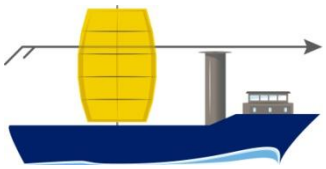
Challenging wind and waves

Linking hydrodynamic research to the maritime industry

Transparent performance prediction and compliance with regulations

Wind-Assisted Ship Propulsion
Proposal for Joint Industry Project



Background

For some years now there has been a resurgence of research on wind-assisted propulsion for ships. This is not the first time. Ever since the diesel engine and propeller have dominated ship propulsion, there has been research on wind propulsion, notably at the time of the oil crisis in the 1980s. Then it did not lead to a major uptake of wind propulsion. Now again various research and development projects are underway, such as the WASP Ecoliner (Figure 1). There are several wind-assisted ships, such as the E-Ship and Estraden (Figure 2) and retrofits have been announced of vessels, such as Viking Grace, Fehn Pollux and a Maersk Tanker. Research is now continuing even though oil prices are low. Also the regulatory framework is increasing pressure to significantly reduce greenhouse gas emissions. A combination of new regulations and higher oil price provide an incentive for the adoption of wind propulsion in shipping, offering potentially large savings on emissions, fuel and cost. Still the uptake is slow.

Figure 1: Example research/development project: The WASP (Ecoliner) design by Dykstra Naval Architects (picture by Dykstra Naval Architects)

The slow uptake of wind propulsion is partially due to marginal profitability and finance options with the present low oil prices and the poor market. However, a recent study by CE Delft [1] on the market potential for wind propulsion found that another major barrier is the shortage of transparent and independently verified information and methods to predict the performance of wind propulsors. Other barriers identified are few examples and custom work to demonstrate compliance with statutory and class rules and regulations.

Figure 2: Example existing installation: Norsepower rotors on Bore's Estraden (picture by Norsepower)

MARIN in cooperation with American Bureau of Shipping (ABS) is proposing a Joint Industry Project (JIP) to investigate and to explore ways of overcoming barriers to the uptake of wind propulsion. To this end, we are pleased to present our proposal for research activities as outlined in this leaflet.

You are cordially invited to participate in this open discussion in the initial stage of developing the JIP. The detailed research proposal will be developed with the potential JIP partners to reflect their research interests and expertise.

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Objectives

The proposed objective for the JIP is to overcome barriers to the uptake of wind-assisted propulsion, and specifically to:

- Improve methods for transparent performance prediction;
- Use the improved methods to provide ship owners/operators with fast low-cost predictions for their fleet;
- Review the regulatory perspective including status of rules and regulations, identify gaps and make recommendations, and provide examples on establishing compliance.

The aim is to cover the majority of all marketed wind-assisted ship propulsors in this pre-competitive project. The project will not get into details of company-specific design solutions.

Potential project partners

Several groups of stakeholders could be identified for this project, including:

- General vendor market, such as providers/developers of wind propulsion systems who would benefit from verifiable and transparent fuel savings predictions. Wind propulsion system providers/developers would be expected to contribute data on their systems because creating sufficient transparency of performance quantification is a general project objective. However, some information may need to remain confidential because of the pre-competitive nature of the project.
- Maritime authorities would benefit from better understanding of the link between fuel and CO_2 saving technologies, and the regulatory framework.
- Independent verifiers could benefit by improving their own methods.
- Ship owners/operators would benefit from transparent and verifiable information on wind propulsion for their fleet.

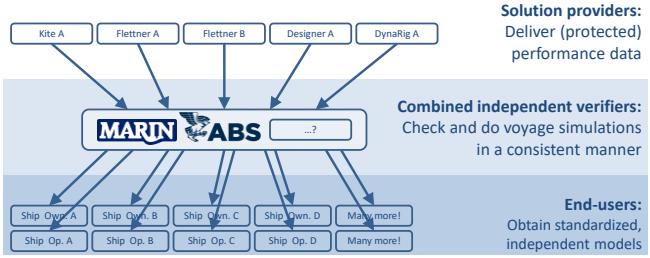

Figure 3: Possible consortium arrangement

Task 1: Improved methods for transparent performance prediction

The main issue to be addressed is the quality, transparency and verifiability of predicting savings in fuel and emissions. Such savings are usually predicted on the basis of calculations, but the assumptions and conditions adopted for these calculations vary wildly amongst publications. As a consequence, reported savings are not necessarily comparable, and it is not always certain whether predictions meet a specified quality standard. Thus, guidance and knowledge are required about the methods and assumptions to be used. The JIP will compare prediction methods to establish the effect on the results obtained and to determine the preferred methods.

The Energy-Efficiency Design Index (EEDI) includes a framework for calculation of CO_2 emissions savings [2], [3]. Essentially, the generated thrust and the required energy (e.g., for Flettner rotor spinning and Turbo Voile aspiration) need to be defined per wind speed and angle. A weighted average is taken of wind angles and speed based on wind distribution worldwide. The result is converted to reduction in CO2 emissions by effectively reducing the required engine.

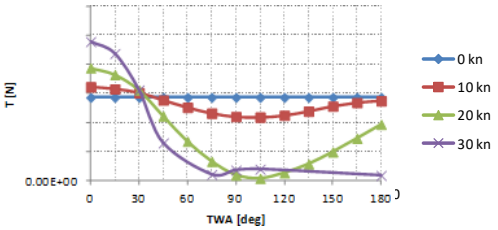

Figure 4: Example of savings on basis of propeller thrust in calm water 4

While the principle is clear, several issues need to be clarified:

- Methods used to determine the wind propulsion force and required energy; whether data from literature are adequate or whether dedicated predictions have to be made using, e.g., scale model tests or CFD; and the level of detail required, e.g., geometry, grids, scale factor;
- Whether the global wind profile is representative of ships using wind-assisted propulsion, and the effect of actual operating routes;
- Constraints that should be taken into account, e.g., the framework does not specify a maximum heel angle not to be exceeded, or the ability to keep course in large seas that go together with high wind velocity;

- The framework does not consider additional losses associated with wind-assisted ship propulsion. Research conducted by MARIN [4[has identified components, such as reduced efficiency of the propulsion installation in part-load, reduced propeller efficiency, and increased hull and rudder resistance due to leeway.

Addressing these issues will contribute to improving the methods to quantify CO_2 reduction in the EEDI framework in a probabilistic sense. In addition, a transparent and validated method is required to assess performance, which is a key driver in owners/operators investment decision-making.

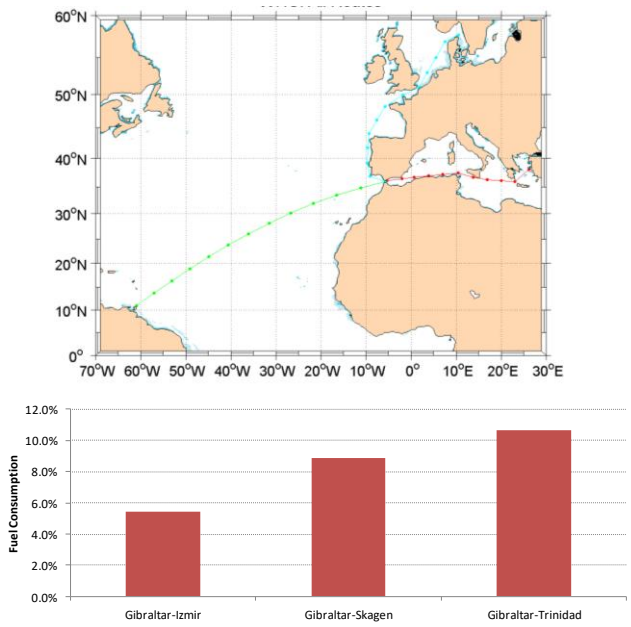

Figure 5: Fuel savings based on hindcast environmental data for specific routes [4]

A task related to optimizing overall propulsion efficiency of some specific wind propulsion systems could be added. For example, for multiple Flettner rotors, the key elements could be identified for improving the rotor control algorithm to maximize overall propulsion efficiency taking into account drift (leeway) effects, minimize drift and rudder losses, and interaction of rotors.

It is proposed to prepare recommended procedures to predict the performance of wind-assisted propulsion, based on previous research. These recommended procedures can be used directly in the JIP or proposed for adoption by, for instance, IMO or ITTC.

Task 2: Transparent performance predictions for ship owners/ operators

Published performance predictions vary in assumptions and methodology used. Hence, information available to ship owners/ operators from various sources is not directly comparable. This JIP aims to provide owners/operators with transparent predictions for their ships, for appropriate wind propulsion technologies based on improved methods, so that they can make their own comparisons of ships and propulsion systems without needing to worry about differences in methodology and assumptions.
To reduce the implementation barrier, obtaining these predictions need to be cost effective.

Task 3: Compliance with statutory and class rules and regulations

Providers/developers of wind propulsion systems have indicated that compliance with statutory and class rules and regulations is a concern. Issues to be addressed include:

- Making sight lines compliant with wind propulsors that are partially blocking the view from the bridge;
- Complying with IMO MSC 137(76) manoeuvring standards that do not state whether these criteria should be met also while using wind-assisted ship propulsion. If so, the required wind angle and speed need to be established;
- Handling the additional heeling moment in terms of the required stability of the vessel;
- Handling the structural integrity and fire safety of the wind propulsion system elements.

In an early development stage, many providers/ developers face uncertainties about compliance, and are not in a position to deal with these issues for a specific design. Hence, there is a need for examples that show how to deal with the most common issues and to provide interpretation of the rules and regulations for wind-assisted ships.

While structural integrity is a ship classification item, bridge visibility, manoeuvring, stability and fire resistance are issues for IMO/Flag. This JIP could provide input to regulatory bodies and have Flag/IMO/IACS validate the findings. The JIP report could become the basis for an IMO Circular or IACS recommendation.

MARIN

Research institute MARIN is a provider of advanced expertise and independent research to the maritime and offshore industry. Using the newest test facilities and simulators and working together with an extensive innovation and research network we achieve our goal of developing cleaner, safer and smarter ships and maritime constructions.

MARIN is involved in wind-assisted ship propulsion in research, collaborative projects and services to clients. Our services and recent work are presented in our leaflet "Performance of Wind Assisted Ships". The most recent research was presented at HIPER 2015 4.

ABS

Founded in 1862, ABS sets the standards for safety and excellence as one of the world's leading ship classification societies. The ABS mission is to serve the public interest as well as the needs of its members and clients by promoting the security of life and property and preserving the natural environment. As classification continues to evolve, ABS assists owners and operators with tackling the most pressing technical, operational and regulatory challenges so the marine and offshore industries can operate with greater levels of safety, security and responsibility.

References

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