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WHISPER

WP1 Publishable summary

Deliverable D1.8 – WP1



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Deliverable description

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Abstract:

This publishable summary presents the main outcomes of WHISPER Work Package 1, covering system design, simulation, integration planning, and data management for wind- and solar-assisted shipping technologies. WP1 defines the technical basis for three retrofit solutions: the SideWind containerized wind-solar system, OceanWings® rigid wing sails, and Solbian marine photovoltaic systems. The work establishes key requirements, design choices, prototype interfaces, and monitoring methods needed to validate fuel savings and CO_2 reductions during future vessel demonstrations.

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WHISPER

Executive summary

WHISPER Work Package 1 establishes the technical foundation for the project's retrofit wind and solar solutions for commercial shipping. It covers the SideWind containerized wind-solar system, OceanWings® automated rigid wing sails, and Solbian lightweight marine PV systems, all intended to reduce fuel consumption and emissions on bulk carriers and containerships.

The work package has progressed the technologies from requirements and concept definition toward detailed design and prototype integration. SideWind has developed a modular Savonius rotor concept supported by CFD and structural analysis, while OceanWings® has defined a class-informed 363 m² wingsail system for installation on ANT TOPIC. Solbian has specified robust semi-flexible PV modules for SideWind containers and bulk carrier hatch covers.

A key WP1 output is the Data Management System, which collects vessel, engine, navigation, fuel-flow, wind, and solar data to assess energy production, fuel savings, CO_2 reductions, and operating conditions. The system combines onboard storage, secure cloud synchronization, and dashboards for project KPI monitoring.

Implementation is most advanced on ANT, where key machinery, navigation, weather, fuel-flow, and renewable-energy data streams have been deployed or prepared. Remaining work includes sea-trial validation, final SideWind prototype testing, completion of Samskip and partner-system interfaces, and confirmation of long-term robustness for removable solar solutions.

1 Project overview

WHISPER aims to decarbonize long-distance shipping routes by utilizing wind and/or solar energy to reduce carbon footprint in bulk carriers and container ships. The goal is to develop three different solutions:

- Wind–Solar Hybrid Power Systems via SideWind System.
- Wind-Assisted Propulsion System (WAPS) via OceanWings® sails.
- Photovoltaic System via Solbian (SOL).

The targeted fuel savings are approximately 29.8 % on retrofit bulk carriers, and 15.3 % on retrofit containerships. WP1 defines technical requirements, system architecture, and integration concepts for all three technologies. Summary of each deliverable and their main results are summarized here.

1.1 System Design Requirements Capture and Architecture (D1.1)

The Deliverable D1.1 of the WHISPER project establishes the system design requirements and architecture for three major energy-saving technologies intended for retrofit on commercial vessels. That work was performed in the first six months of the project (Jan -Jun 2023). The aim was to define high-level logical and physical architecture for integration of energy-saving technologies, these tasks were split into:

1. Wind Solar Hybrid Power System (WSHPS) integrating SideWind (SW) containerized wind turbines and Solbian (SOL) photovoltaic systems.
2. Wind Assisted Propulsion System (WAPS) using AYRO's OceanWings® rigid wing sail system.
3. Power Management System (PMS) and Data Management System (DMS) enabling energy flow optimization and system-wide data capture.





Key design considerations include retrofit practicality, compliance with International maritime (IMO) regulations, electrical integration across differing vessel grid standards, and safe/robust operation in harsh marine environments. Integration to the vessel was one of the main challenges covered by SideWind (SW) multi-domain design, OceanWings (OW) structural/electrical interfaces and installation constraints in addition to positioning of Solbian (SOL) PhotoVoltaics (PV). Overall, D1.1 provides a shared technical direction and interface understanding to progress to a detailed design and, later on, sea trials which aim at quantifying fuel savings.

1.2 SideWind System (D1.3)

SideWind's solution is a containerized wind–solar unit using a horizontally mounted Savonius rotor within modified 40ft containers. The system is designed as a Plug-and-Play solution capable of feeding directly into ship power grids.

Key functions:

- Reduce fuel consumption and emissions using wind and solar power.
- Operate autonomously with full control, monitoring, and emergency shutdown logic.
- Integrate safely on both container ships (Samskip) and bulk carriers (ANT Topic), although ANT Topic will not be used for sea trials.

Rotor design underwent CFD analysis (see D1.2), academic consultation, and field testing.

Key elements:

- 2m diameter Savonius rotor with optimal twist (180° for 40ft).
- Composite blade integration developed/analysed with Canoe and Tensyl.
- Modular shaft design for manufacturability and transport.

Expected generator output (CP = 0.2): Average wind is 5-10 m/s resulting in 0.3 to 2.5 kW capable of delivering up to 66 kW at 30 m/s. This is a conservative estimate based on CFD simulation and global sea wind data, and will be confirmed after the sea trials. The sea trials will determine whether the airflow through the turbines is stronger or weaker than the ambient airflow around the vessel. The findings will play an important role in determining the optimal deployment strategy for SideWind modules. If the turbines can capture airflow accelerated by pressure differences around the ship, the generator output could increase substantially, since the power available from wind is proportional to the cube of wind speed. If this accelerated airflow cannot be effectively utilized, deployment could focus on vessels operating along routes with above-average wind speeds, such as those in the North Sea, and during winter months when average wind speeds are generally higher. This targeted approach would help maximize energy generation, fuel savings, and emissions reductions. When combined with battery storage, SideWind modules can also support peak shaving. Surplus renewable electricity can be stored when onboard demand is low and released during periods of high or sudden power demand. This reduces peak loads on the vessel's conventional generators, potentially lowering fuel consumption, emissions, and generator wear.

Deliverable D1.3 solidifies the SideWind system as a structurally robust, safe, and fully automated wind-energy module designed for maritime deployment. Supported by CFD and FEM analysis, prototype validation, and interdisciplinary engineering, the SW system is moving into the manufacturing and vessel-integration phase, contributing significantly to WHISPER's decarbonisation goals.

1.3 CFD simulations report (D1.2)

As part of WP1, aerodynamic analysis and computational fluid dynamics (CFD) simulations of the Sidewind (SW) turbine were performed. One of the objectives is to explore the possibility of aerodynamically improving the turbine and its position on the vessels and to establish a better foundation for a prediction of the turbine's average power production.

Simulations indicate that under favourable conditions the turbine can operate at an efficiency like a traditional Savonius turbine (i.e. with similar power coefficients). However, its horizontal layout causes a reduced power under unfavourable wind angles. The simulations further showed that unless a turbine is placed right at the wind-facing edge of a vessel's container row it will be significantly shielded from the wind. This narrows the range of usable wind angles.

Several simulations were performed to explore possibilities of improving the performance of the turbine in various ways, e.g. shielding the returning blade, extending the roof, and altering the shape of the turbine blades. While these explorations were limited, they suggest that achieving significant performance improvement is very challenging, especially when operating conditions are highly unstable, as is the case on a vessel's deck.

Simulations also indicate that the turbine's optimal rotational speed is dependent on the height at which it is positioned on a container ship, and unstable flow in simulations of a relatively high position made determination of optimal rotational speed challenging.

Due to the high number of simulations that were needed, a significant compromise between numerical accuracy and simulation speed had to be made. This introduces sizable uncertainty to the results, and they should be viewed with this in mind.

1.4 Oceanwings system design (D1.4)

System Concept and Aerodynamic Principle

The OceanWings System is a fully automated, two elements rigid wingsail designed to deliver propulsion assistance and reduce fuel consumption.

Its concept is based on:

- A two-flap symmetric wing profile, enabling to maximize the delivered thrust for a given surface
- Automatic wing angle of attack and camber management via independently actuated boom and elements

The system automatically trims itself based on real-time wind measurements, using proprietary control algorithms to maximize thrust and reduce engine load.

System High Level Architecture

An OceanWings System consists of:

- An OceanWings Propulsor: 2 composite elements, one boom including 3 slewing modules to manage wing orientation and camber. The function of the propulsor is to generate thrust.
- An OceanWings Foundation (OWF): tilting pedestal allowing horizontal storage and air draft reduction.
- An Embedded control system: centralized PLC, HMI.

The wingsail rotates 360° and can be fully tilted horizontally for port operations, and extreme weather protection.

Main dimensions

Total height above deck	40 m
Wingsail area	363 m²

System Design

The system main components are the following:

- Elements constructed from glass/carbon composite, monobloc shells bonded over spars
- Boom fabricated in marine grade steel, equipped with slewing modules
- Tilting system including hydraulic cylinders, locking actuators, fixed and mobile structure fabricated in marine grade steel.
- Embedded Control System
    - Redundant system architecture with distributed modules
    - Control system that manages actuation, monitoring, and alarm management
    - Sensors that monitor the wind and sea conditions

Ship Integration & Compliance

OceanWings installation on ANT TOPIC requires:

- Forecastle mounting for minimal impact on cargo operations
- Structural reinforcement below deck (shipowner responsibility)
- Electrical, hydraulic, and network interfaces;
    - 400 VAC / 24 VDC electrical power inputs
    - Hydraulic power inputs for tilting system actuation-cover generation system
    - Data inputs for OceanWings internal logic, and performances analyses.

The OceanWings design has been validated by class societies.

System Safety & Risk Assessment

A system analysis has enabled to identify the risks, associated safety functions, preventive measures and safety requirements.

Safety logic ensures fail-safe transitions, emergency stop capabilities, and reconfiguration into flag mode upon power or control failure.

Conclusion

Deliverable D1.4 establishes a complete, class informed design for the OceanWings® 363 system, ready for manufacturing and integration. The system meets aerodynamic, structural, operational, safety, and regulatory requirements for installation on a bulk carrier within WHISPER and provides a scalable platform for future wind assisted propulsion applications.

Key characteristics:

- Height: 38 m; Area: 363 m²; Mass is approximately 88 tons including foundation
- Automated trimming using wind sensors, accelerometers, and PLC controls
- Tilting foundation enabling horizontal stowage for ports and heavy weather

Performance:

- Operational AWS: up to 40 kts with progressive depowering
- Expected fuel savings per wing: 4–9%

1.5 Solar panels specifications and Bill Of Material (D1.5)

The WHISPER project's Deliverable D1.5 defines specifications and design concepts for marine adapted photovoltaic (PV) systems intended for SideWind (SW) containers and bulk carrier hatch covers. Due to harsh marine conditions, monocrystalline silicon cells were selected for their high efficiency, durability, and strong moisture resistance. Conventional glass–aluminium panels were rejected because of corrosion risk, weight, fragility, and vibration sensitivity. Instead, lightweight, semi flexible polymer encapsulated modules are used.

The PV laminate consists of four layers: a UV resistant transparent front layer, a thermoplastic encapsulant, multi busbar monocrystalline cells, and a UV protected backsheet, resulting in a thin (1.8 mm), robust structure. Additional features include anti soiling coatings, low moisture permeability materials, and reinforced substrates to withstand marine loads such as wind and wave forces.

For SW containers, standardized panels (1200 × 2000 mm, 180 W each) are arranged in modular layouts, with 20 panels on a 40 ft container, achieving about 125 W/m². For bulk carrier hatch covers, larger modular systems are designed to fit structural constraints. Each module delivers around 490 W, and a half hatch cover can host 39 modules, producing approximately 19.1 kWp at about 95.5 W/m².

The design accounts for operational constraints such as hatch mobility, crew access, and maintenance. Various substrate materials are being evaluated to balance weight, durability, and cost. Overall, the system provides a lightweight, modular, and electrically safe solution tailored for marine integration, forming a solid basis for manufacturing and deployment.

1.6 Removable Solar System Engineering Specification (D1.6)

This report is part of the WHISPER project, which aims to develop innovative, modular wind-solar hybrid power and propulsion solutions for retrofitting bulk carriers and containerships, targeting significant fuel savings and emission reductions in the maritime industry. This specification focuses on the integration of photovoltaic (PV) solar panels onto the hatch covers of bulk carriers, utilizing their large, flat surfaces without compromising cargo operations or vessel safety. There is no international regulation on use of solar panels at sea.

Key engineering considerations include ensuring that the system is lightweight, durable in harsh marine environments, easy for the crew to operate and remove, compliant with safety and fireproofing standards, and does not interfere with critical vessel operations such as cargo handling or emergency helicopter landings. Lessons from early prototypes highlight challenges with corrosion, connector durability, and system handling. The design emphasizes modularity, minimal maintenance, and the use of robust materials such as stainless steel, composites, or reinforced panels.

For electrical integration, the system features independent power cabinets and inverters for each hatch cover, allowing flexible operation during cargo activities. The connection to the ship's power grid is designed to leverage existing infrastructure where possible, reducing installation complexity and costs. Special attention is given to selecting appropriate connectors and inverters capable of withstanding the maritime environment. The report concludes that extensive testing and collaboration with equipment suppliers are essential for finalizing materials, mounting methods, and electrical solutions to ensure the effectiveness, safety, and profitability of the solar retrofit.

1.7 Data Management System (D1.7)

The deliverable D1.7 "Data Management System (DMS) describes how WHISPER's onboard data infrastructure will be built to quantify the impact of wind and solar assisted technologies on ship energy use, fuel consumption, and emissions. The DMS is designed to collect, standardize, and manage heterogeneous data from

the vessel's Power Management System (or closest equivalents such as generators/aux engines) and from the partner technologies installed onboard: Sidewind turbine (SW), OceanWings® and Solbian PV (SOL), plus navigation and other ship sensors. Its key outcomes are route and operating mode traceability, linking operating conditions to power production, and monitoring power consumption and energy savings through project KPIs and dashboards.

For the ANT's vessel (Bulk carrier), engine and electrical data are acquired via a WE500 Terasaki unit (estimated ~20 MB/day). Navigation and bridge data may come from a JRC VDR, whose raw output can be very large (~16 GB/day) and therefore requires selective retention and further integration testing due to conversion constraints. For the Samskip's (container vessel) vessel navigation data can be sourced from TIMEZERO which is already installed on board. Eefting Energy will provide engine/shaft generator information. Solar and wind inverter data will be retrieved using Modbus RTU (e.g., Huawei SmartLogger/SUN2000).

The collected data is stored on local servers onboard the carriers for up to six months. For long-term storage, it is transferred to a centralized cloud-based server. A key output of the DMS is an online dashboard that enables users to visualize key performance indicators (KPIs), compare vessels, and analyze trends over time.



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