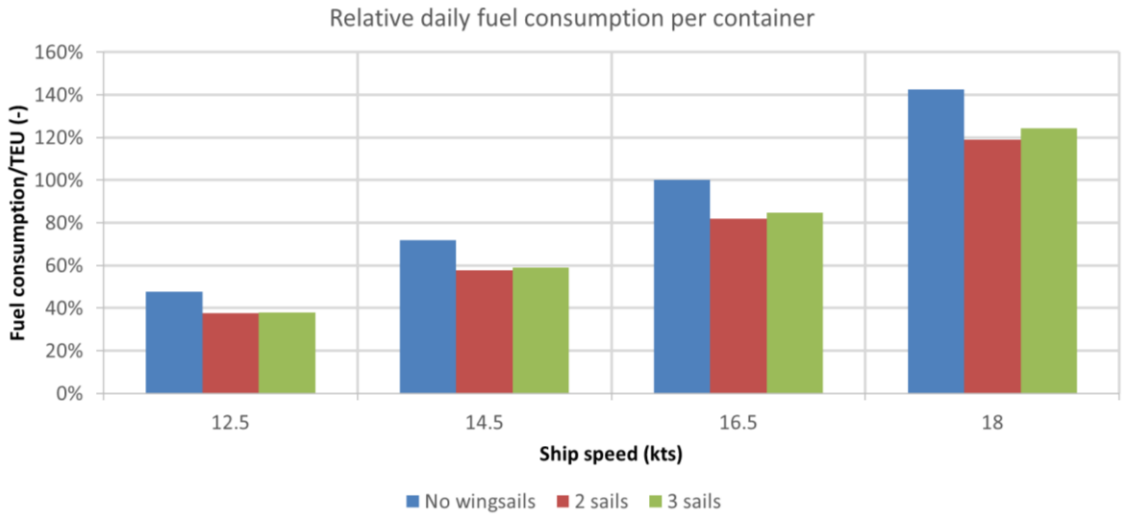


Figure 15. Relative daily fuel consumption per container for different sail configurations.

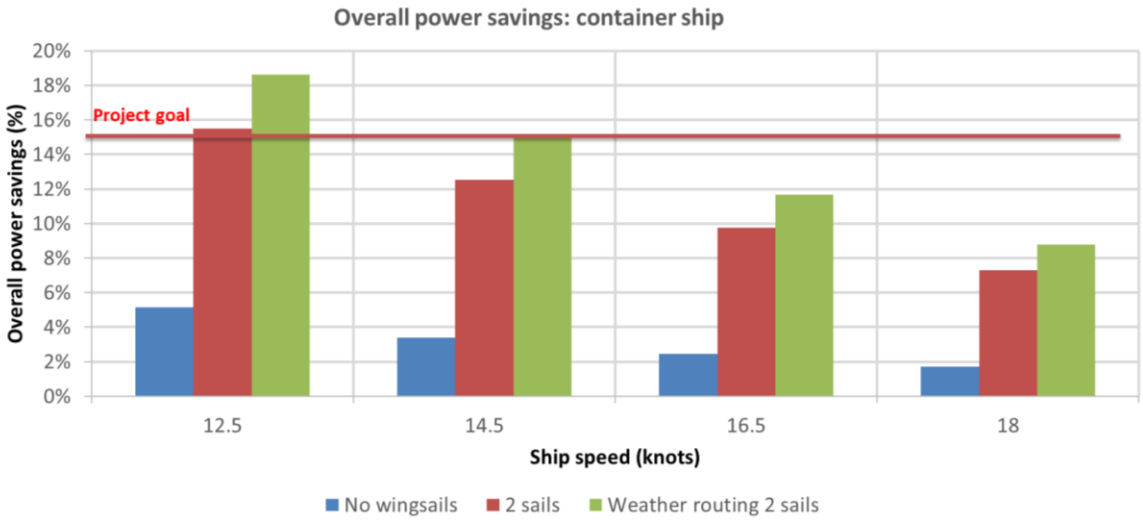


Figure 16. Overall power savings for WHISPER container feeder ship concept.

4.2.2 Gain Assessment for 2 OW 363 at 16.5 knots

Table 8 presents gain assessment induced by WHISPER technologies, showing the updated operational profile with active WAPS. For this setup and this service speed, overall savings of 9.7% are expected, with 7.3% contribution from WAPS and 2.4% from PV panels and wind turbines.

Table 8. WHISPER gain assessment for the 2 OW363 setup at a service speed of 16.5 knots.

	Main Engine Mean Power [kW]	Aux. Engine Mean Power [kW]	Days	Total energy [MWh / year]
At sea (service speed)	4 926	828	265	36 600
At port	0	1 078	100	2 588
		Total		39 190
		Total power savings		9.7 %
		Sails energy		3 165
		Total sail coverage		7.3 %

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

5. CONCLUSIONS

The study presented a methodology for assessing the impact of WAPS and carbon reduction technologies, such as wind turbines and PV panels on fuel savings of two merchant ship designs developed by the WHISPER consortium: a Panamax bulk carrier and a container feeder ship.

The study revealed that for new build Panamax bulk carriers, power savings of up to 28% can be achieved with a six-rigid-sail configuration, under the assumption of an optimistic 60% weather routing benefit and a reduced service speed compared to similar vessels (slow steaming from 14 to 12 knots). According to ship owner Ant Topic and Marfin Management, a service speed of 12 knots is economically acceptable, but further reductions should not be considered, even if they lead to greater fuel savings. It is interesting to note for the reader that the 6-wingsail arrangement and its specific storing arrangement below the sliding hatch covers remains compatible with a Kamsarmax bulk carrier as well, keeping in mind that a new performance assessment will need to be performed on this type of vessel to evaluate the resulting fuel savings.

Regarding container feeder ships, the study revealed that for a service speed of 16.5 knots, configurations without wingsails but with PV panels and wind turbine resulted in 3% power savings and the design including 2 wingsails achieved 10% power savings. The study revealed that the inclusion of two rigid elevator wingsails was the best compromise in terms of cargo-carrying capacity and fuel saving performances, due to design constraints and the high-speed level of this vessel.

From a regulatory compliance perspective, this study does not account for CII or stricter EU regulations, such as FuelEU Maritime, which came into effect in January 2025 and explicitly accounts for the benefits of wind propulsion.

As part of the WHIPSER project, the next phase will focus on validating these findings through sea trials on a retrofit bulk carrier operated by Ant Topic and a container feeder ship operated by Samskip. Additionally, CAPEX and OPEX assessments will be carried out to quantify the financial impact of WAPS integration. CAPEX is particularly important for retrofit applications, since structural modifications are required to integrate WAPS effectively. Furthermore, FuelEU and ETS (Emissions Trading System) calculations will be necessary to assess for the overall financial impact, as these regulations impose penalties on CO_2 emissions. Finally, advanced weather routing optimisation will be explored to improve the fuel saving potential of these innovative ship designs.

ACKNOWLEDGEMENTS

This project was conducted as part of the EU-funded WHISPER consortium, which includes: Verkis, SideWind, OceanWings, Solbian, Stirling Design International, CANOE, Dotcom, Ant Topic, Samskip, BBA//Fjeldco, Inspiralia, Lloyd's register and Athygli. We acknowledge the support of all project partners for their invaluable contributions in shaping the outcomes of this study.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or The European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

This project has received funding from the European Union's Horizon Europe research and innovation program under Grant Agreement Nr. 101096577.

Lloyd's Register is funded by UK Research and Innovation under project agreement Nr. 1006574.

UK Research and Innovation

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

REFERENCES

Charlou, M., Babarit, A., Gentaz, L. (2023). A New Validated Open-Source Numerical Tool for the Evaluation of the Performance of Wind-Assisted Ship Propulsion Systems. *Mechanics and Industry*, 24.

DNV, Clarksons Research, World fleet Register (2024), *https://bound4blue.com/how-suction-sails-work-to-empower-sustainability/*

Dupuy, M., Letournel, L., Paakkari, V., Rongère, F., Sarsila, S., Vuillermoz, L. (2020). Weather Routing Benefit for Different Wind Propulsion Systems. *Journal of Sailing Technology* 8 (1), pp. 200-217.

Hansen, H., Hochkirch, K., Hollenbach, U. (2025). Wind Propulsion Performance Prediction Impact on Bulk Carrier Business Case. *Journal of Sailing Technology* 10(1), pp. 1-18.

Hopes, W., Pearson, D., Buckingham, J. (2021). A CFD Study on Wind Assisted Propulsion Technology for Commercial Shipping. *RINA Wind Propulsion Conference*, London, UK.

Holtrop, J. (1984). A Statistical Re-Analysis of Resistance and Propulsion Data. *International Shipbuilding Progress* 31, pp. 272-276.

Holtrop, J., Mennen, G. G. J. (1982). An Approximate Power Prediction Method. *International Shipbuilding Progress* 29(335), pp.166-170

IMO (2021). 2021 Guidance on Treatment of Innovative Energy Efficiency Technologies for Calculation and Verification of the Attained EEDI and EEXI, MEPC.1/Circ.896. *International Maritime Organization*, London.

IPCC (2018). Global Warming of 1.5°C. *IPCC Report, https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_Full_Report_HR.pdf*

Kerdraon, P., Horel, B., Bot, P., Letourneur, A., Le Touze, D. (2019). 6DOF Behaviour of an Offshore Racing Trimaran in an Unsteady Environment. *SNAME 23rd Chesapeake Sailing Yacht Symposium*, Annapolis, US.

Kramer; J. V., Steen, S. (2022). Sail-Induced Resistance on a Wind-Powered Cargo Ship. *Ocean Engineering* 261, 111688.

Mason, J. (2021). Quantifying Voyage Optimisation with Wind-Assisted Ship Propulsion: A New Climate Mitigation Strategy For Shipping. *PhD Thesis*, University of Manchester.

Nyanya, M. N., Vu, H. B., Schönborn, A., Ölçer, A.I. (2021). Wind and Solar Assisted Ship Propulsion Optimisation and its Application to a Bulk Carrier. *Sustainable Energy Technologies and Assessments* 47, 101397.

Reche-Vilanova, M., Hansen, H., Bingham, H. B. (2021). Performance Prediction Program for Wind-Assisted Cargo Ships. *Journal of Sailing Technology* 6(1), pp. 91-117.

Samskip (2025), Our Network – North Atlantic, *https://en.samskip.is/schedules/our-network/#north-atlantic*

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026

Taimuri, G., Matusiak, J., Mikkola, T., Kujala, P., S. Hirdaris, S. (2020). A 6-DOF Manoeuvring Model for the Rapid Estimation of Hydrodynamic Actions in Deep and Shallow Waters. *Ocean Engineering* 218, 108103.

Tillig, F., Ringsberg, J. W. (2020). Design, Operation and Analysis of Wind-Assisted Cargo Ships. *Ocean Engineering* 211, 107603.

Touma, J. S. (1977). Dependence of the Wind Profile Power Law on Stability for Various Locations. *Journal of the Air Pollution Control Association* 27(9), pp. 863-866.

Van Der Kolk, N. J., Keuning, J. A., Huijsmans, R. H. M. (2022). Part 1: Experimental Validation of a RANS-CFD Methodology for the Hydrodynamics of Wind-Assisted Ships Operating at Leeway Angles. *Ocean Engineering* 178, pp. 375-387.

Viola, I. M., Sacher, M., Xu, J., Wang, F. (2015). A Numerical Method for the Design of Ships with Wind-Assisted Propulsion. *Ocean Engineering* 105, pp. 33-42.

Yasukawa, H., Yoshimura, Y. (2015). Introduction of MMG Standard Method for Ship Manoeuvring Predictions. *Journal of Marine Science and Technology* 20(1), pp. 37-52.

Downloaded from http://onepetro.org/JST/article-pdf/10/01/389/5302005/sname-jst-2025-17.pdf/1 by guest on 09 March 2026