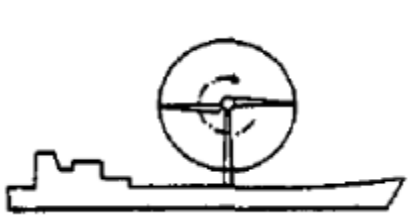
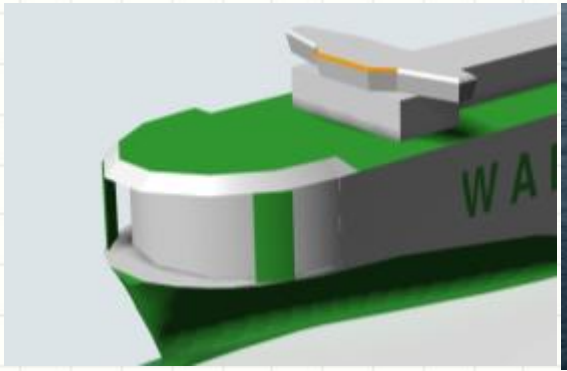


WIND ASSISTED PROPULSION FOR MERCHANT VESSELS

Mårten Silvanius, Naval Architect

April 11, 2013 Helsinki



Agenda

- Background – Why?
- Analysis – How?
  - Conditions in the Baltic Sea
  - Systems
    - Wing sail
    - Flettner rotor
    - Kite
    - Wind turbine
    - Aerodynamics
- Results/Conclusions

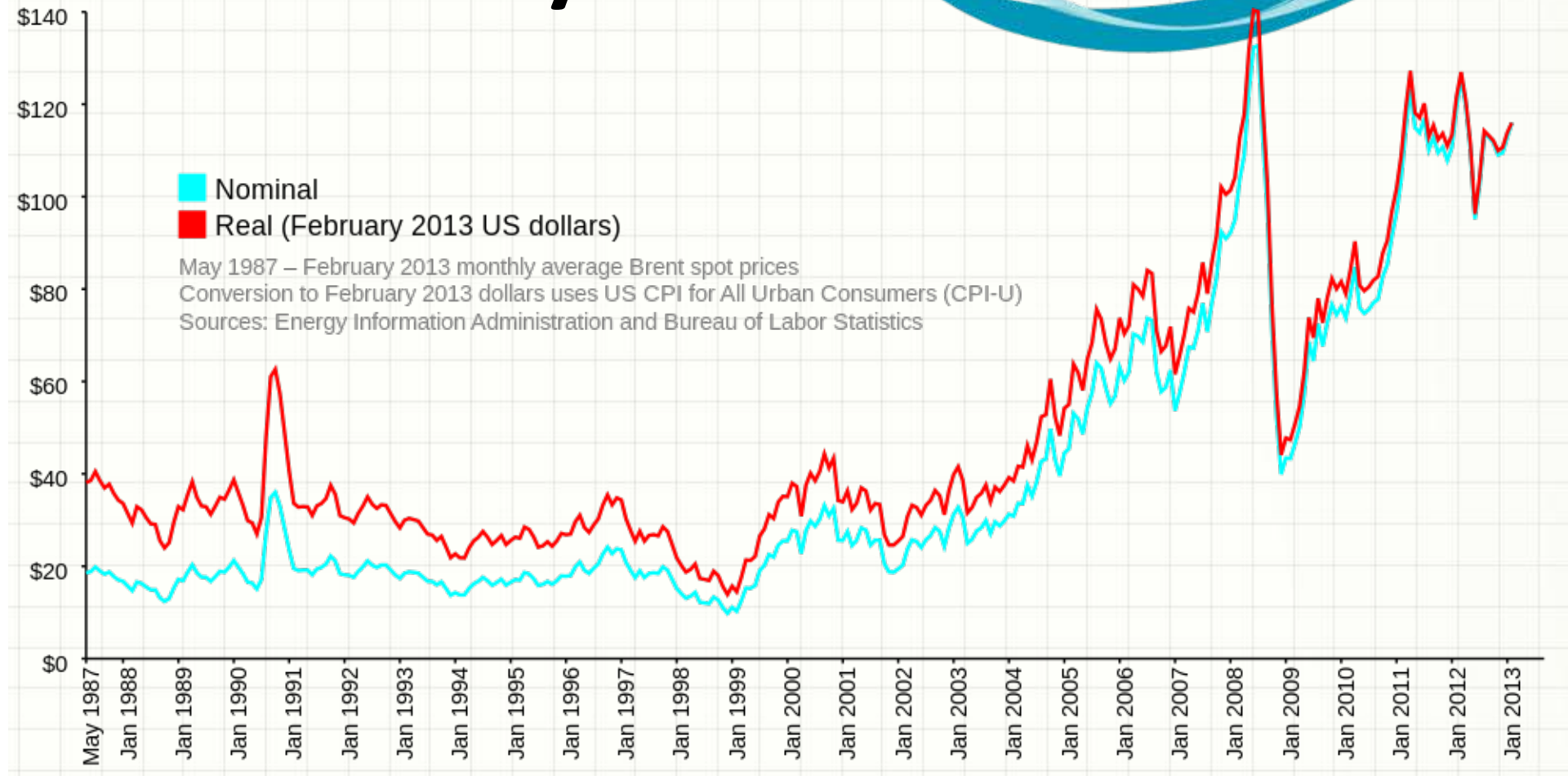
Am I here with the solution or the problem?

Background – Climate changes

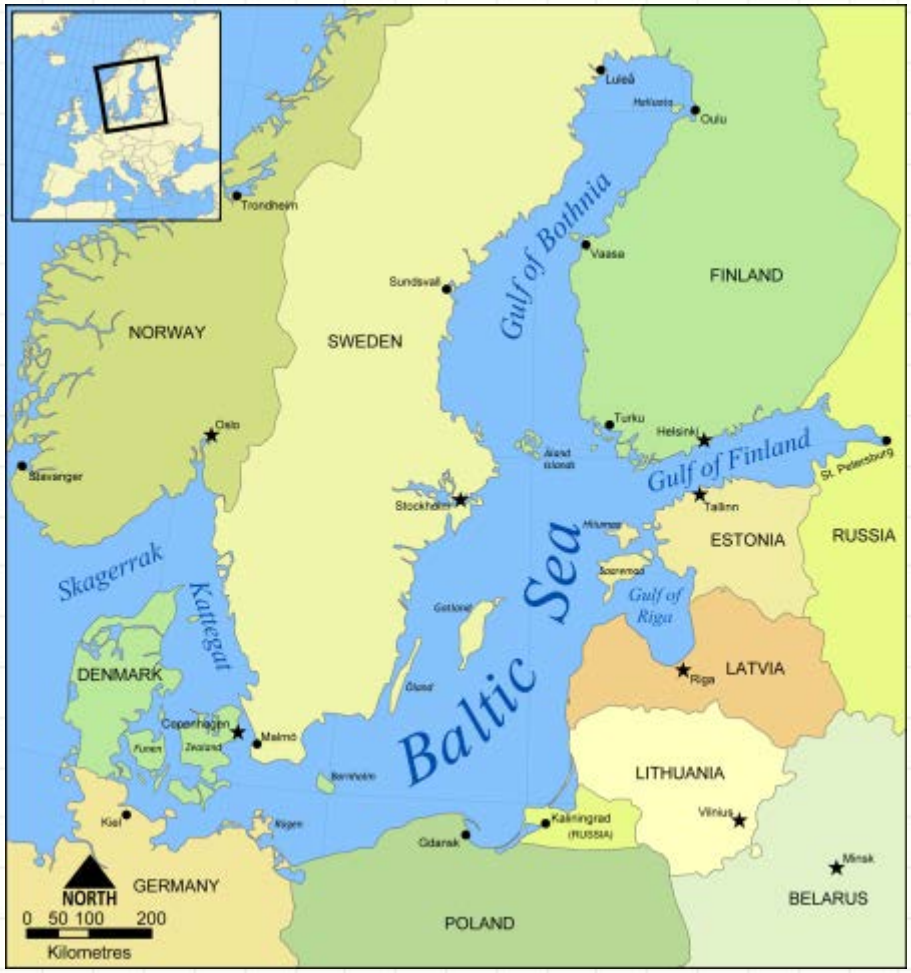
Background – Acidification

Background – Public opinion

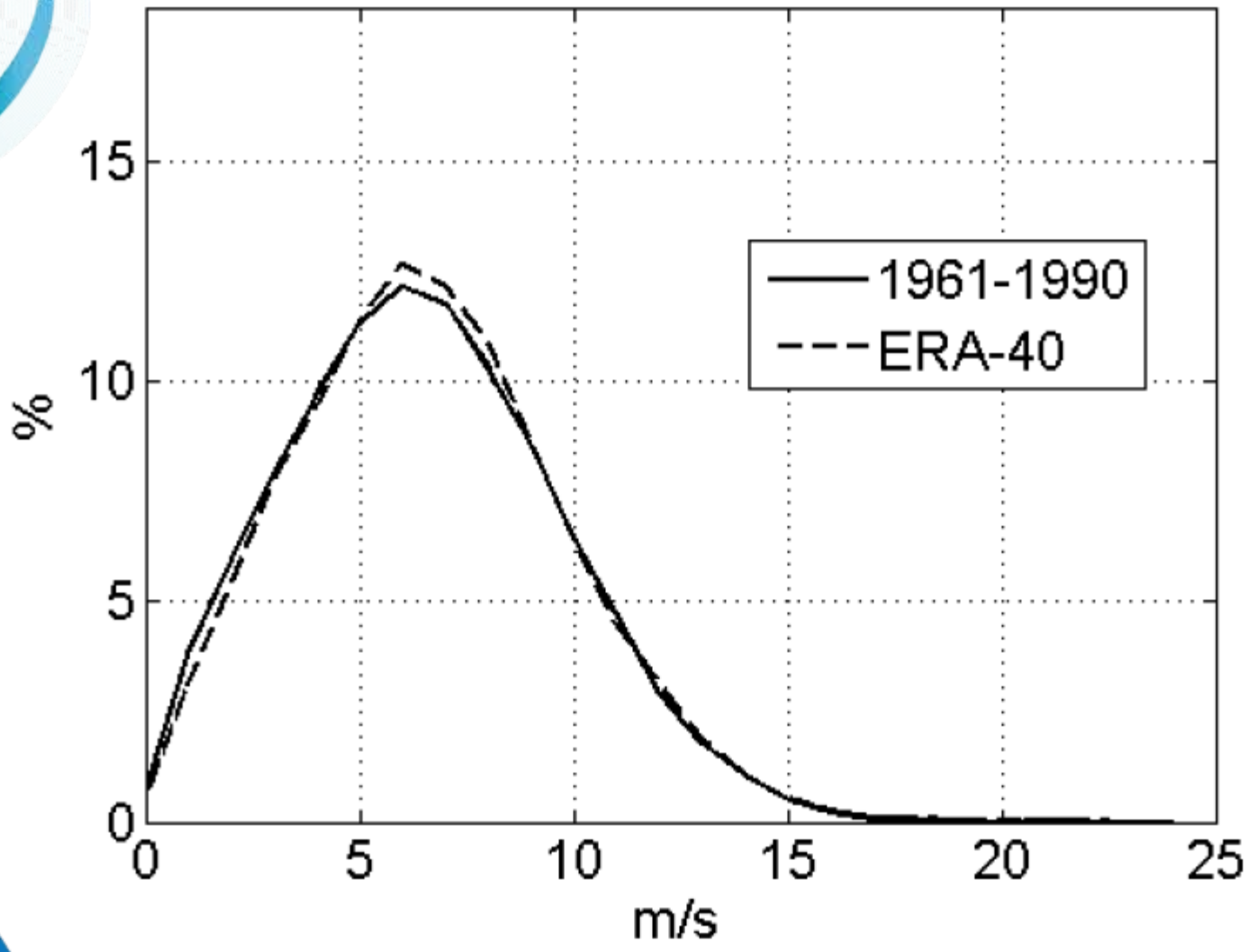
Background – Economy



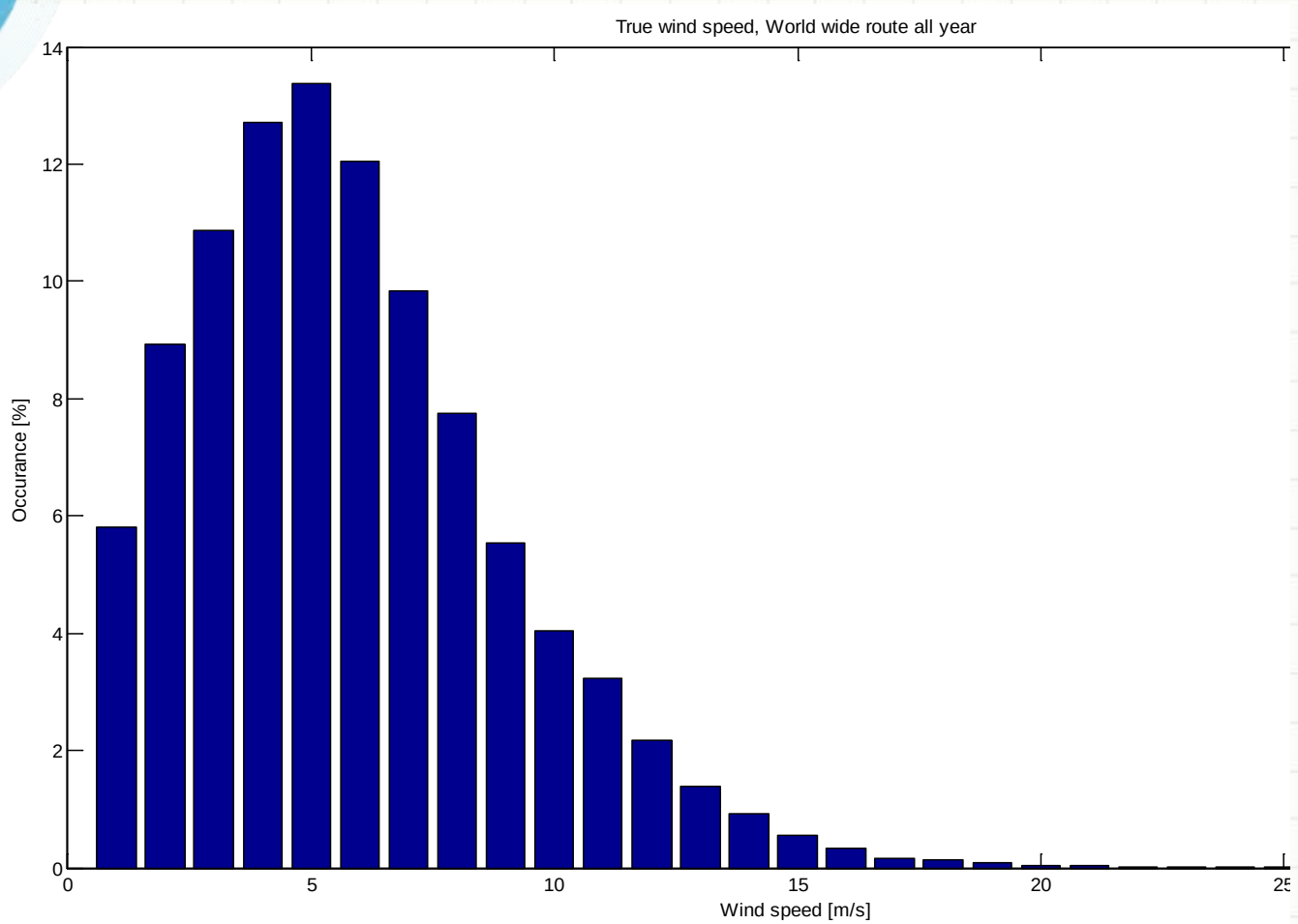
Conditions in the Baltic Sea



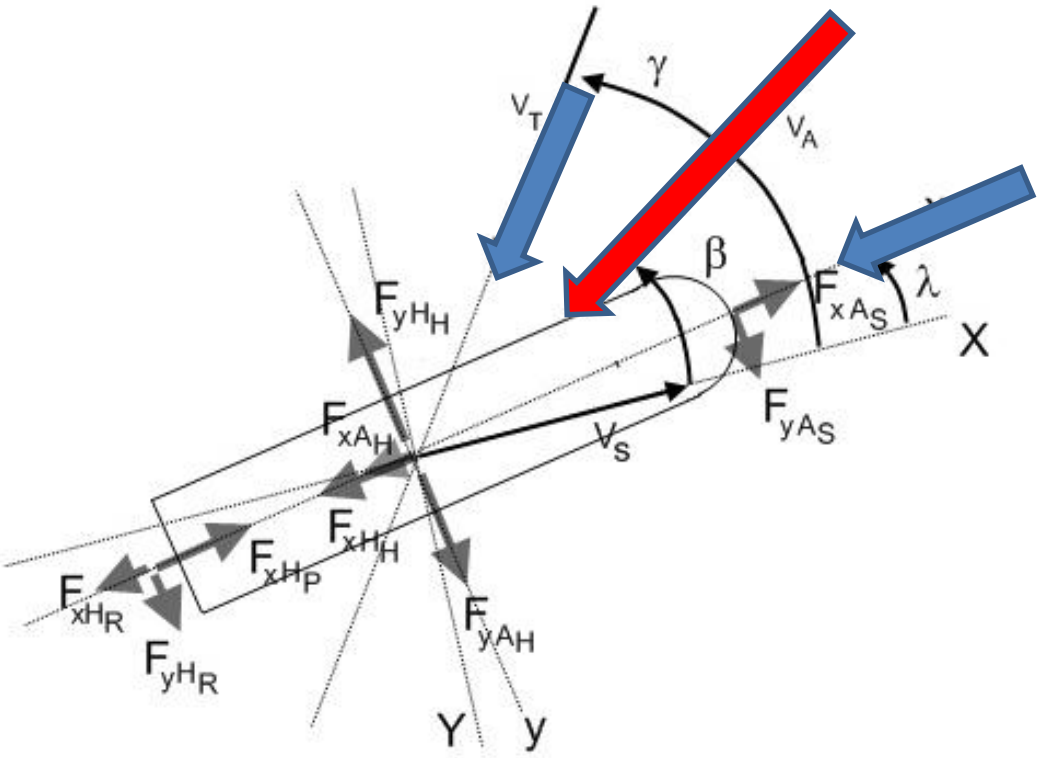
Eastern Gotland basin – True wind speed



World wide route for a PCTC – True wind speed



True / Apparent wind speed and direction



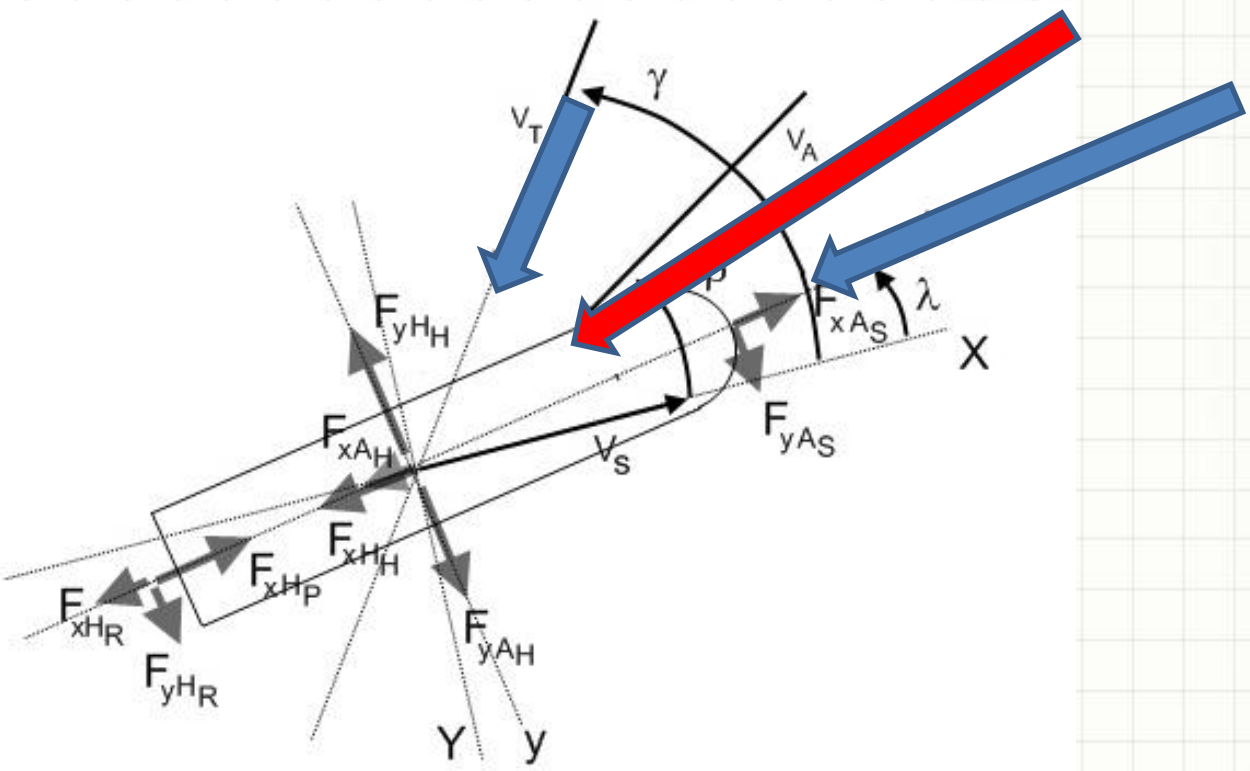
True / Apparent wind speed and direction

True wind

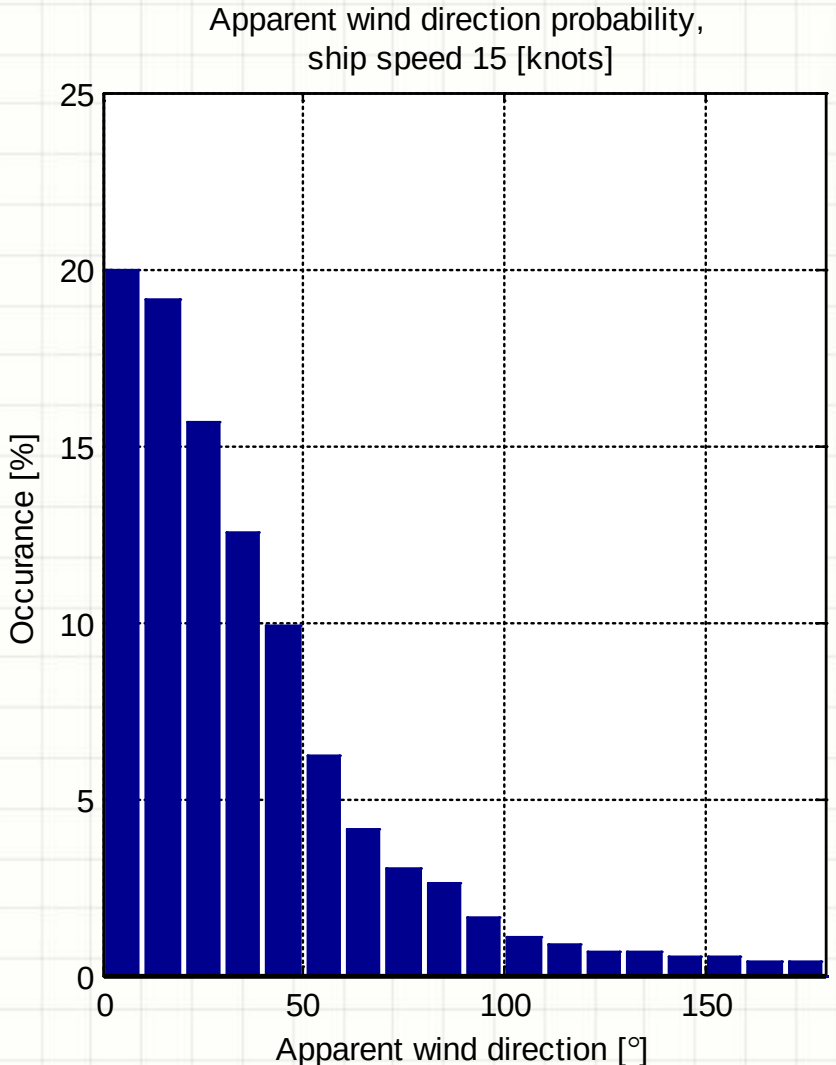
Ship generated wind

Apparent wind

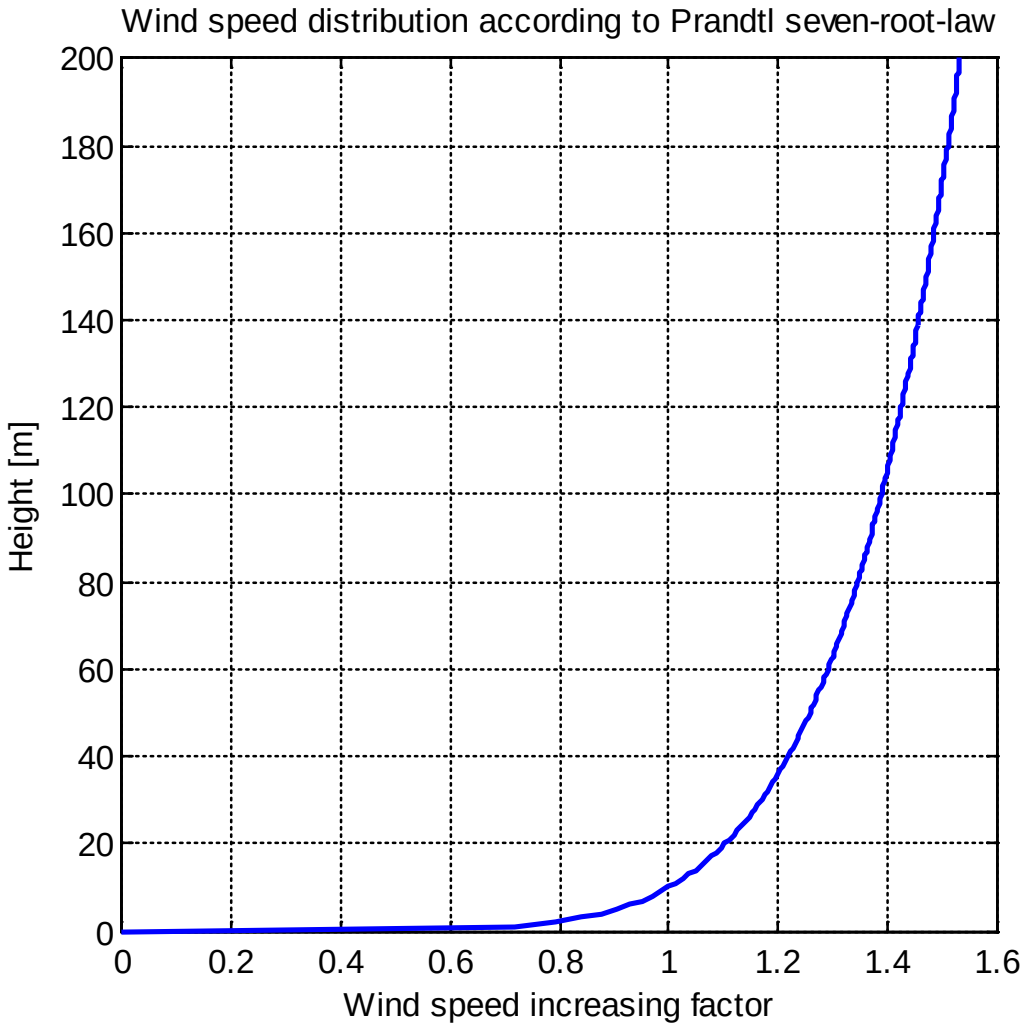
True / Apparent wind speed and direction



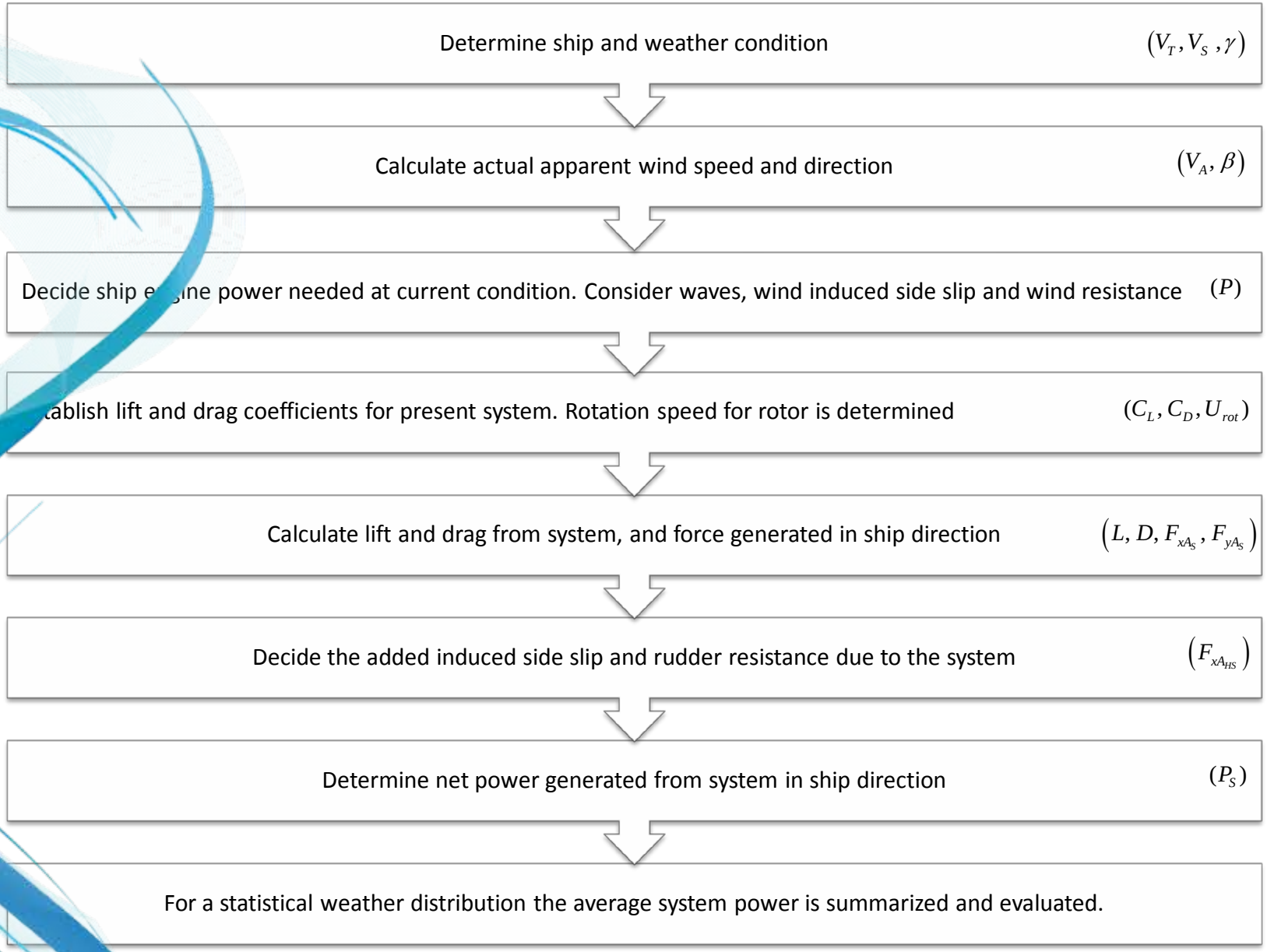
Apparent wind direction at 15 knots



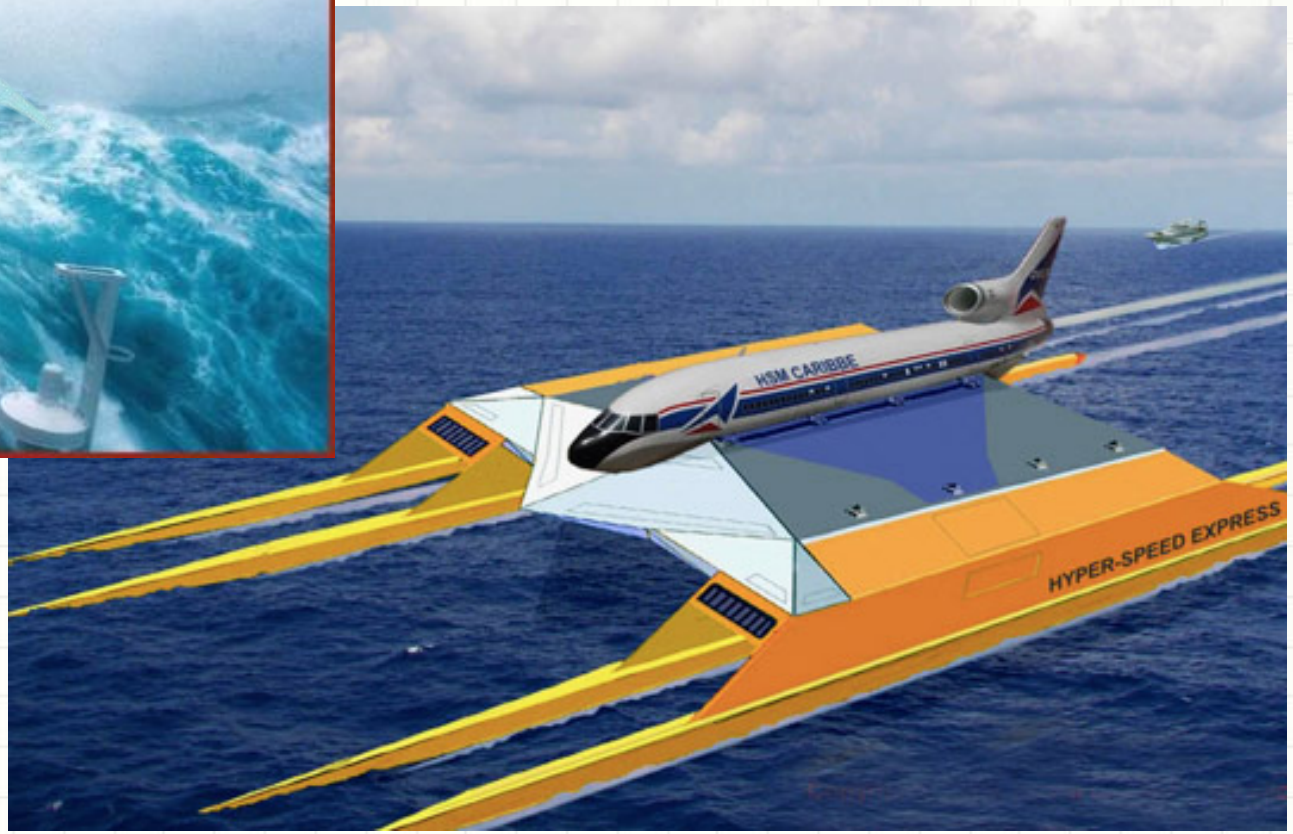
Prandtl effect



How can we make profit of the wind?


Determine ship and weather condition (V_T, V_S, γ)
Calculate actual apparent wind speed and direction (V_A, β)
Decide ship engine power needed at current condition. Consider waves, wind induced side slip and wind resistance (P)
Establish lift and drag coefficients for present system. Rotation speed for rotor is determined (C_L, C_D, U_{rot})
Calculate lift and drag from system, and force generated in ship direction $\left(L, D, F_{xA_S}, F_{yA_S}\right)$
Decide the added induced side slip and rudder resistance due to the system $\left(F_{xA_{HS}}\right)$
Determine net power generated from system in ship direction (P_S)
For a statistical weather distribution the average system power is summarized and evaluated.

Analysis – Ship conditions



Volume load – characteristics

Retrofit

Trends – New build/Retrofit

Trends – New build

Ship type – different qualifications

Retrofit

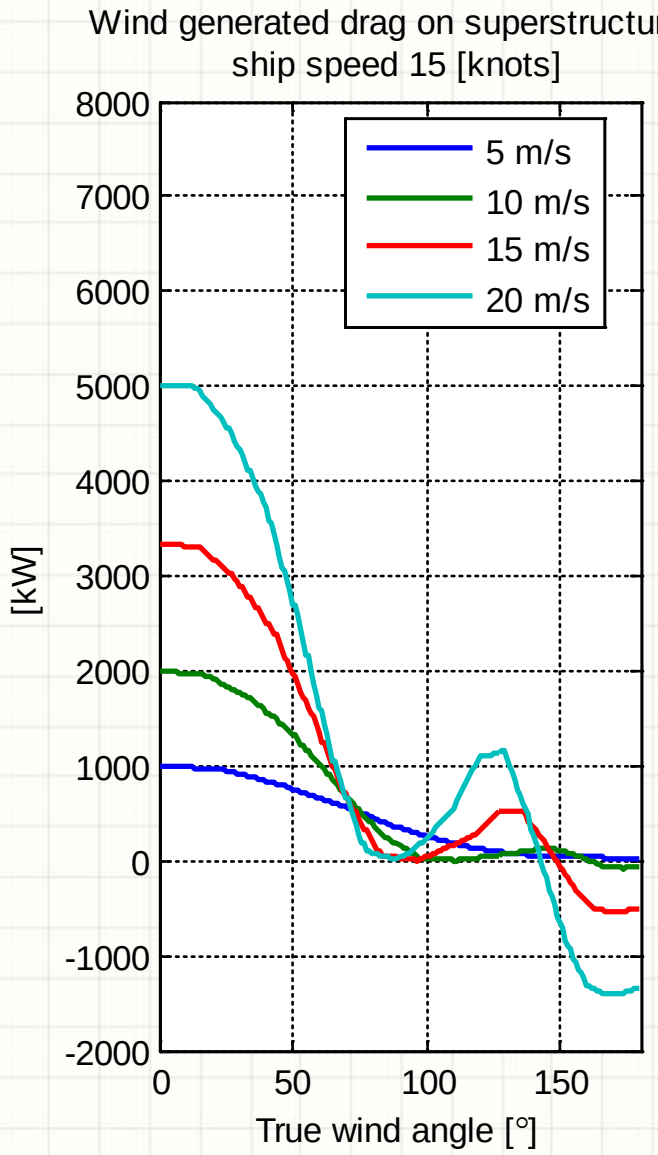
Trends - New build

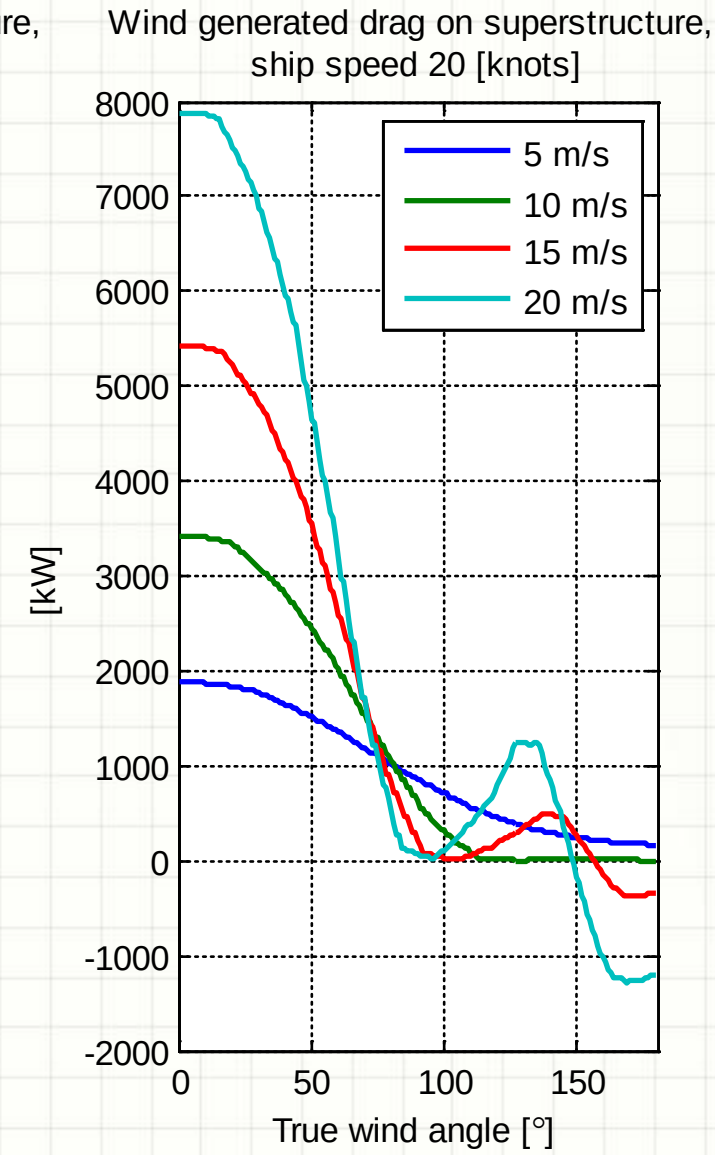
Doubtful construtions

Analysis of an actual ship
M/V Fedora

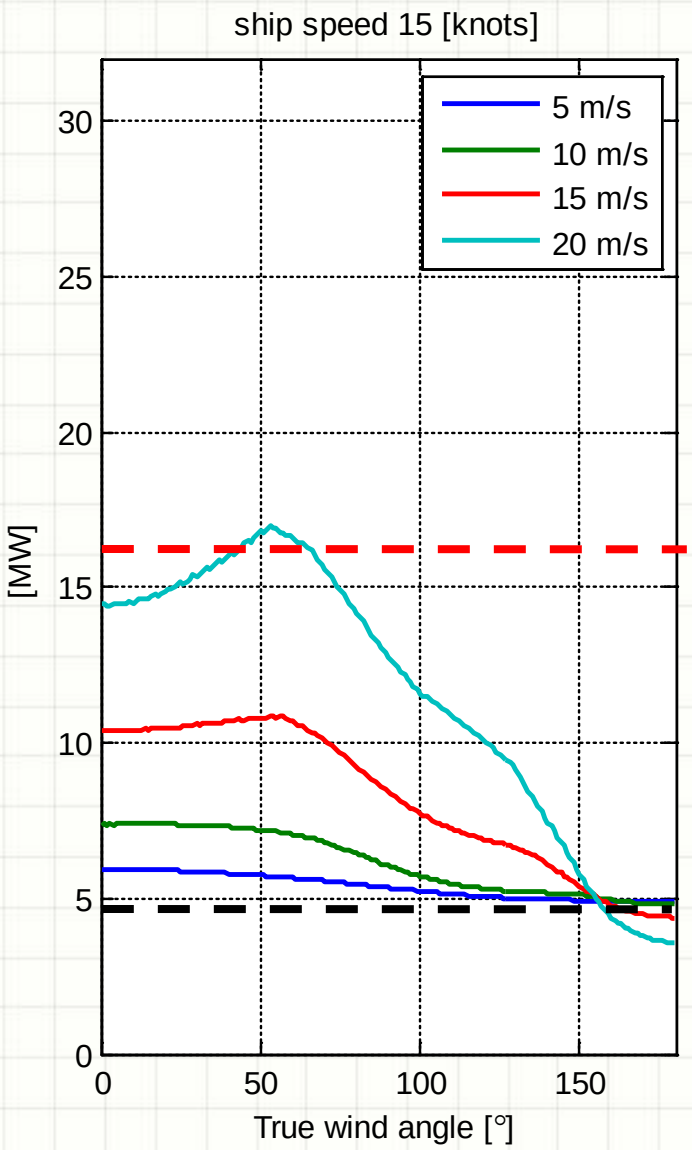
Are the aerodynamics really a problem?

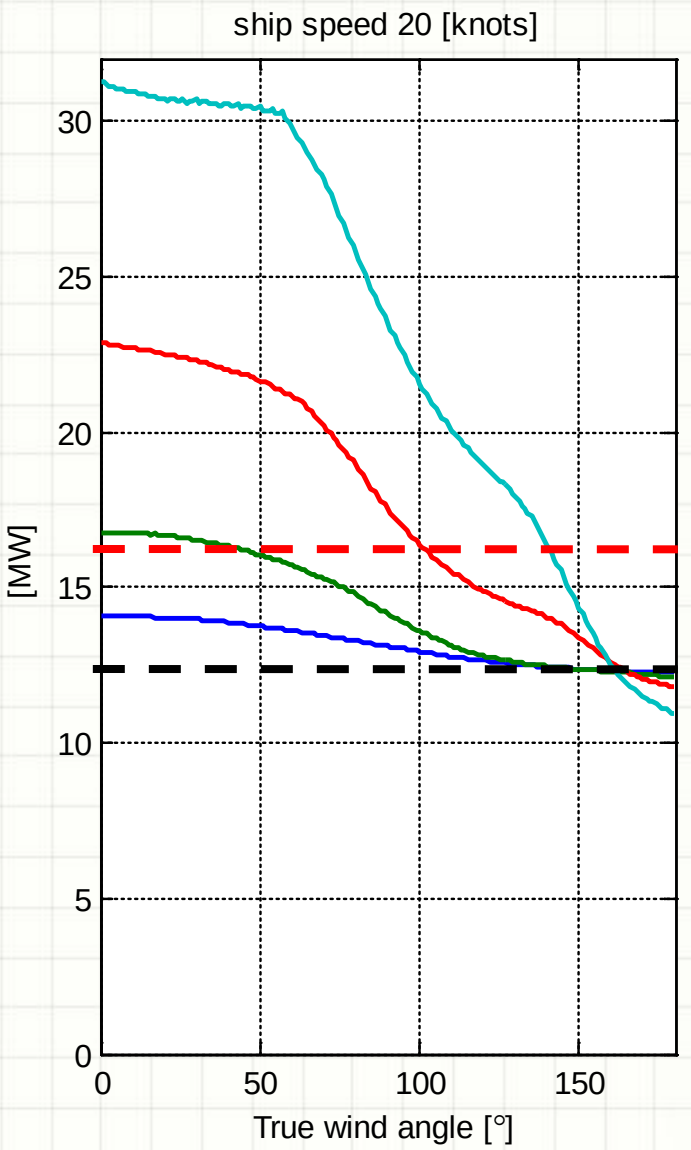
How much will the wind affect?





Total power needed





Results & Conlusions

Kite

- Retrofit
- Considered to have better performace together with a route planning software.
- Sensitive to headwind
- Approximately 5% fuel savings.
- Long payback time

Wing sail/Flettner rotor

- Probably only achievable for new builds
- Savings around 10%, maybe even 20-30%
- Payback time 5-10 years

Aerodynamical improvements

- Both retrofit and new build
- Good performance (ex. 800 ton/year)
- The more head wind the more benefits

Future designs Aerodynamics

Future designs
Sail improvement


UTOPIA