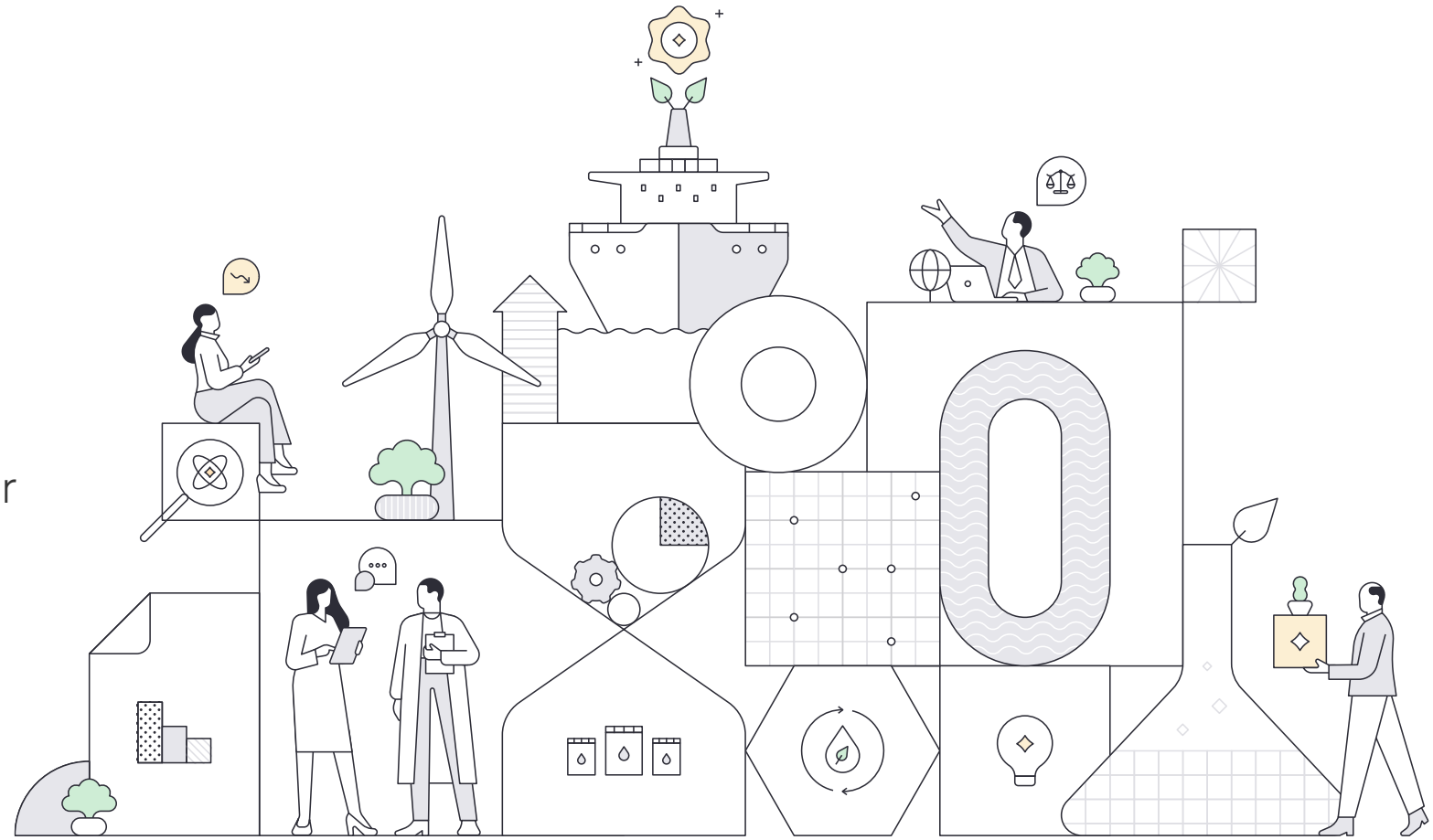
We show the world it is possible

Martin Skov Skjøth-Rasmussen
1st Nordic Roadmap Conference for Future Fuels
DNV Oslo - 15 Nov 2022

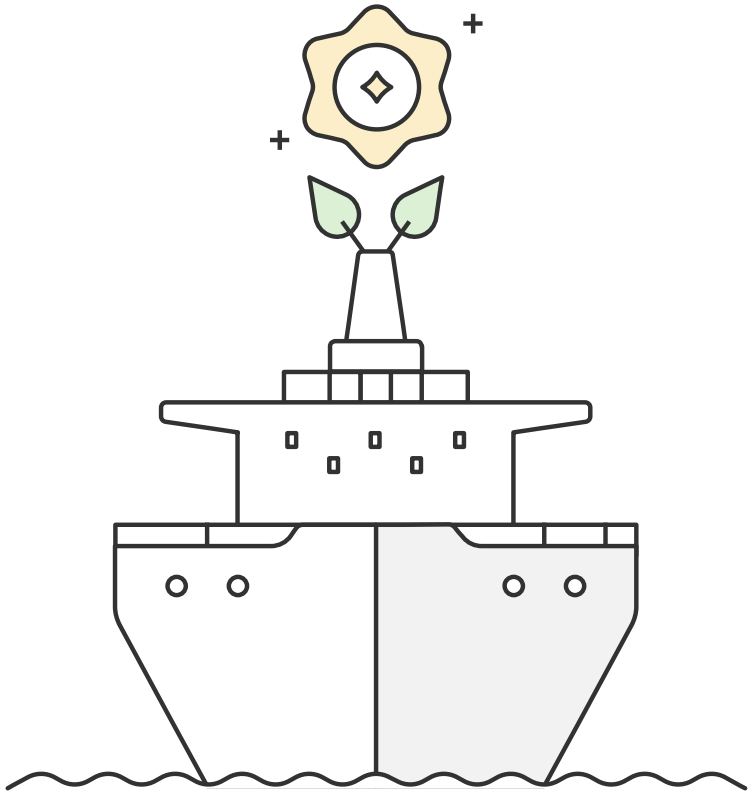
Initiate decarbonization of Nordic shipping through Green Corridors

North European – Baltic Green Corridor



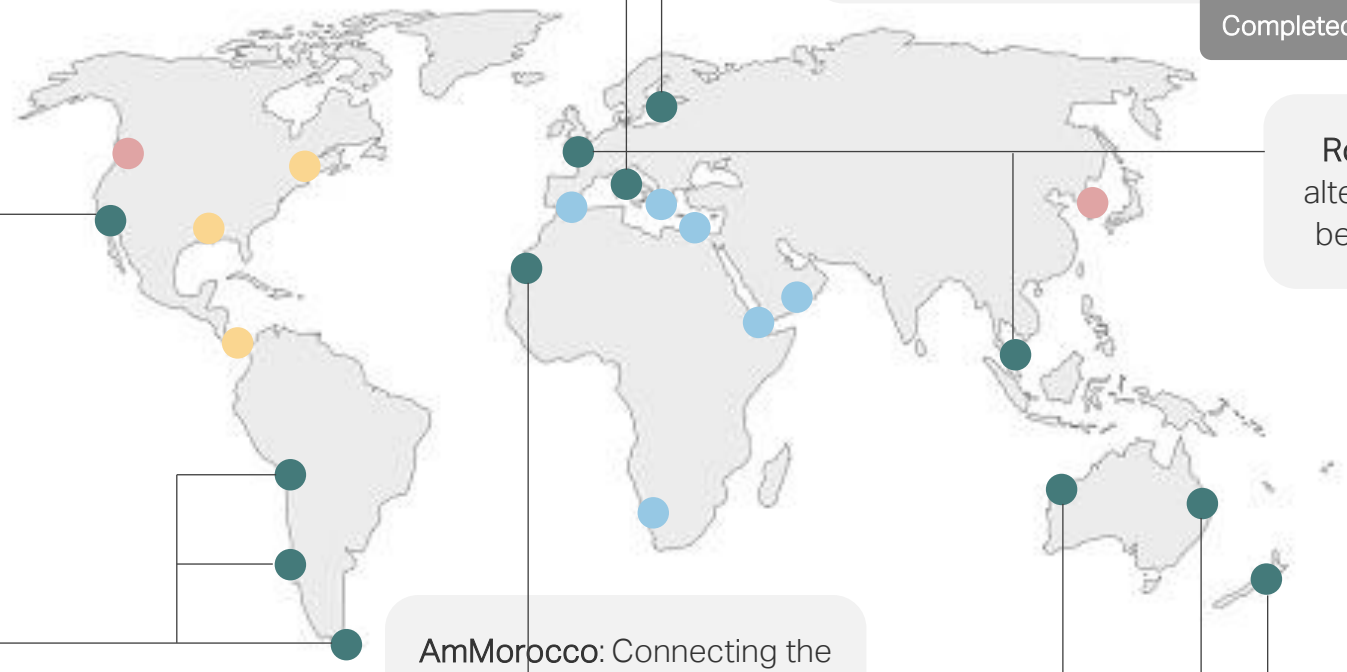
Our vision is to sustainably decarbonize the maritime industry by 2050

Our mission is to be an independent and significant driver of a sustainable maritime decarbonization



Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

Activities on green corridors - Blueprints, Ongoing and upcoming corridors



Planned Pre-Feasibility
Undecided
Center Projects
Screening ongoing

Ongoing Pre-Feasibility

Green Hydrogen Catapult: Possible deep sea green corridor out of Los Angeles / Long Beach

European Green Corridors Network: Possible green corridors in North Sea and Baltic Sea, as well as the Mediterranean region

Completed Pre-Feasibility

Rotterdam-Singapore: Options of alternative fuel for container vessels between some of the largest ports

Ongoing Feasibility

Chilean Green Corridors Network: Possible national and international green corridors out of Chile

Completed Pre-Feasibility

AmMorocco: Connecting the shipping value chain to P2X projects

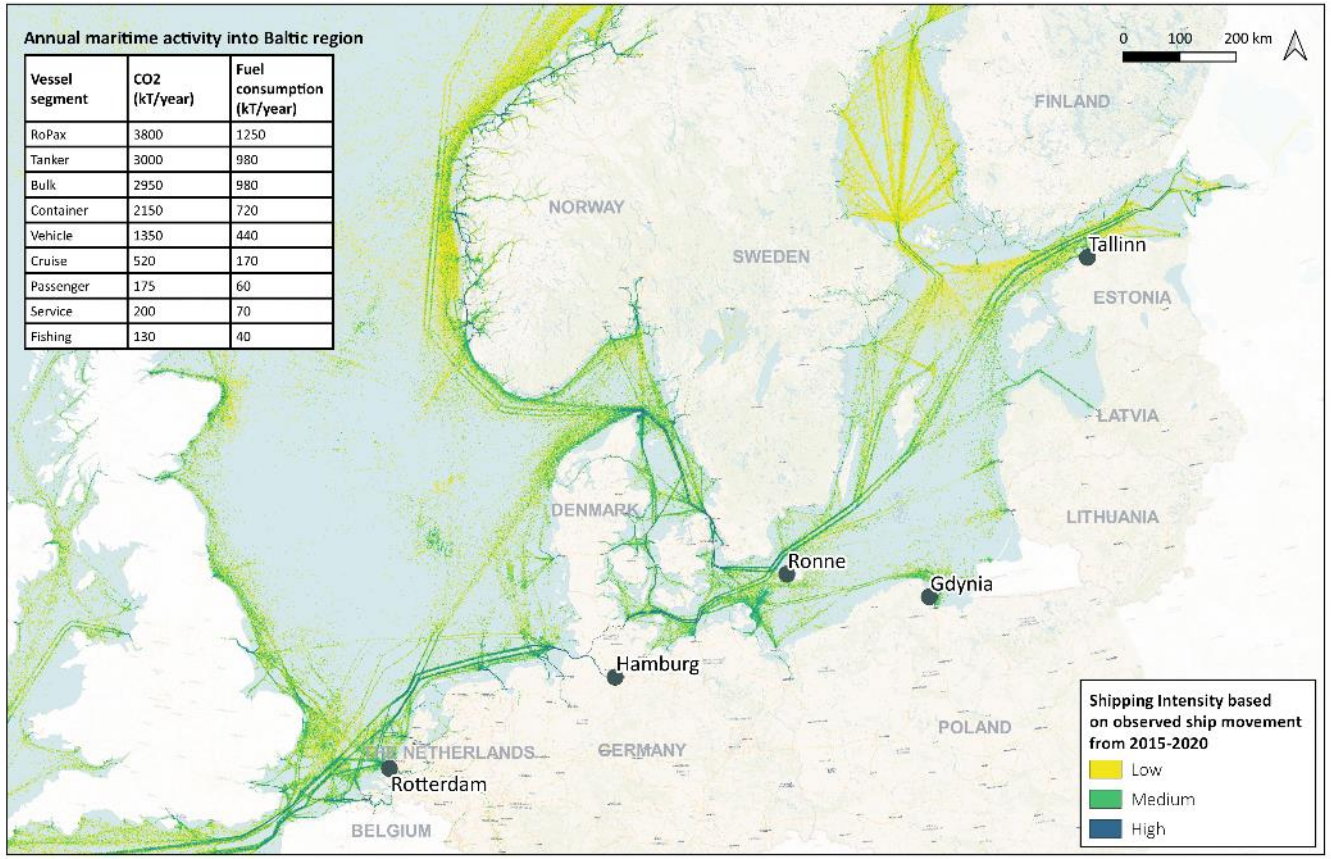
Ongoing Pre-Feasibility

Planned Pre-Feasibility

Australia-New Zealand: Continental options for producing alternative fuels and transport for use in relevant ports

North European – Baltic Green Corridor prefeasibility

Overview of Maritime Activity in the Baltic Region



Sources - Ports: World Port Index; Vessel Density - World Bank and IMF; Maritime Activity - Project Partners; Boundaries: EU NUTS; Basemap: OSM
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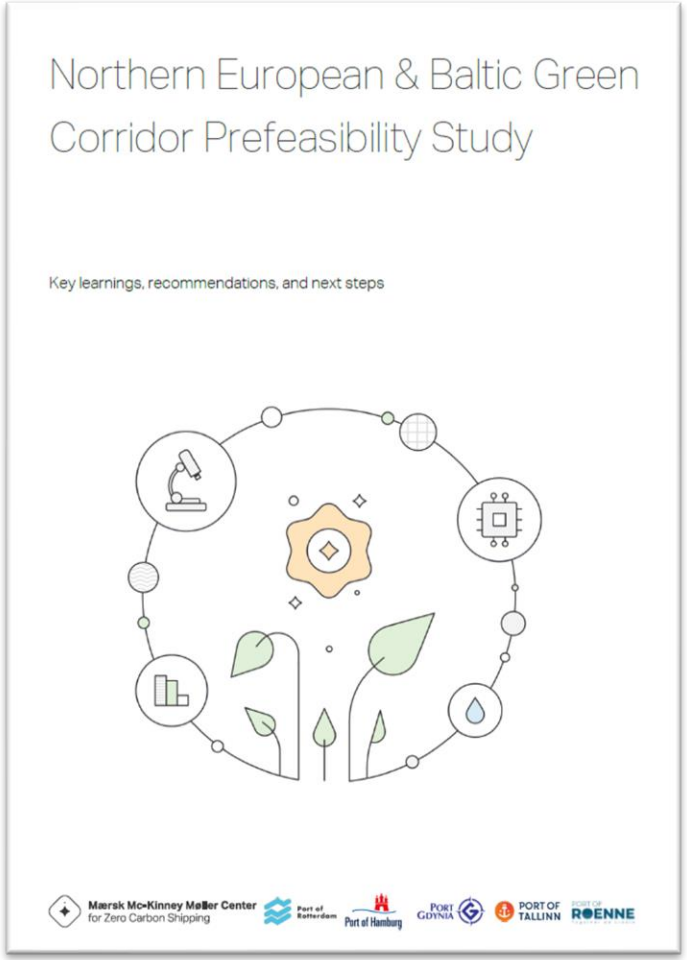
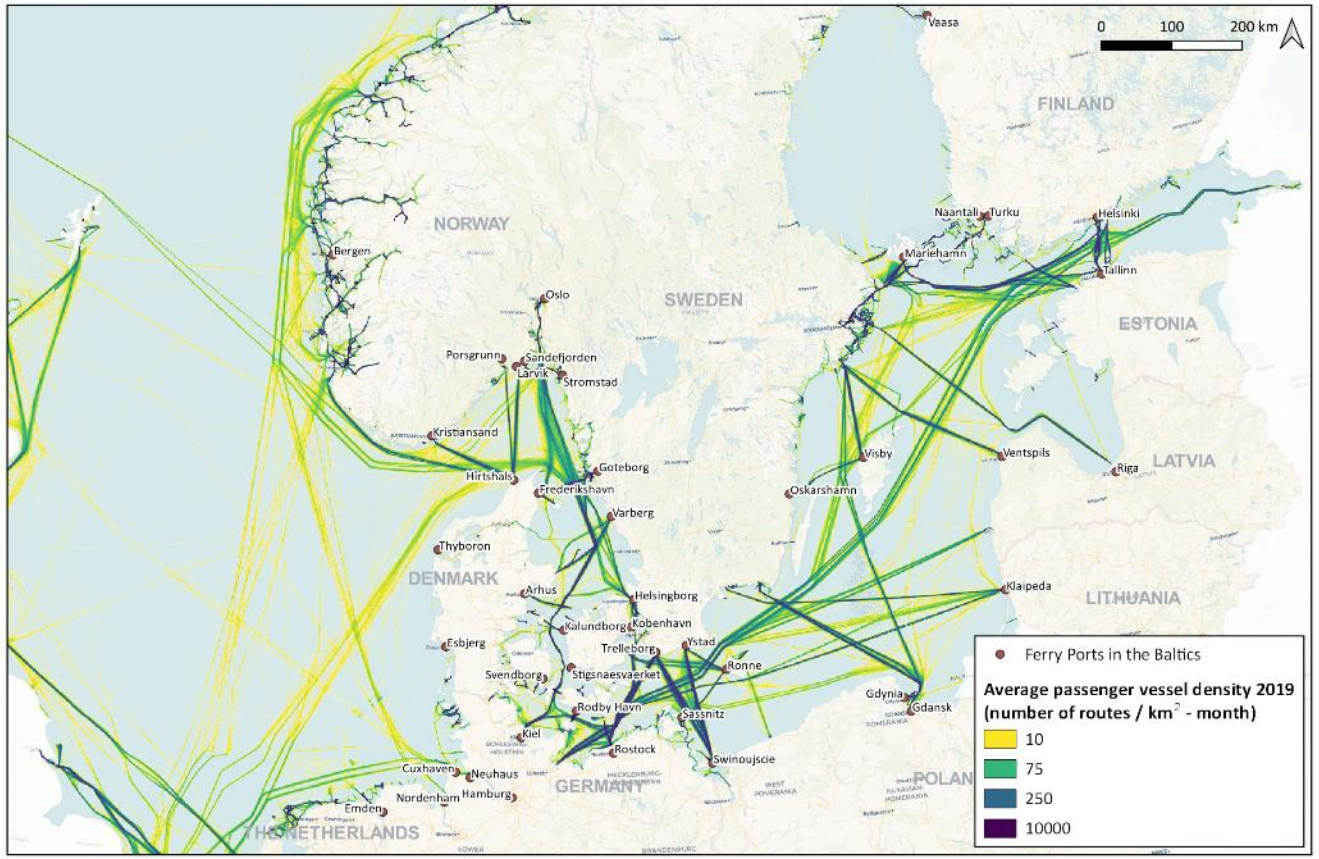


Report available from:
[Green Corridor in Northern Europe and the Baltic Sea | Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping]

Pre-feasibility analysis by:

Port Gdynia · Port of Rotterdam · Hamburg Port Authority · Port of Tallinn · Port of Roenne · Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

Ferry Vessel Traffic in the Baltics



Sources - Vessel Density Data: EMODnet; Passenger Data: Eurostat; Ports: World Port Index; Boundaries: EU NUTS; Basemap: OSM
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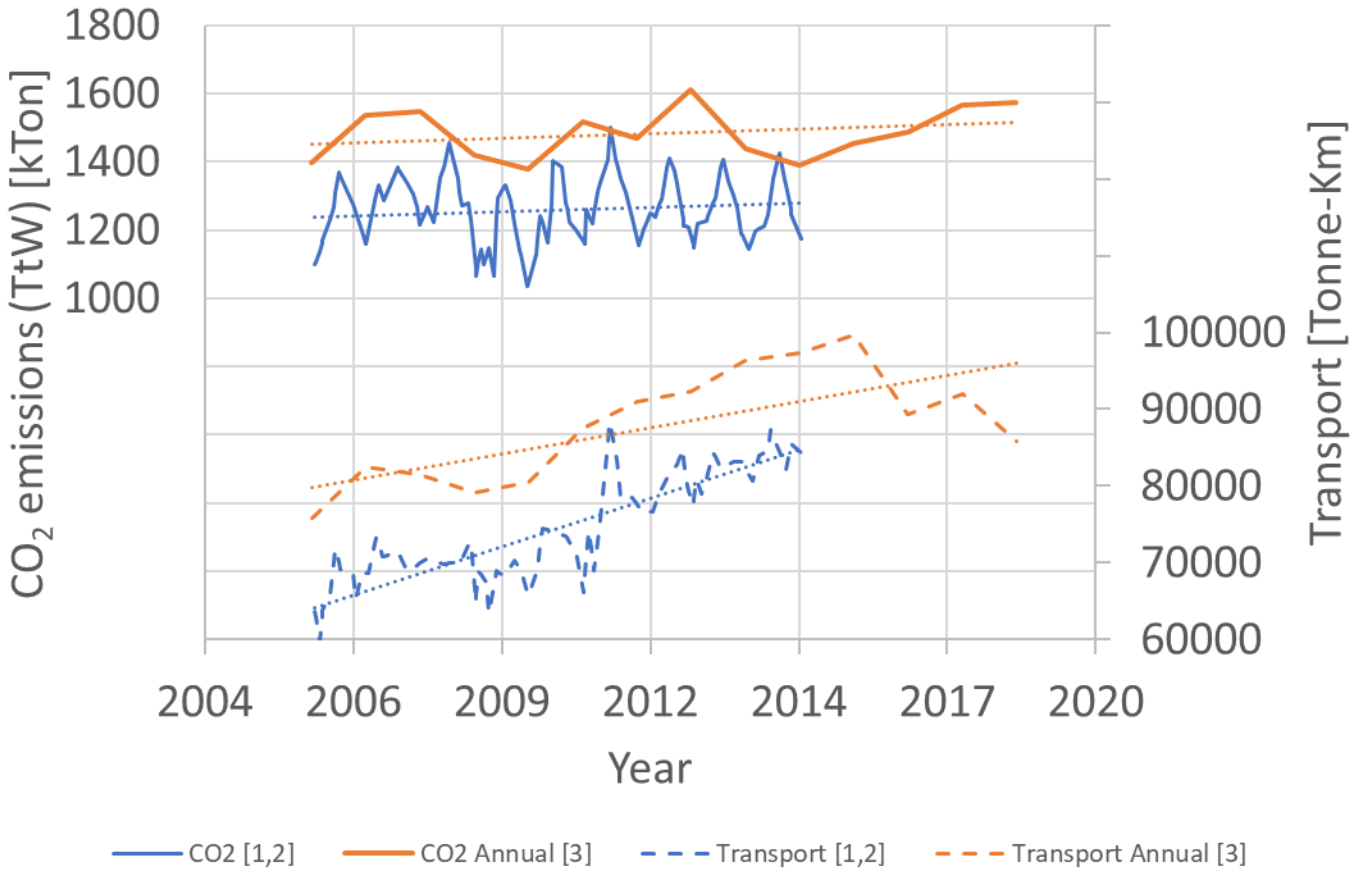
Pre-feasibility has addressed:

- Trade routes
- Vessel segments
- Fuel options and choice
- Port case:
  - Adaption of new fuels
- Stakeholder rounds
- Funding options

Activity levels consistent for decades

Measured in terms of CO_2-emissions and Transport work

Emissions from Shipping in the Baltic Sea, 2006-2014/19 (Reproduction from 1, 2 and 3)



1. Boteler, B., J. Tröltzsch, K. Abhold, M. Lago, T. T. Nguyen, E. Roth, E. Fridell, H. Winnes, E. Ytreberg, M. Quante, V. Matthias, J.-P. Jalkanen, L. Johansson, J. Piotrow, U. Kowalczyk, K. Vahter & U. Raudsepp (2015). SHEBA - Drivers for the shipping sector. SHEBA Project Report
2. Parsmo, R., B. Boteler, J. Troeltzsch, U. Kowalczyk, J. Piotrowicz, J.-P. Jalkanen, L. Johansson, V. Matthias & E. Ytreberg (2016, under review). SHEBA - Sustainable Shipping and Environment of the Baltic Sea Region. SHEBA Project Report
3. Emissions from Baltic Sea shipping in 2006-2019, Jukka-Pekka Jalkanen,, Maritime Working Group, Onlinel, 5 - 8 October 2020,

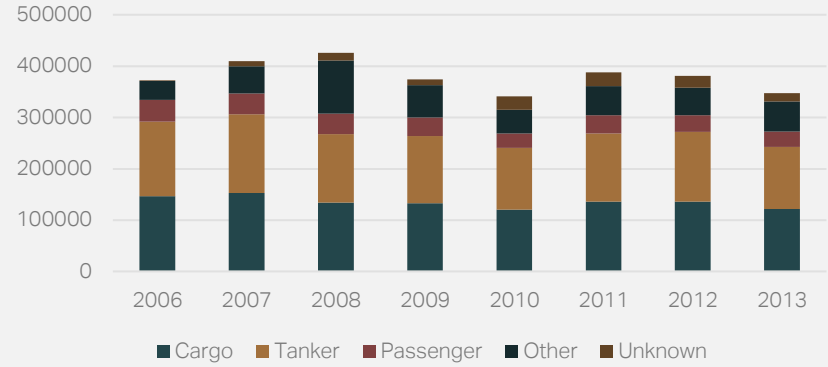
Region activity

Baltic Sea countries (including Russia) controls around 7000 cargo ships with gross tonnage > 1,000, ie.:

- 13% of the world fleet
- 35% of the EU-controlled fleet[1]

The EU-controlled fleet (including Norway) has expanded by more than 70% in the Baltic Sea region in the period 2005 to 2014 (both in GT and DWT) [1]

However, the total number of vessels decreased by 31% for the same period indicating a trend towards larger ship sizes, especially for the cargo transport[2]



Emissions and fuel consumption in the region by segment

Summary of fuel consumption and CO_2 emissions (TtW) for the Baltic Sea fleet during 2018[1]

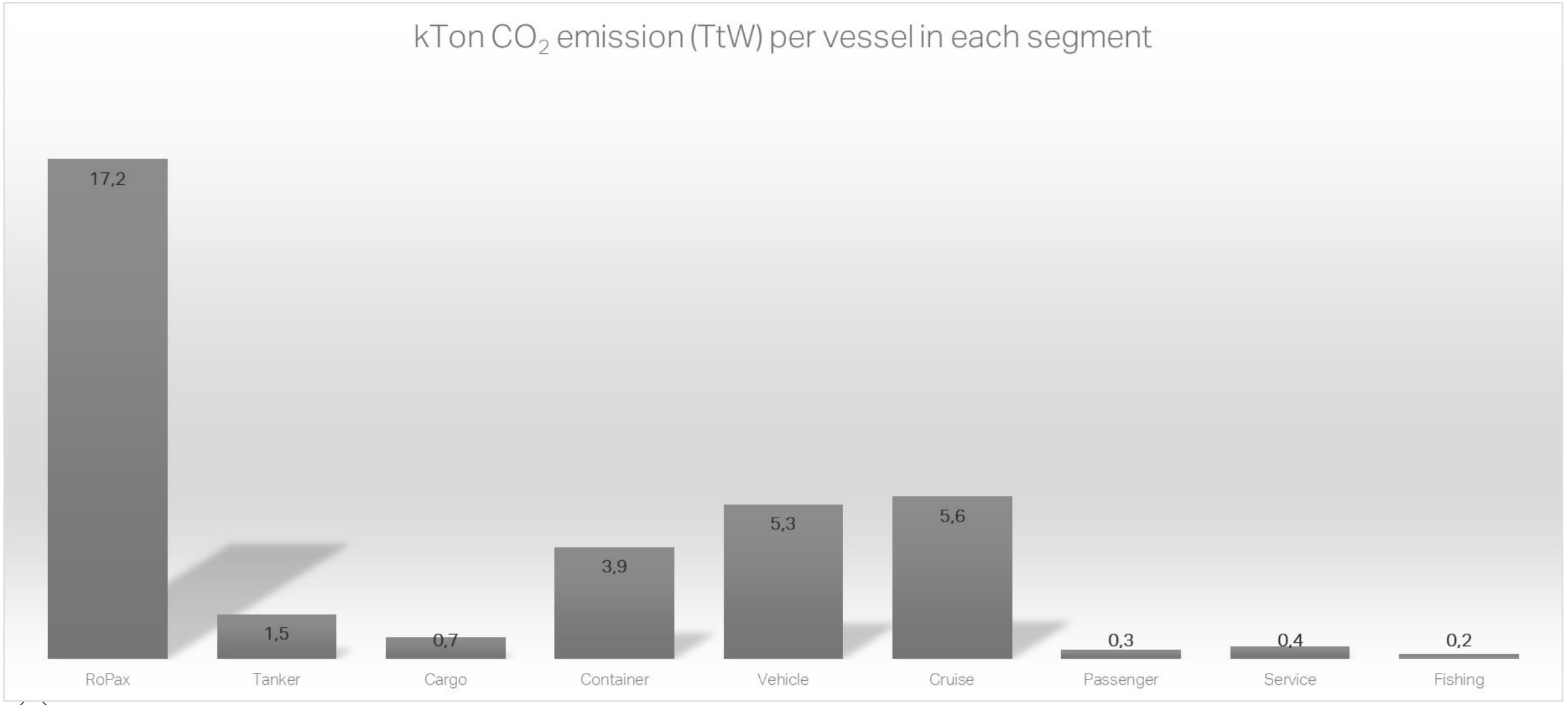
	RoPax	Tanker	Cargo	Container	Vehicle	Cruise	Passenger	Service	Fishing	Total
Ships (#)	218	1.911	4.011	607	259	94	470	401	801	8.772
Fuel Main (kT/yr)	1.053	628	706	495	391	138	29	23	22	3.485
Fuel Aux (kT/yr)	182	341	261	273	63	35	21	33	22	1.231
Total fuel (kT/yr)	1.235	969	967	768	454	173	50	56	44	4.716
CO_2 (kT/yr)	3.754	2.941	2.941	2.337	1.379	526	150	170	134	14.332

Summary of fuel consumption and CO_2 emissions for the Baltic Sea fleet during 2019[2]

	RoPax	Tanker	Cargo	Container	Vehicle	Cruise	Passenger	Service	Fishing	Total
Ships (#)	211	1.981	4.035	492	264	87	465	388	784	8.772
Fuel Main (kT/yr)	1.070	649	720	420	374	130	46	36	21	3.466
Fuel Aux (kT/yr)	181	363	274	247	62	39	25	41	21	1.253
Total fuel (kT/yr)	1.251	1.012	994	667	436	169	71	77	42	4.719
CO_2 (kT/yr)	3.804	3.074	3.021	2.027	1.325	515	217	233	130	14.346

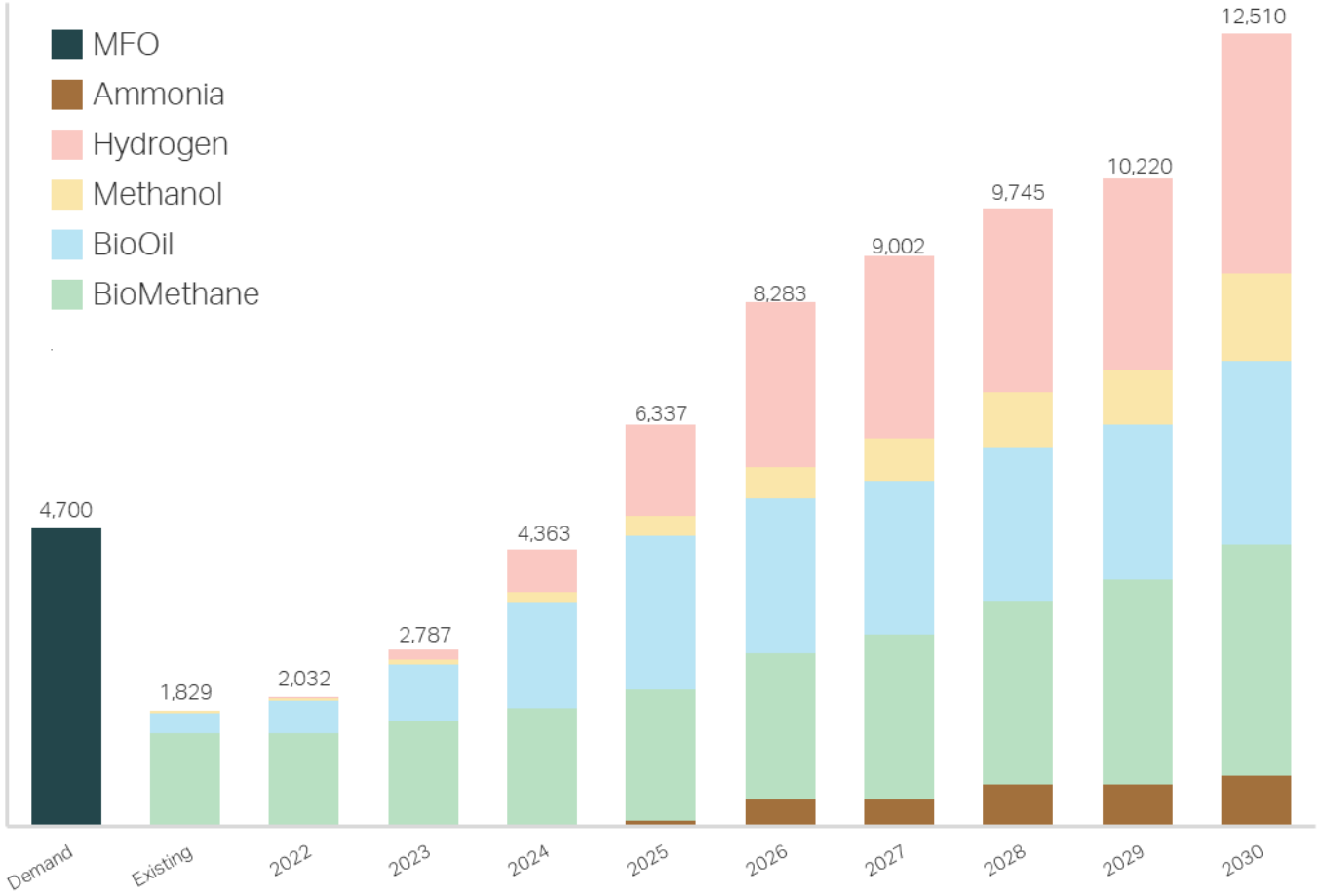
1. Emissions from Baltic Sea shipping in 2006-2018, Jukka-Pekka Jalkanen, Lasse Johansson, Maritime Working Group, Lisbon, Portugal, 23-26 September 2019
2. Emissions from Baltic Sea shipping in 2006-2019, Jukka-Pekka Jalkanen,, Maritime Working Group, Onlinel, 5 - 8 October 2020

Emissions and fuel consumption in the region by segment



Planned Green Fuel Projects in the region[1]

Cumulative Capacity (kTon MFO equivalent/year)



1. Total cummulative planned production capacity without destingtion of sector availability
2. Gas for Climate Market State and Trends report 2021.

Availability of alternative fuels
Current outlook for alternative fuels suggest that all of these will be available within the region, but at different time horizons.

BioOils
Are already available and are foreseen to be fuel with the largest availability within the region in the coming decade

BioMethane
Will be available. Currently between 0,5 & 25% of national gas consumptions is biomethane, expectations are 10% by 2030, so and average growth of 12% growth per year has been assumed[2]

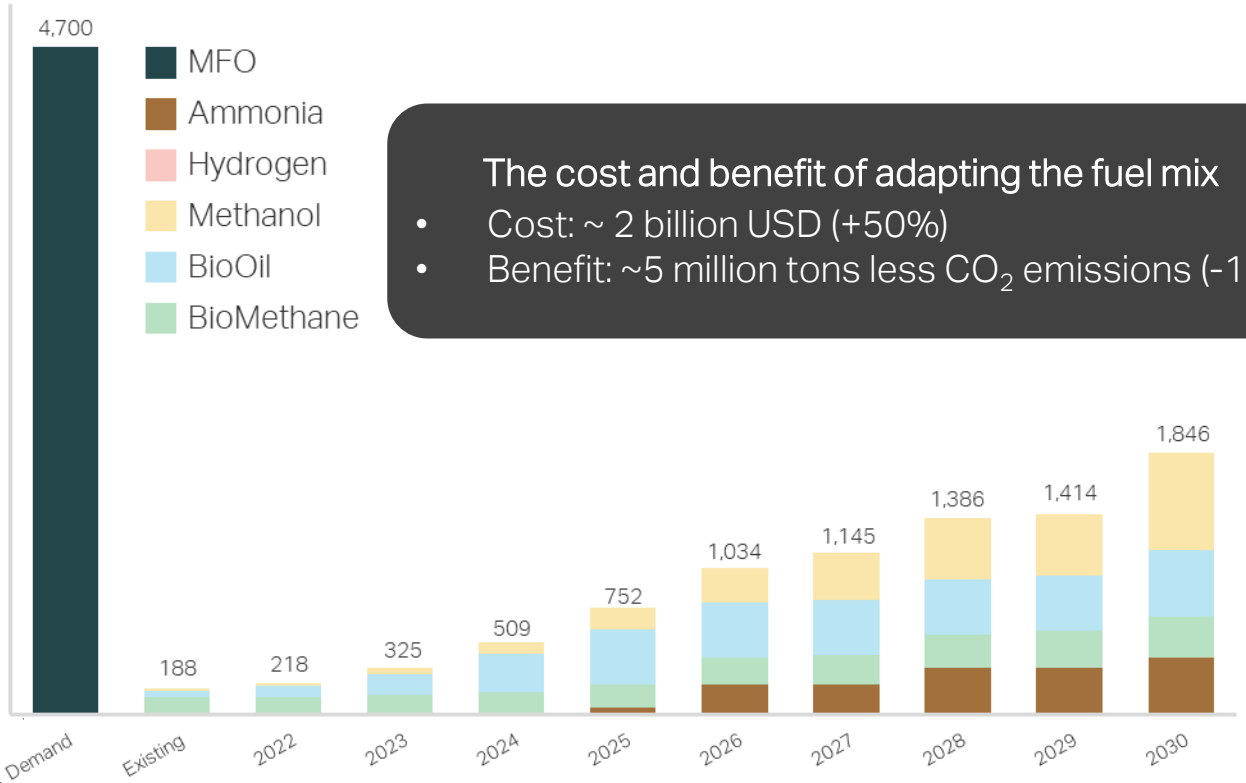
Methanol
Is expected to be available within years, but growth of availability is not seen until end of the decade

Ammonia
Is expected to be available within years, but only limited growth in availability is seen within the decade

Hydrogen
Only anticipated for in-land shipping

Planned Green Fuel Projects in the region

Cumulative Capacity adjusted for estimated sector competition (kTon MFO equivalent/year)



The cost and benefit of adapting the fuel mix

- Cost: ~ 2 billion USD (+50%)
- Benefit: ~5 million tons less CO_2 emissions (-1/3)

1. MMMCZCS Industry Transition Strategy 2021

Availability of alternative fuels considering sector competition
Several fuels will be demanded by other sectors, such as land transport, aviation, chemical industry, and fertilizers, which will limit the actual availability to shipping

BioOils
According the Industry Transition Strategy[1] from MMMCZCS 16% of the available bio-oils, are estimated to be available for shipping

BioMethane
According to the Industry Transition Strategy[1] from MMMCZCS 8% of the available Biomethane is estimated to be available for shipping

Methanol
Has an existing market in the chemical industry, so it is assumed that only 50% of the installed capacity will be available to shipping

Ammonia
Following the Ukraine/Russia, the European fertilizer industry has been put under pressure due to high gas prices and a stop of import from Ukraine. Thus, significant production can go to fertilizers – 50%

Hydrogen
Only anticipated for in-land shipping, and consequently not part of sea transport

Premium cost of services and transport in green corridors

What are the additional cost and saved CO_2 emissions to the customer?

What are the additional cost associated with building a green corridor, how to cover these and who should pay?

Cost of container transport on 1500 TEU vessel on green corridor

Fuel (2025)		LSFO	Bio-Oils	Methanol	Ammonia
Fuel cost [USD/Ton]		660	1775	1340	1000
Vessel rental / Port Costs		-	-	+15%	+15%
Consumption	Sailing [Tons/Day]				
	Berthing [Tons/Day]				
Pilot fuel [Bio-Oil]		-		5%	5%
Single Allocation cost [USD/TEU]		194	392	573	483
CO_2 reduction [WtW]		0	76%	96%	94%
CO_2 per Single Allocation [kg/TEU]		625	149	27	36
Cost of CO_2 reduction [USD/Ton]		-	417	633	491

- New business models are needed!
- A "business as usual" approach can disable a transition!

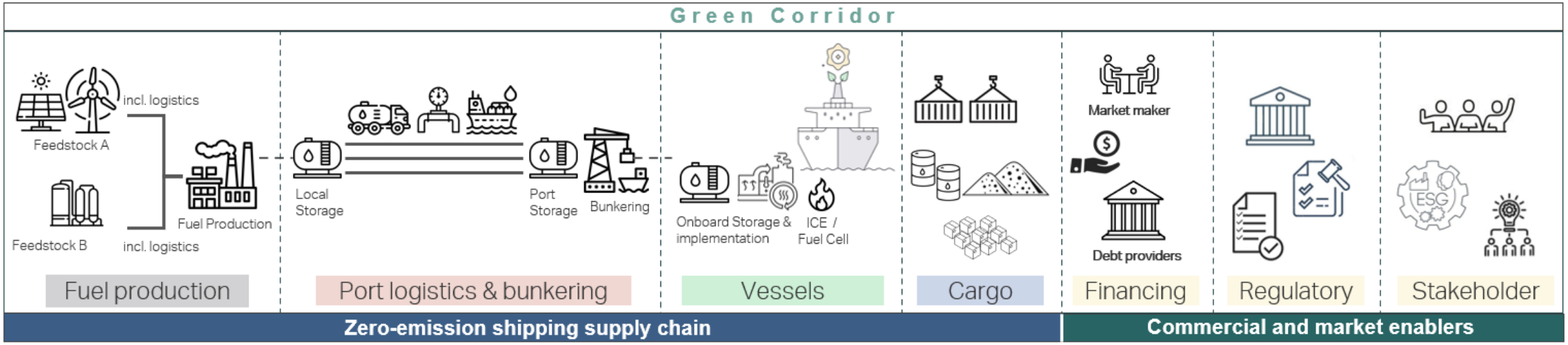
Based on the data and method by Yisong et al. (2020) the additional cost of container transport cost was estimated for selected fuels for 1500 TEU vessel

Cost Details for Two Vessel Types
Hamburg – Kotka[1]

Vessel Type	900 TEU	1500 TEU
Vessel Cost		
Vessel Rental Cost	6000	7500 USD/Day
Full Voyage Times	7	7 Days
Vessel Cost in Total	42000	52500 USD/Sailing
Fuel Cost		
Fuel Consumption on Sailing	30	40 Ton/Day
Fuel Consumption on Berthing	2	2 Ton/
Sailing Time on Sea	4.5	4.5 Days
Berthing Time in Port	2.5	2.5 Days
Price of Heavy Oil	650	650 USD/Ton
Price of Light Oil	1000	1000 USD/Ton
Fuel Cost in Total	92750	122000 USD/Sailing
Port Cost		
Port Cost of Hamburg	13000	14000 USD
Port Cost of Kiel Canal	15000	16000 USD
Port Cost Kotka	13000	14000 USD
Port Cost in Total	41000	44000 USD
Total Sailing Cost	175750	218500 USD/Sailing
Available Capacity	900	1500 TEU
Capacity utilization	75%	75%
Single Allocation Cost	260	194 USD/TEU

1. Yisong L., Xuefeng W., Hao H., and Hui Z. Research on feeder network design: a case study of feeder service for the port of Kotka, European Transport Research Review (2020) 12:61
2. Methanol case with no additional cost no vessel rental, 20% discount on fuel cost (Methanol and pilot fuel), 50% discount on port costs

We need action across the value chain to realize green corridors in the region



Communicate with stakeholders, including ports and shipping companies, to identify alternative fuel demand. Consider providing fuel delivery of alternative fuels	Use port readiness assessment to enable green projects and corridors. Act as a catalyst between fuel producers, shipping companies, and cargo owners to realize green corridors. incentives for using green fuels by first movers Recognize that readiness for new fuels early can be turned into a competitive advantage that could provide growth opportunities.	Aim to find key customers who has a pledge to decarbonize their transport and may be willing to pay for green transport Investigate options with other If relying on electricity to decarbonize, consider where to will get the green energy from	Voice your willingness to pay for green transportation, and the value of decarbonized	Build your awareness of different kinds of fuels, how to handle them, to prepare the social readiness and acceptance Facilitate projects aiming to bring new fuels to ports Recognize that readiness for new fuels early can be turned into a competitive advantage that could provide Develop support schemes and provide funding for first movers. Support green corridor projects to prove they are possible, then push for regulation to encourage alternative fuel adoption

Most important: The whole value chain must come together in order to establish viable solutions

Recommendations on next steps…

Potential green shipping corridors to be assessed in depth

- **National and interregional ferry lines** (RoPax, RoRo, Vehicle) with potential to operate on biooil, biomethane, methanol, or ammonia !
- **Identifying feeder operator(s)** to decarbonize loops from Rotterdam/Hamburg/Bremerhaven into the Baltic sea, with synergies in fuel infrastructure established for ferries
- Build initial fuel supply, port and bunkering infrastructure for the above at selected locations, which followers can subsequently tab into!
- **"Hot-spots"** in the region would be ports with significant ferry and cargo activities
- Develop economic incentive across value chain for first movers to enable a start of the transition!

Thank you!

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