



# Natural propulsion for Transport & Shipping: Performance assessment

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Bermuda Sail  
CL : 1.0



Wing types scaled by their best CL (lift coefficient), to achieve the same aerodynamic lift force.  
Put in propulsive force, this comparison is true only for 90° Apparent Wind Angle, ie. downwind.  
Upwind, CD (drag coef) is determinant, where Turbovoile or Rotor rapidly lose their efficiency.



Wing types efficiency

Bermuda Sail  
CL : 1.0



Wingmast Full Batten  
CL : 1.8



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Articulated Symetric Wing  
CL : 2.2



Asymmetric Flap & Slat Wing  
CL : 3.0



Rotating Twin Wingmast  
CL : 2.0 x2



Turbo Voile  
CL : 6.0 \*



Flettner Rotor  
CL : 7.0 \*



Highest passive CL

KYTE

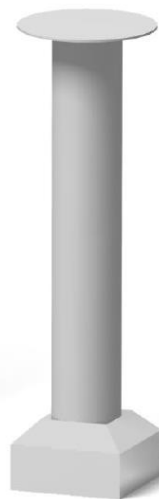


Wing types efficiency

MATHIS RÜHL  
architecture navale



Energy production



Wind propulsion



Crane operations

Ship stationary



Energy production

Ship cruising



Wind propulsion



Crane operations

Ship stationary



Energy production

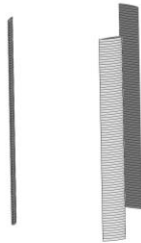
Ship cruising



Wind propulsion



Crane operations



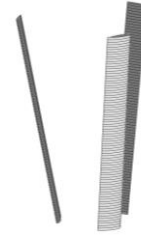
H-type



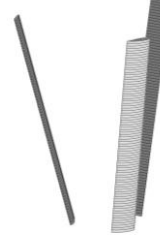
Gorlov-type



Troposkein-type



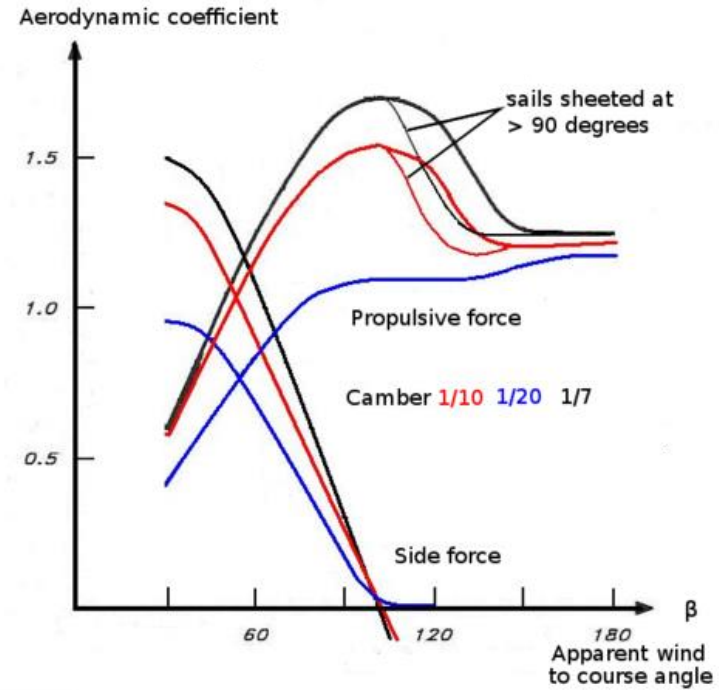
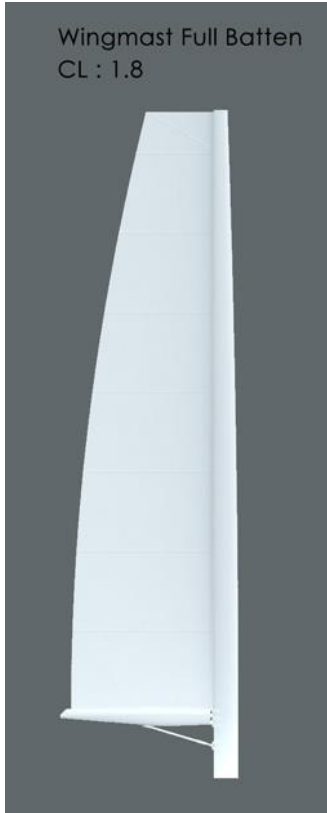
V-type 10.6°



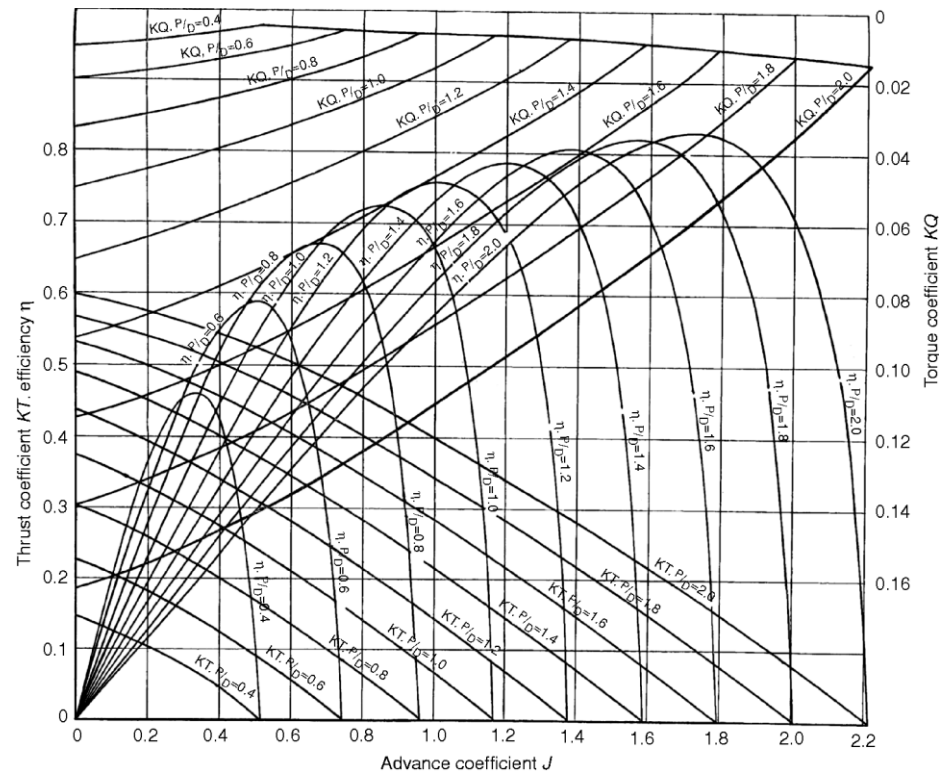
V-type 15°

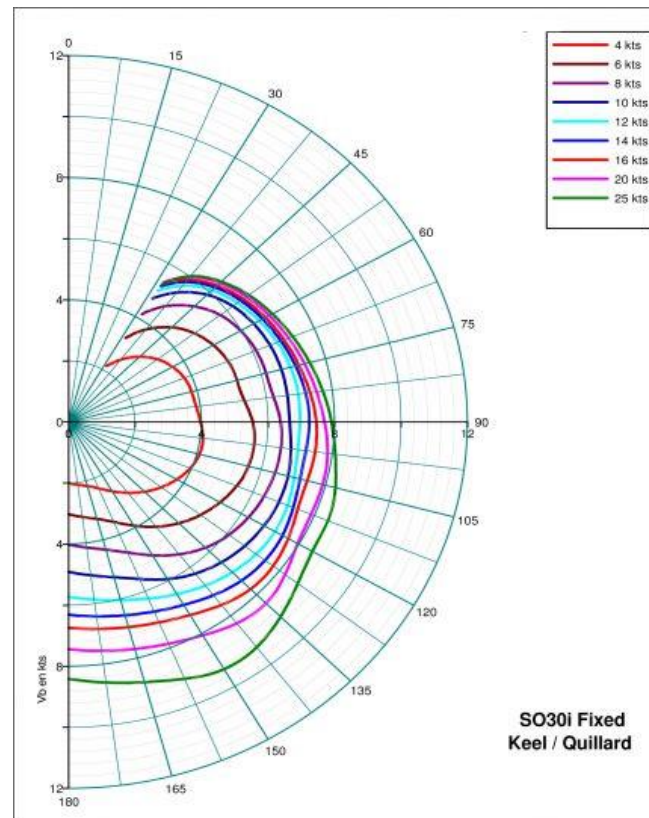
*Different types of VAWT made in QBlade*

Wingmast Full Batten  
CL : 1.8



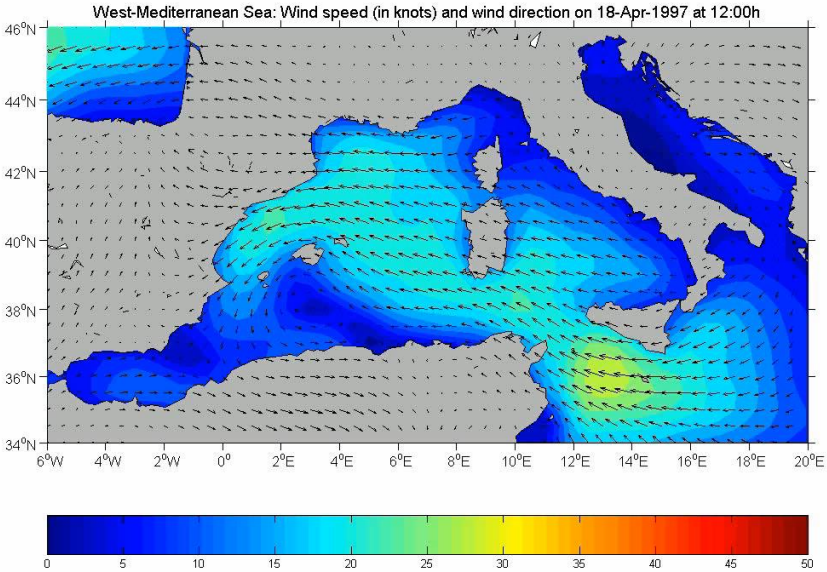
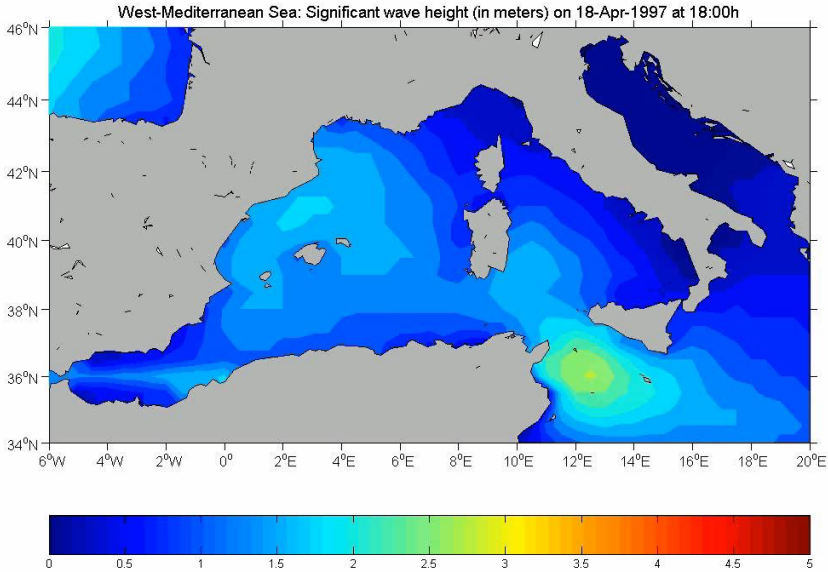




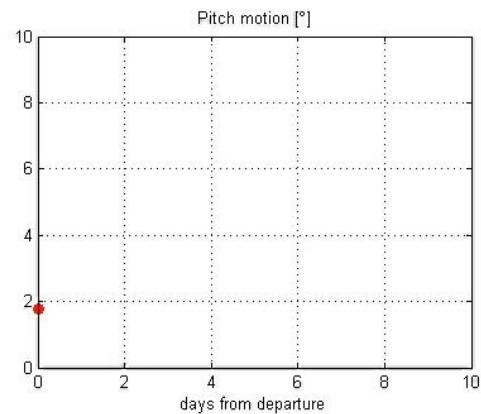
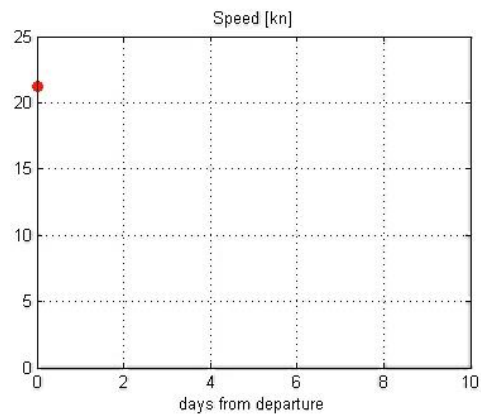
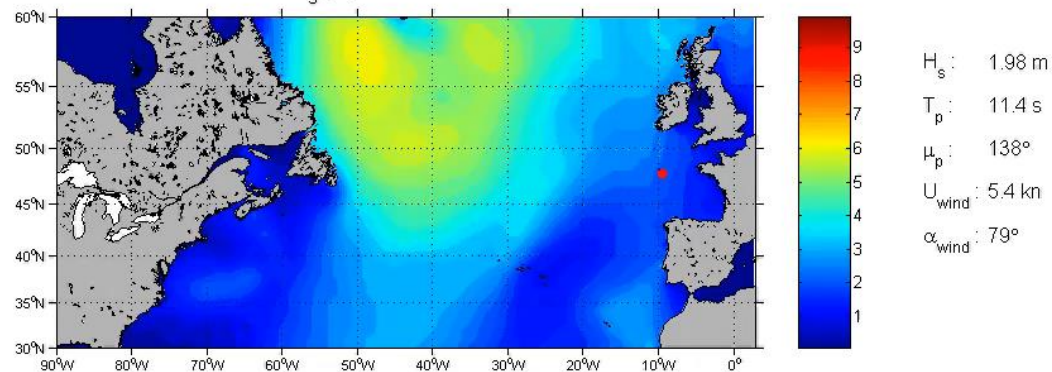


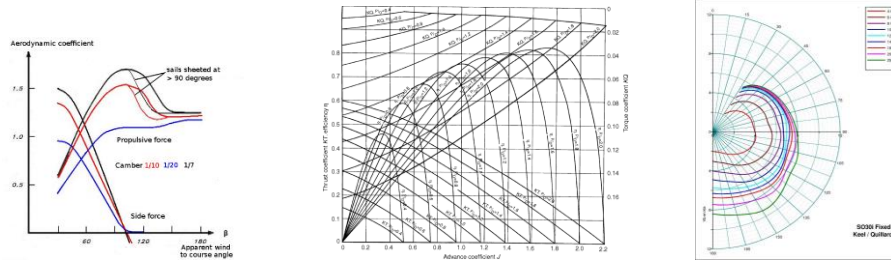




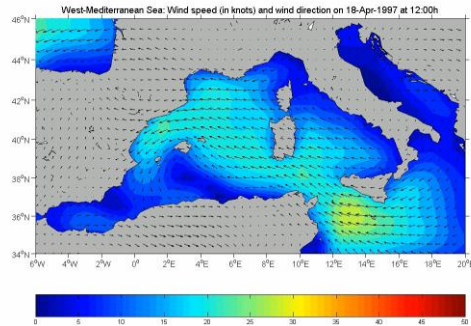


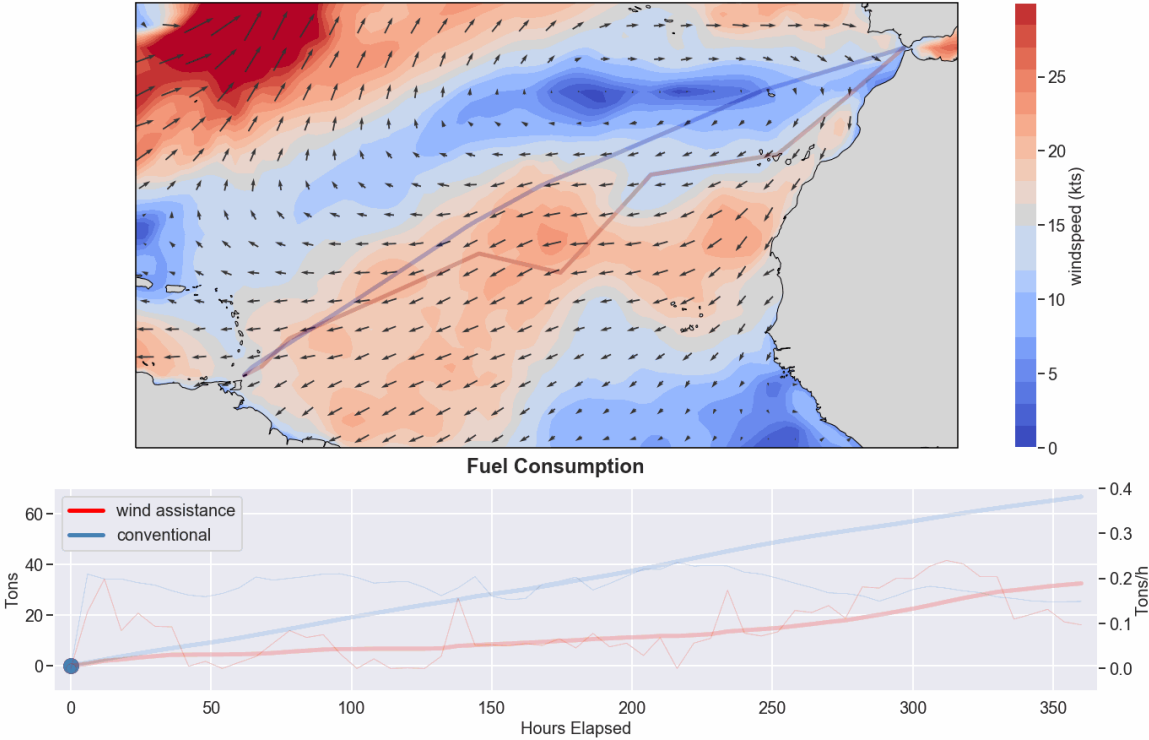
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Let's create voyage simulation

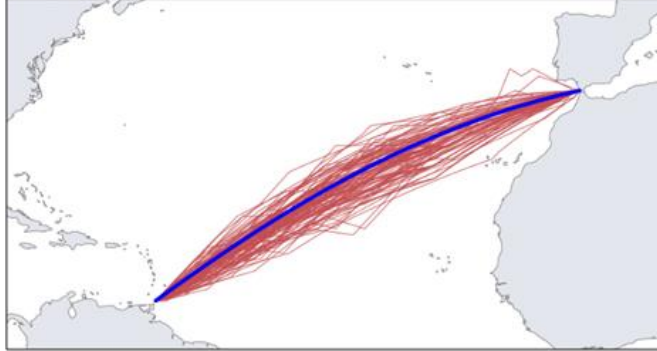




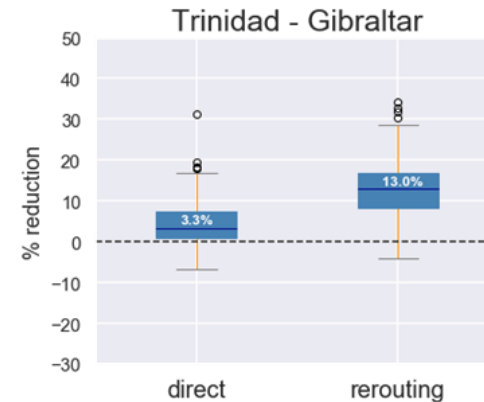
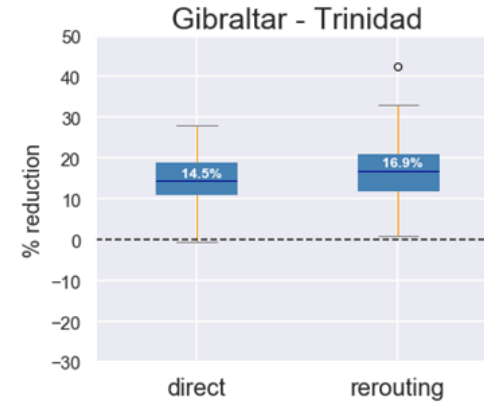
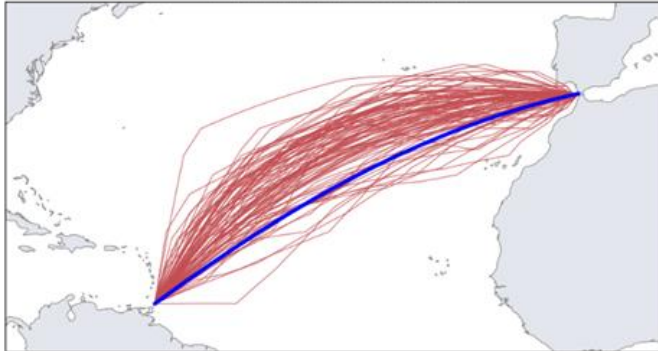
## Scenario studies for wind assistance

### Impact of rerouting on fuel consumption

Gibraltar - Trinidad MHTC Wind Assist

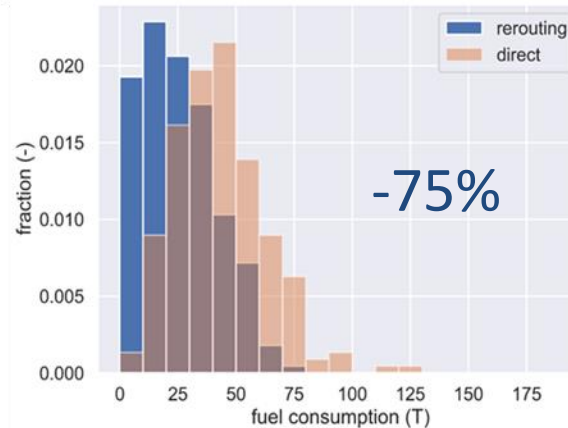
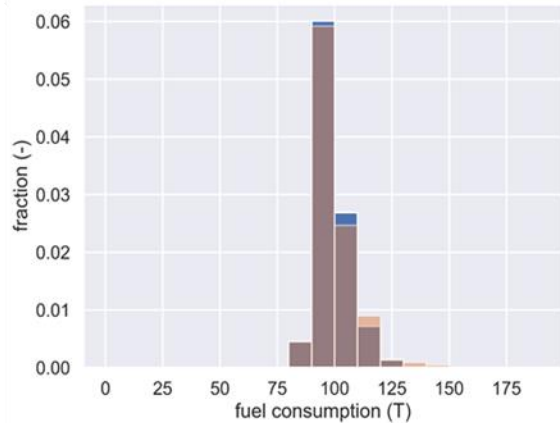
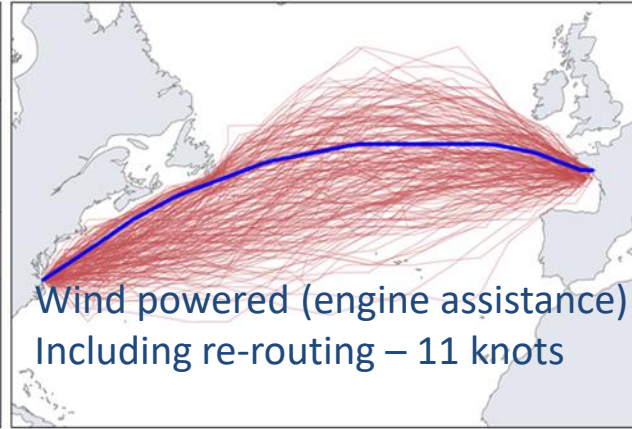
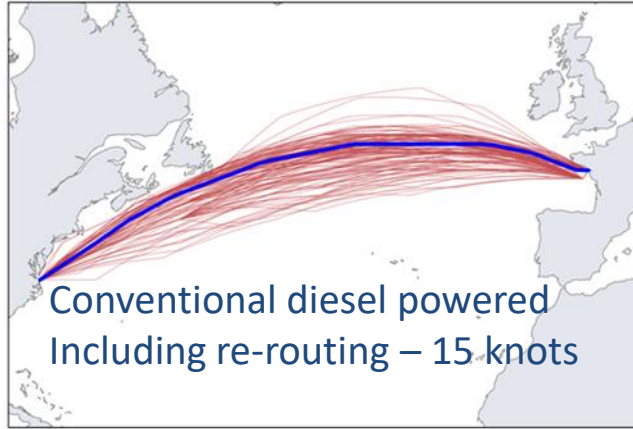


Trinidad - Gibraltar MHTC Wind Assist





## Scenario studies for alternative wind propulsion



# Take aways

- Wind offers a free source of energy that can be captured on almost any kind of ships.
- It can be applied today for refit or new builds. Benefit in terms of energy and emission is immediate.
- It helps compensating the issue of lower energy density, acting as range extender (average value, depending of course on wind conditions).
- Direct gains 5% to 30% emission reduction keeping existing service conditions, and 30 to 100% when adapting operational conditions and logistics (plus dedicated design).
- Today's sail technologies are so far up to 7 times more efficient than (old) soft sail technologies. Further performance is at reach. Do your engineering to optimize solution even further!
- The upcoming decade is going to see a huge development in integrated designs and optimum solutions & operations. You will be, as future naval architect, at the heart of such (r)evolution.





**FREE  
VIRTUAL CONFERENCE**

Canopée, the first modern sail  
ship Zéphyr & Borée

2021  
**NATURAL  
PROPULSION  
IN SHIP DESIGN  
CONFERENCE**

**16 NOVEMBER 2021  
9 AM - 4:30 PM EST**

REGISTRATION  
REQUIRED

SESSIONS WILL BE  
RECORDED

**BROUGHT  
TO YOU BY:**

wind  
support

MARIN  
BETTER SHIPS, BLUE OCEANS

Webb Institute

Thank you for your attention!

Upcoming port of call for wind technology and zero emission shipping



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