NORSEPOWER

Norsepower Rotor Sail™
Saving fuel – and the planet

For bulkers, tankers, RoRos, ferries,
LNG carriers, RoPaxes, passenger ships
and peace of mind

Bringing sails back to shipping

→ More information at norsepower.com

CERTIFIED ISO 9001 · ISO 14001 ISO 45001 UKAS MANAGEMENT SYSTEMS 001

Norsepower Rotor Sails™ save fuel, cut emissions, help with compliance – and make your crew smile

Harness the winds of the future – right now

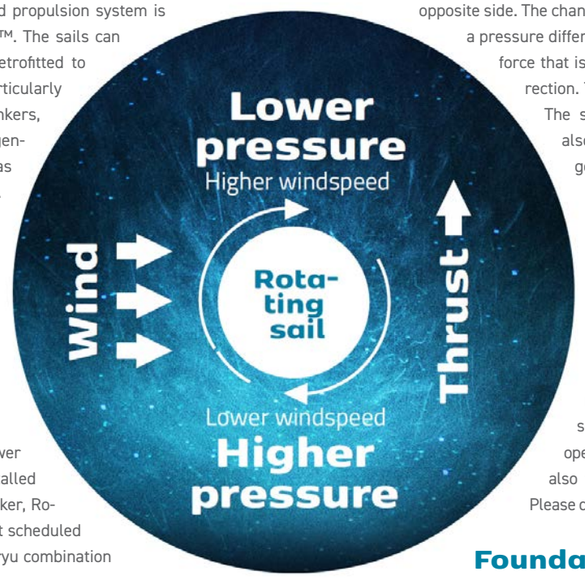
The solution uses a minimal amount of the ship's electric power to rotate the cylinders on the ship's deck. These rotating cylinders use the wind to generate powerful thrust. This allows the main propulsion to be throttled back. The whole auxiliary wind propulsion system is called the Norsepower Rotor Sails™. The sails can be installed on newbuildings or retrofitted to existing ships. The solution is particularly suited to vessel types such as tankers, LNG carriers, Ro-Ros, RoPaxes, general cargo ships, bulk carriers, as well as cruise ships and ferries. It is easy to use, fully automated – and makes the crew happy.

References that make us proud –and the planet cleaner

As of March 2023, 16 Norsepower Rotor Sails™ have already been installed on eight ships including tanker, bulker, Ro-Ro and passenger vessels. The next scheduled installation will be onboard MV Koryu combination carrier, owned by Nippon Marine.

The magic of advanced physics

Norsepower Rotor Sail™ technology is based on a physical phenomenon called the Magnus effect. When wind meets the spinning cylinder, the airflow accelerates on one side of the cylinder and decelerates on the opposite side. The change in the speed of air flow results in a pressure difference, which creates a considerable force that is perpendicular to the wind flow direction. The force pushes the ship forward. The same Magnus effect principle can also be observed e.g. in curve balls in golf, tennis or football.



How many sails is enough?

On a global scale our plan is to sell thousands of Norsepower Rotor Sails™. The recommended number and size on a particular vessel depends on the size, speed, and operating profile of the vessel – and also the wind conditions on the route. Please don't hesitate to contact us for details!

Make the energy efficiency regulations your friend

By improving the energy efficiency of the ship, the Norsepower Rotor Sails™ support the compliance with both, the operational (CII), and the technical (EEDI/EEXI) energy efficiency regulation. The expected index improvement depends on the vessel, the operational profile, and the Norsepower Rotor Sails'™ configuration. Norsepower can provide an indication of the expected compliance improvement upon request.

Years of data & third-party verified savings

Don't just take our word for it, the savings have been verified during extensive measurement and analysis campaigns by third-party companies including SSPA, LR and ABB. The technology is proven to perform according to expectations in varying operating conditions.

Foundations for the greener future

A tilting foundation is available as an option. It allows the Norsepower Rotor Sails™ to be lowered to a horizontal position when reduced height (air draft) is required. The Norsepower Rotor Sails™ are mounted on vessel-tailored foundations. The foundations can be integrated to a new build hull or installed during a yard stay as a retrofit. When the installation of the foundations has been completed, the Norsepower Rotor Sails™ can be lifted on the vessel and att ached to the foundations during a regular port call. Easy, fast, robust and high-quality installations await!

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Fully automated, self-optimising control

An integral part of the Norsepower Rotor Sail™ solution is the Norsepower Control™ automation system. It gives crew control of Norsepower Rotor Sail™ via the Control Panel on the bridge. With it the crew can choose the desired operating mode. In automatic mode the system monitors the wind speed and direction, and automatically selects the correct rotational direction and optimal RPM (revolutions per minute) of the rotors to maximise the fuel savings and minimise the emissions of the vessel.

Deliverables & service – this is what you get

Norsepower Rotor Sails™ are available with heights of 18, 24, 28, 30 and 35 metres. The essential parts of the solution are:

- Norsepower Rotor Sails™
- Norsepower Control System™
  - Automated and self-optimizing
- Norsepower Control Panel™
- Electrical power supplies
  - Low-voltage
- Assembly, testing
- Installation, supervision and commissioning

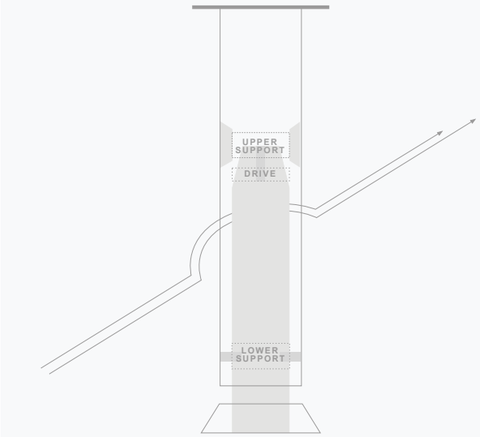
Additionally, Norsepower provides information related to foundation design and manufacturing, cabling, mechanical and electrical installations. We also help you to select the most cost-efficient transportation method.

Norsepower Remote Support Service Agreement™ includes:

- Spare parts
- Remote monitoring with monthly reports
- Remote expert support for possible troubleshooting and corrective maintenance work
- Training for the ship's crew and technical superintendents during the installation and commissioning phase.

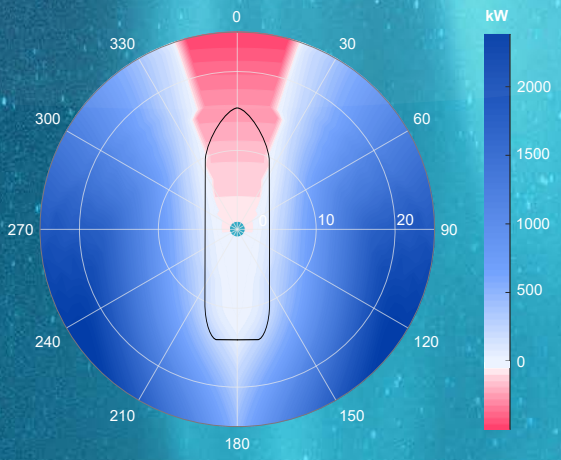
The Norsepower Rotor Sails™ are best suited to vessels with:

- Suitable installation space available on deck
- Operating profile with a high time-at-sea ratio
- Favourable prevailing wind conditions



Technical Specifications

Model	18m X 4m	24m X 4m	28m X 4m	30m X 5m	35m X 5m
Rotor (=visible cylinder part)					
Material	Composite	Composite	Composite	Composite	Composite
Rotor speed [rpm]	0–225	0–225	0–225	0–180	0–180
Rotor Sail assembly weight (no foundation) [tons]	27	30	37	42	63
Foundation & steel tower					
Material	Welded steel	Welded steel	Welded steel	Welded steel	Welded steel
Foundation height (indicative) [m]	2.5	2.5	2.5	3	3
Weight of typical foundation [tons]	12	13	15	17	24
Drive					
Electric motor nominal power [kW]	60	80	100	115	143
Variable speed drive voltage & input frequency [V/Hz]	380-690V, 50/60 Hz	380-690V, 50/60 Hz	380-690V, 50/60 Hz	380-690V, 50/60 Hz	380-690V, 50/60 Hz
Regenerative braking/Brake resistor	Standard / Optional	Standard / Optional	Standard / Optional	Standard / Optional	Standard / Optional
Control system software	NorseControl™	NorseControl™	NorseControl™	NorseControl™	NorseControl™
Remote control and monitoring System	Standard	Standard	Standard	Standard	Standard
Hydraulic tilting mechanism	Optional	Optional	Optional	Optional	Optional
ATEX compliant design	Optional	Optional	Optional	Optional	Optional
Ice prevention	Optional	Optional	Optional	Optional	Optional
Ambient conditions					
Operational temperature [C°] (basic version)	- 20...+50	- 20...+50	- 20...+50	- 20...+50	- 20...+50
Maximum operational wind speed, [m/s]	35	35	35	35	35
Survival wind speed [m/s]	70	70	70	70	70
Maximum continuous thrust force [kN]	175	175	205	300	350



Polar Diagram: 24m x 4m Norsepower Rotor Sail™

Rotor Propulsion Power [kW] &
True Wind [m/s] STW = 19kn, EFF = 0.7

The polar diagram displays the forward thrust produced by the Norsepower Rotor Sail™ in propulsion power equivalent kW's for different true wind angles and true wind speeds for a ship sailing at 19 knots. In this example, propulsion power equivalent of approximately 2000 kW or more of forward thrust is produced when the true wind speed is more than 22 m/s and the true wind angle is 105 – 135 or 225 – 255 degrees from the bow. Correspondingly, more than 500 kW of propulsion power is produced with 10 m/s and 60 – 130 or 230 – 300 degrees from the bow.

At Norsepower we work continuously to develop and further improve our system, so we reserve the right to make changes to the information presented in this brochure without notice.

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