

norsepowerTM

Technology presentation and Experiences from Horizon2020

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Tuomas Riski, CEO





Part 1: Company presentation



Introduction to Norsepower

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



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 in 2014-2015 to Bore's M/S Estraden
- The results from M/S Estraden have confirmed the expected performance of the Rotor Sail Solution. Average fuel savings exceed 6% on the route between Rotterdam and Teesport (UK)
- Next delivery projects are ongoing



Auxiliary Wind Propulsion

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

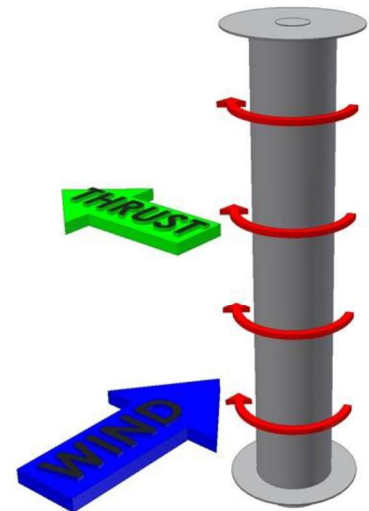
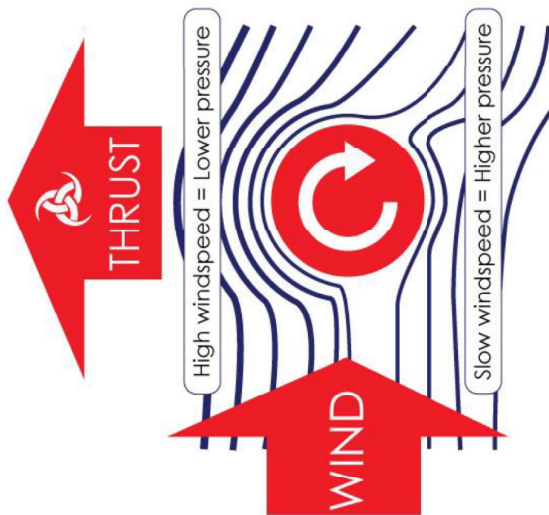


Physics: Magnus Effect (1/2)

- Visit <http://tinyurl.com/nmjyymo> to see the video
- Start from 00:20
- Jump from 00:35 to 00:55

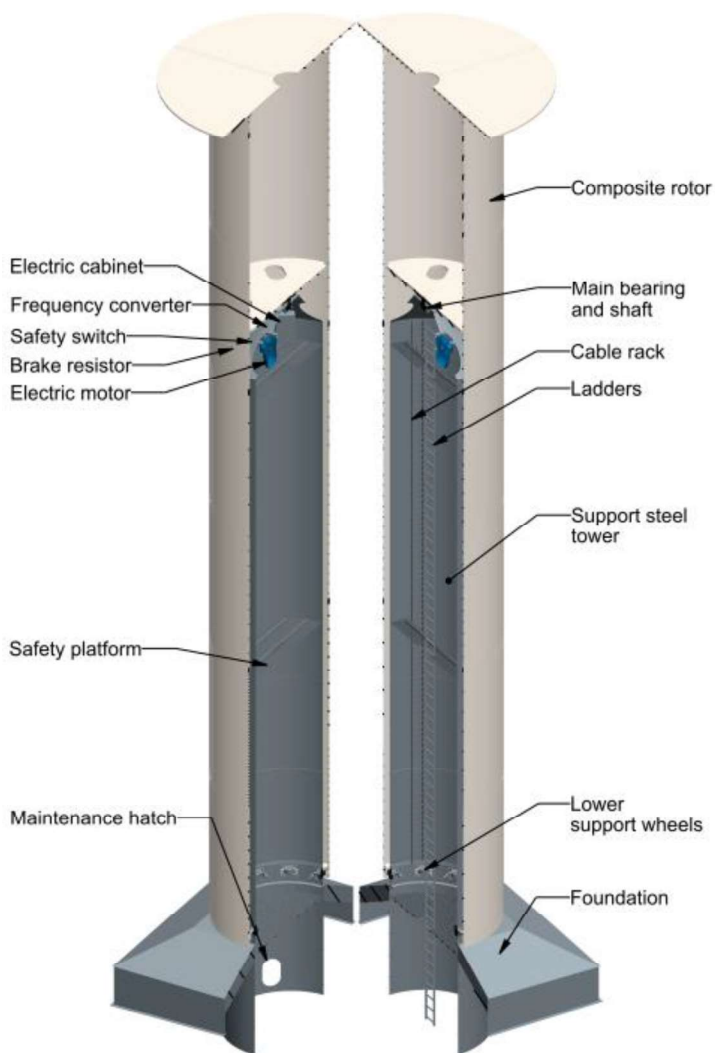


Physics: Magnus Effect (2/2)



- When wind meets a spinning object, a high and low pressure differential is created, creating thrust at 90 degree angle to the wind
- Flettner (DE) and Savonius (FI) discovered the fundamentals of a “Flettner rotor” in 1920s
- Norsepower has modernized the technology entirely by introducing high tech materials and automated operation

Norsepower Rotor Sails



- Main components
 - Composite rotor
 - Internal support steel tower
 - Upper support main bearing
 - Motor and drive for rotation
 - Lower support rollers
 - Foundation on ship's deck
- Properties
 - Rotor heights 18m, 24m, 30m
 - Rotor diameters 3m, 4m, 5m
 - Weight 20...45t
 - Revolution speed max. 250rpm
 - Average El. consumption 15...35kW

Rotor Sails on board M/S Estraden



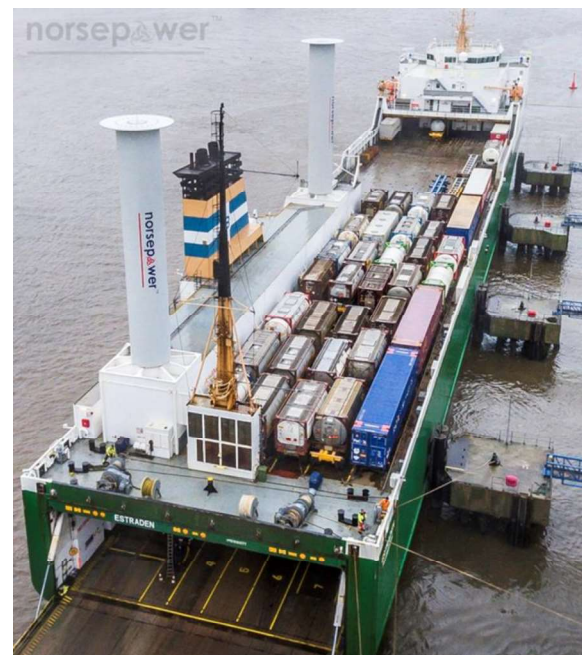
Experiences from M/S Estraden

Technical performance

- Thrust performance as expected
- System availability exceeds 99%
- Noise and vibrations are on low level
- The automation system works as intended

Operator experiences

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



Average annual net savings: **6,1% (400 t of fuel and 1200 t of CO2)**
Payback period: **4 years (MGO, 500 USD/t)**

Most promising route areas for Rotor Sails

- The technology performs best when the average wind speed is high and typical winds are coming from the beam
- Examples of routes and areas with a high savings potential:
 - Northern Pacific crossing
 - Northern Atlantic crossing
 - North Sea and Baltic Sea areas

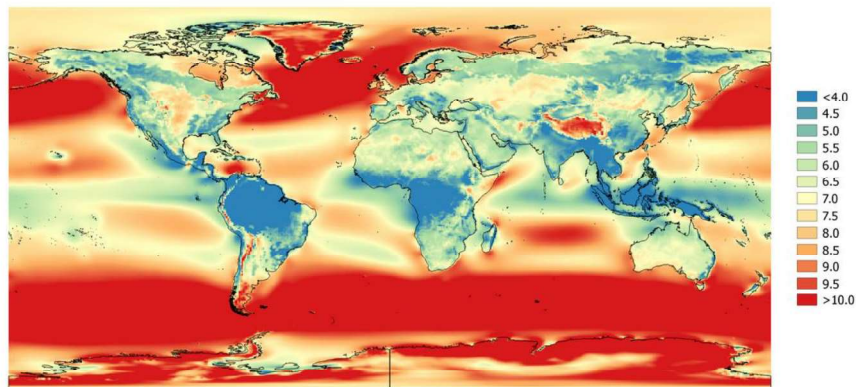


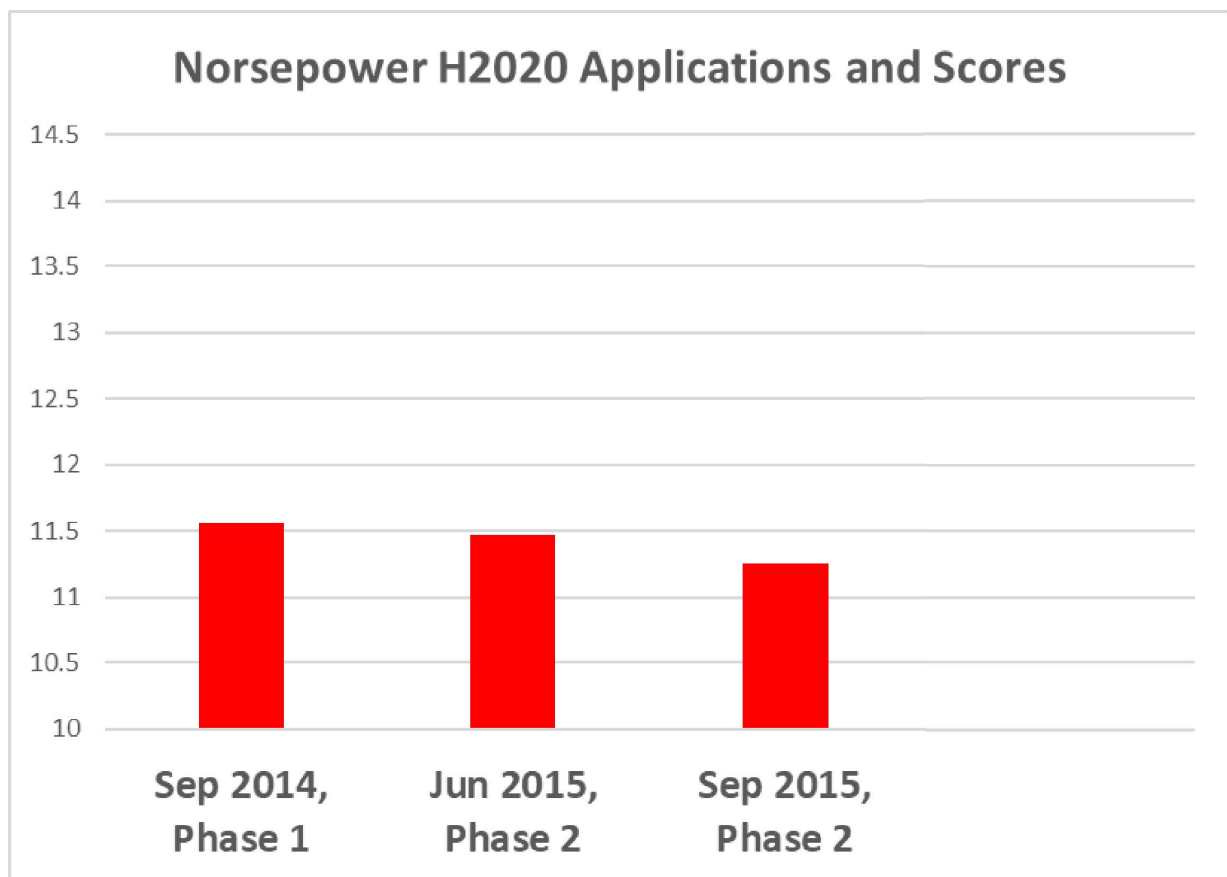
Figure 1
Mean wind speed at 100m from MERRA reanalysis. Period 1979-2013.

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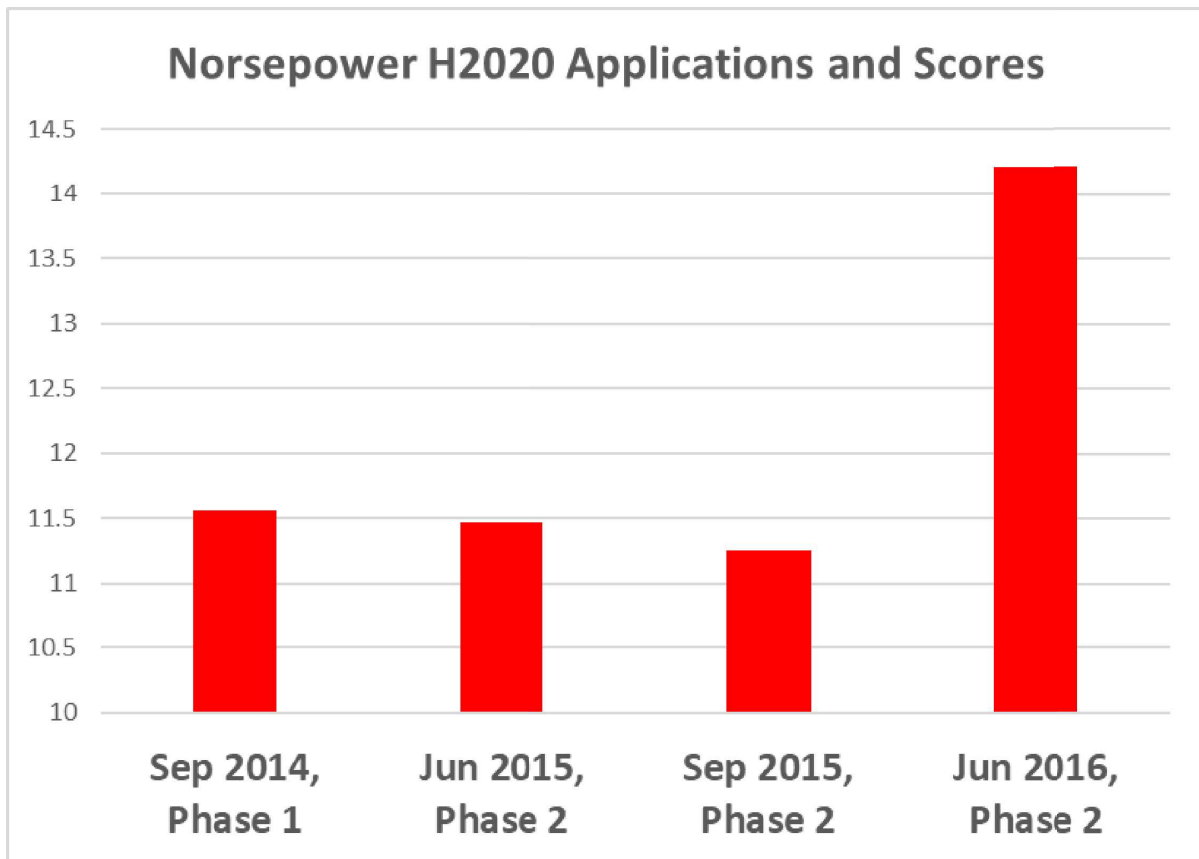
Part 2: Experiences from Horizon2020



Norsepower's Horizon2020 SME instrument: Track record of applications until 2015



Norsepower's Horizon2020 SME instrument: Track record of applications, including 2016



Norsepower's Horizon2020 SME instrument: Remarks of the successful application #4

- The application process was implemented as a project, guided by a consultant from Spinverse Oy
- Norsepower's staff (CEO and CTO) wrote the application
- The consultant commented the application after every iteration round
 - Three (3) iterations were completed overall
- Roughly 70% of the texts of the final application were simply copy-pasted from the latest (rejected) application
- Anyhow the change in score was dramatic!
- The only feasible conclusion is, that the new part (30% of the text) made up 95% of the score!
- Lesson learned: When applying for H2020, details DO matter, and expert consultants know, how and where the crucial details should be presented!

Norsepower's H2020 project: scope

- One 24 x 4 Rotor Sail will be installed as a retrofit onboard the Viking Line's Viking Grace in the spring of 2018
- This is the first time ever when a modern mechanical sail is installed on board a cruise ferry
- The project is a major milestone in the commercialisation of Norsepower's technology



Norsepower's H2020 project: experiences so far

- Getting the Grant Agreement signed required some effort, but the process was properly led by the Commission. The same consultant (Spinverse) supported the process
- Reporting to the Commission takes some time and effort, but at least so far it has not caused any issues to meet the expectations of the Commission (supported by the consultant)
- So far the biggest pain of the H2020 process has been application procedure



Next projects of the Norsepower story

Maersk P-class tanker

- Two 30 x 5 Rotor Sails will be installed in 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 and one option with Xiamen Shipbuilding Industry Co. Ltd.
- Design includes two 24 x 4 Rotor Sails
- Delivery is planned in 2020



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Tuomas Riski

CEO, Partner, Norsepower Oy Ltd

tuomas.riski@norsepower.com

+358 50 330 5732

