TOWARDS ZERO-EMISSION SHIPPING

Jorrit Harmsen

TNO innovation for life

AN INTEGRATED APPROACH ON EMISSION REDUCTION: SETTING COURSE TOWARDS THE IMO CLIMATE AGREEMENT

COP21 – PARIS

Pressure on GHG reduction

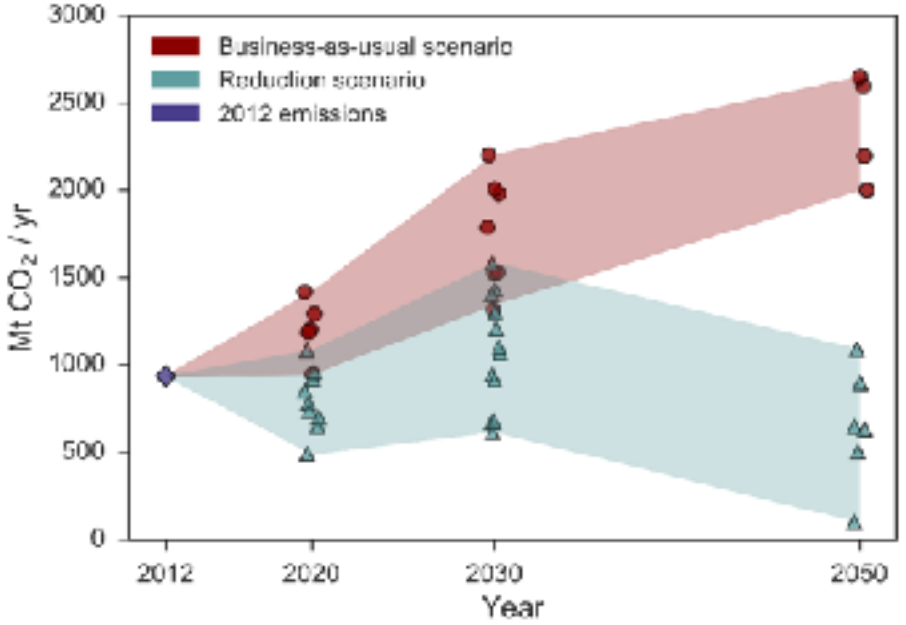
90% CO_2 reduction needed in order to meet the Parish targets

IMO AGREEMENT 2018

- Cut CO_2 by 50% in 2050 compared to the level of 2008
  - Improve overall efficiency by 40% in 2030 and 70% in 2050
  - Improve CO_2 performance of new build shipping

SUSTAINABILITY AND MARITIME

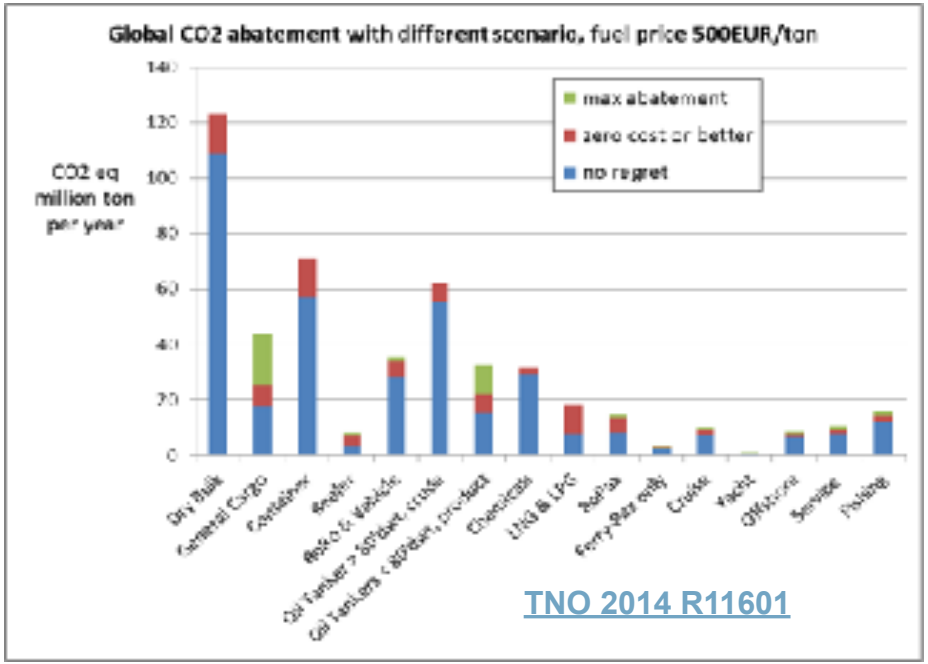
- Cut CO_2 by 50% in 2050 compared to the level of 2008
- What if we don't?
- Coordinated focus, monitoring and support of the sector stakeholders is much needed in order to improve the environmental performance.



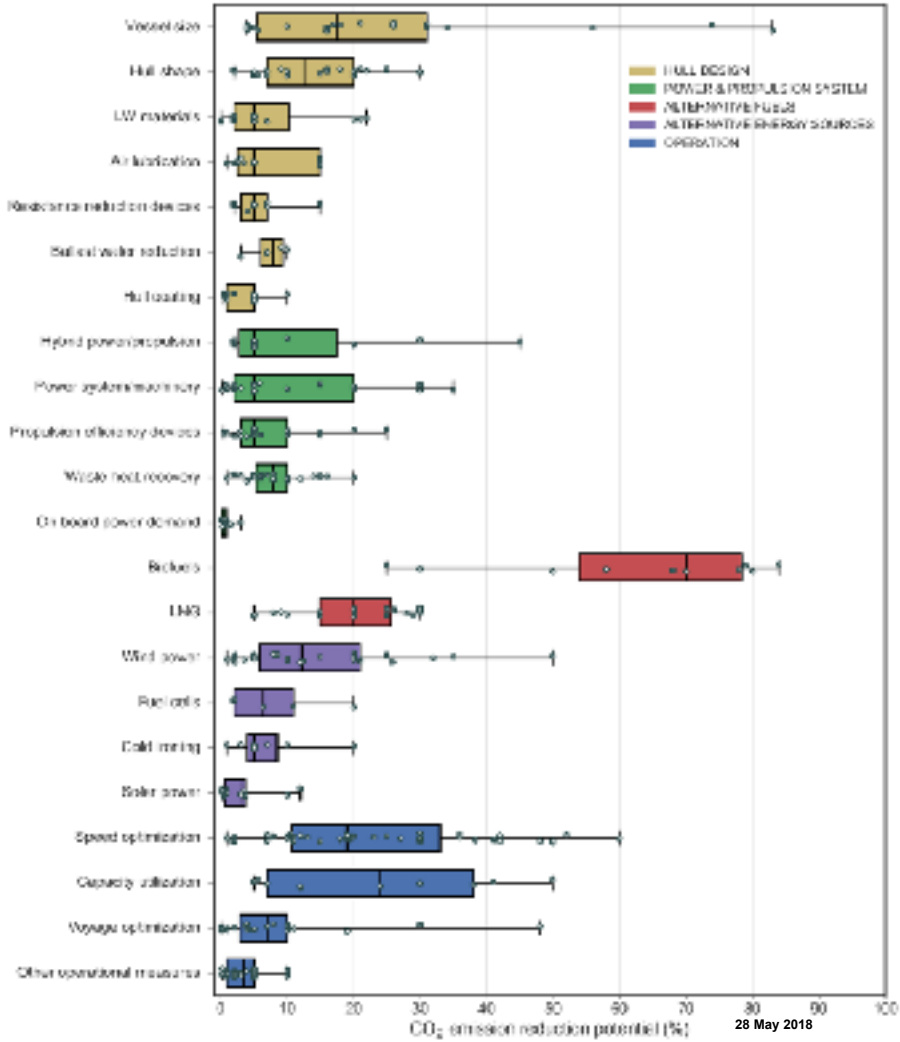
State-of-the-art technologies, measures, and potential for reducing GHG emissions from shipping – A review

Ewert A. Bouman[a,*], Elizabeth Lindstad[b], Agathe I. Rialland[b], Anders H. Strømman

POSSIBLE ABATEMENT OPTIONS



TNO 2014 R11601

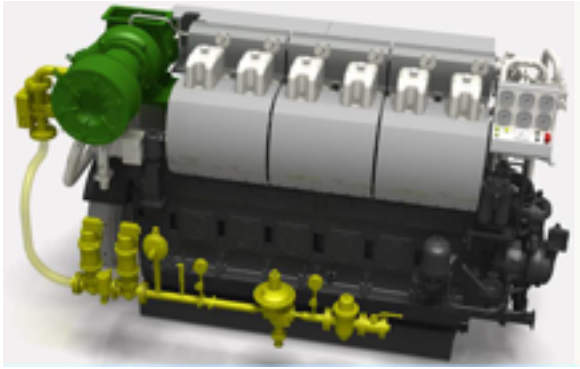


INTEGRATED MARITIME EMISSION REDUCTION APPROACH

Prerequisites	Abatement options / Operational profile	Hull Design and life cycle	Propulsion systems	Energy carriers	Pre/post-processing	Operations
▪ **Emission goal!!** ▪ Emission Monitoring ▪ Objective appreciation ▪ Financing	**Deep sea**					
	Short sea					
	Inland					
	Maritime services					
External influences (e.g. energy sector, political pressure, multimodal)						

IMO 2018

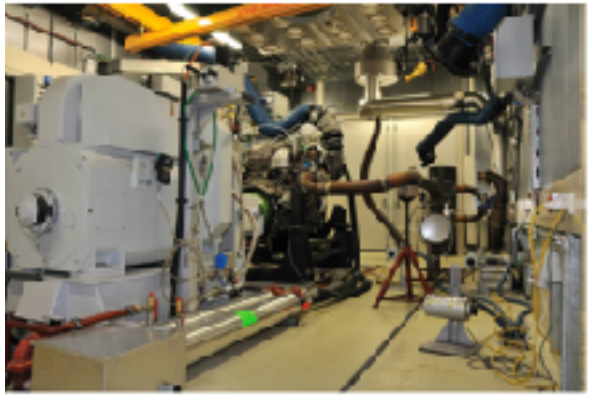
DEVELOPMENT OF NEW PROPULSION SYSTEMS



DEVELOPMENT OF PROPULSION SYSTEMS

- Goal: Research and validation propulsion systems that are attributing to the IMO 2018 target.

- Example project:
  - At the TNO Powertrains Test Centre Helmond:
    - TNO has developed and tested a new duel fuel engine concept: Reactivity Controlled Compression Ignition (RCCI)
    - The benefit of RCCI is ultra low Nox and improved efficiency
  - Virtual engine concepts development
    - Rightsizing of the power drive line
    - Digital modelling of new driveline concepts



DEVELOPMENT OF NEW ENERGY CARRIERS

ULSFO bunker fuel price soars to record level on strong futures market

London (Platts)--28 Sep 2017 820 am EDT/1220 GMT

Ultra low sulfur bunker fuel in Rotterdam has hit the highest assessed level since the 30P Global Platts assessment began in September 2015, supported by strong gains in futures over the last few weeks.

THE OXFORD INSTITUTE FOR ENERGY STUDIES

OXFORD

Updated and revised: March 2016

The LNG Shipping Forecast: costs rebounding, outlook uncertain

Biobrandstof voor elk schip in de Rotterdamse haven

Eerste cruiseschip op waterstof is dichterbij dan je denkt

Viking Cruises werkt aan de introductie van waterstof-brandstofceltechnologie op zijn cruiseschepen. Het bedrijf wil 's werelds eerste scheepvaartbedrijf zijn dat een cruiseschip op vloeibaar waterstof naar de markt brengt.

Order Placed for 4 More Methanol Bunker-Powered Vessels

DEVELOPMENT OF ENERGY CARRIERS

- Goal: Determine the optimal energy carrier for the different maritime operational profiles by 2020 towards the IMO 2018 agreement.

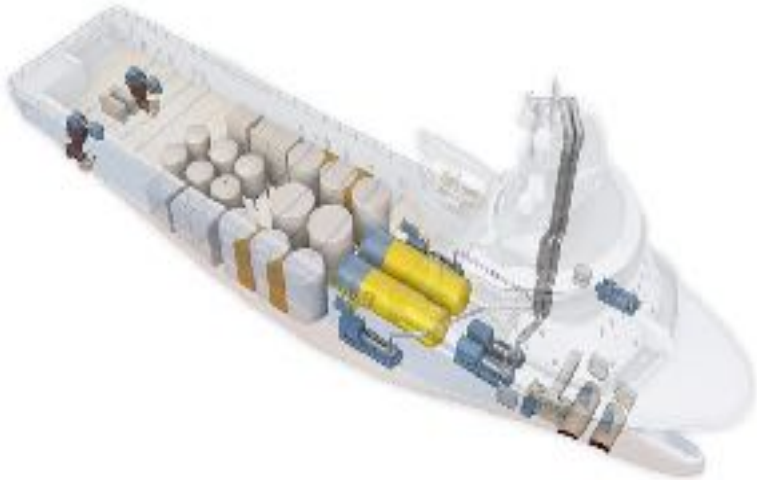
- Example projects:
  - Research on fuel production and chain analysis (power2X, H_2, NH_3)
  - Research on safe storage and transfer of alternative fuels
  - Cross-comparison of different fuel pathways
  - Assessment on economic, operational and environmental business cases

❖ Currently ongoing project development for Methanol within Short Sea Shipping (TU Delft, MKC and TNO)

DEVELOPMENT OF PRE/POST PROCESSING TECH

- Goal: Determine the optimal pre-post processing technology for the different maritime operational profiles by 2020 towards the IMO 2018 agreement.

- Example projects:
  - Carbon capture for LNG-fuelled cargo vessel
    - Energy efficient CO2 capture by making use of the engine heat and the cold of the LNG
    - Target: techno-economic feasibility study of CO2 capture, compression, liquefaction and storage onboard
  - Research on methane slip LNG



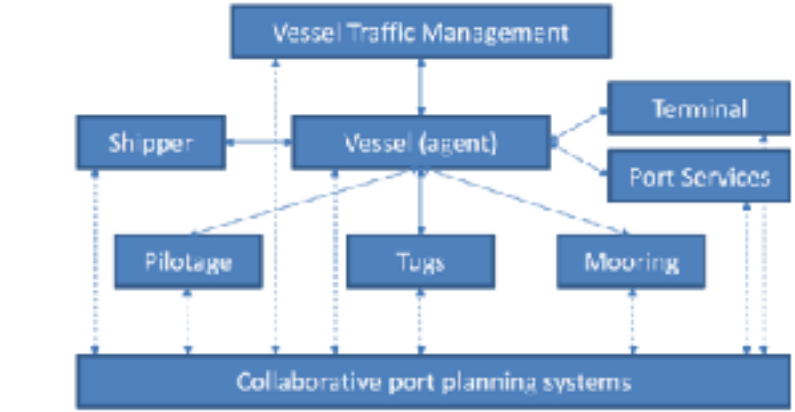
SUSTAINABILITY THROUGH DATA DRIVEN OPERATIONS

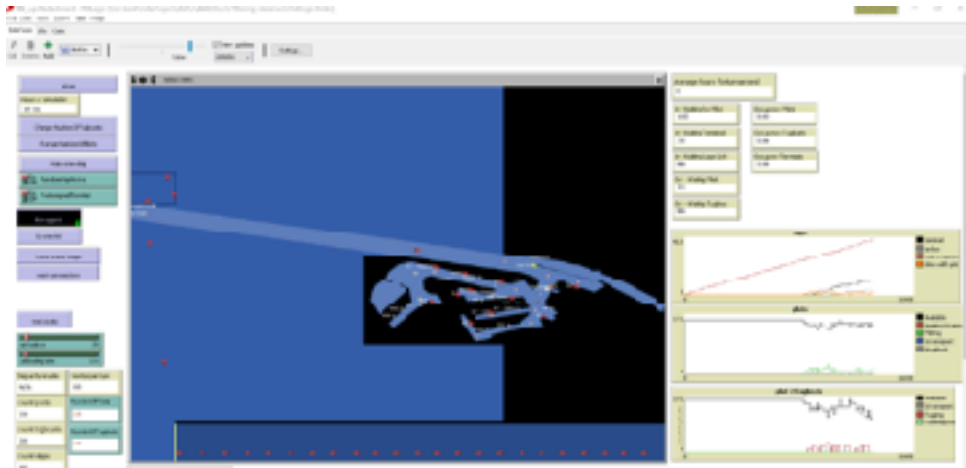
- Goal: improve fuel efficiency of stakeholders through better allignment of different stakeholders driven by data.

- Example projects:
  - Selforganisation in logistics and vessel traffic management (SwarmPort)
  - ETA Prediction seagoing vessels
  - ETA Prediction for efficient navigation for inland shipping (PROMINENT)
  - Synchromodal transport awareness via Serious Gaming
  - Roadmapping (Outlook International Freight)

SWARMPORT

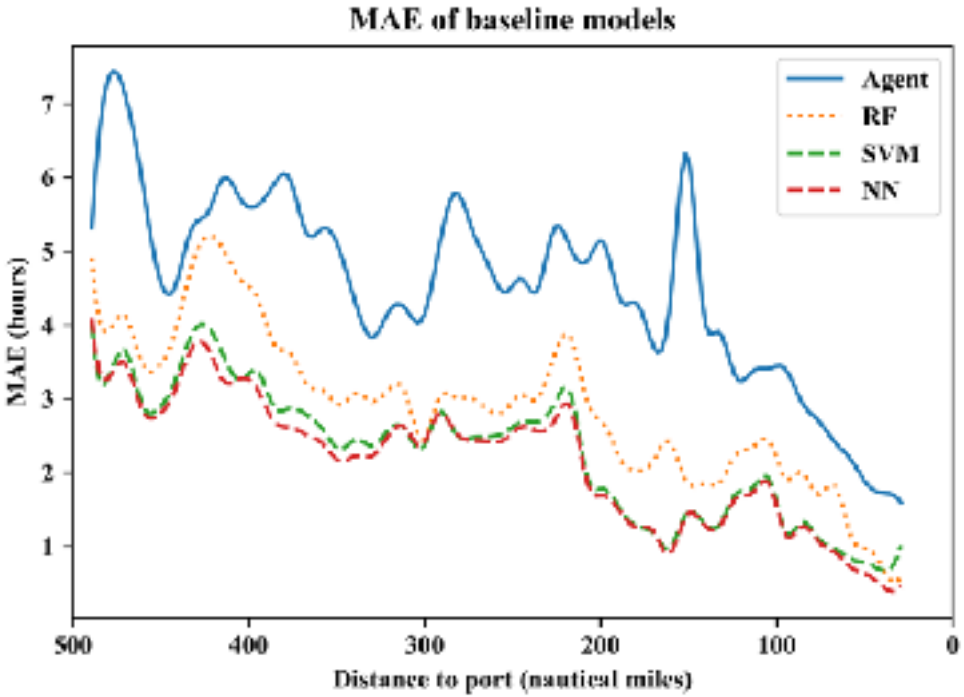
- Development of agent based modelling for nautical services in Rotterdam
- Aim is to be able to develop scenarios for improved efficiency of services
  - Lower iddle time of nautical services
  - Lower waiting times for vessels entering the port





ETA PREDICTOR SEAGOING VESSELS

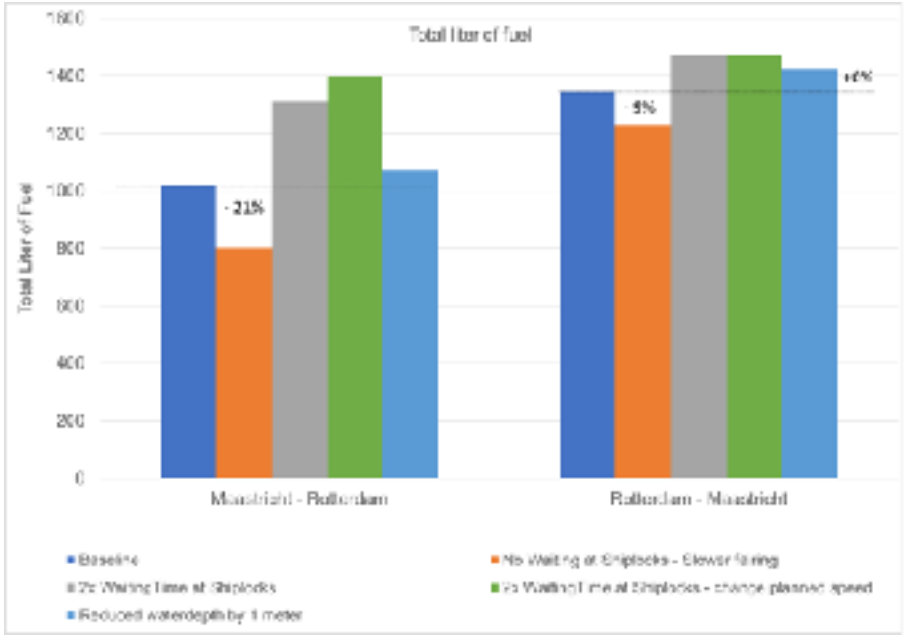
- Use of three data analytic methods for prediction of the ETA
  - Physical model for first part of the journey (AIS, weather, currents, planning deviations)
  - Neural network for second part of the journey (AIS, meteo, data of agent, data of contracts)
  - Machine learning (logbooks ship + 22 other data elements)
- Figure presents the mean error in the current ETA (blue) and the error of ETA using different methods.



EFFICIENT INLAND NAVIGATION TOOL

- Tool developed in PROMINENT in order to
  - Predict the ETA of vessels
  - give advice on the optimal sailing speed and RPM
- Tool uses combination of powertrain and ship design data of the vessel and detailed fairway data (currents, levels, etc)
- Furthermore scenarios on interaction with locks and terminals haver been designed.

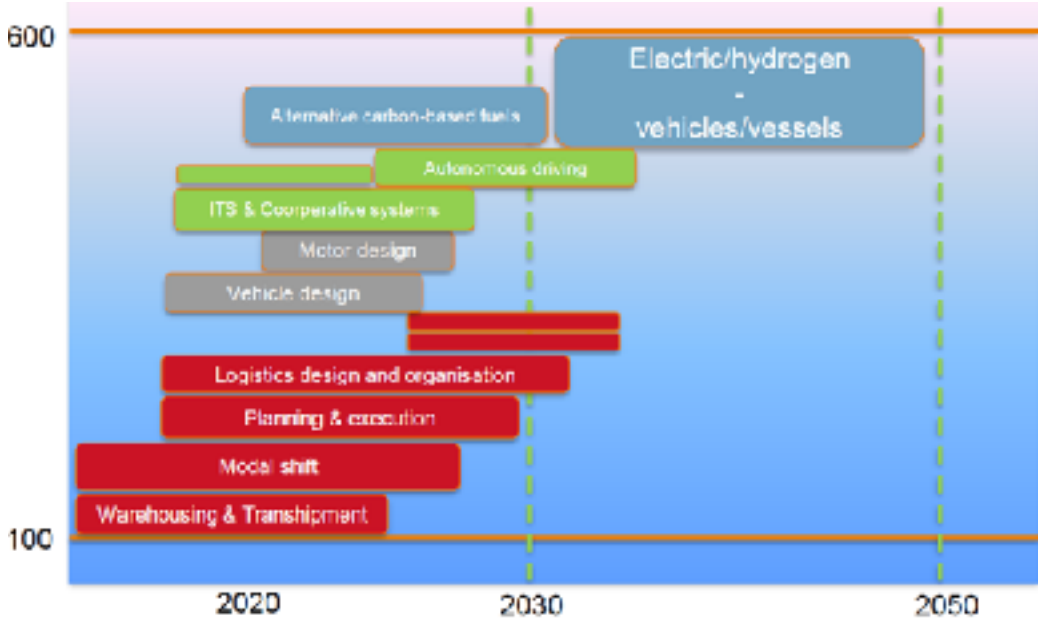
- The tool shows that CO_2 up to 20% are possible with the same ETA by improved ship performance and cooperation



ENABLING BEHAVIOURAL CHANGE: SERIOUS GAMING

- Serious Game – A game not only aimed at entertainment

OUTLOOK INTERNATIONAL FREIGHT



CONCLUSION

2020 Goal:
Together determine the course(s) per operational profile,
based on measured emissions and objectively validated solutions

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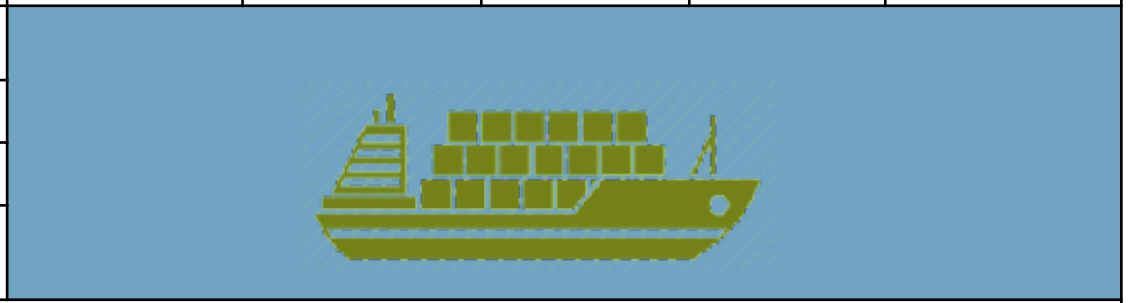
▪ **Emission goal!!** ▪ Emission Monitoring ▪ Objective apprecition ▪ Financing	**Deep sea**					
	Short sea					
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External influences (e.g. energy sector, political pressure, multimodal)						

THANK YOU
GREEN MARITIME PERFORMANCE
JORRIT
HARMSEN
TNO innovation
for life