Commercially viable renewable energy solution with wind propulsion technology

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Introduction to Norsepower

- Visit https://www.youtube.com/watch?v=G-fuPbhtTFo to see the video

Company

Background and current status

- Norsepower has brought to market the first proven auxiliary wind propulsion system
- The first Rotor Sail was tested on land during 2014
- The first commercial project with two Rotor Sails was delivered between 2014-2015 to Bore's M/S Estraden
- Viking Line's cruise ferry Viking Grace started Rotor Sail assisted cruises in April, 2018
- Maersk Pelican started Rotor Sail -assisted voyages in August, 2018

Introduction

Auxiliary Wind Propulsion

- Depending on wind conditions up to 50% of service power is replaced with wind propulsion
  → HYBRID system
  - Average savings depend on configuration and on the wind conditions of the route / route area
- Norsepower's technology is well suited to:
  - Tankers
  - Bulk cargo vessels
  - Ro-Ro, Ropax, Ferries, Short Route Ferries
  - Cruise ships
- Compatible with all other ways to save fuel

DELTAMARIN®

Physics:
Magnus -effect

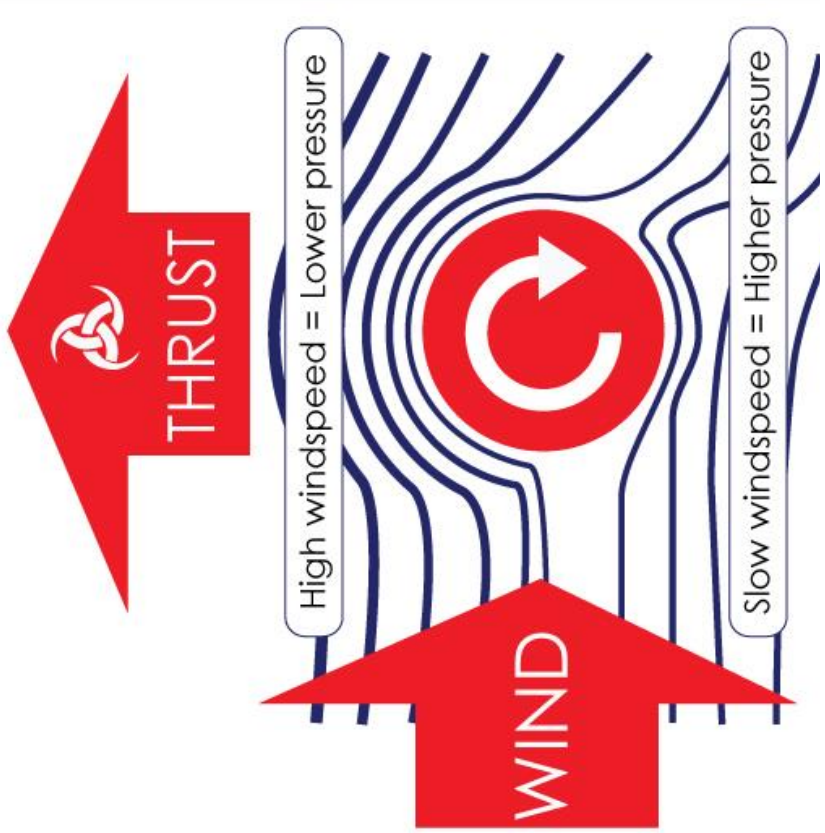
- Visit http://tinyurl.com/nmjyzmo to see the video

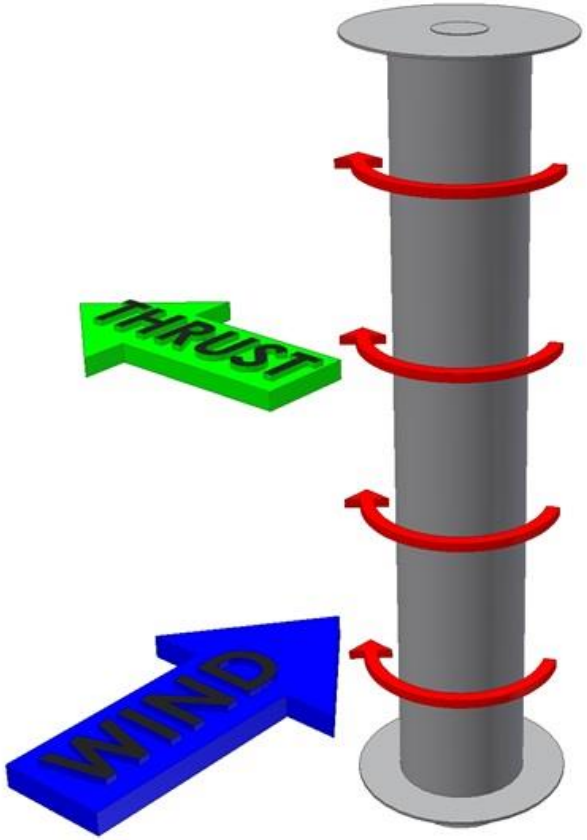
Source: YouTube

Rotor Sail

Physics of the Rotor Sail: Magnus Effect explained

- When wind meets a spinning object, it results in a high and low pressure differential, which creates thrust at a 90 degree angle to the wind
- Flettner (DE) and Savonius (FI) discovered the fundamentals of a "Flettner rotor" in 1920s
- Norsepower has modernised the technology entirely by introducing high tech materials and automated operation





Bore

SPLIETHOFF GROUP

Bore, part of the Spliethoff Group since July 2016

Established in 1921 as a shipbroker.

Worldwide ocean transport

spliethoff

- The Spliethoff Group operates a large and modern fleet of more than 100 vessels ranging from 2,100 to 23,000 tonnes
- The Spliethoff Group is one of the largest shipping companies in the Netherlands
- Head office in Amsterdam

spliethoff

SEVENSTAR YACHT TRANSPORT

wijnne barends

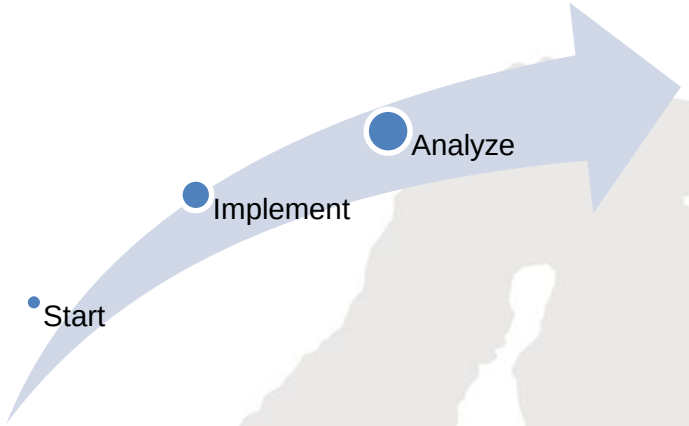
TRANSFENNICA

Bore

BIGLIFT

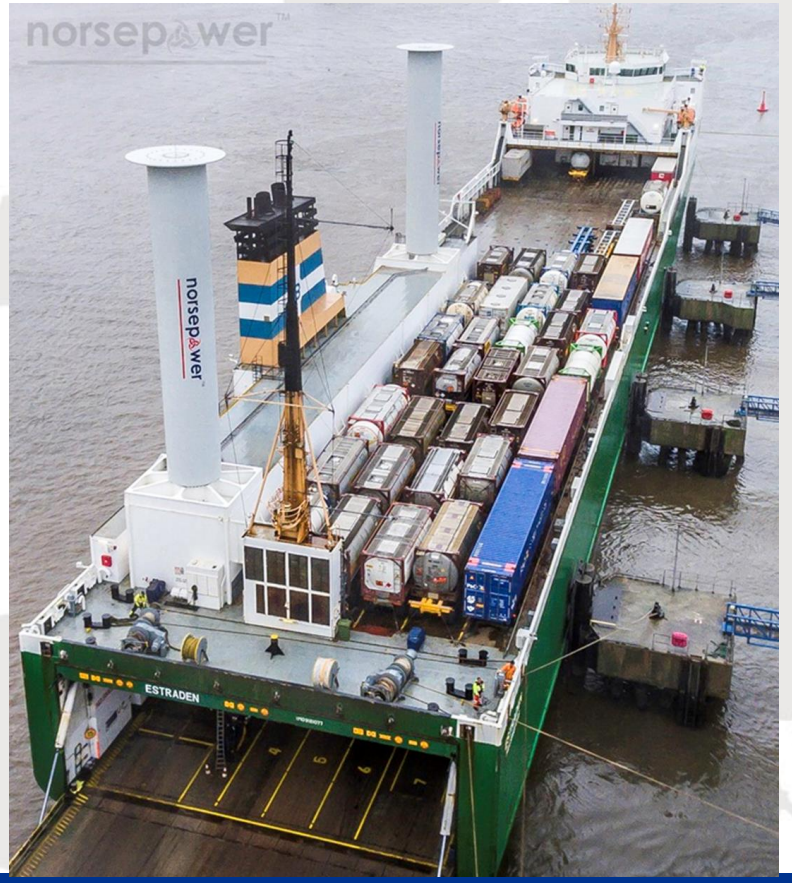
Rotor Sails on board M/S Estraden

Approach



- Project schedule setup
- Identify wind conditions, based on historical data for the sailing area!
- Install systems

  -VFD, NAPA, Rotorsails
- Do reference period 3-6 months
- Do trial period 6-8 months
- Perform analysis of the fuel savings



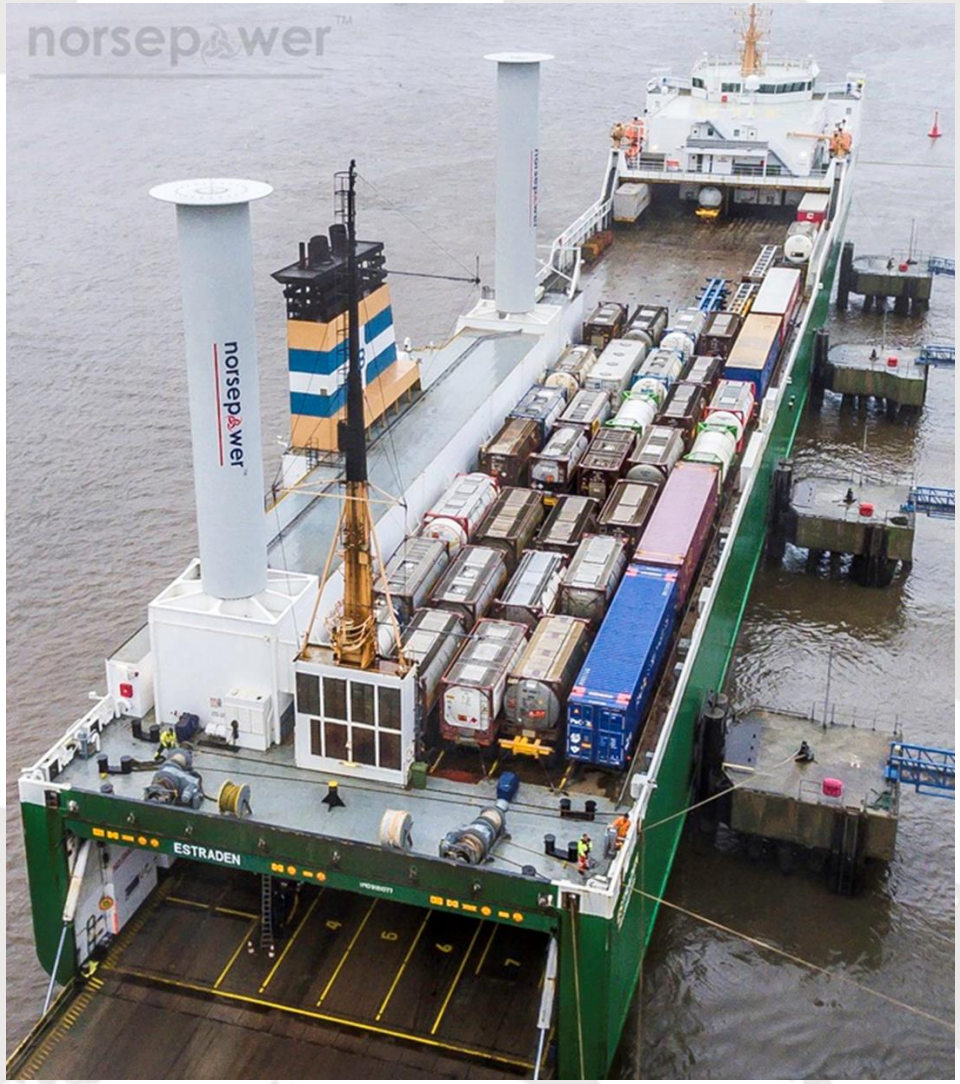
Experiences from M/S Estraden

Technical performance

- Thrust performance as expected
- System availability exceeds 98%
- Noise and vibrations remain at low levels
- The automation system works as intended
- Less input power than calculated. Abt. 7%.

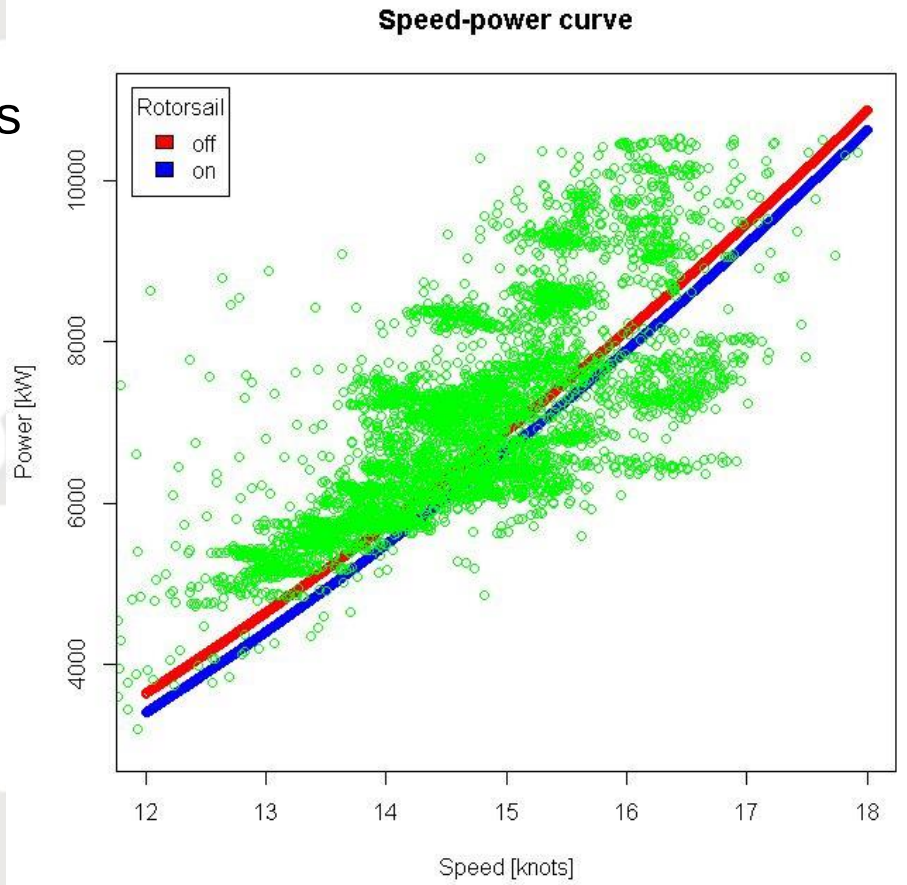
Operator experiences

- The rotor has a stabilising effect on the roll motion of the vessel
- No recognisable effect on rudder angles or leeway
- The system is easy to operate and the crew is able to use it after minimal training



Fuel saving results

- Independent research body (NAPA Oy from Finland) has measured fuel consumption and propulsion power requirements in different conditions
- Regression analysis shows, that during the analysis period the Rotor Sail has reduced the propulsion power consumption significantly
- While using two Rotor Sails, the **net fuel consumption during trail period was reduced in average by 6,1%, equalling 400 t of fuel and 1200 t of CO_2**
- **During the years, a net fuel saving of abt. 5 % has been observed**
- **Payback period: <4 years (MGO, 650 USD/t)**



Project pipeline

Recent and next projects

Viking Grace

- One 24 x 4 Rotor Sail was installed as a retrofit onboard the Viking Line's Viking Grace in April 2018
- The installation of foundation and cabling work were done during a docking in the beginning of 2018

Maersk P-class tanker

- Two 30 x 5 Rotor Sails were installed in August 2018 as a retrofit on a Maersk P-class oil products tanker
- The combined projected average fuel savings on typical global shipping routes are expected to be around 10%.
- Norsepower estimates that up to 20% average fuel savings are possible on routes with favourable wind conditions

Viking Line newbuilding

- Viking Line has placed an order for one 2800 passenger cruise ferry newbuilding with Xiamen Shipbuilding Industry Co. Ltd.
- Norsepower has an order from Xiamen Shipbuilding Industry for delivery of two 24 m high Rotor Sails
- Operation is planned to start in 2021

MISSION

To reduce the environmental impact of shipping by providing efficient, easy to use and reliable auxiliary wind propulsion for ships.

VISION

To maintain the market leader position in a growing market for auxiliary wind propulsion systems for large ships.

norsepower™

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