Direct Application of Wind Power

Wind Energy
Zero - Emissions
Zero - Cost
Zero - Volatility
Zero - Infrastructure
Zero - Storage

Wind Propulsion Technology
Zero - Development Time
Zero - Compatibility Issues
Zero - Additional Crew
Zero - CAPEX?

Win-Win-Wind Situation

RETROFIT
5-20% propulsive energy & optimised up to 30%

OPTIMISED NEWBUILD
50-80%+ possible with operational changes

Source: MEPC79 INF.21

Decarbonizing the Maritime Sector: Innovative approach to bridging the Global North-South Gap
IMO-UNEP-Norway Innovation Forum  |  28 September 2023
Market Development – 2023+

2030 - EU Report 2016 ‘...market potential for bulk carriers, tankers & container vessels = up to 10,700 installed systems (varied by fuel price, speed, discount rate)

2050 - UK Government Clean Maritime Plan (July 2019), research: 37,000 – 40,000 vessels with wind propulsion systems installed or roughly 40-45% of the global fleet.
Sail Cargo - Development Cycle

Example: Fuel prices (MGO/tn) (Local Currency/Purchasing Power)

- US$900 (Sing)
- US$1,100 (Fiji)
- US$1,800+ (Wallis & Futuna)

Virtuous Cycles

- Reduced reliance on Fossil Fuels & lower alternative fuel requirements
- Transfer fuel costs to salary/service improvements
- Reduce/eliminate need for government route/vessel/fuel subsidies
- Improve resilience – fuel cost/availability fluctuations/disaster response etc

Source: MCST Archive

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Small Vessel & Traditional Sail Developments

Operations: Cargo

Operations: Fisheries

Operations: Cruise

Technology & Networks

Ship Designs

Builds & Retrofits

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Fishing Vessels in Focus

Name: Grand Largue (Avel Vor Technologies)
Size: 16m trawler
Location: Brittany, France
System: Automated soft sail
Description: Two bipods masts, allowing for retrofit. Three self-steering jibs, with operations of winding/unwinding by an hydraulic roller + automation system for controlling sails.
Sea trials: decrease in fuel consumption (wind conditions/route) + decreased rolling consistently.
Work Underway: two generations are using soft sail configurations + rigid wing sails being considered.

Name: Balueiro Segundo (Bound4Blue)
Size: 593 GT, 41m LOA
Location: Spain (Peru)
System: eSAIL® -fixed suction wing system
Description: This 12m rig is installed in the stern, a stubby, non-rotating wing sail with vents and an internal fan generating suction which pulls in the boundary layer around the wing generating an enhanced effect.
Work Underway: Continued monitoring of commercial fishing activities and further development of the system.

Name: SailLine Fishing
Size: Various small test vessel sizes
Location: Scotland, UK
System: Retractable Balpha Mast Soft Sail
Description: A complete foldable mast system for mast lengths up to 8.5m. The stainless steel mast housing would fit directly onto a mast step and the mast is carbon fibre 100 x 70mm. Length up to 8.5m made to suit vessel requirements.
Work Underway: Continued monitoring of commercial fishing activities and further development for scaled versions.
Some Key Considerations Assessing WPT

**Wind-Assist**

- **Size limitation & location – air draft, deck space stowage when retracted, rig interaction**
- **Often operated as a motor vessel – no changes to speed, route, handling etc.**
- **Navigation and other systems may need reconfiguring**
- **Engine calibration to maintain efficiency with variable wind power delivery.**
- **Access to cargo hatches and other deck equipment**
- **Freeboard Interaction**
- **Standard Hull Design**

**Primary Wind & Newbuild Wind-Assist**

- **Integrated design elements – access, stability, ballast, cargo/passenger configurations etc.**
- **Modularisation possible to increase flexibility**
- **Navigation and other systems may need reconfiguring**
- **Optimal rig positioning + hybrid system potential**
- **Potential for energy harvesting when wind energy high**
- **Full integration wind/engines. Hybrid/electric options.**
- **Weather routing for wind and voyage optimisation lead to substantial increased performance**
- **Hull optimised for wind, length/slim design options**

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Rotor sail

Flettner Rotor or Rotor Sails are rotating composite cylinders with a top disc and possibly a bottom disc that are rotated at up to 300 rpm (dependent on size/application) by low power motors and as the wind catches the rig, they use the Magnus effect (difference in air pressure on different sides of a spinning object) to generate thrust. Systems already designed include ones deployed on rail systems, hinged and telescopic versions. The original concept was developed in the 1920’s with a small number of installations, however the modern, upgraded version of these sails were first installed on modern vessels in 2010’s.

Considerations
- Deck space
- Retractability
- Navigation/Line of Sight
- Beam/Head Wind Performance
- Vibration/Motor

Installed Sizes (to date)
1m x 18m – 5m x 35m
Suction wing

Suction Wings (Ventifoil, Turbosail, eSAIL) are stubby, non-rotating wing sails with vents and an internal fan (or other device) that creates suction which pulls in the boundary layer around the wing generating enhanced effect. Installations to date have been deployed on the bow, stern and as deck containers and flatrack.

The system was originally designed and deployed in the 1980’s

Considerations
- Deck space
- Retractability
- Navigation/Line of Sight
- Suction device

Installed Sizes (to date)
- 10m-17m
**Hard sail & Hybrid sail**

Hard or rigid sails are defined by the use of a rigid materials and design and these types of system have been used extensively in the racing world. There are quite a variety of different systems from wing sails, foils and JAMDA style rigs, some with single or multiple foils, others deploying movable flaps and some segmented. Some rig designs have solar panels for added ancillary power generation.

Note: There are also hybrid wing sails developed that have a rigid frame, but flexible soft coverings. Rigid sails were first deployed on modern commercial vessels in the 1970s and 1980’s.

**Considerations**
- Deck space
- Retractability
- Navigation/Line of Sight
- Windage/Stability

**Installed Sizes (to date)**
- 2m x 9m -15m x 35m
New robust materials & production techniques are lengthening their usability/lifespan and automated furling systems and control systems reduce the need for additional crew for large installations (smaller rigs can still be handled manually). Commercial applications require masts to be either retractable or foldable.

Soft sails come in a wide variety of configurations and these include both traditional sail rigs and new designs such as the dynarig system. Many of these systems are well-tested and their use has been extensive throughout the world both commercially and more prevalently in leisure sailing recently.

Considerations
- Deck space
- Retractability
- Navigation/Line of Sight
- Windage/Stability
- Material longevity

Sizes
- highly variable/flexible
Kite

Kites are deployed at over 200m above the vessel with a tether attached to the bow of the vessel to assist with propulsion. The kites take advantage of constant winds at those high elevations and can either be passive (maintain a single position) or dynamic (controlled deployment in a figure of eight or other configuration to maximise thrust). Kites are primarily generating thrust however the tether could also be used to generate electrical energy. First generation towing kites were first deployed in the 2010’s.

Considerations

- Wind Resources/Direction
- Deployment/Retrieval
- Control systems
- Material longevity

Sizes
(deployed/designed)
500m² – 1000m²
**Turbine**
Turbines using marine adapted wind turbines to either generate electrical energy or a combination of electrical energy and thrust. Turbine systems are being designed that are both vertical and horizontal configurations.

**Considerations**
- Wind Resources/Direction
- Mountings/Forces
- Vibration/Stability
- Material longevity

**Sizes**
- Containerised or Free Standing

**Hull Form**
Hull Form designs take the whole of the vessel and adapt the ship's hull itself so that it functions as a large 'sail', capturing the power of the wind to generate thrust. Applicable primarily to newbuilds.