
Sustainability in ship operations in the era of Industry 4.0

Who we are

DANAOS and Research

- ✓ Fleet of 76 container ships
- ✓ Ranking among the top in the Greek shipping business.
- ✓ Strong invest in research and innovation
- ✓ Best-of-breed maritime software
- ✓ Participation in a number of EU projects (40+), funded under different EU research programs, with a strong motivation to apply innovation and creative thinking across all aspects of maritime operation.
- ✓ Member of FRANZ EDELMAN academy and winner of the homonymous award in 2012 (the highest worldwide distinction in applied operation Research).

Websites:

- https://danaosrc.com/
- https://www.danaosshipping.gr/
- https://www.danaos.gr/

Running Projects

Introduction - Main topics

- Updated outlook on drivers and regulations (GHG emissions reduction)
- Fuel availability & infrastructure to shift towards carbon-neutral operational blueprint
- Shipping in the era of digitalization; Technological advancements. Gap Analysis (SOTA & BEYOND)

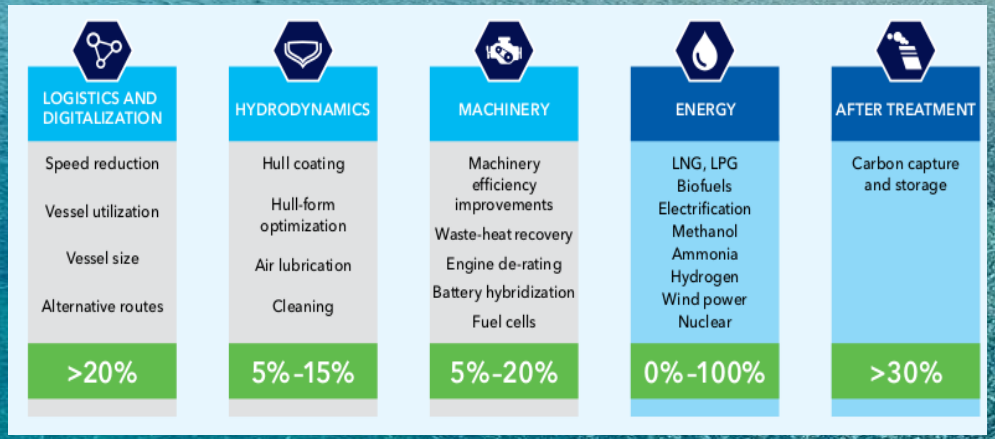
Decarbonization of the maritime sector -
Background, Motivation & Rationale

- The 2022 IMO mandated report for emissions reduction - Decarbonization of the shipping industry
- Well to Wake holistic supply chain optimization for GHG emissions reduction
- Growth of international trade, projected to almost double by 2035 and growing at a rate of approximately 3% per year until 2050
- Replace manual procedures concerning core & third party modules of the industry (shipowners, ports, suppliers, chartererers) with automated administrative workflows (Layer of transparency)

CO_2 emission across global shipping in 2015 & 2035 (projected)

Decarbonization of the maritime sector -
Outlooks & Drivers

GHG emission-reduction potential of technologies

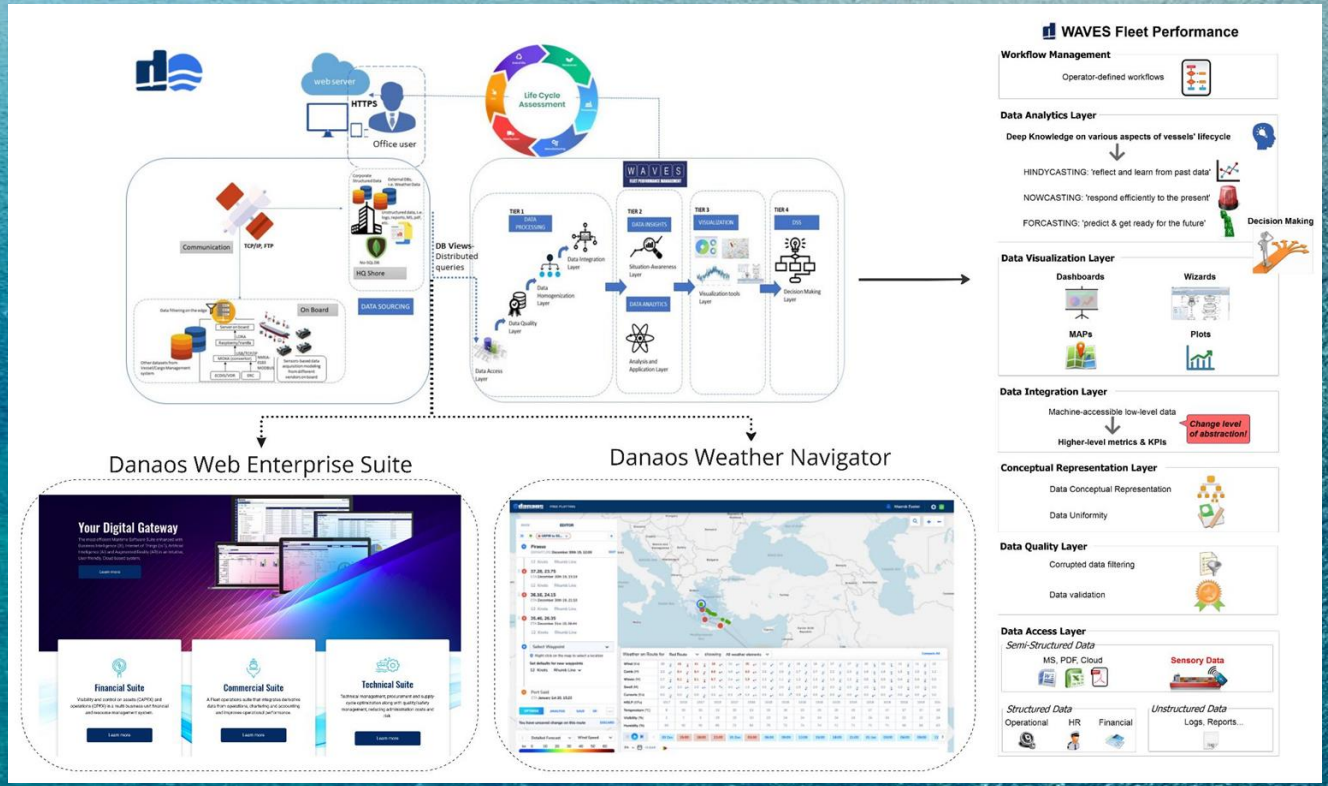


Current SOTA - Company infrastructure

DANAOS Functionality:

- Data acquisition network - Reporting : (***Danaos Application Suite*** / ***Waves***) *(SaaS - Multi Tenant Architecture)*
- Weather Routing Optimization: (***Weather Navigator***)
- Voyage Estimation – (Crewing, Cargo Handling, Bunkering, Freight): (***Danaos Application Suite***)
- Visualization - Causal Analysis - Predictive Maintenance - Post Voyage Analysis: (***WAVES***)

Current SOTA - Company infrastructure



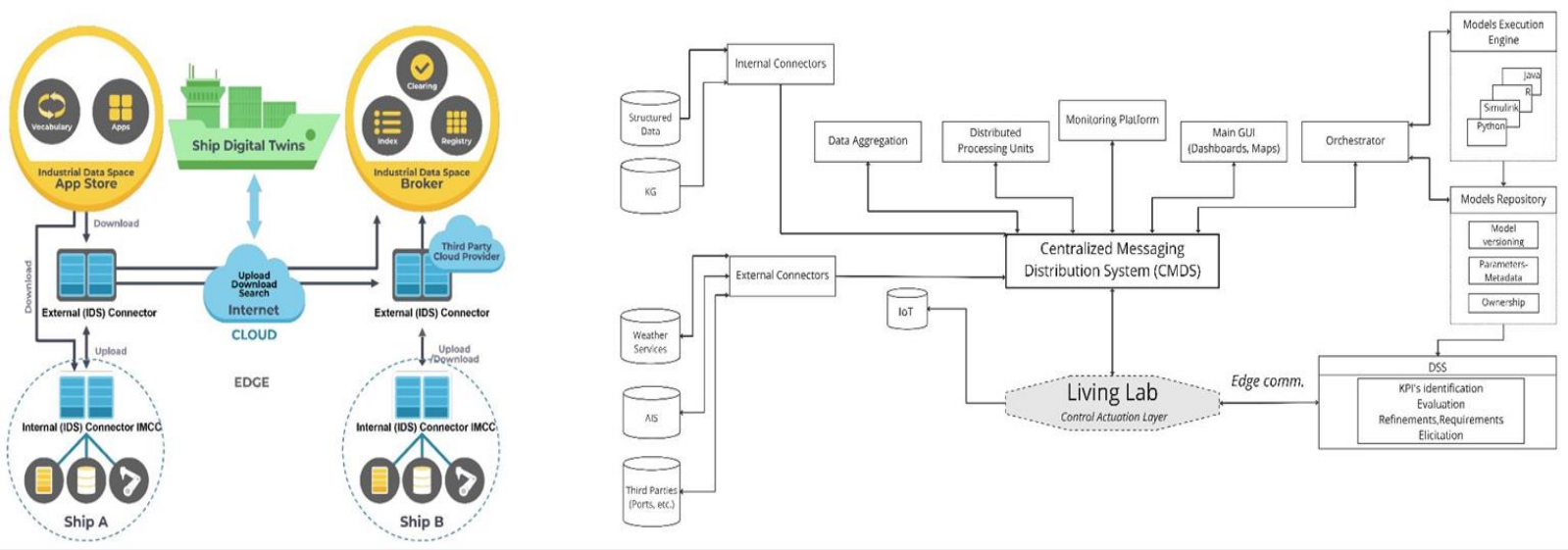
Tech trends & Beyond SOTA - Digital Twins for green shipping

A Digital Twin constitutes:

- Virtual holistic representation of the vessel that spans its life-cycle
- Updated from near to real-time data, utilizing simulation, machine learning and reasoning
- Decision-making, sensing and control actuation.

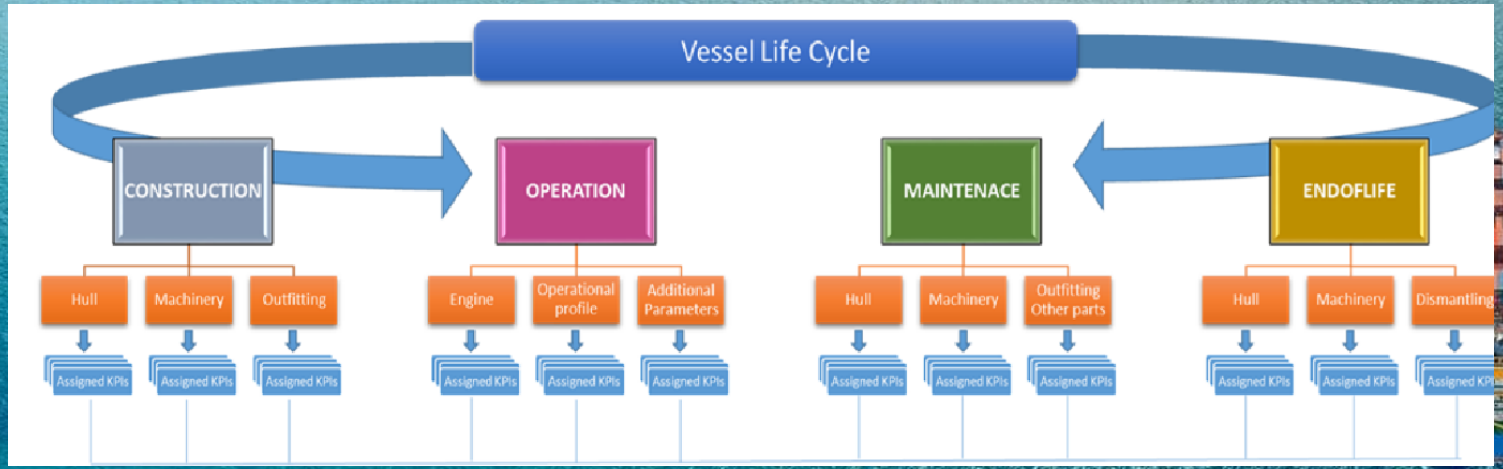
By combining core structural properties of traditional MIS and Digital Twin simulation capabilities, organizations can gain a better insight of their internal operations and pave the way for a fully automated and fault tolerant decision making procedure, facilitating towards a carbon neutral operational blueprint.

Tech trends & Beyond SOTA - Digital Twins for green shipping



Holistic representation of the envisaged DT framework

Tech trends & Beyond SOTA - Static Life Cycle Assessment (LCA)



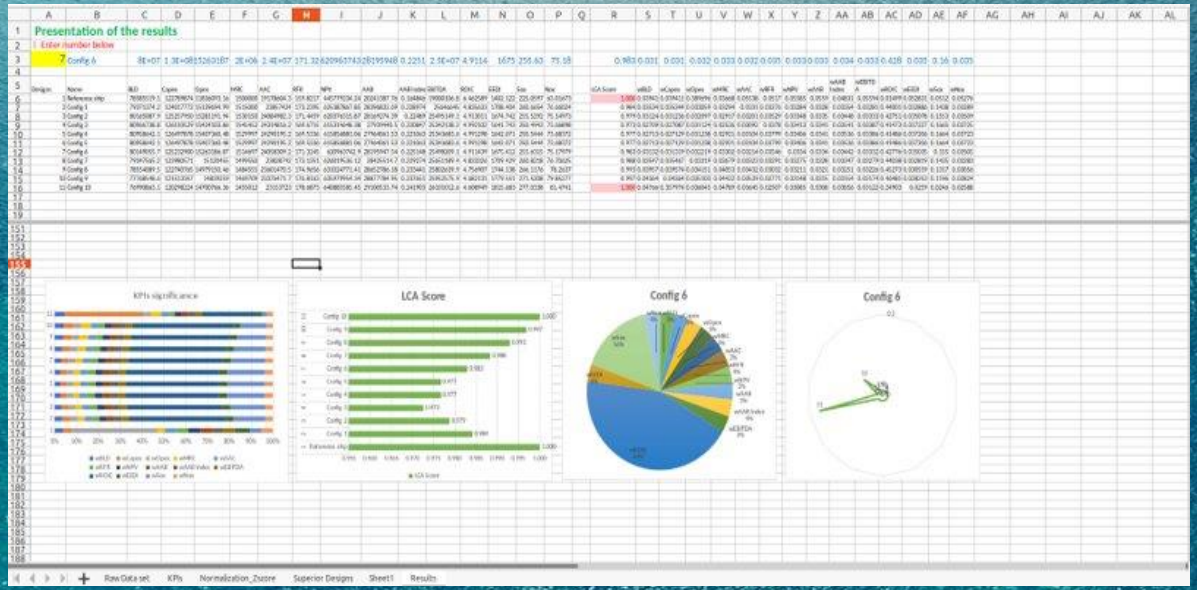
Tech trends & Beyond SOTA - Static Life Cycle Assessment (LCA)

Table 3: Features - KPI's - Calculation

Features	Indicators	Calculation
F_t		
SFOC	CO_2	$P * SFOC * EF_{CO_2}$ (1)
DWT	NOX	$P * SFOC * EF_{NOX}$
AUX/E	SOX	$P * SFOC * EF_{SOX}$
STW	OPEX	
DRFT	CAPEX	
M/E	EEOI($\frac{gr}{tn*mile}$)[1]	$FOC*EF_{CO_2}/M_c*Dist$
Pr_p	FOC	see section 3.1.4
Pr_d	$EEDI_{required}$	$a * b^{-c}$
F_t	$EEXI_{required}$	$(1 - Z/100) * EEDI_{ref}$
RPM_{ME}	$CII_{required}$	$(100-Z)/100*CII_{Ref}$ (1)
P	AER	$FOC*EF_{CO_2}/DWT*Dist$

KPI Calculation

Multi- constraint optimization

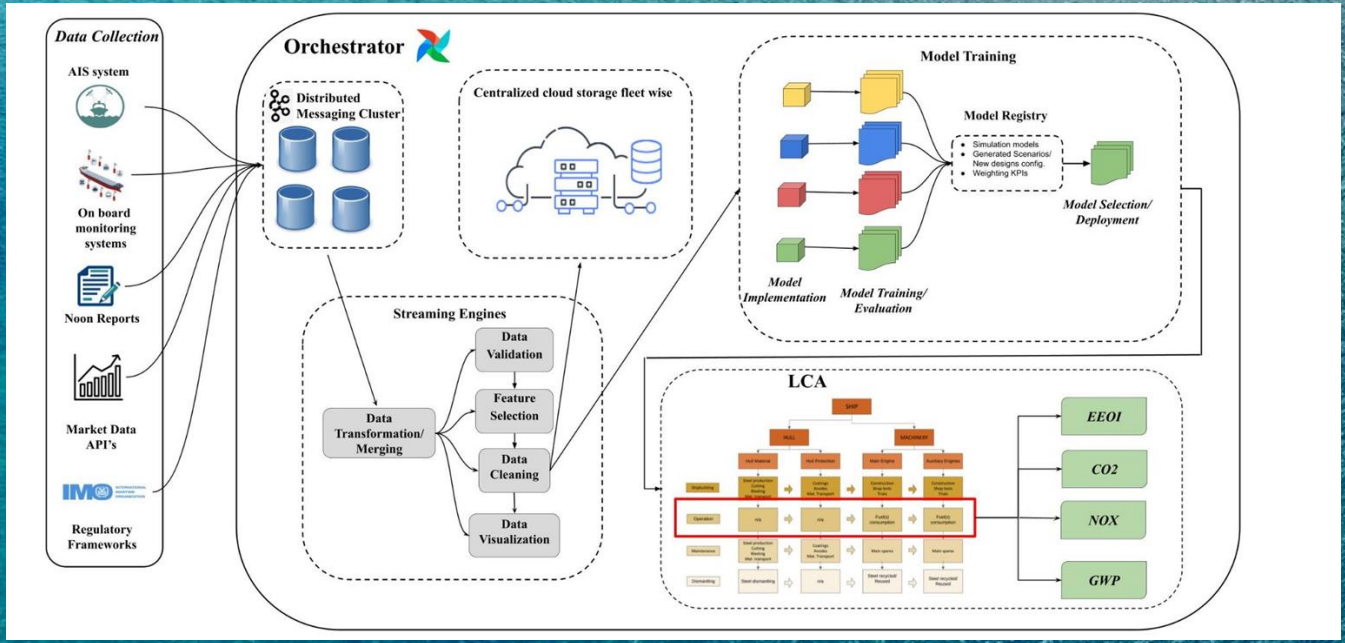


Evaluation of possible scenarios
(Financial & Environmental assessment)

Tech trends & Beyond SOTA - Dynamic LCA

DLCA - “Static LCA extension”

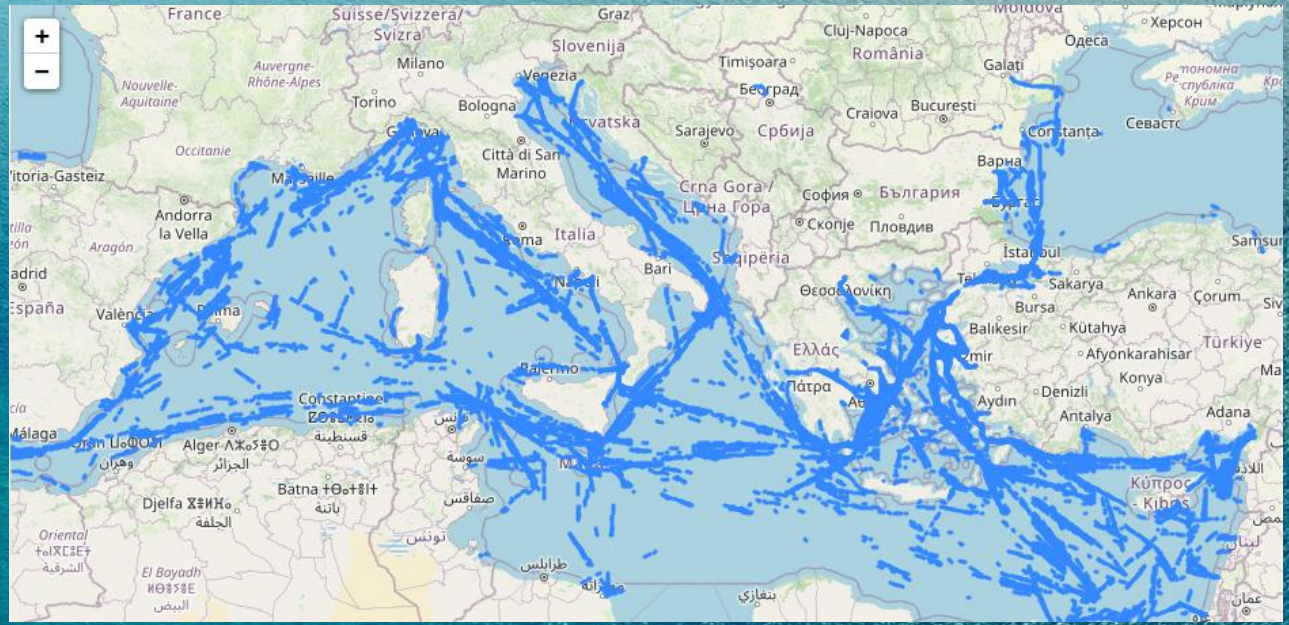
- Employ an LCA ecosystem; Updated from real time information (operational data, market analysis, regulatory frameworks)
- Dynamic Weighting factors (depending on current vessel state, tech trends & new regulations)
- Utilization of automated workflows to generate appropriate scenarios (retrofitting, new design, operational /CII optimization) depending the vessel & the desired outcome



Envisaged DLCA pipeline

Tech trends & Beyond SOTA - Trajectory Mining

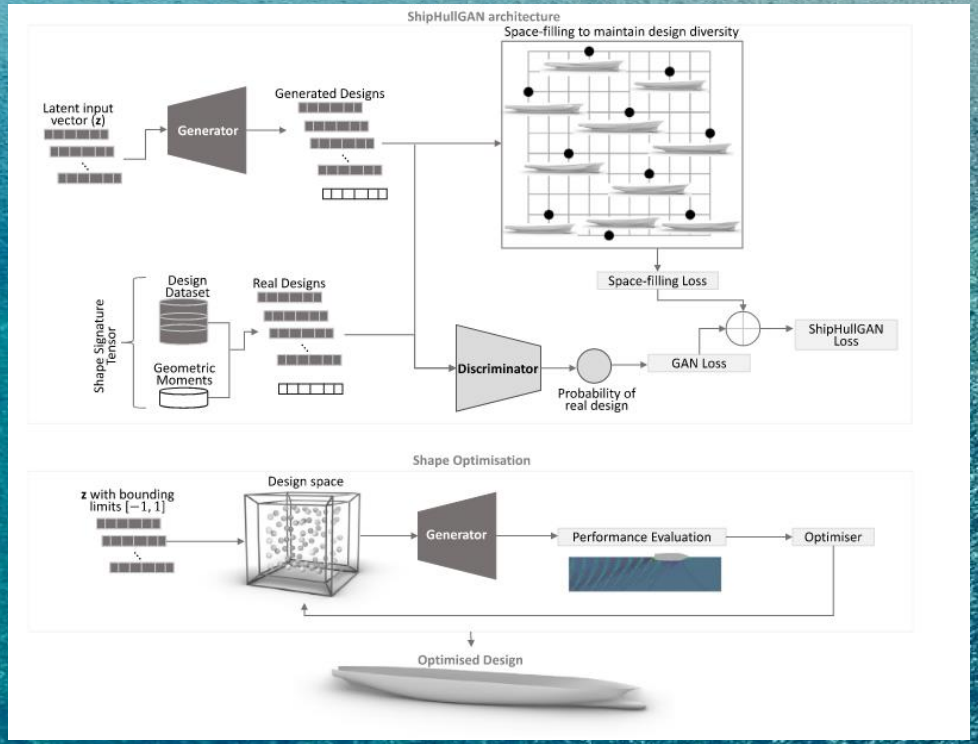
- Utilizing repository of past trajectories (AIS) build a Black Box that suggest routes based on a set of constraints (ambient weather conditions, ETA, Emissions, traffic congestion, etc)



Tech trends & Beyond SOTA - New Build Design utilizing GANNs

- Utilizing Generative models to ideally combine existing ship designs to propose new alternative ***"optimal"*** designs

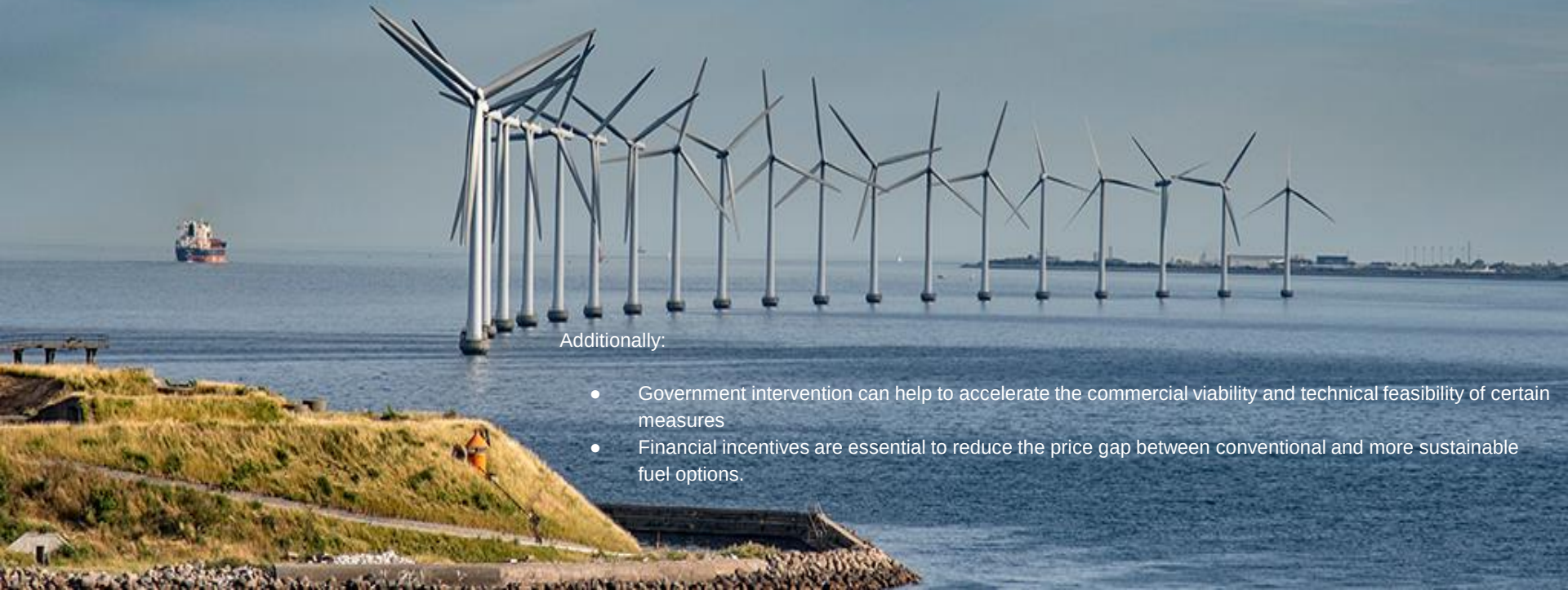
By Shahroz Khan, et. al



Conclusions & Future steps

The feasibility of international shipping decarbonization depends on:

- The formulation of possible decarbonisation pathways, that will result to the required CO2 emission reduction ranging from 82-95% by 2035.
- Required reductions could be realised via alternative fuels and renewable energy.
- Technological measures are available to increase the energy efficiency of ships and could yield a substantial part of emission reductions.



Additionally:

- Government intervention can help to accelerate the commercial viability and technical feasibility of certain measures
- Financial incentives are essential to reduce the price gap between conventional and more sustainable fuel options.