A Performance Prediction and Weather Routing Module for the unique wind assisted and hybrid propulsion concept VINDSKIP® are developed by research institute Fraunhofer CML on behalf of Vindskip AS

To account for the innovative approach of Vindskip®, using the aerodynamic lift generated by the Apparent Wind as a propulsive force, it is necessary to introduce a Weather Routing Module. This module can find the optimum route across the ocean meeting the ETA with the lowest possible fuel consumption.

The Weather Routing Module version Vindskip® approaches the task through two integrated parts, consisting of a Performance Prediction and a Weather Routing part.
The Performance Prediction approach utilizes a constraint optimization routine to balance aerodynamic and hydrodynamic forces to determine the total resistance while satisfying the equilibrium condition for three degrees of freedom. For the Weather Routing an implementation of the A*-algorithm on a dynamic grid is utilized, including avoidance of land masses and harsh weather according to IMO guidelines.
In its simplest form Weather Routing could be the consideration of favourable wind angles in the Route Planning. However, neglecting the hydrodynamic response to the aerodynamic forces can cause significant errors in the prediction of the propulsion power demand and the corresponding fuel consumption.

The Vindskip®-concept consists of three parts working together in a dynamic unit:

The Wind Power System
The ability the ship design has to generate a pull in the speed direction as a function of the Apparent Wind Angle of Attack β, due to its aerofoil shape adopted to the ship's superstructure.
The system is optimized through extensive CFD-studies to give pull from AWA β 18 degrees to 180 degrees. Also, to minimize Leeway angle and Rudder angle thus reducing drag.
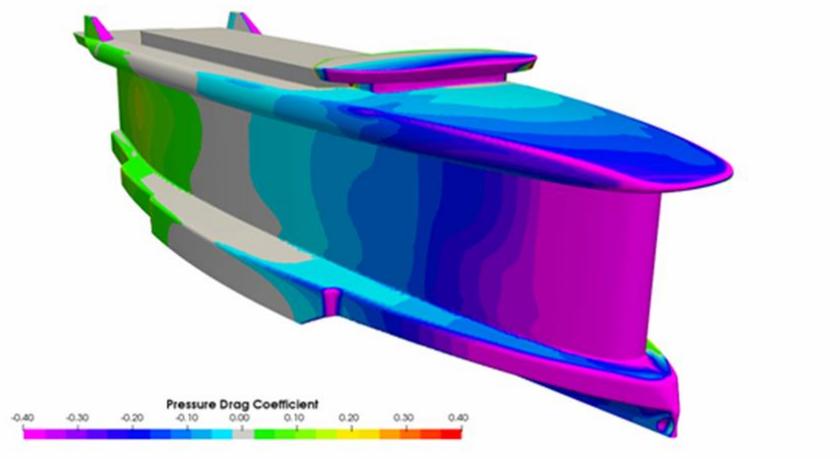
Fig 1. This CFD-image of the pressure distribution over the hull, where the pink colour represent under pressure, is explaining the Pull in the speed direction being generated.

Cruise Control
An LNG propulsion system has been devised to meet the Vindskip® requirements, keeping a constant speed on the ship even if the wind will vary over time, retaining a high level of efficiency over a wide range of power outputs.

BRUNVOLL

Neptune II CPP Propulsion control system

Neptune-II CPP is an electronic remote control system for propulsion for vessels with CP-propellers. It is designed according to the fail-safe principle and is built up with a high level of redundancy. The system is very user friendly, highly accurate, and advanced and flexible with many possibilities.

Overall technical details:

Type of system:	Neptune-II CPP for single screw vessel with TS gear one LNG engine and one electro motor per propeller.
Control stations:	Four. Three standard panel bridge, One advanced ECR-panel.
Control of:	Propeller pitch, engine RPM, clutches. Automatic load control*
Control mode:	Combinator, Fixed RPM, PTO, PTI (Variable), Boost, "Cruise control mode"

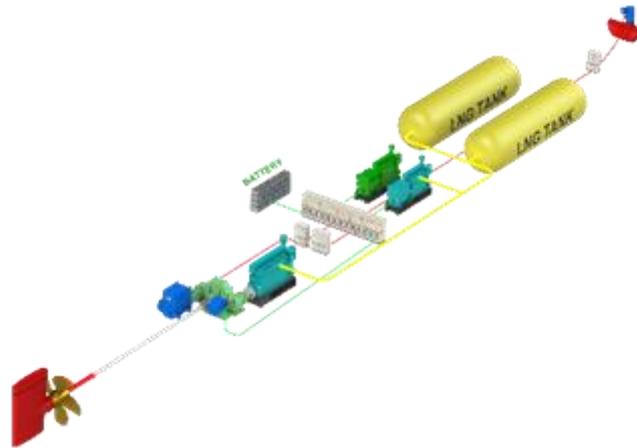**Advanced ECR panel**   **Bridge panel**

Fig 2. LNG-propulsion system

Weather Routing System

The Weather Routing System version Vindskip® is an advanced computer program, based on an Algorithm and where all the parameters of the ship are entered into the program.
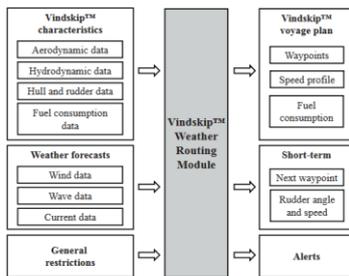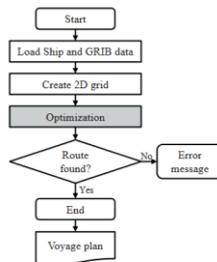

Fig. 2. Scope of the Vindskip™ Weather Routing Module
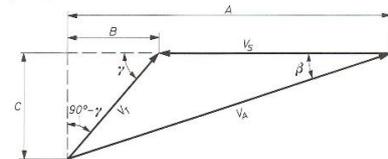
Fig. 3. Approach of the Vindskip™ Weather Routing Module

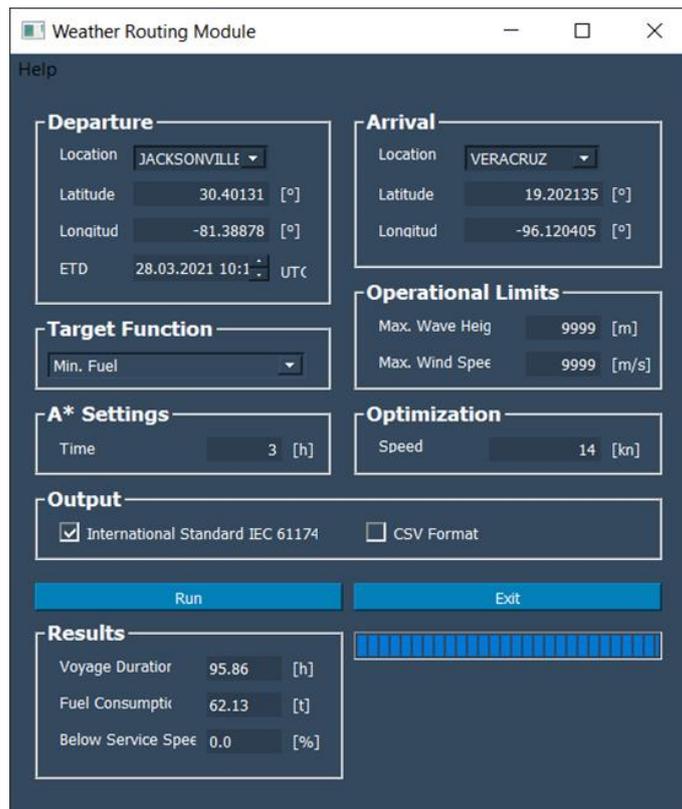*Fig 3. Graphic representation of WRM parameters*

Fig 4. The Weather Routing Module App, were you put in where you are and where you are going and press the Run button. Out comes the result and a RTZ file are generated to be imported into the NAVTOR Navstation.
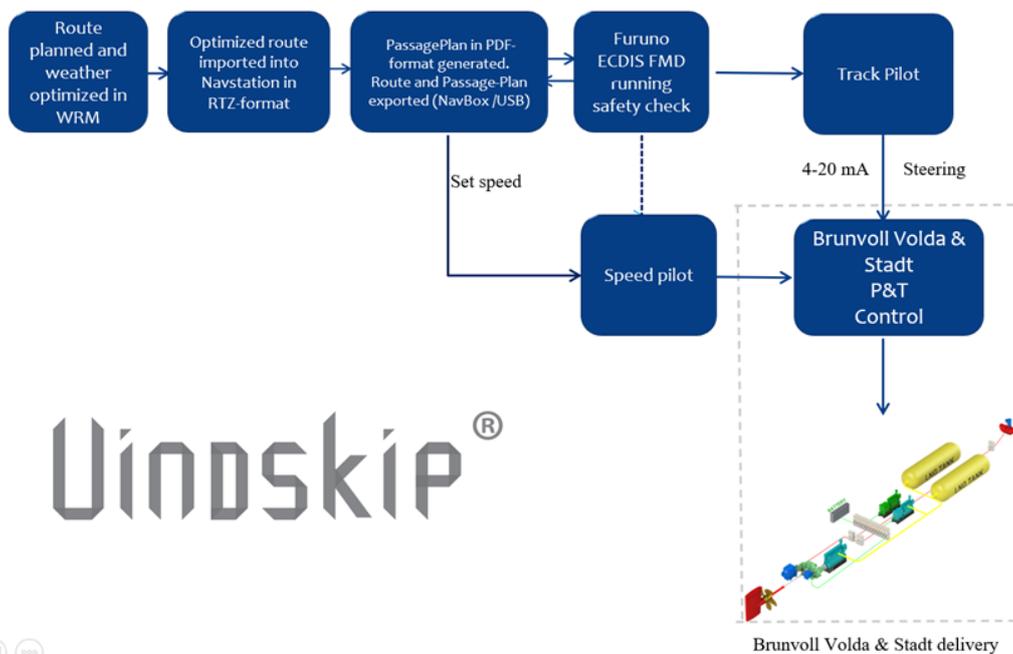

Fig. 5. Graphic representation of how the Weather Routing System is working and how Vindskip® will follow the generated route autonomously over the sea.
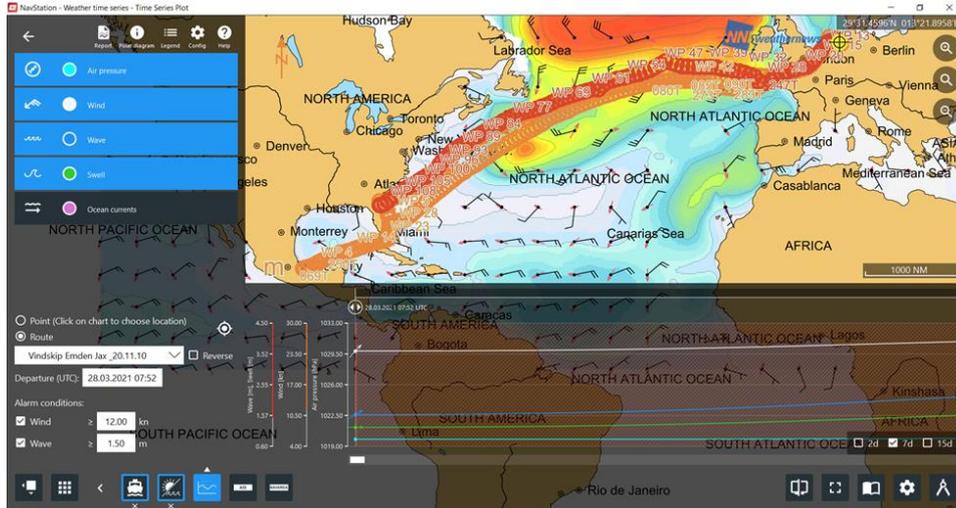
Fig 6. The weather optimized route is imported into the NAVTOR Navstation and visualized, and a Passage Plan are generated.
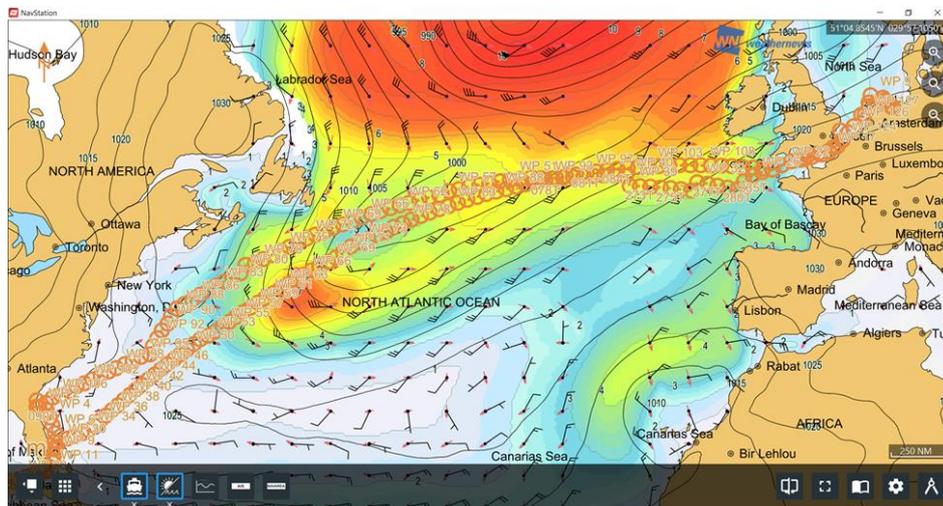

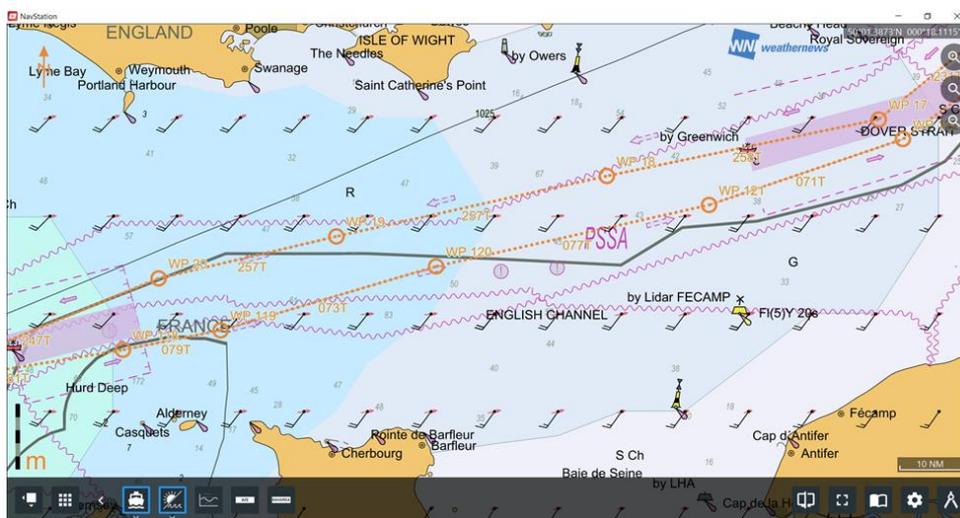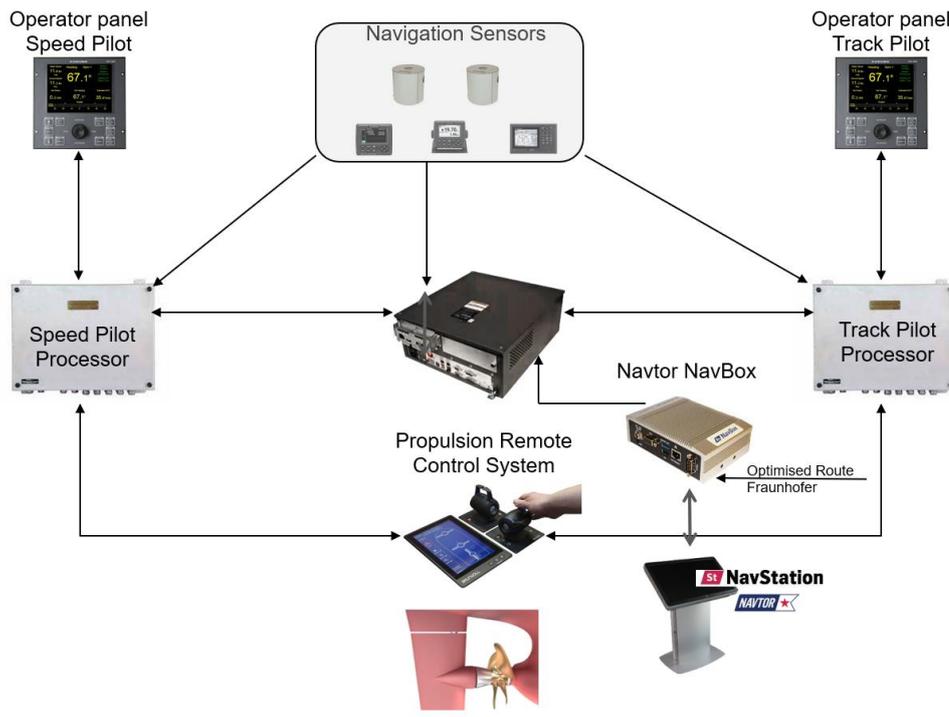*Fig 7. The presentation of the Route with way Points and wind and waves.*

Fig 8. The English Channel is restricted area.

Fig 9. Vindskip® will now follow this route autonomously across the Atlantic, for example.
The key is the Track pilot and the Speed pilot, who "knows" when the ship is arriving at a Way Point
and adjust the speed and course according to the actual current point and the next point.

30th March 2021
Terje Lade
Manager Vindskip AS