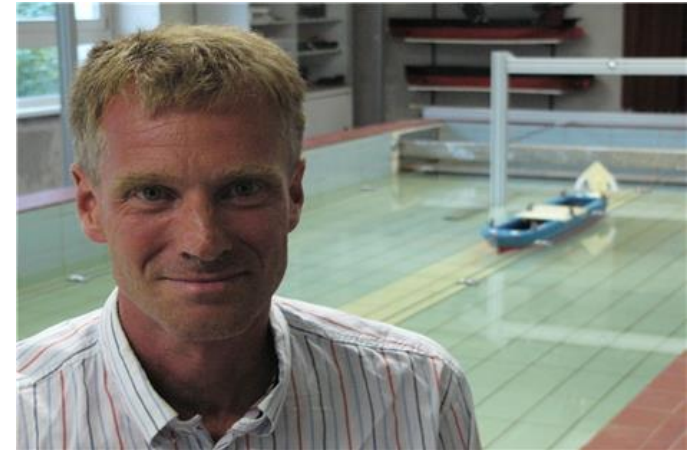


Innovative Sail Technology for Cargo Ships » Wind Hybrid Coaster «

Sustainable Sea Transport
Talanoa, Fiji 2014



Maritime Department Leer

- Founded in 1854 as 'School of Navigation'
- Incorporated in HS-Emden/Leer (University of applied Sciences)
- Maritime region (shipping, shipbuilding)
- About 400 students: Nautical Studies, Ship Management
- Special competence in ship operation research



Maritime Department Leer

- **HS Emden-Leer was/is cooperating in ambitious sail related projects:**
 - **SkySails-Technology (2002-2008)**
 - First trials with full scale ship
 - **E-Ship of Enercon (2007-2010)**
 - First innovative Wind Hybrid Ship
 - **Wind Hybrid Coaster (2011-2015)**
 - Innovations in Flettner Rotor technology, e.g. light weight materials



Overview

- Introduction/FAQ
- **Sail Performance – from Prediction to Reality**
- Concept “E-Ship 1“
- Concept “Wind Hybrid Coaster“
- Outlook



- **How much can you save with Sail Propulsion?**

or

- **How long is the „Pay back Time“ on the investment?**



FAQ + Answers

- **Salesman:**

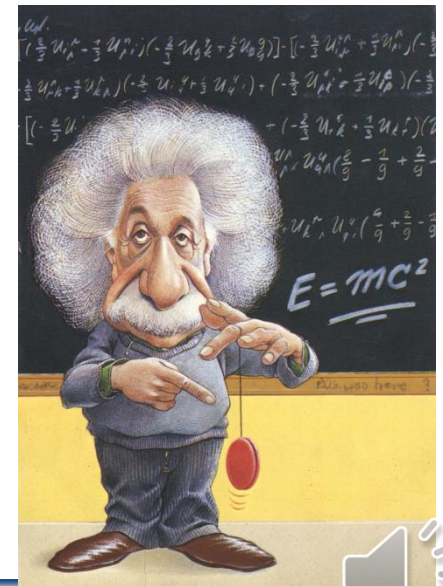
- You can save „up to“ (0 ... 100%) !?



- **Researcher:**

- One can predict savings of approx. ... (% ,€) of ... (reference value) under the following conditions and assumptions:

1. ...
2. ...
- ...
100. ...



Sail Performance: from Prediction to Reality

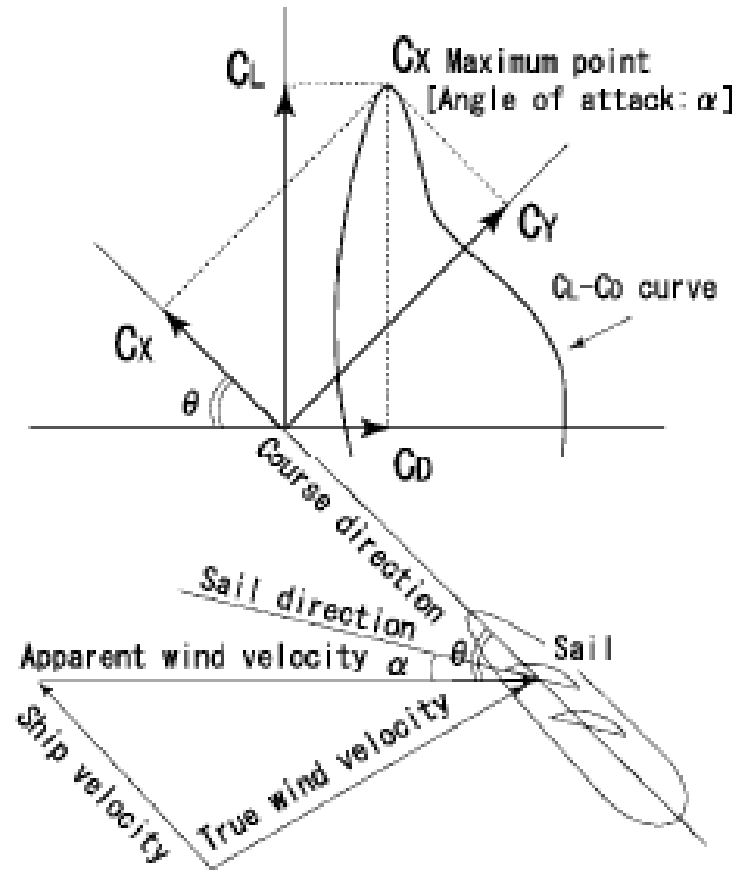
Mathematical Definitions

$$F_{Lift} = \frac{1}{2} * \rho * v^2 * C_L * A_{Sail}$$

$$F_{Drag} = \frac{1}{2} * \rho * v^2 * C_D * A_{Sail}$$

$$F_{Sail(long)} = \frac{1}{2} * \rho * v^2 * C_x * A_{Sail}$$

$$F_{Sail(trans)} = \frac{1}{2} * \rho * v^2 * C_y * A_{Sail}$$



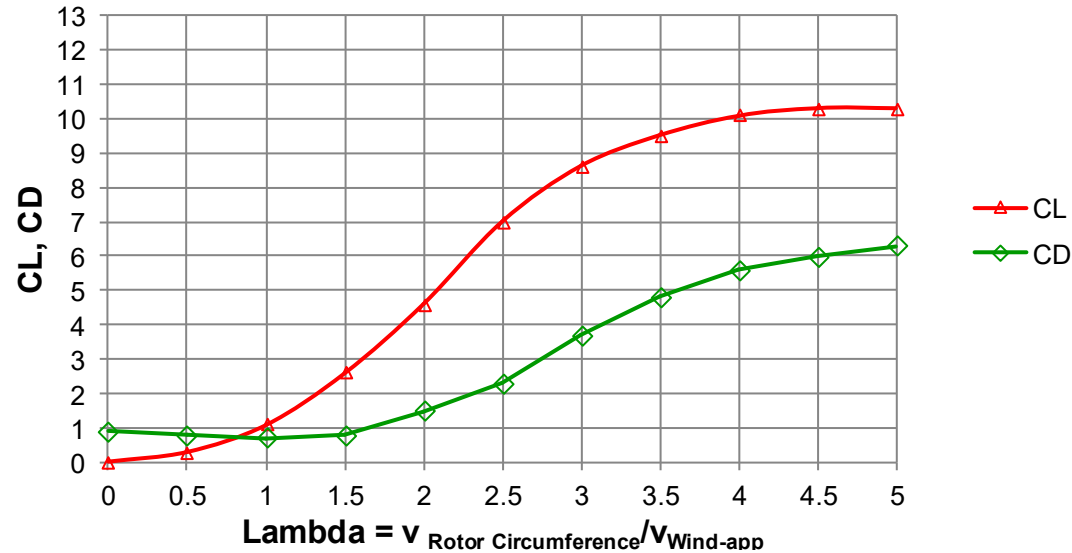
Source: T. Fujiwara



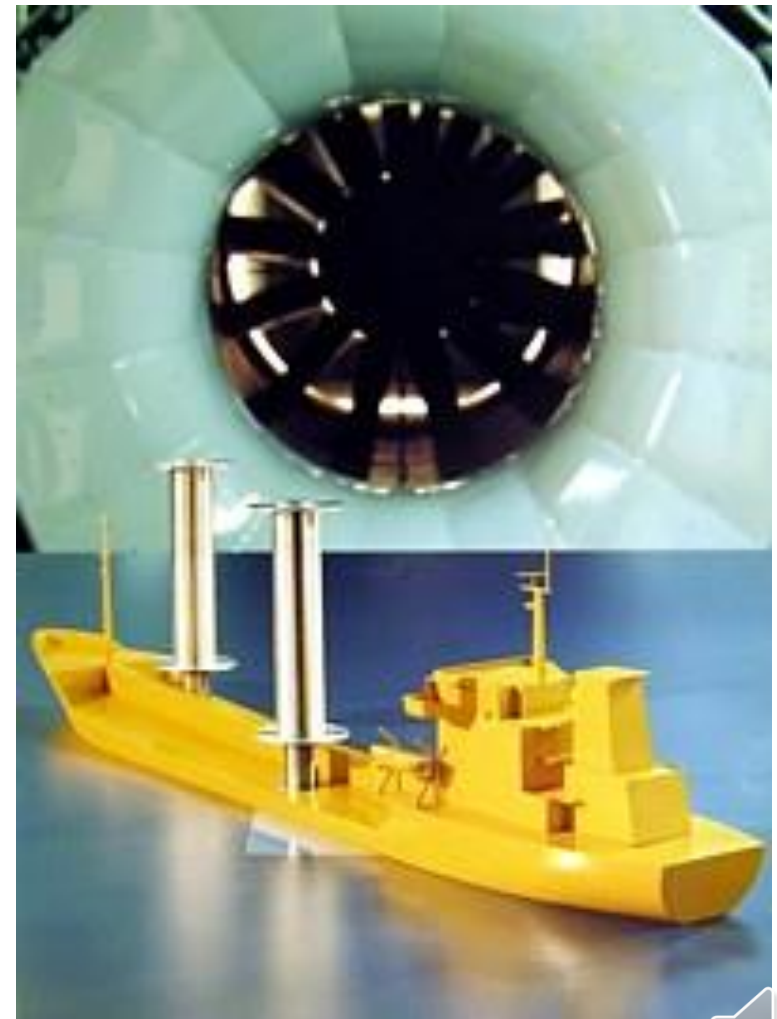
Sail Performance: from Prediction to Reality

Model Tests

CL, CD vs. Lambda

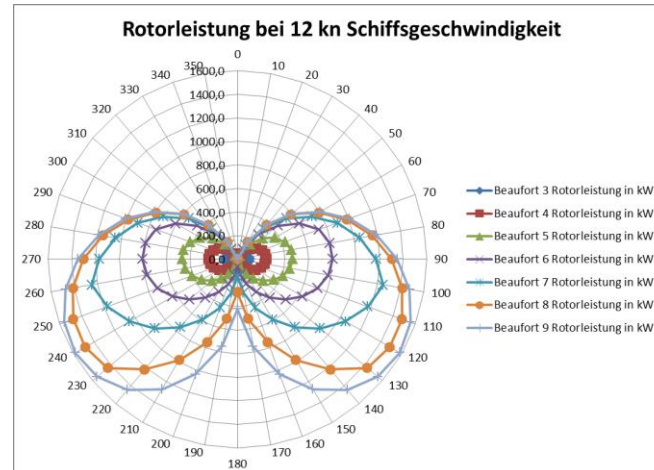


$$F_{Lift} = \frac{1}{2} * \rho * v^2 * CL * A_{Sail}$$

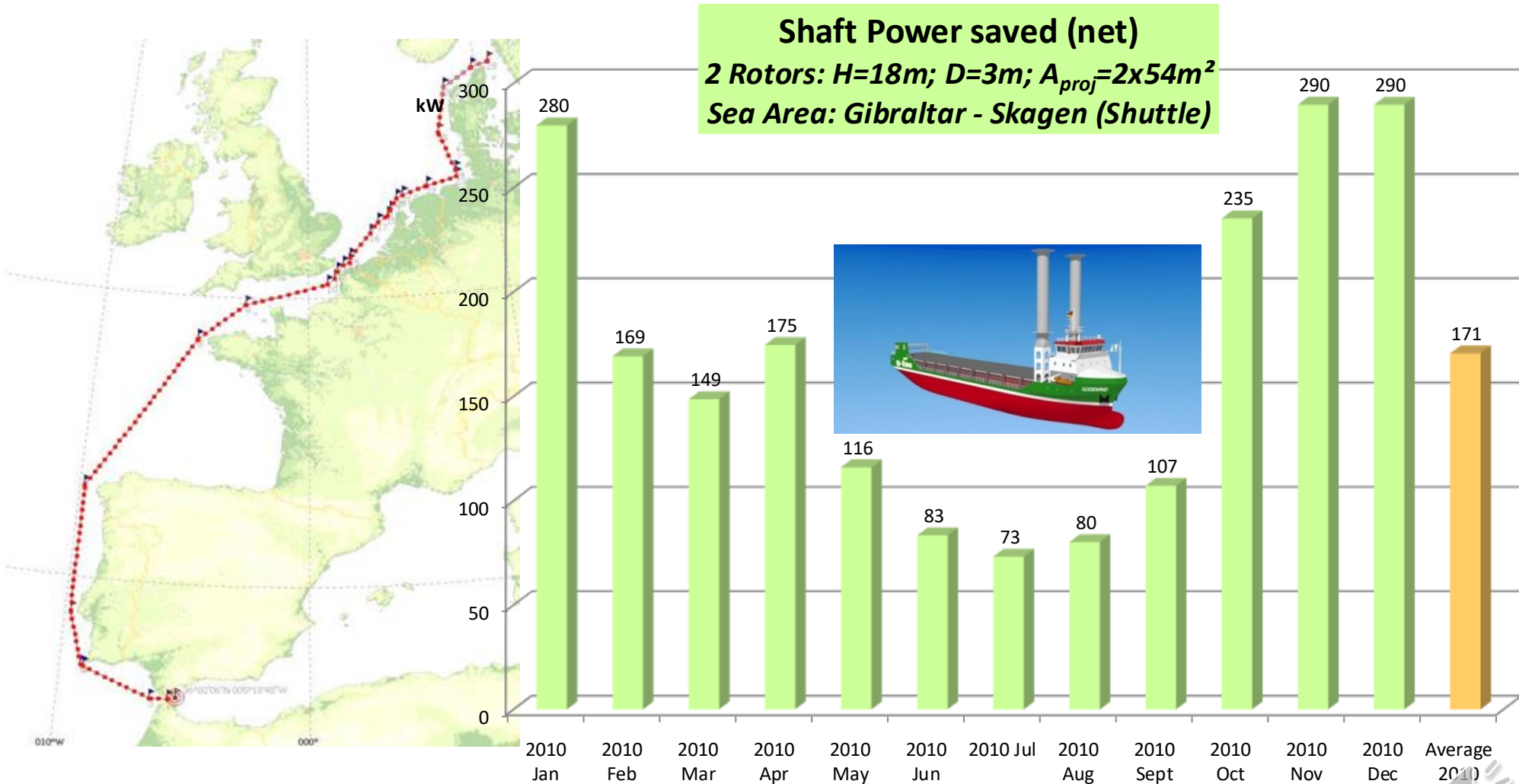


Sail Performance: from Prediction to Reality

- Voyage simulation
 - on basis of wind tunnel data (CL, CD)
 - ship performance model (polar diagram)
 - hourly weather data from routing software SPOS (Meteoconsult) for one year
 - hydrodynamics and propeller effects not included (special investigation by MARIN)



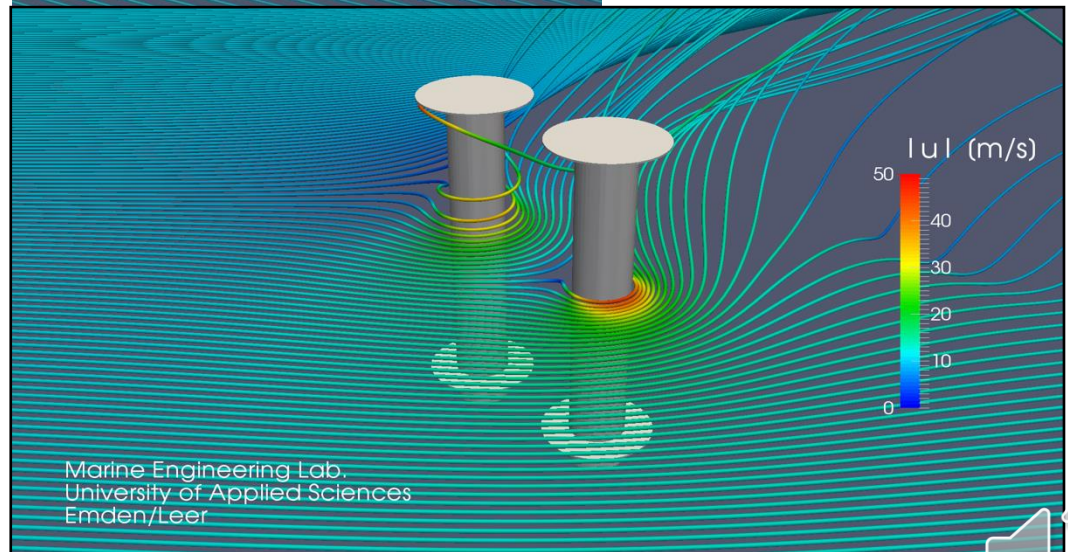
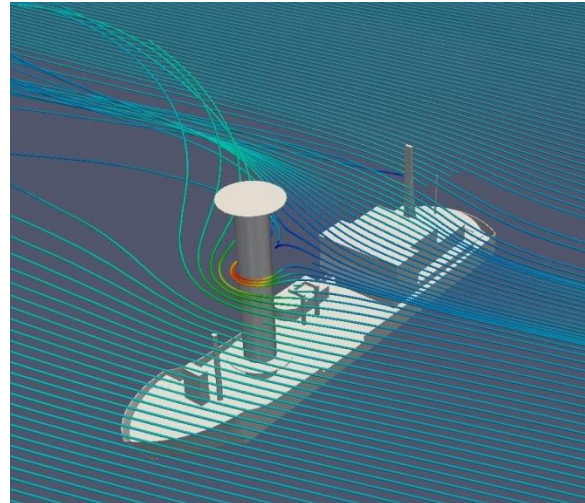
Sail Performance: from Prediction to Reality



Sail Performance: from Prediction to Reality

- Transfer to “full scale” ...
- real flow conditions?
- aerodynamic interaction?
 - rotor – rotor
 - ship – rotor

- analysis methodology: CFD



Concept “Flettner Rotor”

- R&D Project “E-Ship 1”

performed by

Enercon, Aurich/Germany
one of the world’s leading
wind turbine manufacturers

Motto:

“Energy for the World”

supported by HS Emden/Leer



Concept “Flettner Rotor”

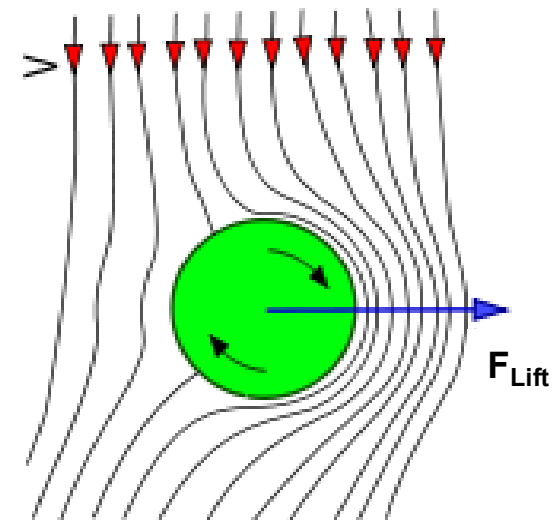
- Objectives:
 - Optimized cargo carrier for the transport of wind turbine plants (own cargo)
 - Reduction of transportation costs
 - Environmental protection
 - “Image”



Concept “Flettner Rotor”

■ Sailing Technology:

- 4 Flettner Rotors (25 m x 4,30 m)
- Functional principle:
“Magnus Effect”



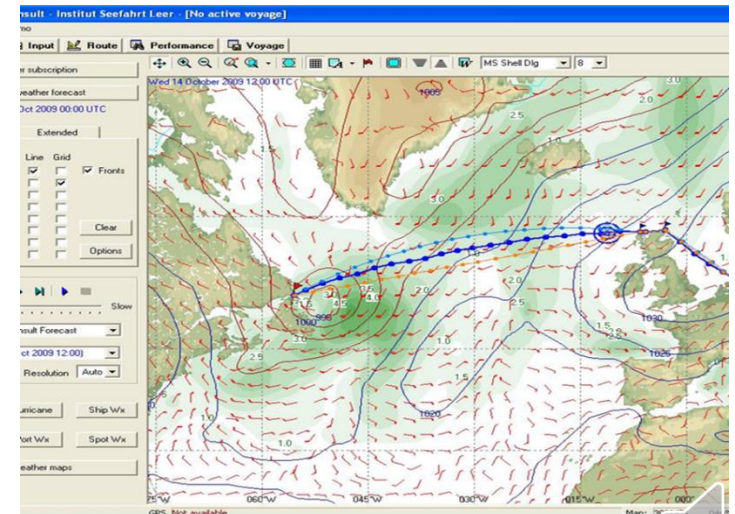
Concept “Flettner Rotor”

- **Historical Background:**
 - The german engineer **Anton Flettner** developed an innovative wind propulsion system in the 1920's – “Flettner Rotors”
 - Flettner had no economical success –The age of “Dieselization” had just started!



Concept “Flettner Rotor”

- **System Advantages:**
 - High performance
 - Safe and fully automated operation
 - no sail handling
 - automatic switch on/off
 - integrated power management and propulsion control (Hybrid-Diesel-Electric)
 - automatic RPM-control
 - ‘routing’ for optimal efficiency (under construction)



Concept “Flettner Rotor”

- First Sea Trials “E-Ship 1” – North Sea 2010



Concept “Flettner Rotor”

- **Evaluation „E-Ship 1“**
- Overall Performance (Enercon, 19.07.2013)
- 3 years of operational experience, over 170 000 miles
 - all measures: 25% savings
- additional potential:
 - optimal routing
 - optimal flow conditions
 - more sail area



Concept “Flettner Rotor”

■ R&D Project “Wind Hybrid Coaster”

- next generation Flettner Rotor ...
- high performance (drive, aerodynamics)
- light weight materials
- suitable for smaller ships
(coast ships)
- efficient manufacturing
- reducing costs
- routing system
- optimized ship



Outlook

- The transformation to a sustainable economy on basis of renewable energy is inevitable – the sooner the better
- (innovative) wind power in shipping is in an early phase – comparable to the beginnings of wind power plants in the 1970's/1980's
- First projects and their results are encouraging and proof the general approach
- More pilot projects are needed to build up competence and to develop efficient technology fulfilling the demands of modern shipping



Outlook

- **What can we do together?**
- university partnership



- common projects (research, student activities)
- global network building with the maritime industry
- develop a common vision to navigate into the future



Outlook

- Thank you!

