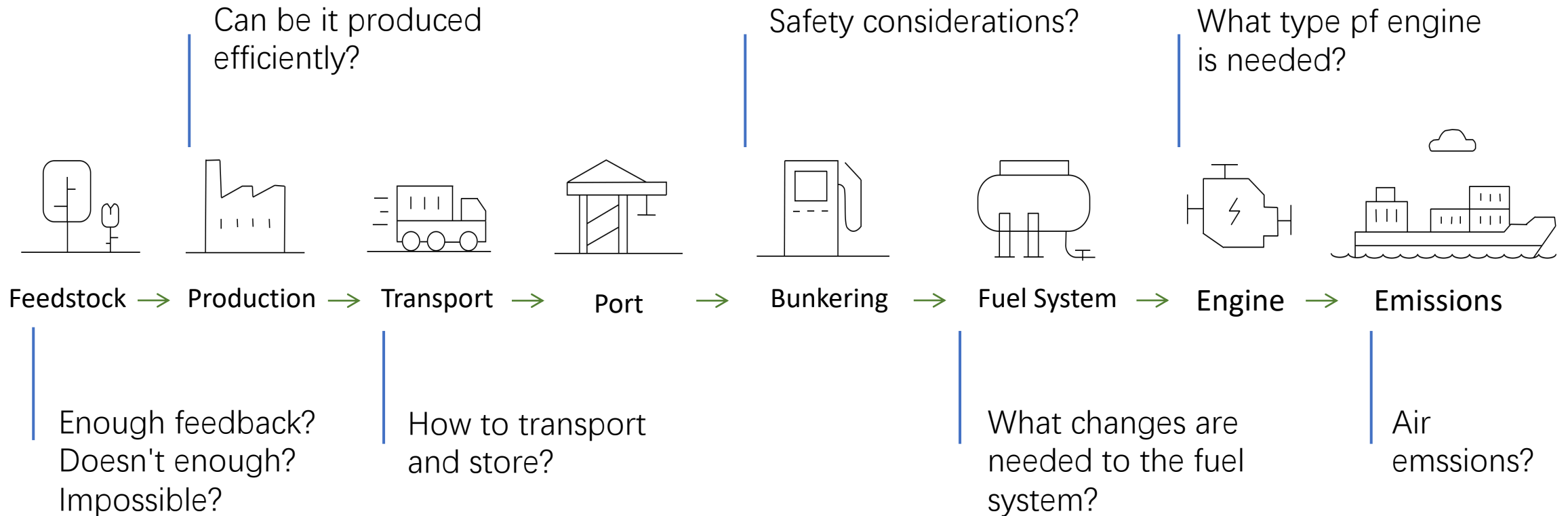




Dealfeng Rotor Sail System

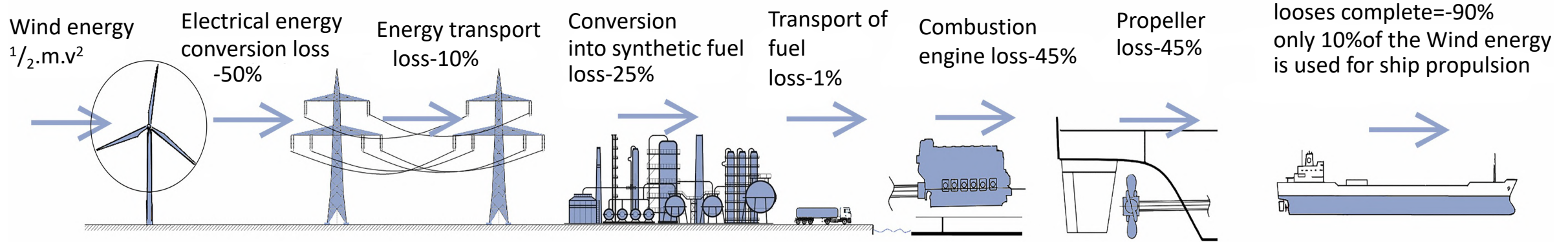
The Disadvantages of the Fuels

- For each of the fuels, transformation needs to happen across the entire fuel supply chain, process is complicated.



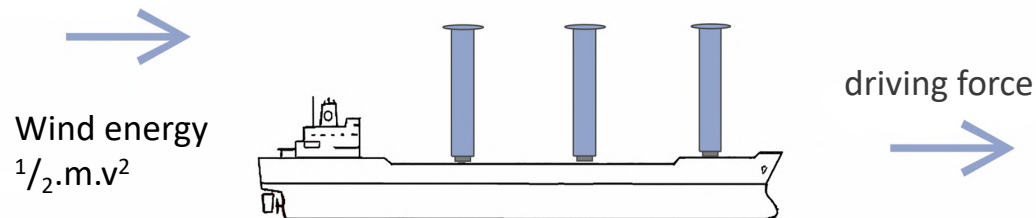
Direct Application of Wind Power

The long way from wind energy to driving force...



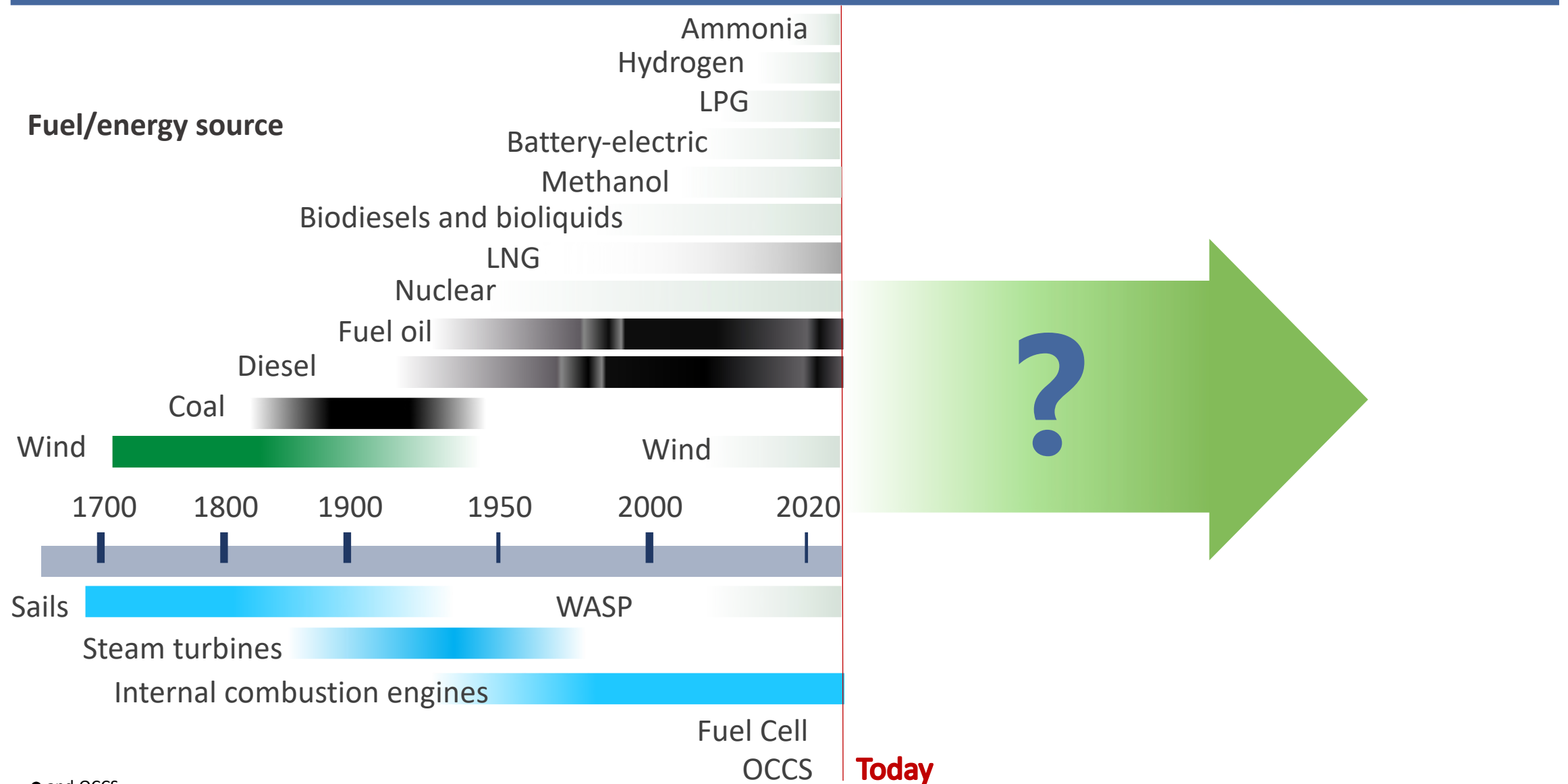
WAP ships, the short way from wind energy to driving force, like

“PLUG & PLAY”



- advantages of a sailing ship:
- uses high wind potential on the open sea
 - No losses due to energy conversion
 - No losses due to energy transport
 - No land-based infrastructure necessary
 - One sailing ship replaces 10 land-based wind power plants
 - No fuel costs for the shipping company (wind is for free)
 - less dependency of shipowners on fuel producers

Propulsion Technologies



● and OCCS

WASP: wind assisted propulsion

LNG: Liquefied Natural Gas

LPG: Liquefied Petroleum Gas

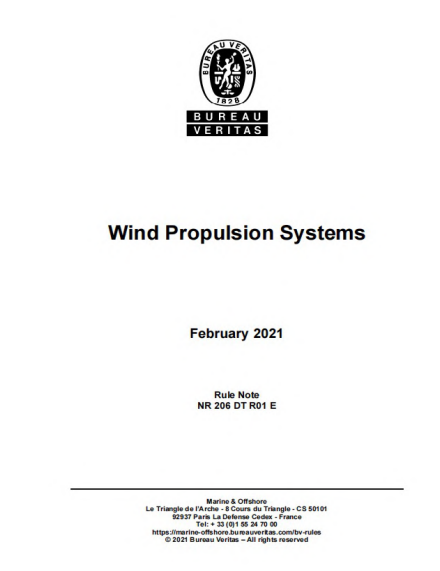
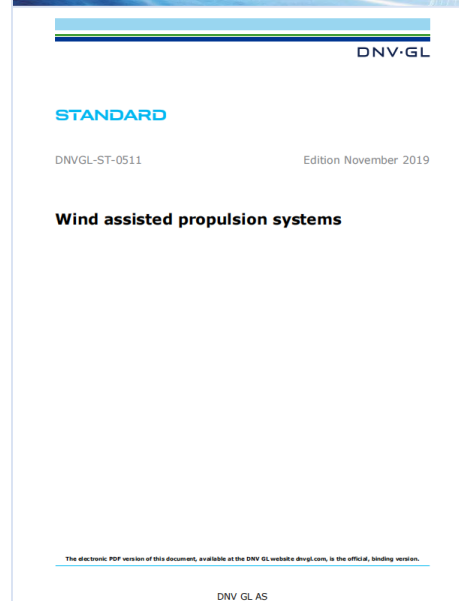
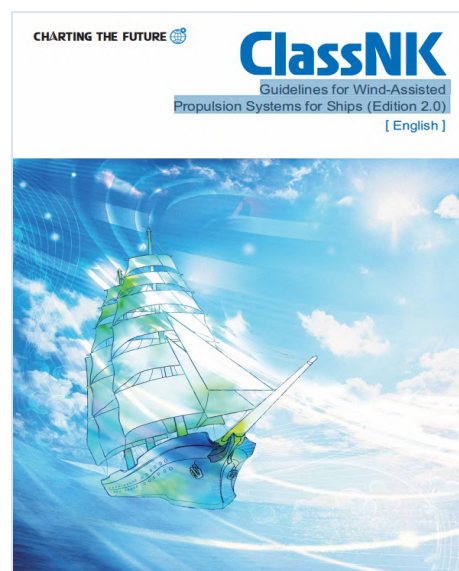
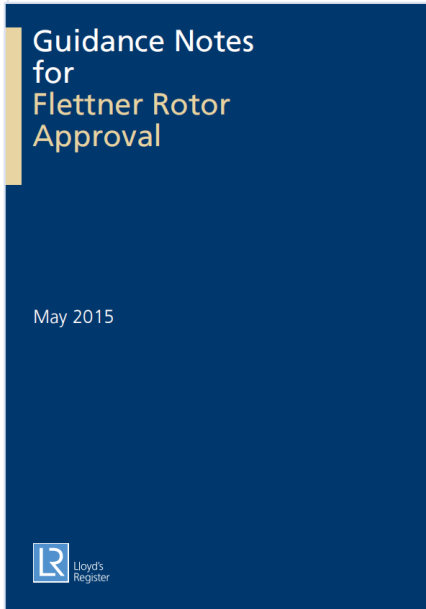
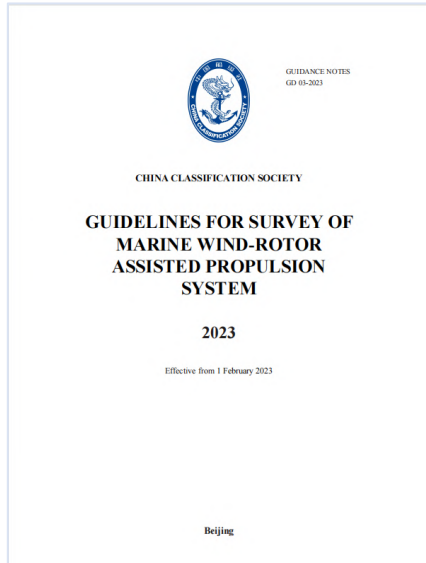
OCCS: Onboard Carbon Capture and Storage Source: BV

WAPS Current Market

Wind Assistance Rig: track record until end 2024

Wind Assistance Rig (Type)	Ship Installations Completed and Contracted (by end of 2024)							Rigs Installed/to be Installed (by end of 2024)								
							2024	±	2014 to end of 1H2023	2H2023 until end of 2024	Rig Name™	2014 to end of 1H2023	2H2023 until end of 2024	By Maker	By Rig Type (%)	
Rotor Sail	1			2		1	2	1 (-1)	1	8	4	Norsepower	15	5	20	50 Rotor Sail (57%)
				1					1	2	4 ¹	Anemoi	7	17	24	
									1	-	3	Dealfeng	-	5	5	
				1		1				2	-	Eco	2	-	2	
Suction Wing							2			2	2	Ventifoil	4	4	8	19 Suction Wing (22%)
							2		1	3	2	e-Sail	4	7	11	
Rigid Wing Sail				1				1		2	-	-	6	-	6	18 Rigid Wing Sail (21%)
								1		1	1 ¹	Wind Challenger	1	1	2	
										-	1	Ocean Wings	-	4	4	
										-	2	Wind Wings	-	6	6	
Wind Assistance installations Ships and Rigs by year until end of 2024	1			5		2	6	3 (-1)	3	21	18	Note ¹ Combined Wind Challenger and AMT Rotor Sail Rig	41	46	87	Source: LR
										By end of 2024= 39 Wind Assisted Ships				By end of 2024= 87 Wind Assistance Rigs		

Class's Regulations of Wind Propulsion



- BV: Wind Propulsion Systems
- CCS: Guidelines for Survey of Marine Wind-Rotor Assisted Propulsion System 2023
- ClassNK: Guidelines for Wind-Assisted Propulsion Systems for Ships (Edition 2.0)
- LR: Guidance Notes for Flettner Rotor Approval
- DNV: Wind assisted propulsion systems
- ABS: WIND ASSISTED PROPULSION SYSTEM INSTALLATION JULY 2022

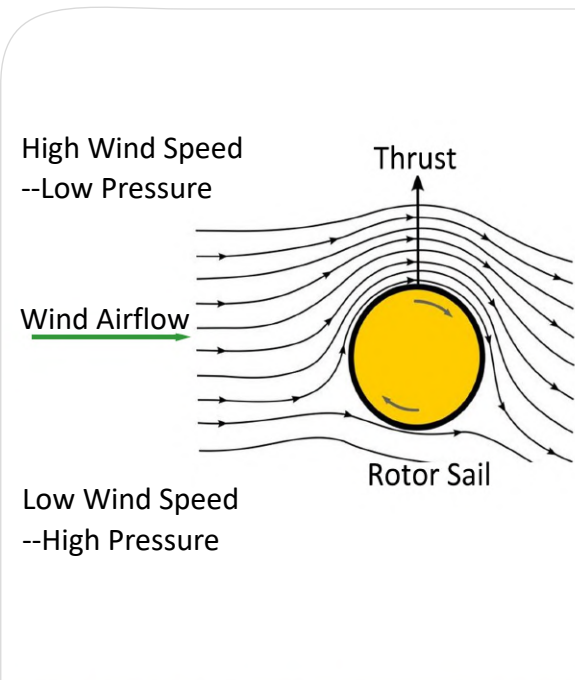
Rotor Working Principle - Magnus effect

Magnus effect

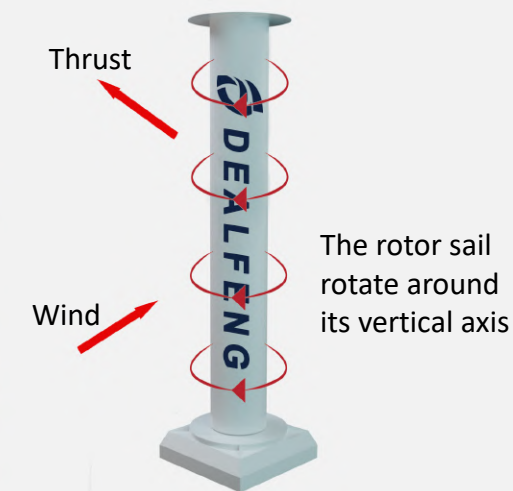
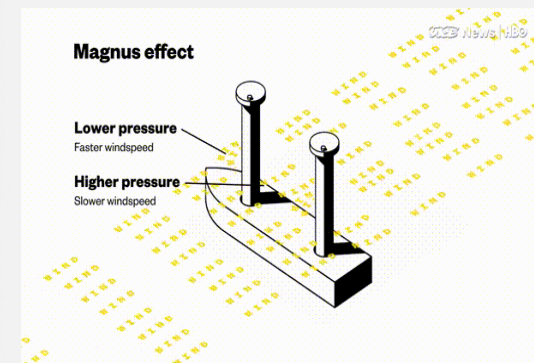
- When the rotation angular velocity vector of a rotating object does not coincide with the object flight velocity vector, a transverse force will be generated in the direction perpendicular to the plane composed of the rotation angular velocity vector and the translational velocity vector.
- The phenomenon that the flight path of an object deflects under the action of this transverse force is called the Magnus effect, which is most commonly visible in ball games where spin is applied (football, tennis, golf)

Rotor Sail

- The rotor sail use Magnus effect to harness wind power for propulsion.
- When the wind meets the spinning cylinder, the air flow accelerates on one side and decelerates on the opposite side.
- The difference in pressure creates a thrust force that helps push the ship forward through the water. Thereby, the ship can reduce the use of main engine power and thus resulting in lowering fuel consumption and CO2 emission by 5~25%, and even more.
- Scientific fundamentals discovered already in the 1920s (Flettner Rotor).
- Dealfeng has optimized and modernized the technology - by introducing high-tech materials and automation.



Flettner Rotor



Comparison of Two Sails



Rotor Sails



Rigid Wing Sail

Rotor sail and rigid wing sail comparison

- Comparing to Rigid Wing Sail, Rotor Sails have better vision and are easier to meet the 5% SOLAS requirement.
- The Rotor Sail does not have a complex hydraulic system to rise and fall while sailing.
- Rotor Sail has lower equipment cost and maintenance cost.
- Rotor Sail has higher propulsion efficiency in the same sail area.

Introduction to Dealfeng

About us

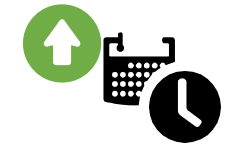
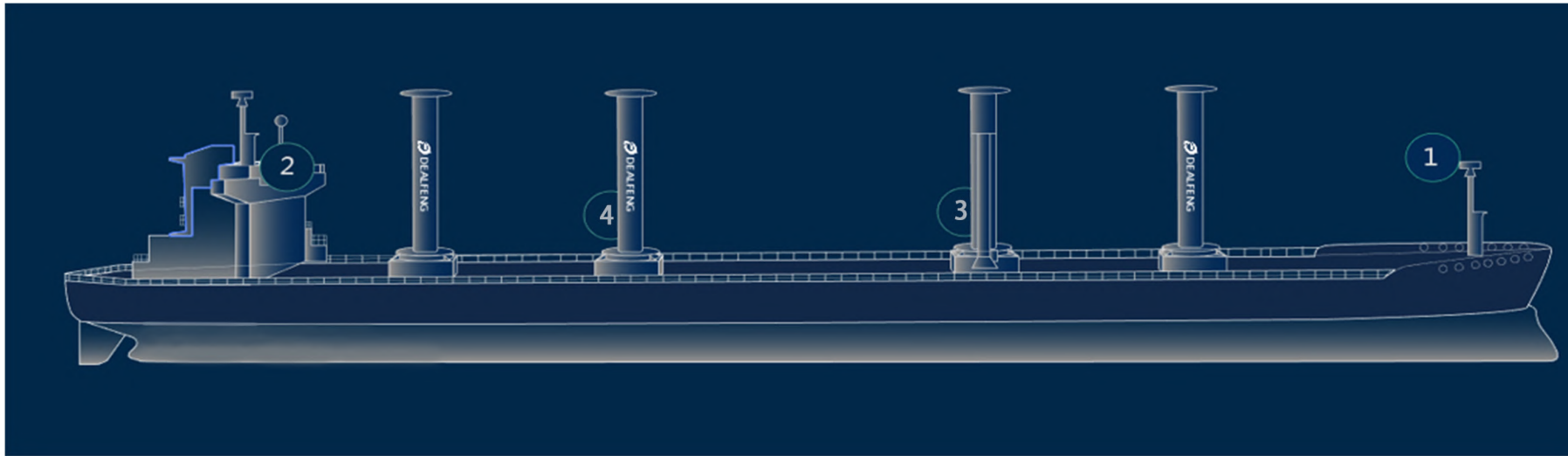
- Dealfeng New Energy Technologies Ltd has installed the auxiliary wind propulsion system - **the first rotor sail system on a newbuild product oil tanker in China.**
- Dealfeng is a Chinese innovative clean energy technologies company integrating the R&D and manufacturing of marine energy saving and emission reduction system. At present, Dealfeng has a professional technical backbone composed of marine machinery design engineers and naval architects with many years of working experience in shipping industry and develop WAP rotor sail system.

Landmark events

- Dealfeng started research and design wind assisted ship propulsion rotor sail system from 2016.
- Dealfeng obtained the LR AIP certification for rotor sail system in 2021.
- Dealfeng has successfully completed the prototype production and onshore test of 24M X 4M rotor sail in December 2021.
- Dealfeng obtained the AIP certification for rotor sail system from CCS and Class NK in 2022.
- Dealfeng signed a newbuild contract for rotor sail installation on one 5000 DWT product oil tanker in October 2022.
- Dealfeng signed a retrofit project with CNOOC and will finish the installation in Dec. 2023.



Rotor Composition



EFFICIENCY



AVAILABILITY



EMISSIONS



MAINTENANCE

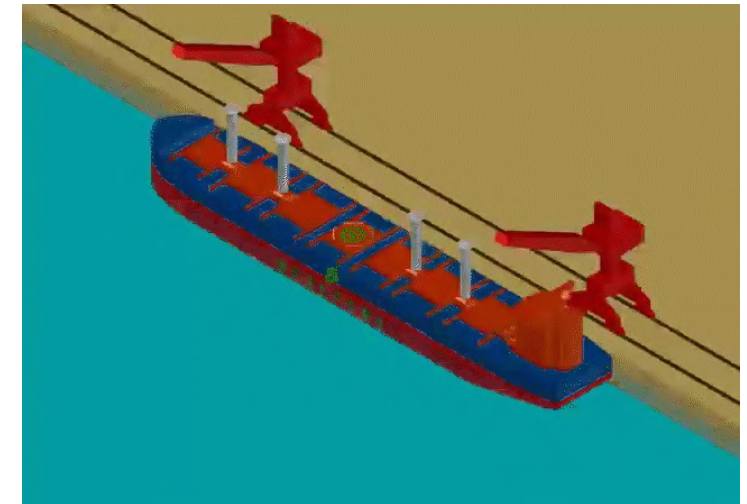
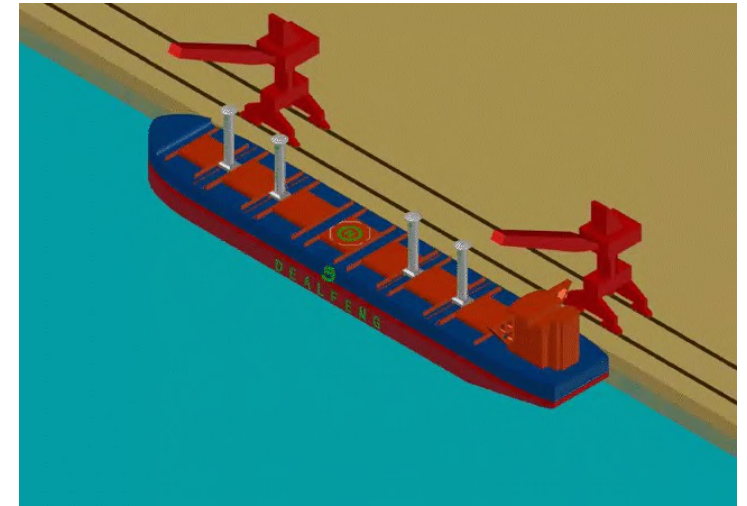
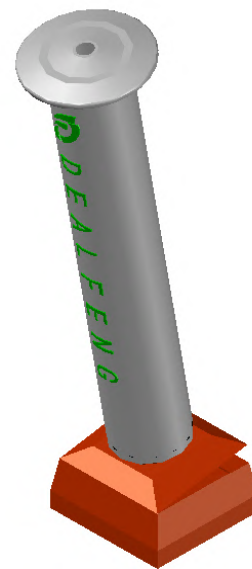
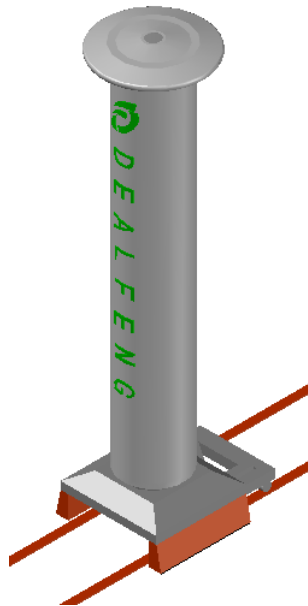
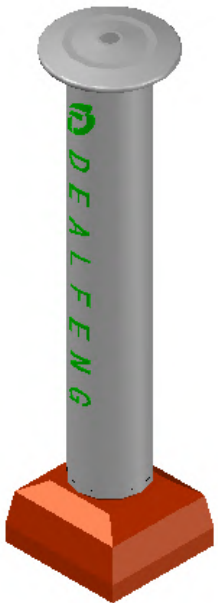
Rotor System Compositions:

1. Multifunctional sensor
2. Central controller
3. Foundation and inner tower (steel)
4. Outer rotor (composite material)

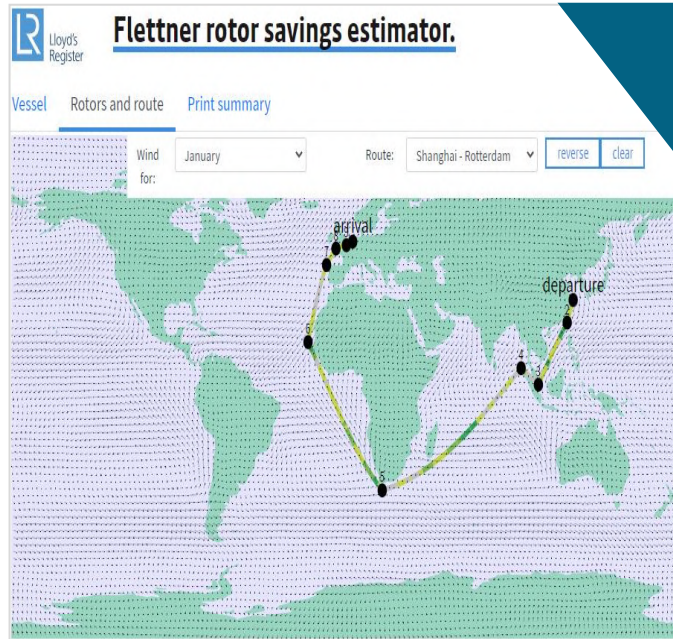
Introduction to Dealfeng Rotor Sail

Three types of foundation

- Fixed foundation: suitable for tanker, RORO, Ro Pax etc. The cheapest foundation, simple structure and convenient installation, the highest ROI.
- Rail foundation: suitable for bulk carrier etc. Cheaper foundation, lateral and vertical movable, higher ROI.
- Folding foundation: suitable for the most vessel types, the most expensive foundation, rotor height variable.



Case Study – 82,000 DWT – Bulk Carrier



Selected Route Results

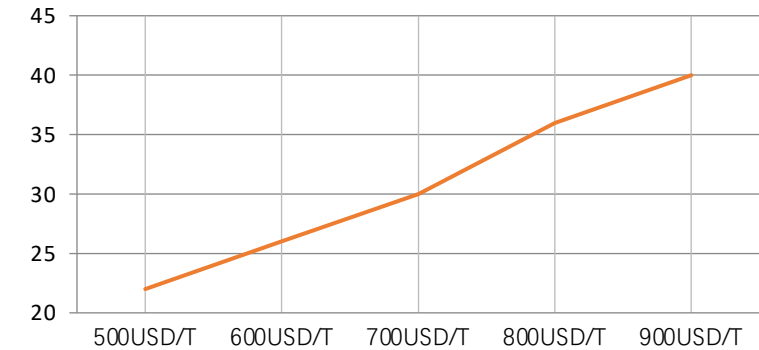
Distance: 14142.3 NM
 Duration: 53.6 days
 Avg Speed: 11.0 knots
 Monthly savings in propulsion consumption and emissions

Month	FO (t)	CO ₂ (t)
Jan	47.6	149.9
Feb	40.7	128.3
Mar	36.9	116.3
Apr	43.3	136.5
May	45.3	142.8
Jun	74.6	235.1
Jul	93.2	293.8
Aug	93.5	294.7
Sep	84.0	264.6
Oct	68.9	217.2
Nov	56.1	176.7
Dec	55.5	175.0
Yearly Avg	61.6	194.2

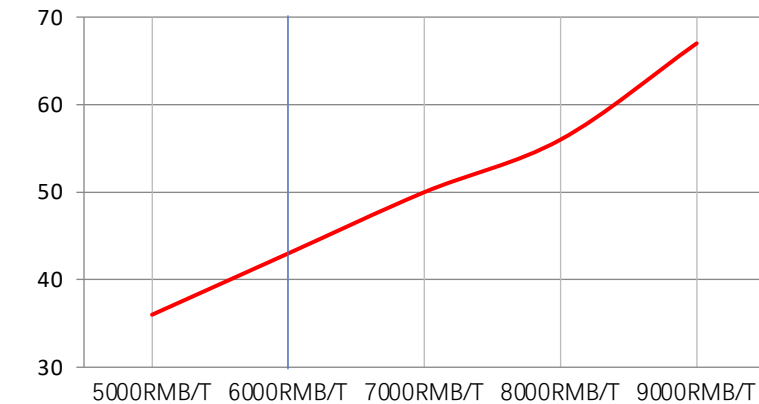
Savings in global wind conditions*: **8.8 %**

**yearly average wind conditions over all major trading routes as defined in MERC 62/INF 34

ROI of Rotor Sail based on international oil price (unit: %)



ROI of Rotor Sail based on China oil price (unit: %)



Source: LR

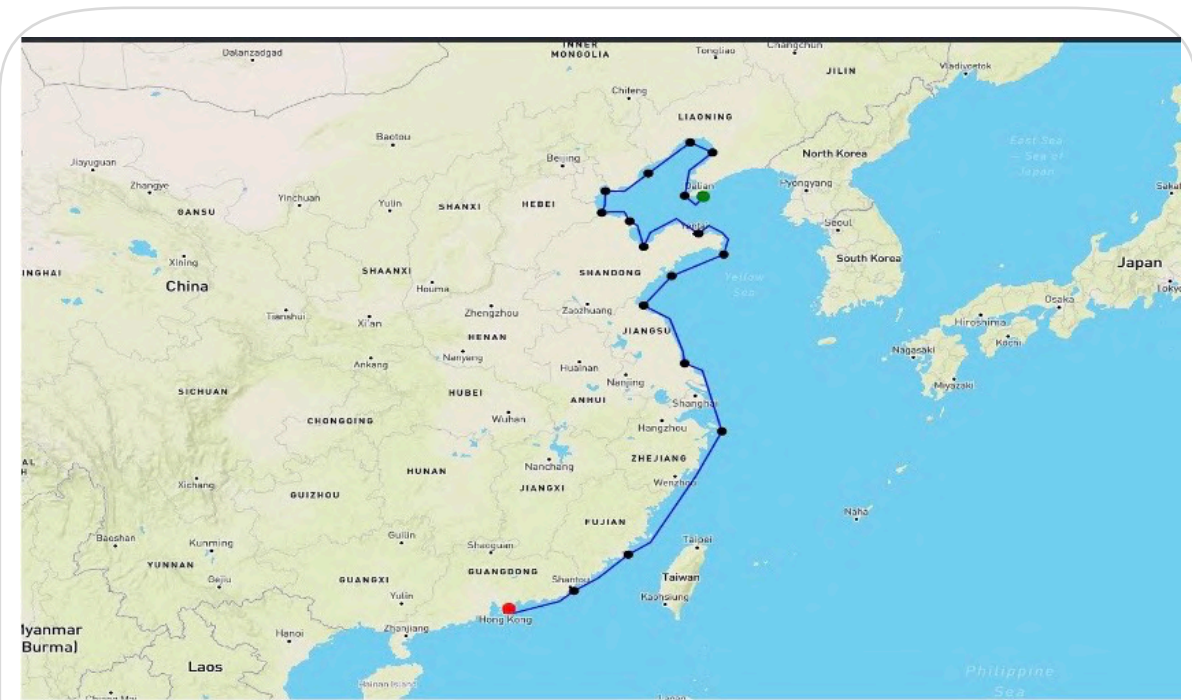
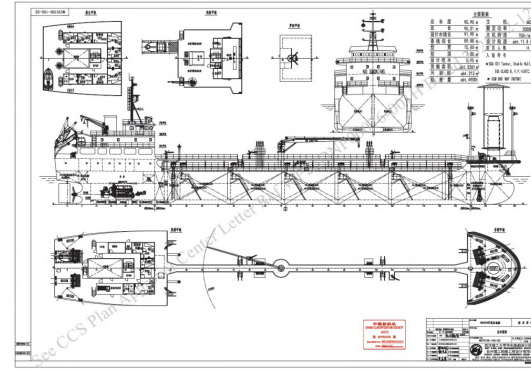
- **Shipowner can get revenue by fuel saving**

As the figure on the left, from the Flettner rotor calculator of Lloyd's Register (LR), the 82k DWT bulk carrier with 4 (four) 24m x 4m Rotor Sails can realize 8.8% of average net saving of propulsion power and fuel consumption (61.6 tons of monthly fuel saving, totally 739 tons of annual fuel saving and 2330 tons of annual CO2 emission) from Shanghai to Rotterdam, the pay back period for Dealfeng rotor sail is about 3-4 years.

Actual Installation Case

Newbuild 5000 DWT Product Oil Tanker

- The newbuild product oil tanker MV Zhong Ran 36 is China's the first vessel that will be equipped with Rotor Sail which is fixed foundation type.
- The rotor sail location is a classic arrangement at the bow of the vessel. At present, this solution has become the mainstream arrangement for Green energy-saving dual-fuel tanker.
- The estimated fuel saving, and emissions reduction are about 9% for this vessel, depending on the route and the wind condition.
- Dealfeng rotor sail will finish the installation in Oct. 2023.



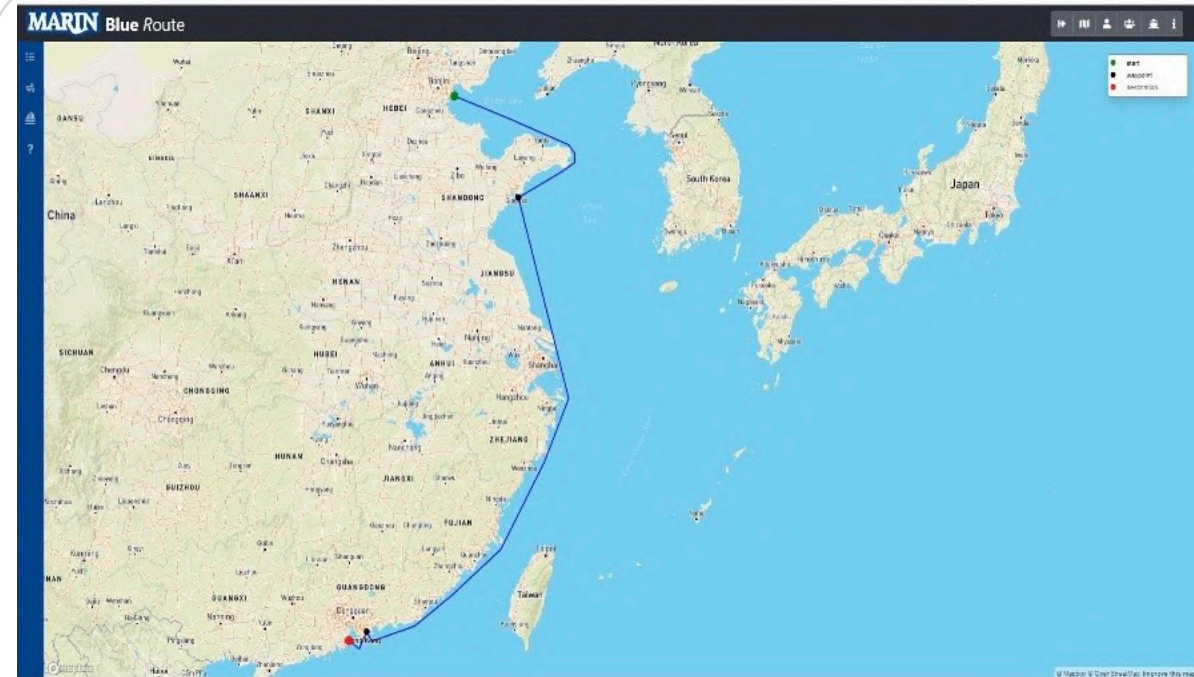
China coast shipping route: Dalian to Shenshen

Source: Marine

Actual Installation Case

Retrofitting on HYSY 225/226 Barges

- COOEC is a listed company controlled by China National Offshore Oil Corporation which is one of the worlds top 500 companies. It is the only large general contracting company in China with capacities to undertake the design, procurement, construction, offshore installation, commissioning and maintenance of offshore oil and gas development projects, as well as the liquefied natural gas, offshore wind power, refining and chemical projects, etc. It is also one of the largest and the most competitive EPCI contractors of offshore oil and gas projects in the Asia-Pacific region.
- It will be equipped with two (2) sets 4x18m Dealfeng Rotor Sail on the vessel HYSY 226 firstly.
- Dealfeng estimates the Rotor Sails will reduce the average fuel consumption and CO2 emissions from the vessel by approximately 10.5%. Rotor sails will be retrofitted in December 2023.



China coast shipping route: Tianjin to Zhuhai.

Source: Marine

THANKS !

DEALFENG

NO SMOKING

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