Green Corridors: Feasibility phase blueprint

Blueprint
August 2022

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

McKinsey & Company

Introduction to the green corridor feasibility phase blueprint

Reaching zero carbon shipping by 2050 will require innovative solutions, industry-wide collaboration, and resource deployment at scale.

Green corridors are increasingly seen as an essential part of the solution, viewed as catalyzers to the transition toward zero carbon shipping. Establishing green shipping corridors, where vessels can run on alternative fuels, will be an essential step to decarbonize shipping. However, there is still limited knowledge on how to take green corridor concepts from ideas to implementation.

Consequently, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, in a joint effort with McKinsey & Company, has developed a new blueprint for assessing the feasibility of green corridors. The blueprint provides an approach to designing and demonstrating the feasibility of green corridors. It is intended to serve as a ready-to-use guide for any stakeholder involved in green corridors for decarbonizing shipping and includes 80+ off-the-shelf pages outlining methodology, analysis, and illustrative templates at each step of the value chain and across the ecosystem. The guide is relevant to all stakeholders that wish to engage in green corridors. It can be used by individual stakeholders assessing feasibility at single steps of the supply chain or by a consortium and stakeholder collaborations addressing feasibility across the supply chain and ecosystem. The starting point for the feasibility phase blueprint is the assumption that a green corridor has been selected (e.g., as a result of a pre-feasibility assessment). The purpose of the feasibility blueprint is to provide a framework for a deeper evaluation of the selected green corridor scenario to determine its technical, economic and regulatory feasibility and identify levers and actions to mitigate potential gaps and risks.

We recognize that the realization of green corridors requires solutions to address commercial gaps such as the higher costs of zero-emission fuels and the mobilization of demand. It requires solutions to de-risk the ecosystem related to green corridors and bridge the difference in time horizons and risk profiles from the long-term investments in fuel production and infrastructure to the shorter-term procurement of vessels and fuel by shipowners. Therefore, a key element of this green corridor feasibility blueprint is to provide an approach and design that addresses these commercial gaps and reduces risks across the larger ecosystem. Lowering risks can increase stakeholder confidence in investing and align on a roadmap and governance structure feasible for meeting decarbonization targets and timelines.

The blueprint is a living document that will be refined over time as we collectively gain more knowledge and hands-on experience building green corridors. We welcome any knowledge sharing that can bring us closer to implementing green corridors and moving the industry toward zero carbon shipping.

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We set out to define a feasibility phase blueprint

Objectives

1. Define the **"gold standard" blueprint to design** and **demonstrate the feasibility of green corridors** on a global scale
2. Spell out **enablers in accelerating the implementation** of green corridors
3. **Accelerate the industry toward action** with an applicable, scalable approach to establishing green corridors

that will evolve as it is tested by green corridor projects

What this document is

- A **ready-to-use guide** to conduct **feasibility assessments for green corridors**
- A **phased, stepwise methodology** incl. analyses and illustrative templates
- A **living document** that will evolve as the sector gains more knowledge and hands-on experience in green corridors

This blueprint is guided by our joint experience in shipping decarbonization

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Independent, not-for-profit, data-driven research and development center focused on accelerating marine industry decarbonization through thought leadership, R&D programs, and targeted advocacy

24 Strategic Partners across the shipping ecosystem

11 Knowledge Partners and 22 Mission Ambassadors

2 ongoing studies for green corridors in Europe and the Americas

McKinsey & Company

Leading global management consultancy with extensive experience and deep expertise in the shipping industry

Knowledge partner to Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping and Getting to Zero Coalition/ Mission Possible Partnership on green corridors

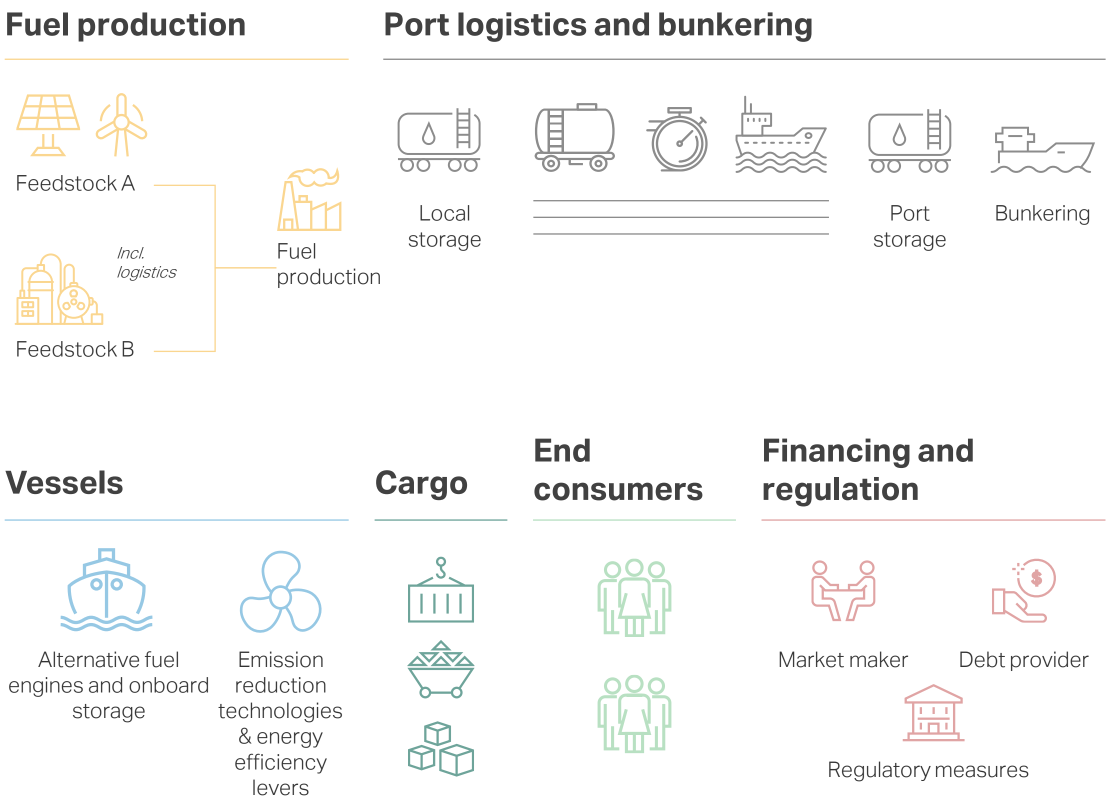
4 out of 5 top container shipping lines served, and leaders in cruise, dry bulk, tanker, ferry, and other segments

85% of the top 30 energy companies served

What are green corridors, and why is proving their feasibility important?

What are green corridors?

Green corridors are shipping routes on which there are commercially operating ships using exclusively[1] **alternative fuels**[2]



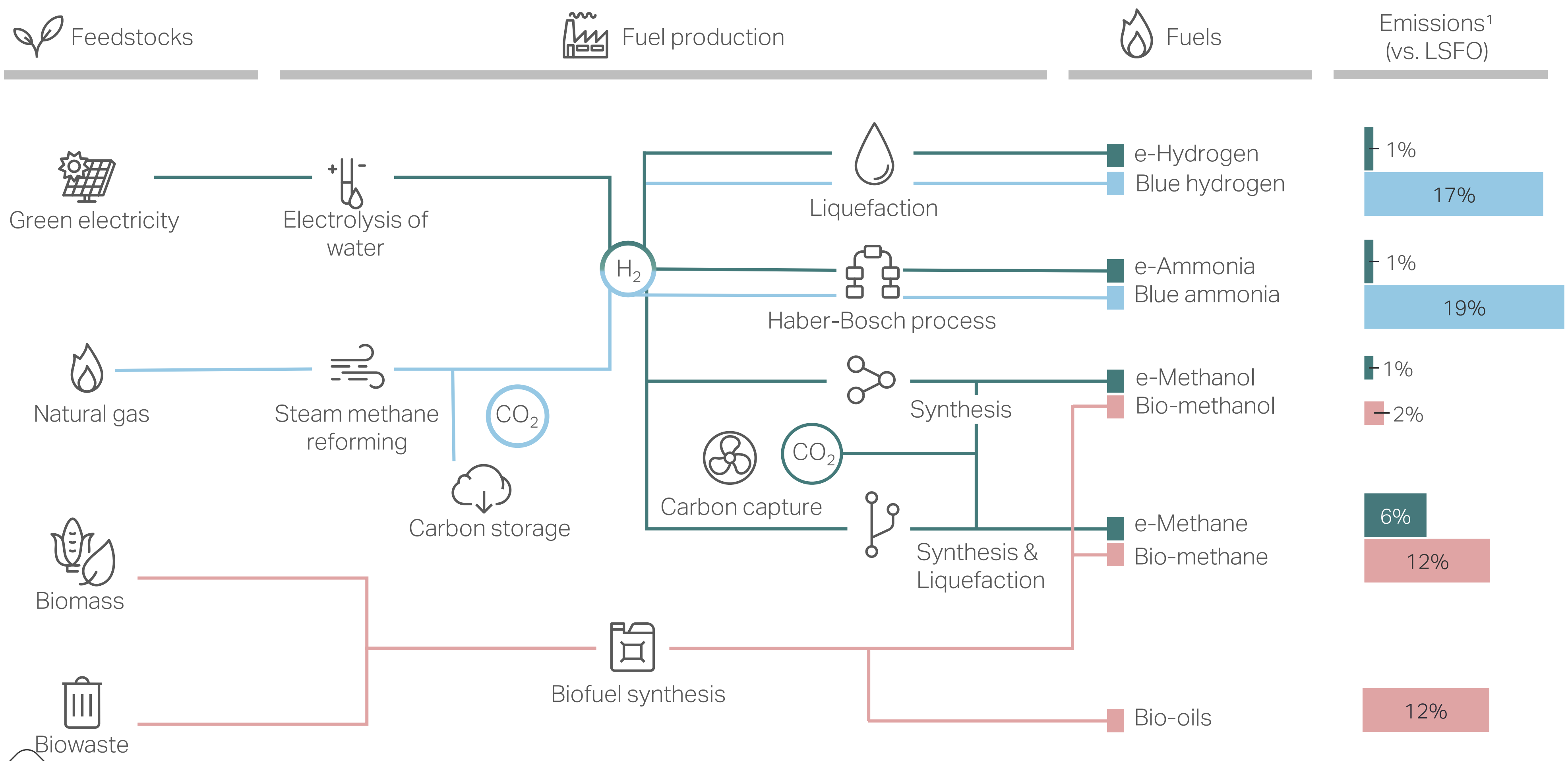
Why are green corridors important?

1. **Provide an approach and design** for industry players to gain confidence and embark on an accelerated decarbonization journey
2. **Initiate end-to-end decarbonization** within a supply chain
3. **Promotes closer dialogue and collaboration** between public and private stakeholders involved in the overall ecosystem

1. The definition distinguish between definition and implementation of a green corridor. In practice, a green corridor may be implemented as a transitory phased approach, where the use of alternative fuels evolve gradually, and design is made scalable to ensure flexibility and the realization of the green corridor.
2. Alternative fuels defined on the following page

How do we define alternative fuels?

NOT EXHAUSTIVE



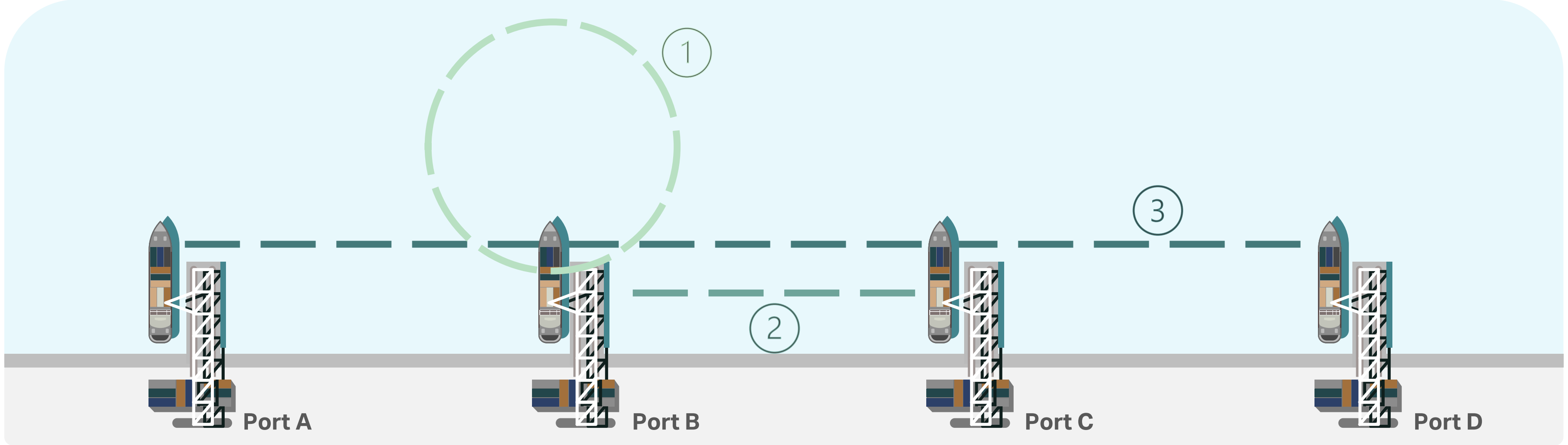
Alternative fuels are derived from sources other than petroleum; some are derived from renewable sources. Often, they have a lower environmental impact than fossil-based hydrocarbons.

Source: MMM Center for Zero Carbon Shipping

The green corridor feasibility phase blueprint can be applied to all corridor types

Main corridor types	Description
1 Single point	Single-point corridors establish zero-emission shipping routes around **a particular location,** i.e., a port hub allowing round-trip bunkering
2 Point to point	Point-to-point corridors are single-route green corridors between **2 ports.** Typically, more niche segments or based around a commodity transportation route
3 Network	Network green corridors establish routes between **3 or more ports** where vessels can sail on alternative fuels

Corridor types — Network corridor — Point-to-point corridor — Single-point corridor



Methodological steps for feasibility study are **agnostic to corridor type**

Stakeholder engagement may be more complex for network and point-to- point corridors as it can involve more port authorities and governments and span different countries and continents

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This document focuses on the feasibility phase of the green corridor project development

Project phases	Pre-feasibility	Feasibility	Select	Define	Execute	Operate
	Project baselining Value chain mapping Establish screening criteria (selection framework and justification) High-level screening of potential corridors Initial engagement with relevant regulatory bodies and government	Technical, economic, regulatory feasibility assessment Risk registry and mitigation plan Outline of decisions and commitments required by stakeholders Roadmap and milestones up to operation	Definition of criteria for selecting final concept Deep dive on key elements from feasibility phase as relevant to ranking criteria. Rank of concepts based on criteria and selection of final concept outlined in the feasibility study	FEED[1], detailed engineering design, and detailed commercial design related to (infrastructure, production, vessels, etc.) Contractual commitments between stakeholders, before final investment decisions (FID)	Finalized project details Project com-missioning and execution Preparation for handover	Operation of green corridor

Outputs and legal agreements

Letter of intent

Memorandum of understanding

Heads of agreement

Final investment decision (FID) and consortium execution contract

Handover to operators

Uncertainty

Focus of blueprint

Go/no-go decision point

1. Front-end engineering and design

The pre-feasibility and feasibility stage of green corridor project development differ in project purpose, activities and maturity

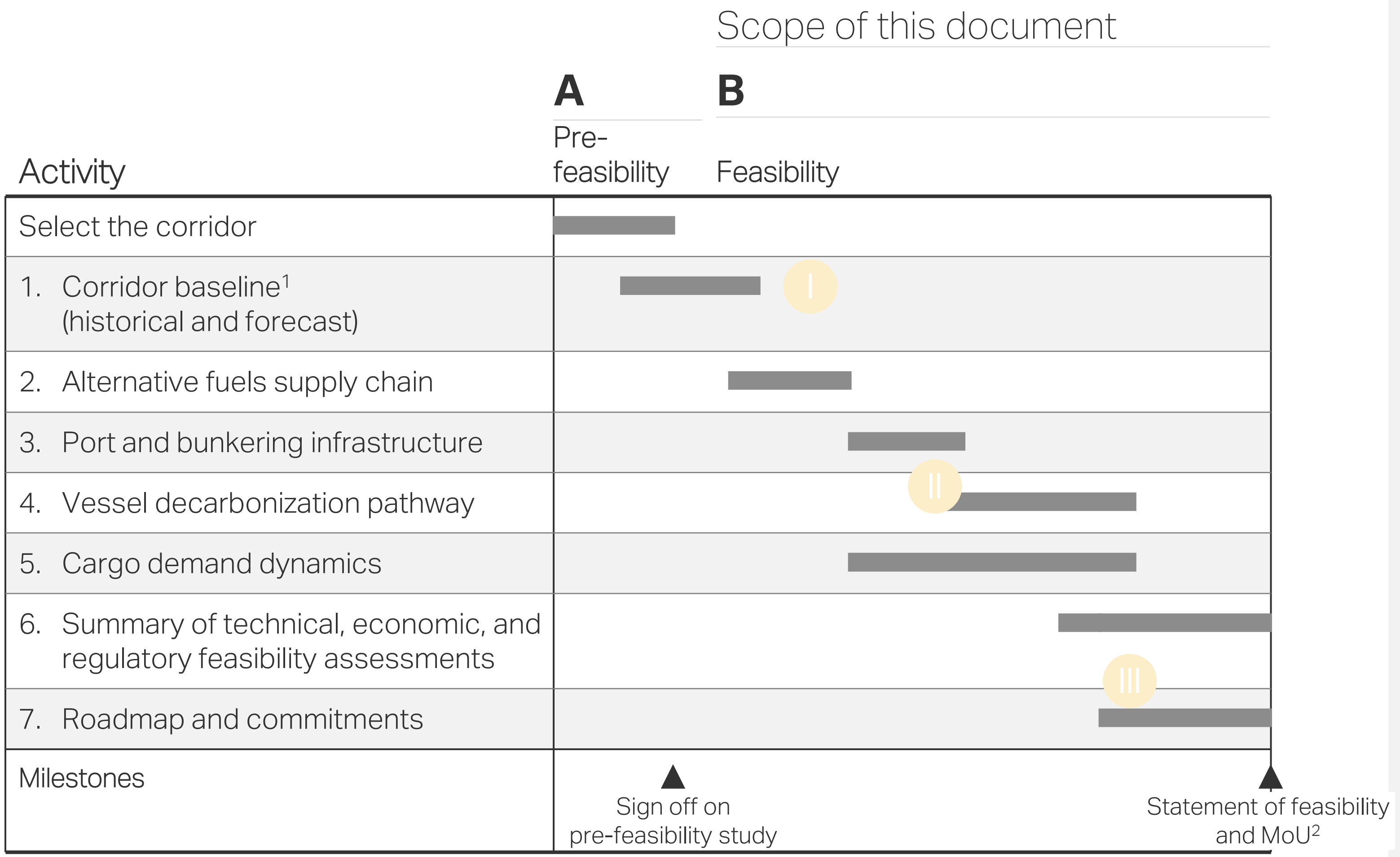
Project phases	Pre-feasibility	Feasibility
Purpose	• A high-level mapping of the value chain of one or more potential green corridors in order to select the most promising and viable corridor(s) to further mature • This phase uses a selection framework to screen potential corridors based on specific criteria • The work done in this phase is used to determine whether further investigation and maturation of the green corridor project is required (I.e., moving to the feasibility phase)	• An in-depth assessment and evaluation of a specific green corridor (e.g., from pre-feasibility) to determine its feasibility and the actions required to address potential gaps and risks • This phase evaluates the technical, economic, and regulatory feasibility of a corridor and identifies main gaps and risks • The work done in this phase is used to determine whether the green corridor project should proceed into the next phases where costs and commitments begin to escalate
Key questions	• What is the screening criteria for the corridors? • What are the most promising corridors based on the screening criteria (e.g., from an emission or technological perspective)? • What is the baseline for the corridors? (i.e., potential fuel pathways, vessel and voyage characteristics, trade flows, existing regulation, etc.)? • What are the potential stakeholders involved in the corridor?	• Is the green corridor design/concept feasible from an economic, technical and regulatory perspective? • What levers are required to close potential cost and commercial gaps and make the project financeable? • What are the main risks and mitigating actions? • What are the required commitments and decision across stakeholders?

Focus of this blueprint

The feasibility blueprint is structured into seven chapters to assess the technical, regulatory, and economic feasibility of green corridors

	1	2	3	4	5	6	7
Chapters	**Corridor baseline**	**Alternative fuels supply chain**	**Port and bunkering infrastructure**	**Vessel decarbonization pathway**	**Cargo demand dynamics**	**Summary of technical, economic, and regulatory feasibility assessments**	**Roadmap and commitments**
Stakeholders	All stakeholders	Fuel producers	Port and bunkering operators	Shipowners and operators	Cargo owners	All stakeholders	All stakeholders
Scope	High-level output from pre-feasibility phase: – Shortlist of potential alternative fuels – Vessel and voyage character-istics – Trade flows – Regulatory framework	Feasibility assessment for each decarbonization pathway along value chain: Technical feasibility Economic feasibility Regulatory feasibility				Feasibility assessment summary, highlighting: – Main gaps to address – Cross-cutting opportunities (e.g., gaps in economic feasibility could be addressed with consortium commitments) Risk registry	Development of roadmap and required commitments for the next phases of the project, up to operation

This blueprint clearly defines the sequencing of analyses incl. interdependencies



1. Based on a pre-feasibility assessment
2. Memorandum of understanding

Interdependence highlights

I — Corridor characteristics (e.g., vessel type, product, existing policy frameworks) inform all further feasibility assessments

II — Assessing vessel infrastructure requirements over time depends on understanding economics/ availability of alternative fuel supply, resulting TCO for shipowners, and decarbonization ambition for corridor

III — Defining key milestones and commitments by value chain participant requires sign-off of rest of feasibility study

The feasibility phase blueprint covers seven distinct chapters

x.x Feasibility assessment

1. Corridor baseline[1] (historical and forecast)

1.1 Identify sources of alternative fuel best suited to meet future demand, considering renewable energy/ feedstock availability and announced projects

1.2 Identify the current and expected storage and bunkering infrastructure along the corridor (based on geography, fuels, segment, volume, etc.)

1.3 Specify the characteristics of vessels in the corridor (incl. types, sizes, ages, fuel consumption, voyage characteristics), technical profile, and emissions

1.4 Develop a holistic understanding of the trade flows incl. type (cargo types), nature (e.g., origin-destination, trans-shipment), and ownership

1.5 Assess the high-level financing and regulatory characteristics on this route

2. Alternative fuels supply chain

2.1 Estimate fuel demand in regions relevant to corridor across sectors, and specifically for shipping

2.2 Define expected production centers for alternative fuels considering announced projects (capacity, developers, timelines) and import options, and identify potential demand-supply gaps

2.3 Identify and quantify cost-down trajectories for drivers of fuel costs (e.g., technology capex, electricity prices)

2.4 Quantify capex requirements and assess financing options on each step of value chain, considering offtake potential for producers

2.5 Assess feasibility of alternative fuel production for corridor

3. Port , storage, and bunkering infrastructure

3.1 Estimate current demand and capacity for alternative fuels and identify potential storage and bunkering ports based on:

- Expected demand for alternative fuels (inside and outside corridor)
- Capacity for alternative fuels
- Existing and planned infrastructure
- Regulatory frameworks in place for port and bunkering

3.2 Estimate the required investments for storage and bunkering infrastructure for retrofitting/newbuild to meet corridor demand

3.3 Assess feasibility of alternative fuel storage and bunkering infrastructure development

4. Vessel decarbonization pathway

4.1 Define future fleet size requirements for corridor

4.2 Estimate TCO evolution of decarbonization options

4.3 Define the vessel decarbonization pathway for this corridor based on timing, fuel availability, and TCO evolution for the corridor

4.4 Define number of newbuilds and retrofit vessels with modifications over time, and implications for value chain players

4.5 Quantify capex requirements for converting existing and new vessels (incl. propulsion technology, onboard storage), and review financing potential

4.6 Assess feasibility of vessel decarbonization pathway in the corridor

5. Cargo demand dynamics

5.1 Assess the cargo's sensitivity to changes in shipping/transport costs over time (elasticity of demand, trade fluctuations, share of shipping as part of overall product cost and emissions)

5.2 Identify potential competing routes and transport modes for corridor (alternative transport/routes)

5.3 Estimate customer and end-consumer willingness to pay (decarbonization commitments, commercial alliances, customer survey, etc.)

5.3 Identify mechanisms that would support customer/ end-consumer willingness to pay (long-term offtake agreements, green cargo credits, etc.)

5.4 Assess the feasibility of cargo owners adopting decarbonized shipping

6. Summary of technical, economic, and regulatory feasibility assessments

6.1 Technical feasibility assessment: Consolidate technical feasibility assessments, specifying main gaps to target state by value chain step

6.2 Economic feasibility assessment: Consolidate economic feasibility assessments by value chain step, assessing potential sharing of decarbonization costs across value chain

6.3 Regulatory feasibility assessment: Assess regulatory feasibility of green corridor, incl.:

- "Must-have" regulatory and policy changes for green corridor to go ahead
- Regulation and policies to close cost gaps
- Ensure alignment with UN commitments and directions

6.4 Develop risk register and identify potential mitigation actions

7. Roadmap and commitments

7.1 Catalog investment decisions, expected lead times to execute projects, and required commercial arrangements (e.g., offtake agreements, funding levers) planned over time by value chain participant

7.2 Build an integrated roadmap for each value chain participant, considering sequencing and lead time of projects and risk scenarios, and map relevant milestones

7.3 Define the project governance and resourcing requirements to complete Select and Define phases

7.4 Develop a communications and engagement plan for internal and external stakeholders in Select and Define phases

7.5 Socialize and sign off on the integrated roadmap

1. Based on a pre-feasibility assessment

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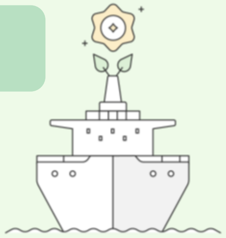
04 Appendix

Chapter 1 summarizes the high-level output on chosen corridor that would be expected from a pre-feasibility study



Chapter 1: Corridor baseline (historical and forecast)

Key questions		Chapter analyses	
I.	What is the **decarbonization potential** and **timeline** for this green corridor? Who are the **main stakeholders in the corridor** ecosystem across the value chain?		Embedded in chapter analyses 1.1 through 1.5
II.	What are the **potential alternative fuels and sources** best suited for corridor?	1.1	Identify **sources of alternative fuel** best suited to meet future demand, considering import options, announced projects, renewable energy/feedstock availability
III.	What is the **port and bunkering infrastructure like?**	1.2	Identify the current and expected **storage and bunkering infrastructure** along the corridor (based on geography, fuels, segment, volume, etc.)
IV.	What are the key **technical and emissions characteristics of the vessels** trading there?	1.3	Specify the **characteristics of vessels** in the corridor (incl. types, sizes, ages, fuel consumption, voyage characteristics), **technical profile, and emissions**
V.	What is the nature of the **trade flows** and the end-customer **characteristics** along the corridor?	1.4	Develop a holistic understanding of the trade flows incl. **type** (cargo types), **nature** (e.g., origin-destination, trans-shipment), and **ownership** (BCO, FF[1])
VI.	What are the key **market and commercial enablers** in this corridor?	1.5	Assess the high-level **financing and regulatory** characteristics on this route

1.Beneficial cargo owner, freight forwarder

1.1 Identify sources of alternative fuel best suited to meet future demand

	Methodology – steps	Inputs
A	**Fuel demand:** Create high-level estimate for future **demand for alternative fuels** over time (refined in chapter 2)	– Current fuel consumption within corridor – Expected volume growth for trade flows for top products shipped (in 5-year steps across relevant time horizon) – Expected fuel efficiency gains – global and regional estimates (in 5-year steps across relevant time horizon) – Project assumptions on conversion to alternative fuels over time
B	Create overview of **existing and planned alternative fuel production (near corridor/import to corridor)** (overview by vol., type, capacity, operator, and location)	– Current and expected projects by company and fuel type – Current and expected production levels by fuel type and maturity level – Location of expected production sites and import routes to corridor – Volumes of alternative fuel available to shipping (considering other sectors)
C	Assess **availability of feedstocks for required fuel supply** – understand current and potential hubs from feedstock perspective	– Current and expected sources of renewable energy – Solar and wind potential geospatial mapping – Biowaste and biomass mapping of sources, quantity, and stakeholders
D	Estimate **gap between fuel demand** for the corridor and **expected supply** from import/expected production centers	– Expected fuel demand – chapter 1.1.A output – Expected fuel supply – chapter 1.1.B, 1.1.C output
E	Select **potential sourcing and type of alternative fuel** to be used in green corridor	– Combination of above

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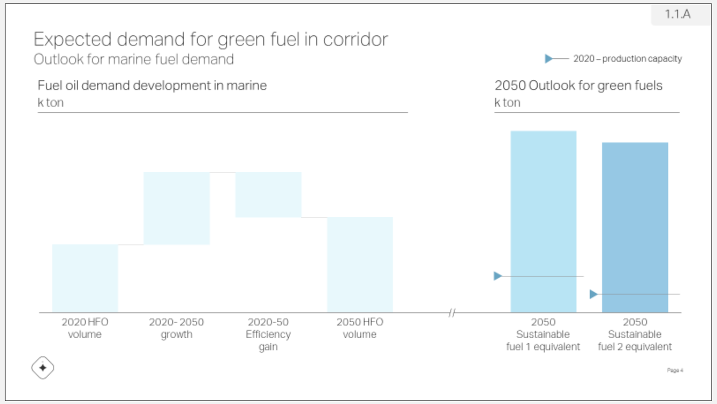
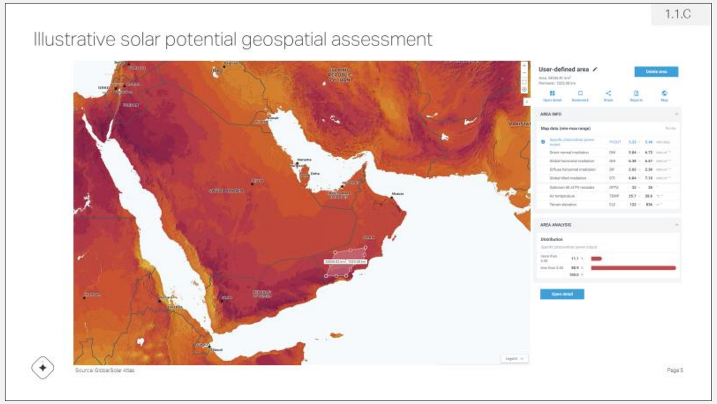
Useful information

Alternative fuel demand estimate should be directional to unlock assessment of feedstock availability for corridor. Projection is then refined in subsequent steps of feasibility study (e.g., chapter 5 on cargo demand dynamics)

Illustrative examples



1.1.A

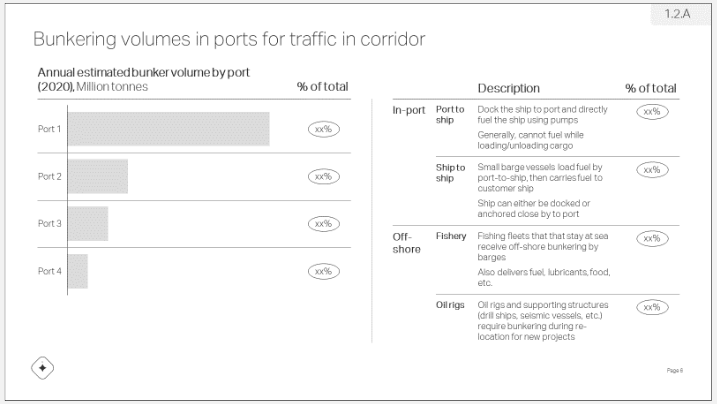


1.1.C

1.2 Identify the current and expected storage and bunkering infrastructure along the corridor

Methodology – steps	Inputs
A. Identify **current and potential bunkering locations and demand profile** for vessels running on alternative fuels	– Voyage characteristics – Geography of current and potential bunkering based on voyage – Bunkering demand profile (volume, frequency, fuel type, etc.) – Fuel type characteristics (density, etc.)
B. Create overview of **existing port, storage, and bunkering infrastructure** along with planned future investments in facilities	– Description of onshore and marine bunkering/storage infrastructure by fuel type – Description of any planned additions to infrastructure – Description of current and expected capacity – Description of possible limitations to expansion (e.g., protected land)
C. Describe **ownership and operatorship of port and bunkering infrastructure**	– Ownership structure (e.g., state-owned, private) – Operator for ports, bunkering – pre-feasibility study output – Existing agreements between operator/owner
D. Assess whether port/bunkering infrastructure has **green corridor potential**	– Combination of above

Illustrative examples



1.2.A

1.3 Specify the characteristics of vessels in the corridor, technical profile, and emissions

	Methodology – steps	Inputs
A	Create **overview of owners and operators of vessels** active in the corridor	– Pre-feasibility study output
B	Develop **overview of number and type of vessels** operating within and in/out of corridor	– Number by segment (e.g., bulker, containers, refers, tankers) – Number of vessels by size (e.g., handysize, capesize) – Number of vessels by age (e.g., newbuild, 10+ years) – Expected vessel newbuilds (orderbook)
C	Identify **vessel routing** behavior	– Vessel routes within and in/out of corridor (schedules, number of trips, etc.)
D	Identify **technical profile of vessels** active in corridor	– Propulsion technologies, engine systems, onboard storage for vessels
E	Estimate **annual fuel consumption** on corridor based on high-level assessment of **annual fuel consumption for ships on corridor**	– Number of ships on corridor by size – Average fuel consumption by size
F	Calculate **corridor emissions**	– Vessel annual fuel consumption – chapter 1.3.E output – Emissions factor to convert fuel to resulting emissions
G	Assess if key characteristics of vessels are a good **fit for a green corridor**	– Combination of above

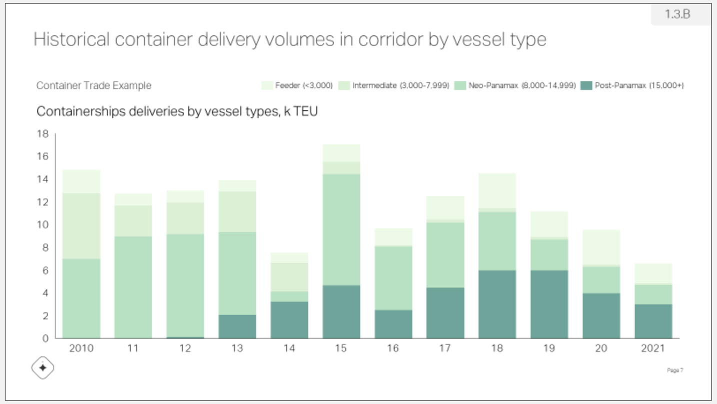
!

Useful information

Depending on data availability, alternative ways to calculate the annual fuel consumption for the vessels include:
- Fuel consumption data from government authorities (reported tons of fuel burned by vessel in corridor)
- Storage capacity/refueling frequency data (number and size of storage facilities, number of refueling events per site)

Illustrative examples

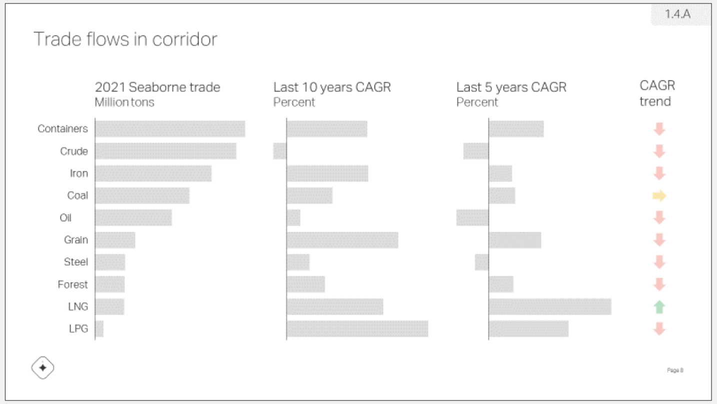
1.3.B



1.4 Develop an understanding of the trade flows incl. type, nature, and ownership

Methodology – steps		Inputs
A	Map the current and projected **cargo trade flows and growth** (volume/value)	– Types of goods for each vessel segment (e.g., commodities, passengers, consumer) – Current and projected trade volume (DWT/TEU[1]) of commodities/products – Current and projected trade value of commodities/ products
B	Describe the **nature of cargo** along corridor (origin-destination)	– Trade type (import/export) – Origin-destination vs. trans-shipment
C	Map key **stakeholders** related to cargo	– Beneficial cargo owners and intermediaries (freights forwarders, third parties, etc.) – pre-feasibility study output
D	Assess if trade flows and cargo are a good **fit for a green corridor**	– Combination of above

Illustrative examples



1.4.A

1.Deadweight tonnage and 20-foot equivalent unit

1.5 Assess the high-level financing and regulatory characteristics on this route

Methodology – steps		Inputs
A	Assess the **financing environment** relevant to the corridor (considering possible local specificities)	– Financing/incentive options and stakeholders involved (e.g., government/local authority financial support for fuel production, active private players) – pre-feasibility study output
B	Identify existing **regulatory requirements** at international, national and, as needed, local levels	– Regulatory bodies at international, national, and local levels – pre-feasibility study output – Regulations impacting entire value chain, from fuel/ feedstock production to bunkering and shipping
C	Identify **health, safety and environmental policies** that impact the decarbonization of the corridor	– Health, safety and environmental policies from regional/ national/international bodies (.e.g., permitting processes and duration)
D	Assess the **challenges and opportunities** presented by the financing, regulatory, and stakeholder environment	– Combination of above

Illustrative examples: N/A

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04 Appendix

Chapter 2: Alternative fuels supply chain

Key questions

I. What is the **required volume of alternative fuel** for this corridor, given voyage and vessel characteristics?

II. What is the **range of expected production of alternative fuels** relevant to the corridor, based on import options, announced project, feedstock availability, regulation, etc.?

III. Is the **available fuel volume sufficient** to match expected demand by shipping?

IV. How much **additional production capacity** will be required? Where should it be built?

V. What are the main **drivers impacting the cost of alternative fuels** and price for shipowners, and how will they evolve over time?

VI. What is the **investment/financing required** for alternative fuel production to supply the corridor, and what are **commercial/funding models** (e.g., offtake agreements, subsidies, government guarantees) to make investment feasible?

Chapter analyses

2.1 **Estimate fuel demand** for the corridor

2.2 Define **expected production centers** for alternative fuels considering **announced projects** (capacity, developers, timelines) **and import options,** and identify **potential demand-supply gaps** and opportunities **for new potential locations and capacity**

2.4 Identify and quantify cost and **cost-down trajectories** for drivers of fuel costs (e.g., technology capex, electricity prices)

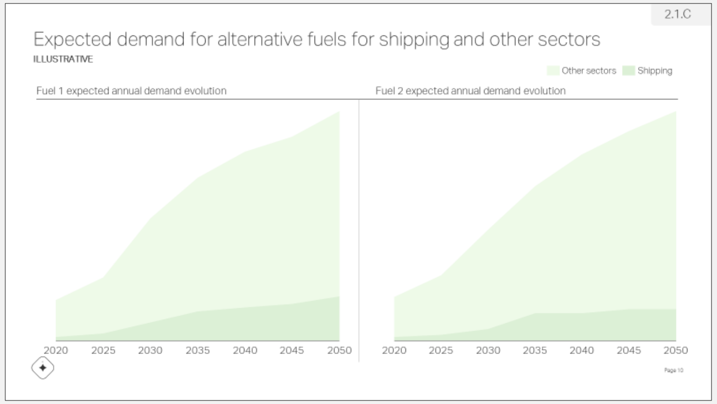
2.5 Quantify **capex requirements and assess financing options,** considering offtake potential for producers

2.6 Assess **feasibility** of alternative fuel production for the corridor

2.1 Estimate fuel demand for the corridor

Methodology – steps	Inputs
A Estimate **energy demand for corridor** based on expected evolution of trade route, vessel utilization, vessel and engine types and sizes, etc.	– Vessel and voyage characteristics – chapter 1 output
B Calculate **alternative fuel demand for corridor** based on fuel characteristics	– Applicability of fuels by vessel type – chapter 1 output – Fuel characteristics (e.g., density, calorific value)
C Assess **expected competition for fuels** – high-level alternative fuel requirements from other sectors and availability for shipping	– Sectors to use alternative fuels by 2050[1] – Expected capacity of alternative fuels (per fuel) to be used by each sector until 2050[1]

Illustrative examples



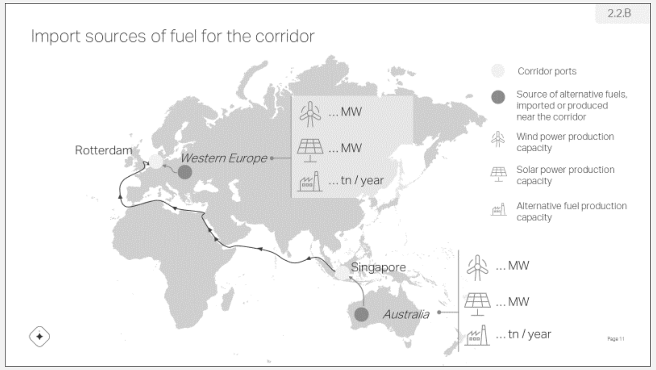
2.1.C

1.Depending on project timeline

2.2 Define expected production centers for alternative fuels and identify potential demand-supply gaps

	Methodology – steps	Inputs
A	Perform **high-level gap analysis between fuel demand for corridor and expected local production,** to identify **import requirements**	– Market-level overview of expected fuel supply – High-level estimate of future demand – Chapter 1 output
B	Identify **range of volume/capacity of alternative fuels expected to be produced** over time in nearby/ import locations	– Alternative fuel projects announced (incl. capability, developers, timeline of production/scale-up, capacity committed to shipping and other sectors – Market estimates of alternative fuels capacity for relevant locations – Policies announced to incentivize development of alternative fuel production infrastructure
C	Estimate **fuel capacity available to the corridor over time,** and **estimate potential gaps vs. demand**	– Capacity of alternative fuels expected to be produced – Chapter 2.2.B output – Capacity from announced projects excluding committed volumes – Chapter 2.2.B output – Fuel demand for corridor – Chapter 2.1 output
D	For supply/demand gaps: Identify **advantageous geographies for alternative fuel production** (RES potential, RES power pricing, existing infrastructure; access to feedstock, regulatory support) for in-scope alternative fuels	– Renewable energy potential (e.g., solar and wind capacity factors) – Chapter 1 output – Mapping of feedstock sources – Chapter 1 output – Supportive regulation/funding and other market enablers – Chapter 1 output
E	Define **sources of alternative fuels for shipping** over time, considering expected and additional fuel production	– Alternative fuel availability to shipping based on announced projects – Chapter 2.2.C output – Additional fuel production required – Chapter 2.2.D output

Illustrative examples



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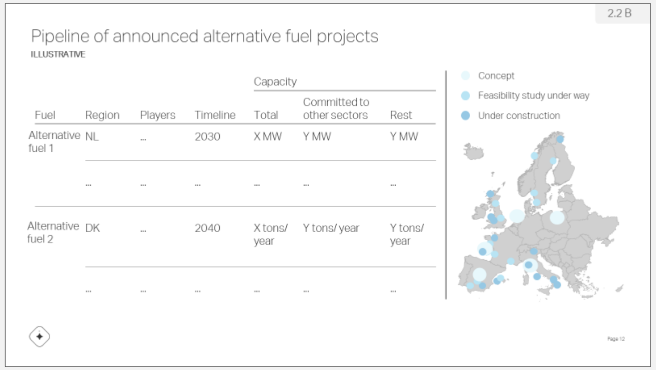

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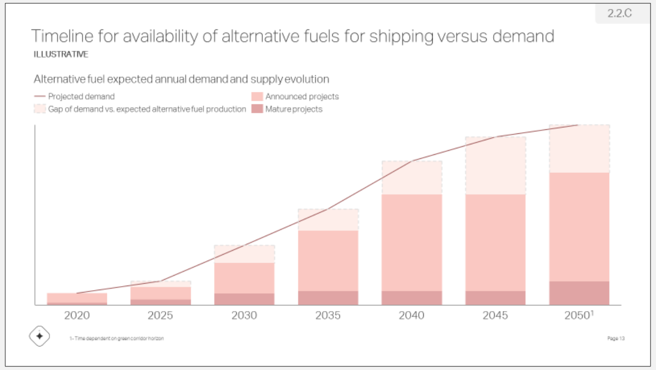


2.2.C

2.3 Identify and quantify cost and cost-down trajectories for drivers of fuel production costs

Methodology – steps		Inputs
A	Identify main **drivers of costs for alternative fuel** across value chain, **quantity starting points for costs** This includes, as applicable: – Fuel/feedstock production technology cost (capex, opex) – (Renewable) electricity price – Fuel storage costs (e.g., H_2 liquefaction) – Fuel transportation costs	– Value chain and supply chain for each alternative fuel – Chapter. 2.2 output – Maturity and deployment of fuel production technology, and feedstock production technology (e.g., new R&D technologies for fuel cells, more mature technology of solar/wind power) – Key drivers of cost – variable costs/costs that are expected to evolve
B	Define **cost evolution for key cost drivers of alternative fuel** until 2050[1] based on similar cost-down trajectories for comparable technologies (e.g., evolution of hydrogen fuel cells vs. solar panel cost evolution); include **evolution of transportation costs** for fuel sourced from other locations vs. produced locally	– Examples of similar technologies and their cost-down trajectories over time – Estimated starting points for costs across relevant alternative fuels value chain – Chapter 2.3.A output
C	Estimate the **potential price of alternative fuels** depending on source, considering **logistics costs and potential margin for alternative fuels**	– Mode of storage and transportation for fuel – Chapter 2.3.A output

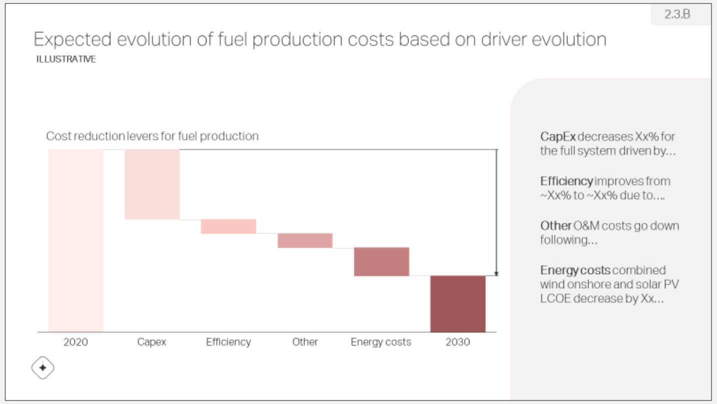
!

Useful information

The Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping NavigaTE model is a ready-to-use techno-economic model built on proprietary, industry-verified data and assumptions, which covers the entire maritime energy value chain from alternative fuel production to onboard vessel systems, with a perspective on the cost-down trajectories of alternative fuels and ship efficiency technologies

1.Depending on project timeline

Illustrative examples

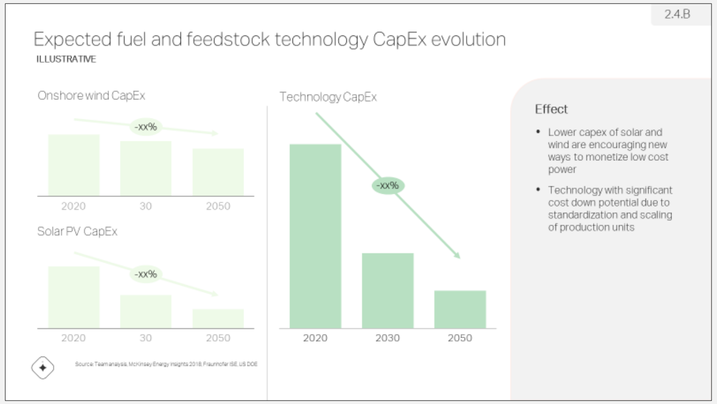


2.3.B

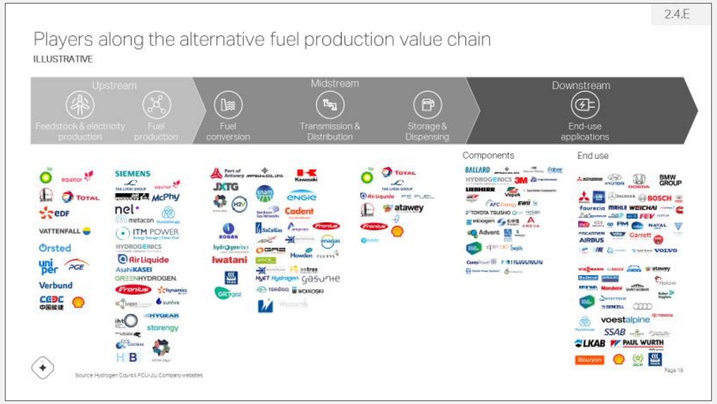
2.4 Quantify capex requirements and assess financing options, considering offtake potential for producers

	Methodology – steps	Inputs
A	List **new infrastructure/capex investments required for each step of the alternative fuel value chains,** for example: – Feedstock production cost capex – Feedstock storage, transportation capex – Fuel production cost capex – Fuel storage, transportation capex	– Value chain and supply chain for each alternative fuel – Chapter 2.3 output
B	Quantify **capex requirements** for relevant stakeholders along the fuel value chain, and evolution for relevant timeline for the corridor	– Alternative fuel production project definition (e.g., location, mode of transport) – Chapter 2.3 output – Projection for evolution of drivers of cost for alternative fuels – Chapter 2.3.B output
C	Assess **offtake potential** for fuel producers, considering alternative fuel demand in the location	– Location proposed to build alternative fuel production center – Chapter 2.2 output – Map of potential fuel end users, and total fuel demand expected in region – Chapter. 2.1 output
D	Assess **financing and funding options** (incl. cost of capital) to support investments	– Public and private financing options, incl. cost of capital estimate and "green" investment subsidies – Local funding/subsidy programs for alternative fuel projects
E	Identify **players for each step of the value chain** (incl. manufacturers, utilities, energy players, logistics) and identify **ability to invest at required scale and pace** by player, based on size and decarbonization commitments	– Players for each step of value chain – Revenue/turnover by company – Decarbonization/ESG commitments and involved partnership

Illustrative examples



2.4.B



2.4.E

2.5 Assess feasibility of alternative fuel production for the corridor

Output of chapter

1 **Proposed source of alternative fuels** for green corridor (source of renewable energy, feedstock, and fuel production centers) and **evolution of alternative fuel supply and demand** (both total and shipping-only) over time for regions relevant to the corridor (local or international/imported)

2 **Technical feasibility** of alternative fuel production, incl.:

- Expected feedstock production locations and capacity
- Fuel production locations and capacity
- Transportation of fuel to relevant region in corridor

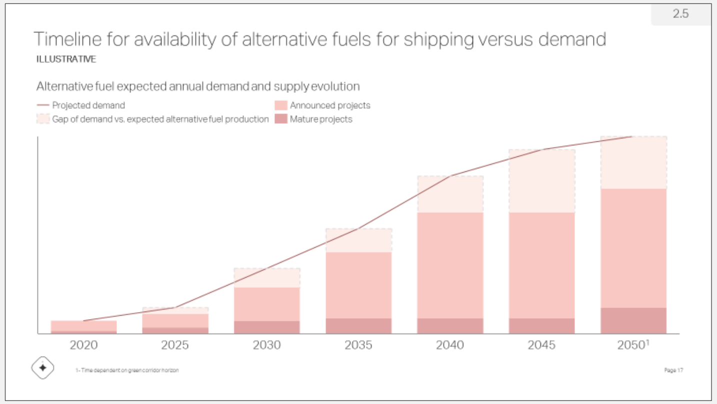
3 **Economic feasibility** of alternative fuel production project development, incl.:

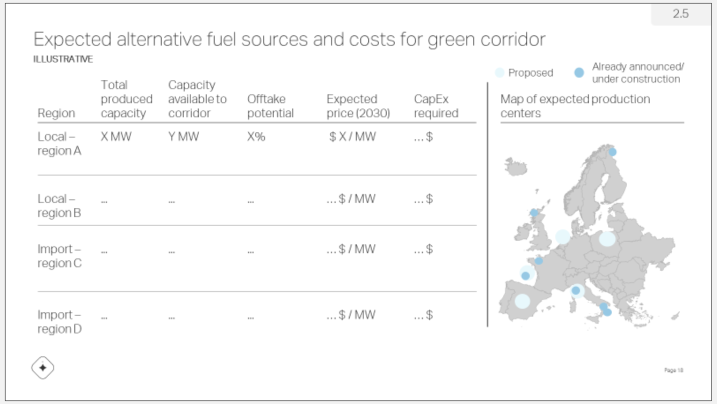
- Resulting capex requirements
- Offtake potential and financing potential
- Cost of production over time
- Expected cost of production and potential price of alternative fuels, and evolution over time

4 **Regulatory feasibility** of alternative fuel production projects development:

- Regulatory and policy structure to allow/enable alternative fuel and feedstock production, storage and distribution (e.g., for hydrogen, carbon capture, storage, and transport)
- Regulations on scale of alternative fuel production, and health and safety guidelines on handling, storage, and use
- Carbon credits and other tailwinds

Illustrative examples





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04 Appendix

Chapter 3: Port, storage, and bunkering infrastructure

Key questions

I. What is the expected **required capacity** for storage and bunkering in this corridor?

II. What are the **expected port and bunkering sites** for the green corridor?

III. How much of the required capacity can be covered by **retrofitting existing infrastructure** and how much **additional infrastructure** is required?

IV. Will it be **feasible from a regulatory perspective to develop** storage and bunkering infrastructure?

V. What are the **required investments and financing potential** for retrofitting/developing infrastructure?

Chapter analyses

3.1 Estimate the current **demand and capacity for alternative fuels** and identify potential storage and bunkering ports based on:

- Expected demand from alternative fuels (inside and outside the corridor)
- Capacity for alternative fuels
- Existing and planned infrastructure
- Regulatory frameworks for port and bunkering sites

3.2 Estimate the required **investments for retrofitting/building** new storage and bunkering infrastructure to meet corridor demand

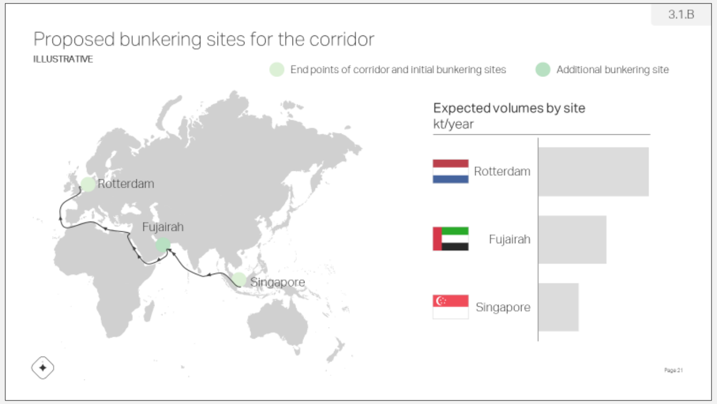
3.3 **Assess the feasibility** of alternative fuel storage and bunkering infrastructure development

3.1 Estimate the current demand and capacity for alternative fuels and identify potential storage and bunkering ports

Methodology – steps	Inputs
A — Detail the green corridor's **storage and bunkering demand profile** based on vessel, voyage, and fuel characteristics	– Voyage characteristics (location of bunkering) – Chapter 1 output – Characteristics of alternative fuels (physical state, density, etc.) – Bunkering demand for alternative fuels (from inside and outside the corridor) – Chapter 1 output – Storage requirements given the expected fuel volume and physical state of the fuel (i.e., refrigerated, pressurized etc.)
B — Map current and expected **storage and bunkering ports/regions and their infrastructure and capacity**	– Overview of current and planned infrastructure/capacity for bunkering and storage sites (incl. barges, storage tanks) – Location and potential capacity of new bunkering sites in the corridor – Stakeholders of bunkering sites used by vessels in the corridor – Readiness of fuel storage/bunkering systems and safety standards for handling alternative fuel (e.g., ammonia, hydrogen)
C — Assess the green corridor port and bunkering sites' **ability to handle the zero-emission vessel** segment and alternative fuels	– Regulations for handling alternative fuels – Permitting processes for handling alternative fuels – Safety standards and verification of fuel suitability related to LCA
D — Assess potential **gaps between storage/bunkering infrastructure and fuel demand** in the corridor	– Combination of the above

Useful information
Another area of consideration is the size of relevant ports in terms of employee count; alternative fuel handling, storage, and bunkering might require additional employees

Illustrative examples



3.1.B

3.2 Estimate the required investments for retrofitting/building new storage and bunkering infrastructure to meet corridor demand

Methodology – steps		Inputs
A	Assess the infrastructure required for **importing of alternative fuels to storage sites** (for sites inside/outside the corridor and potential new sites required to meet fuel demand)	– Technical feasibility of converting existing infrastructure – Chapter 3.1 output – Expand demand for fuel import – Chapter 3.1 output – Alternative fuel production sites – Chapter 2 output – Cost estimate (capex and opex) required for fuel transportation (pipelines, vehicles, etc.)
B	Assess the infrastructure required to **store alternative fuels at bunkering sites** (same sites as Step A)	– Technical feasibility of converting existing infrastructure – Chapter 3.1 output – Regulatory readiness of storage and bunkering sites (safety and permitting for e.g. ammonia, hydrogen, etc.) – Expand demand for storage – Chapter 3.1 output – Land available for alternative fuel storage and estimate of its storage capacity – Cost estimate of alternative fuel storage facilities, incl. economies of scale and sharing infrastructure with other demand sources
C	Assess the infrastructure required to **bunker alternative fuels at sites** (same sites as Step A)	– Technical feasibility of converting existing infrastructure – Chapter 3.1 output – Regulatory readiness of storage and bunkering sites (safety and permitting for e.g. ammonia, hydrogen, etc.) – Expand demand for bunkering – Chapter 3.1 output – Estimate the number of bunkering barges required for given storage capacity – Cost estimate of alternative fuel storage facilities, incl. economies of scale and sharing infrastructure with other demand sources
D	Create an overview of the **total infrastructure required and cost implications**, and identify financing capacity for required investments	– Combination of the above

Illustrative examples: N/A

3.3 Assess the feasibility of alternative fuel storage and bunkering infrastructure development

Output of chapter

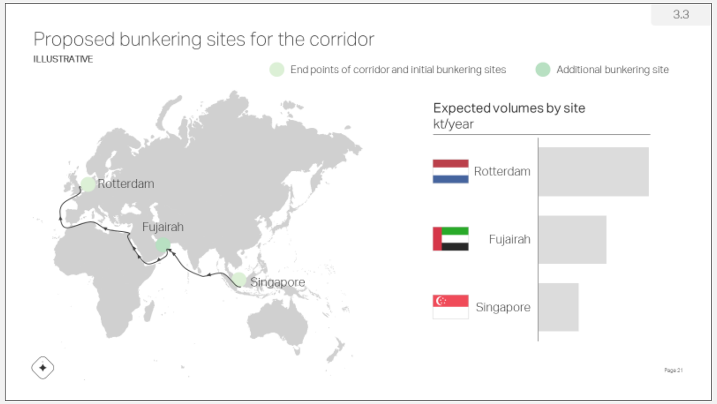
1 **Overview of required port and bunkering infrastructure to meet the corridor's alternative fuel demand** (location, capacity, technologies)

2 **Technical feasibility of alternative fuel bunkering, storage, and logistics** connecting to ports, incl.:
- Potential for **conversion/retrofitting** of infrastructure for alternative fuels
- Logistic solution for alternative fuel transportation to storage sites
- **Potential land availability** for new infrastructure (if required)
- **Operational capacity** based on fuel type (e.g., required skills to handle fuel)

3 **Economic feasibility** for conversion/retrofit the and development of infrastructure, incl.:
- Resulting capex requirements
- Opex costs (for storage tanks, ports, new bunkering barges, etc.)
- Opportunities to share bunkering and storage infrastructure based on demand outside corridor
- Financing capacity and potential

4 **Regulatory feasibility**, incl. the ability of **fuel to be stored/ bunkered at ports**, **health and safety guidelines** for storage, bunkering, logistics, and fuel handling **process definitions**

Illustrative examples



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04 Appendix

Chapter 4: Vessel decarbonization pathway for the corridor

Key questions

I. What is the corridor's expected **evolution of vessel requirements**[1] (incl. vessel types and sizes)?

II. What are the **potential decarbonization pathways** for this corridor based on the shortlist of alternative fuels? What is the **resulting TCO**[2] **per fuel**?

III. What is the **optimal decarbonization pathway** based on decarbonization timing and TCO perspective, also considering fuel and tech availability?

IV. How **many vessels are** expected to be **newbuilds**, and how many **retrofitted** over time to meet the corridor's decarbonization ambition?

V. What are the required **modifications to existing vessels**?

VI. What are the **capacity requirements for other shipbuilding value chain players** (e.g., shipyards, engine manufacturers)?

VII. What are the resulting **investment requirements** and potential financing opportunities? Which potential players could commit this capex?

Chapter analyses

4.1 Define the corridor's **future vessel size requirements** for corridor

4.2 Estimate the **TCO evolution of decarbonization options**, based on:
- Fuel and technology maturity and availability
- Costs for alternative fuels and technology (cost-down trajectory)
- Fuel characteristics (e.g., density and emissions)

4.3 Define the corridor's **vessel decarbonization pathway** for this corridor based on timing, fuel availability, and TCO evolution

4.4 Define the **number of newbuilds and retrofitted vessels with modifications** over time and the **implications for value chain players**

4.5 Quantify the **capex requirements for converting existing and new vessels** (incl. propulsion technology, onboard storage) and review financing potential

4.6 Assess the **feasibility of the corridor's vessel decarbonization pathway**

1. Vessels may include both vessels that operate on/through the corridor and can be substituted in/out of the corridor depending on ship operators' fleet optimization.
2. Total cost of ownership

4.1 Define the corridor's future fleet size requirements

Methodology – steps		Inputs
A	Estimate the **expected evolution of shipping demand in the relevant route**	– Expected evolution of the corridor's shipping demand – Chapter 1 output
B	Estimate the **future/evolving utilization of vessels**, based on the conversion to alternative fuel usage and availability of green corridors/bunkering in other routes	– Number of vessels in corridor – Chapter 1 output – Current utilization per vessel, number of vessels – Nearby green corridors – Ship operators' fleet optimization – Alternative fuel bunkering capabilities in nearby ports
C	Define the corridor's **expected evolution of vessel requirements** (i.e., number of vessels, capacity, type, size)	– Evolution of the corridor's shipping demand for corridor – Chapter 4.1.A output – Expected utilization of vessels – Chapter 4.1.B output

Illustrative example: N/A

4.2 Estimate the TCO evolution of decarbonization options

Methodology – steps	Inputs
A **Define available decarbonization options** to meet the target state in the proposed decarbonization timing	– Decarbonization potential and ambition (if available) for the corridor – Alternative fuel shortlist – Chapter 2 output – Propulsion technology and fuel availability/maturity
B **Gather key inputs/assumptions for the TCO model**, incl. costs for fuel and logistics, fuel characteristics, capex requirements, and carbon cost	– Fuel characteristics, e.g., heating value (MJ/tn), CO_2 emissions – Vessel characteristics (e.g., size, type, vessel readiness intelligence) – Chapter 4.1 output – Capex requirements for vessels, incl. cost of propulsion systems and onboard storage – Alternative fuel production cost and price ($/tn) – Chapter 2 output – Cost of alternative fuel logistics for storage and bunkering – Chapter 3 output – Evolution of carbon pricing applicable to the shipping sector – Efficiency improvement assumptions – Chapter 1 output – Other operational costs (high-level estimate), e.g., loss of capacity
C **Estimate the TCO of decarbonization options** based on expected corridor fleet characteristics **until 2050**[1]	– Modeling based on above data

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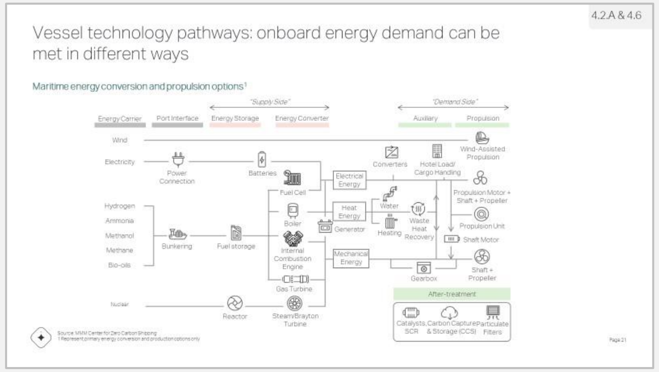
Useful information

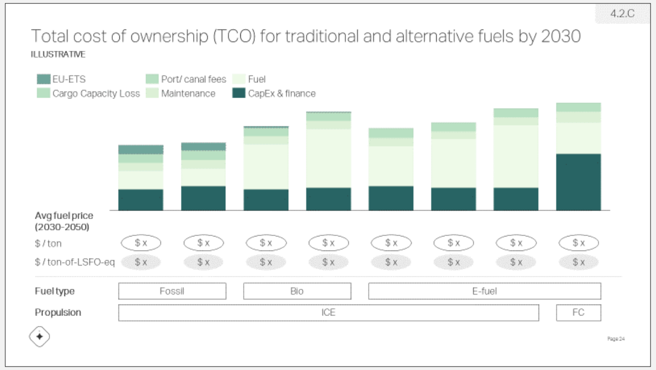
- The **Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping NavigaTE model** is a ready-to-use techno-economic model built on proprietary, industry-verified data and assumptions, which covers the entire maritime energy value chain from alternative fuel production to onboard vessel systems, and can be used to perform the steps above, assessing the TCO of vessels for various vessel segments, fuels, and engine configurations
- Given **uncertainties in estimating carbon pricing** over time, running sensitivity scenarios (incl. a scenario with no carbon pricing) is recommended to assess its impact on TCO1

1. Depending on scope of exercise

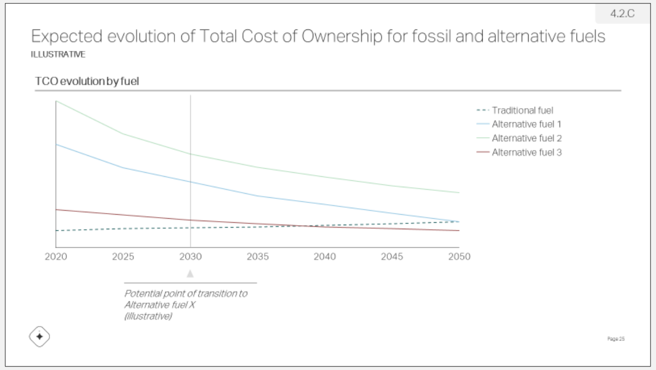
Illustrative examples



4.2A



4.2C



4.2C

4.3 Define the corridor's vessel decarbonization pathway based on timing, fuel availability, and TCO evolution

Methodology – steps		Inputs
A	**Determine the decarbonization pathway: high-level sequencing of optimal fuels on an incremental basis** (e.g., per year), based on the TCO per fuel, emissions per fuel, fuel availability and decarbonization timeline for the corridor	– TCO of each decarbonization option – Chapter 4.2 output – Emissions per fuel – Chapter 4.2 output – Decarbonization potential and ambition (if available) for the corridor – Volume of alternative fuels required by vessels (TCO model output) – Chapter 4.2 output – Alternative fuel availability – Chapter 2 output
B	Determine the **TCO evolution and financial gap between optimal and fossil fuels**	– TCO of each decarbonization option vs. fossil fuels, included required volume per fuel – Chapter 4.2 output
C	Identify **policies that could help close the gap of fuel costs** (e.g., carbon credits, alternative fuel, and infrastructure incentives/subsidies, etc.) and **technology developments** that could accelerate decarbonization	– Discussion with stakeholders – TCO[1] output to identify cost drivers with the largest gaps – Chapter 4.2 output

!

Useful information

The **Fleet Decarbonization Optimizer (FDO) solution** is a ready-to-use advanced algorithm-based engine that can be used to perform steps A and B, by calculating the lowest-cost combination of decarbonization actions for a given fleet, leveraging fleet-specific data, and the proprietary NavigaTE model. The FDO solution is codeveloped and offered by McKinsey & Company, Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, and Maersk Broker Advisory Services

4.4 Define the number of newbuilds and retrofitted vessels with modifications over time and the implications for value chain players

	Methodology – steps	Inputs
A	**Define the probable renewal schedule** for vessels in ship owners' fleets based on vessel characteristics, leveraging the current orderbook of players in the route	– Chapter 4.1.A output – Information on vessels (types, sizes, year built, propulsion systems) – Chapter 1 output
B	Define how the decarbonization pathway **impacts asset utilization and optionality of use** in other routes	– Decarbonization pathway – Chapter 4.2 output
C	Estimate **technical and economic implications of different propulsion technologies/engines** (e.g., trade-off between single/dual-fuel engines and expected vessel utilization)	– Costs of single-fuel engines for alternative and dual-fuel engines – (Opportunity) cost of lower vessel utilization
D	Define **technologies (incl. onboard fuel storage) for new vessels** and **required modifications** to retrofit vessels	– Decarbonization pathway – Chapter 4.3 output – Use of single- or dual-fuel engines – Chapter 4.4.C output
E	Define the **number of newbuilds** and **vessels to be modified** for alt. fuel usage over time, considering: – Future fleet size requirements – Current renewal schedule – Expected asset utilization	– Probable renewal schedule – Chapter 4.4.A output – Future fleet requirements – Chapter 4.1 output – Expected asset utilization – Chapter 4.4.C output
F	**Detail implications and assess capacity and readiness** (e.g., knowledge) of players in the shipbuilding value chain (e.g., shipyards, engine manufacturers)	– Shipbuilding value chain – Proposed vessel renewal schedule – Expected spare capacity and readiness for relevant players in the shipbuilding value chain (e.g., shipyards, engine manufacturers)

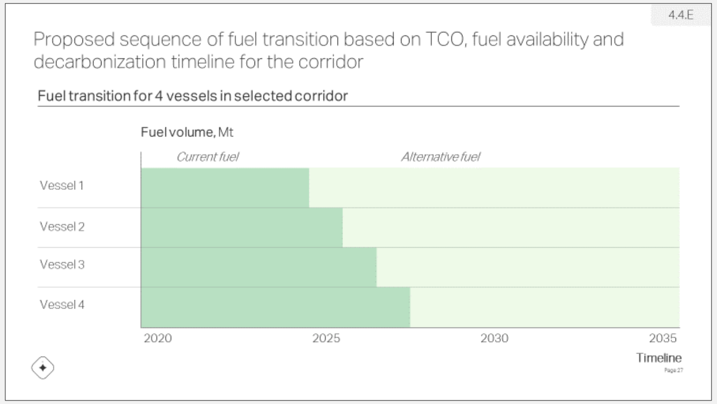
!

Useful information

– The number of new vessels required annually can be estimated based on the current vessels' characteristics (i.e., age profile). If shipowners/ship operators relevant to the corridor are willing to share a **refined view of their scrapping plan, then the number of new vessels required can be more accurately defined**

– The **Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping NavigaTE model** is a ready-to-use tool that can be used to support steps A to E

Illustrative examples



4.4.E

4.5 Quantify the capex requirements for converting existing and new vessels and review financing potential

	Methodology – steps	Inputs
A	Define **new propulsion technology/onboard storage investments required** for the alternative fuels of the optimal decarbonization pathway, and **quantify the expected evolution of capex requirements** (e.g., based on tech maturity and financial environment)	– Decarbonization pathway – Chapter 4.3 output – Modifications to existing/new vessels – Chapter 4.4 output – Capex per propulsion technology and storage option and expected cost-down trajectories
B	**Compare the capex** of new technologies vs. traditional engine/storage capex for new vessels	– Capex per propulsion technology and storage option
C	Assess **financing and funding options (incl. cost of capital)** for ship operators and shipowners	– Public and private financing options, incl. cost of capital estimate and "green" investment subsidies – Local funding/subsidy programs for alternative fuel projects
D	Identify relevant **ship operators/shipowners per step of the value chain** and assess their **ability to invest at the required scale and pace** based on size and decarbonization commitments	– Relevant players/stakeholders – Chapter 1 output – Revenue/turnover by company – Decarbonization/ESG commitments and relevant partnerships by player

1.Depending on scope of exercise
Illustrative examples: N/A

4.6 Assess the feasibility of the corridor's vessel decarbonization pathway

Output of chapter

1

Vessel decarbonization pathway and timeline considering alternative fuels based on TCO and emissions per fuel

Modifications to existing vessels and characteristics of new vessels (i.e., alternative fuels, onboard storage, technologies)

2

Technical feasibility of vessel conversion to use alternative fuels, incl.:

- Application of alternative fuels to vessel, voyage, and cargo characteristics
- Fuel and technology availability and maturity over time
- Vessel renewal/new ordering timelines

3

Economic feasibility of vessel conversion to use alternative fuels, incl.:

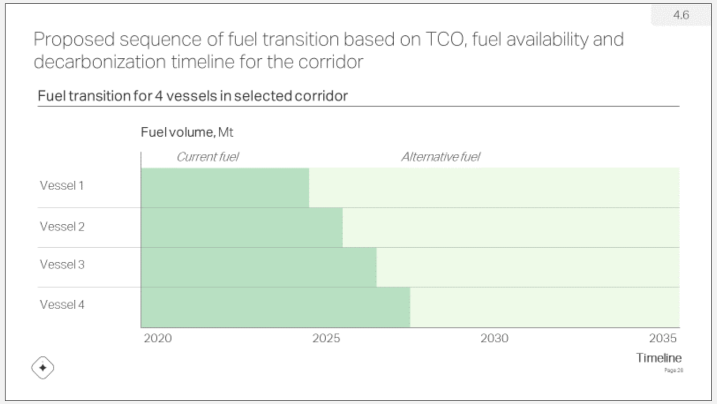
- TCO[1] comparison, incl. capex, for existing and new vessels between alternative and fossil fuels (e.g., HFO, VLSFO[2])
- Resulting financing needs, funding sources, and respective cost of capital

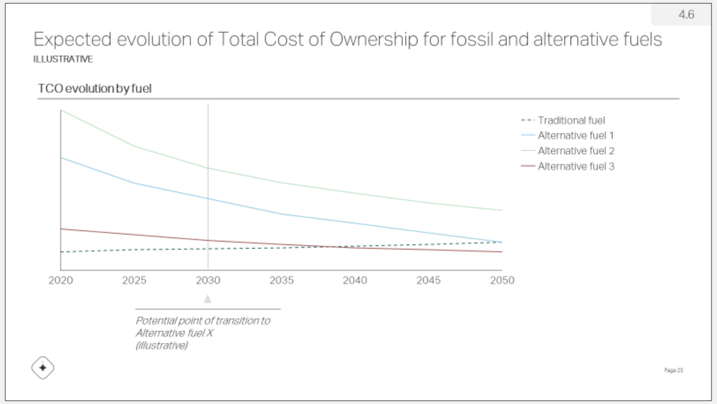
4

Regulatory feasibility of vessel conversion to use alternative fuels:

- Regulations regarding use and onboard storage of alternative fuels
- Regulatory/policy tailwinds to enable decarbonization (e.g., carbon pricing measures such as EU ETS[1], Contract for Differences)

Illustrative examples





1 Emissions Trading Scheme
2 Heavy Fuel Oil, Very Low Sulphur Fuel Oil

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04 Appendix

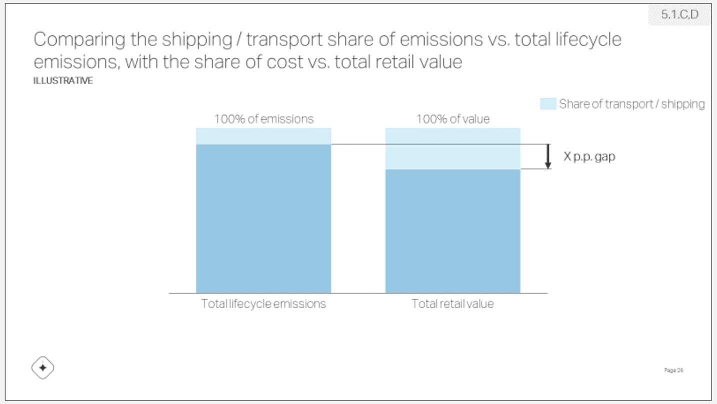
Chapter 5: Cargo demand dynamics

Key questions	Chapter analyses
I. What are the **trade patterns** for the cargo types in the corridor? Who **owns the cargo**?	*Chapter 1 output (cargo by type, current, and expected volume/ value, cargo owners, regulatory environment overview)*
II. What is customers' and end consumers' **willingness to pay** for decarbonized shipping services, and how is this expected to change over time?	5.1 Assess the cargo's **sensitivity to changes in shipping/transportation costs** over time (elasticity of demand, trade fluctuations, share of shipping as part of overall product cost and emissions) 5.2 Identify the corridor's potential **competing routes and transportation modes** (alternative transportation/routes) 5.3 Estimate customer and end consumer **willingness to pay** (decarbonization commitments, commercial alliances, customer surveys, etc.)
III. What **levers can support customer/end consumer willingness to pay** for decarbonized shipping services?	5.4 Identify **mechanisms that would support customer/end consumer willingness to pay** (long-term offtake agreements, green cargo credits, etc.) 5.5 Assess cargo owners' **feasibility of adopting decarbonized shipping**

5.1 Assess the cargo's sensitivity to changes in shipping/transportation costs over time

	Methodology – steps	Inputs
A	Assess the cargo's **elasticity of demand** through industry research or historical analyses	– Market research reports – Historical shipping services sales data
B	Identify **fluctuations in traded volumes,** e.g., based on seasonality, fronthaul-backhaul.	– Inbound/outbound products/commodities per segments over time – Historical intra-year volume development
C	Estimate the **relative weight of shipping costs to the retail value of cargo**	– Shipping cost per unit of cargo for the most relevant cargo types – Retail value per unit of cargo for the most relevant cargo types
D	Estimate the **relative weight of shipping emissions to the total emissions of cargo**	– Shipping-related emissions per unit of cargo – Total life cycle emissions per unit of cargo
E	Assess high-level **abatement opportunities for nonshipping emissions** of cargo	– Overview of nonshipping emission sources for cargo – Overview of potential abatement opportunities for nonshipping emission, and estimated costs
F	Evaluate the **ability of cargo to carry a high-level decarbonized shipping premium** over time	– Combination of the above

Illustrative examples

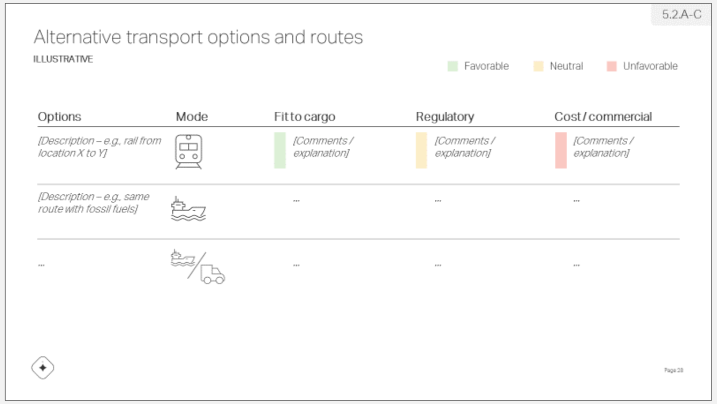


5.1.C,D

5.2 Identify the corridor's potential competing routes and transportation modes (alternative transportation/routes)

Methodology – steps		Inputs
A	Identify **alternative transportation options/routes** that cargo could take to bypass higher shipping costs in the corridor	– Map of alternative transportation options and routes outside of the corridor (trucks, rail, alternative shipping routes, same route with fossil fuels, etc.)
B	Assess the available **capacity of alternative transportation options/ routes** for cargo	– Volume development of cargo (Chapter 1 output) – Available capacity of alternative transportation options
C	Estimate **transportation cost** of alternative options/routes	– Cost estimate of alternative transportation options
D	Assess the **feasibility of cargo bypassing the corridor's trade route**	– Combination of the above

Illustrative examples



5.2.A-C

5.3 Estimate customer and end consumer willingness to pay

Methodology – steps		Inputs
A	Identify **drivers of willingness to pay** for decarbonized shipping (i.e., driven by end consumers or cargo owners with Scope 3 emissions targets)	– Cargo owner/end consumer value chain mapping – Chapter 1 output – Industry decarbonization maturity level and investor/consumer pressure – Engagement with cargo owners
B	[Deep-dive from (A) for cargo owners] Create an overview of **stakeholder decarbonization commitments** and **commercial alliances**	– Engagement with cargo owners – Published reports detailing Scope 3 emission targets by value chain player – Membership of decarbonization alliances (e.g., Sustainable Freight Buyers Alliance, First Movers Coalition, coZEV[1] Coalition)
C	[Deep-dive from (A) for end consumers] Conduct **end consumer surveys** to assess the willingness to pay for decarbonized shipping services	– End-consumer surveys
D	Assess **contract/charter dynamics** to understand potential commercial or contractual constraints	– Estimate length of contracts of affreightment/offtake agreements
E	Estimate the **willingness to pay** of cargo stakeholders	– Combination of the above – Chapters 5.1, 5.2 output
F	Map stakeholders by their **willingness to pay and corridor cargo volume** they represent	– Stakeholder willingness to pay range estimate – Chapter 5.3.E output – Corridor cargo volume per stakeholder group

Illustrative examples

5.3.F

1.Cargo owners for zero emission vessels

5.4 Identify mechanisms that would support customer/ end consumer willingness to pay

Methodology – steps		Inputs
A	Assess **opportunities from longer-term offtake agreements** that de-risk alternative fuel costs	– Estimate cost savings from longer-term offtake agreements – Regulatory/commercial frameworks for offtake agreements
B	Identify existing/potential **book and claim systems** in the corridor (e.g., green cargo credits)	– Overview of existing book and claim systems – Regulatory framework around book and claim systems
C	Identify opportunities to **bundle demand** from multiple cargo owners and end consumers	– Identify potential alliances between cargo owners/end consumers in the corridor – Estimate aggregate demand from alliances
D	Assess the **overall feasibility of levers to materialize willingness to pay**	– Combination of the above

Illustrative example: N/A

5.5 Assess cargo owner's feasibility of adopting decarbonized shipping

Output of chapter

1 **Assessment of the main drivers of willingness to pay for decarbonized shipping** and potential **levers to materialize willingness to pay**

Mapping of willingness to pay vs. volume of cargo transported in corridor per stakeholder group/company

2 **Technical feasibility:**
- N/A

3 **Economic feasibility:**
- Estimate customer/consumer willingness to pay for decarbonized shipping services

4 **Regulatory feasibility:**
- Identify any existing or potential future regulatory constraints on cargo transportation in the corridor (e.g., transportation of waste, CO_2)

Illustrative examples

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04 Appendix

Chapter 6: Summary of technical, economic, and regulatory feasibility assessments

Key questions

I. What are the **technical challenges** (if any) for the implementation of the green corridor, and **how do they evolve over time?**

II. How **economically feasible** is the green corridor over time and **how does this impact each step of the value chain?** Are there **synergies** that can be realized across these steps (e.g., cross-subsidies)?

III. What are the **financing requirements** and the funding sources to enable the green corridor?

IV. What are the **regulatory and policy constraints** for the decarbonization pathway? What are the **main regulatory and policy changes required** to realize or accelerate the decarbonization pathway?

V. What are the **potential risks** for the implementation of the green corridor and how can they be **mitigated?**

Chapter analyses

6.1 **Technical feasibility assessment**: Consolidate technical feasibility assessments, specifying main gaps to the target state by value chain step and mitigating actions

6.2 **Economic feasibility assessment:** Consolidate economic feasibility assessments by value chain step, assessing the potential sharing of decarbonization costs across the value chain

6.3 **Regulatory feasibility assessment:** Assess the regulatory feasibility of the green corridor, incl.

- "Must-have" regulatory and policy changes for the green corridor to go ahead
- Regulation and policies to close cost gaps
- Ensure alignment with UN commitments and directions

6.4 Develop a **risk register** and identify potential **mitigation actions**

6.1 Technical feasibility assessment: Consolidate technical feasibility assessments, specifying main gaps to the target state by value chain step

	Methodology – steps	Inputs
A	Identify **technical challenges** (if any) across the value chain	– Technical assessment – Chapters 2-4 output
B	Define how technical challenges are **expected to evolve/be resolved over time** (e.g., timing for availability of ammonia-fueled engines) and **how this aligns with the project timeline**	– Technical assessment – Chapters 2-4 output – Technical/technological trends and outlook based on market reports – Overall project timeline – pre-feasibility study output
C	**Categorize technical challenges** based on their severity and impact on the green corridor (critical vs. lower-priority challenges)	– Technical challenges – Chapter 6.1.B output
D	Define **scenarios for timing the resolution of main technical challenges,** assessing project timeline implications and actions required	– Technical assessment – Chapters 2-4 output – Current proposed decarbonization pathway (Chapter 4 output)
E	Define and prioritize **actions to accelerate** the technical enablement of green corridors, highlighting stakeholders that should be involved	– Technical assessment – Chapters 2-4 output – Current proposed decarbonization pathway – Chapter 4 output – Scenarios for the resolution of technical challenges – Chapter 6.1.D output

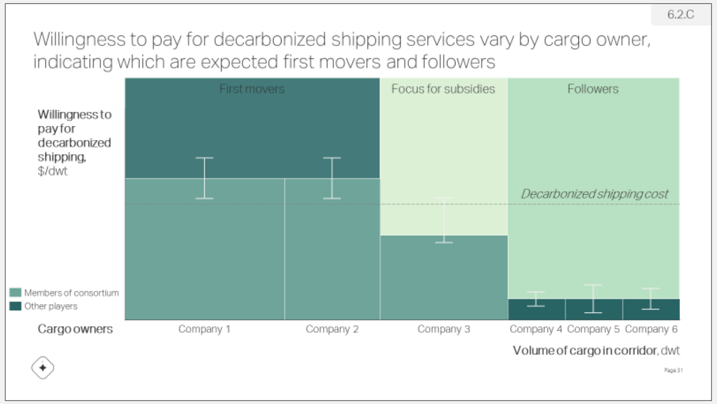
Illustrative examples: N/A

6.2 Economic feasibility assessment: Consolidate assessments by value chain step, assessing the potential sharing of decarbonization costs

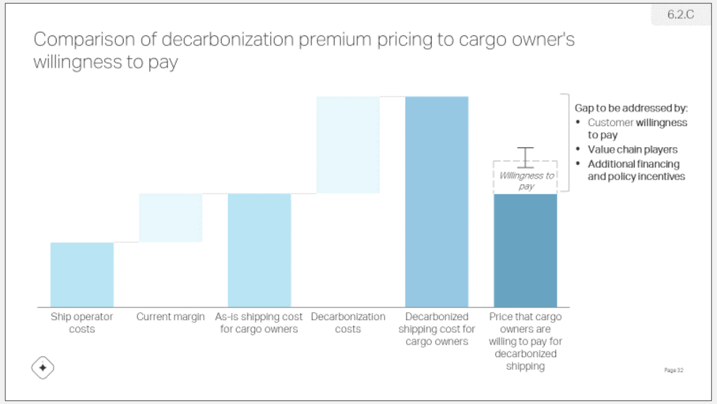
	Methodology – steps	Inputs
A	Integrate the **economic assessment outputs** for each value chain step from previous chapters	– Chapters 2-4 output
B	**Estimate overall incremental cost impact** across the value chain to meet the green corridor's decarbonization ambition	– Opex requirements – Chapters 2-4 output – Capex requirements – Chapters 2-4 output
C	Assess **how incremental costs can be addressed** across different levers: – **Additional financing** (incl. public funding, subsidies) and **policy incentives** – **Value chain players** – **Customer/end consumer willingness to pay**	– Chapters 2-4 output – Overall feasibility/cost impact – Chapter 6.2.B output – Customer willingness to pay – Chapter 5 output
D	Summarize the **overall economic feasibility assessment** for the green corridor project, assessing **if returns meet acceptable thresholds** and identifying **additional sources in case of an outstanding gap**	– Combination of the above – Public and private financing options, incl. cost of capital estimate and "green" investment subsidies – Local/national/global funding and subsidy programs for alternative fuel projects

Illustrative examples

6.2.C



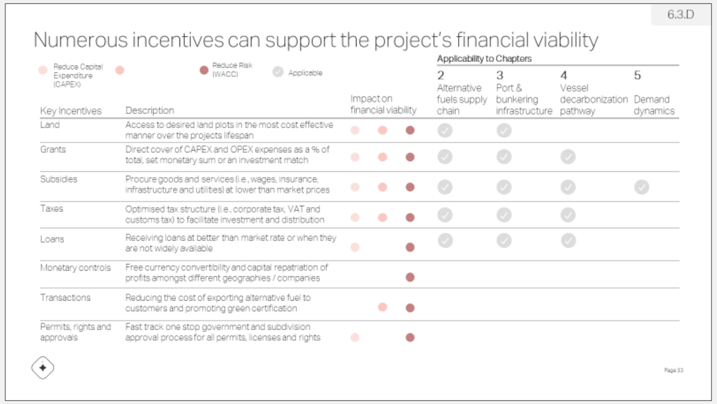
6.2.C



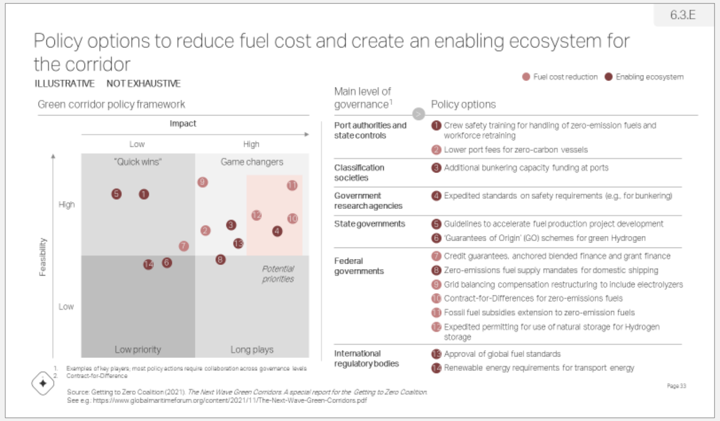
6.3 Regulatory feasibility assessment: Assess the regulatory feasibility of the green corridor

	Methodology – steps	Inputs
A	Identify **potential regulatory challenges** across the value chain and relevant levels of governance (international, regional, national, local) **and compliance with applicable sustainability conventions and guidelines**), incl.: • Regulatory/policy constraints • Areas with lacking policy/regulatory structure or guidelines • Compliance with conventions and guidelines such as UN Global Compact, Just Transition, and individual stakeholder commitments	– Chapters **2-4 output** – UN Global Compact commitments – Just Transition targets and commitments – Commitments from partners/stakeholders
B	**Categorize** regulatory challenges based on their **severity and impact** on the green corridor (critical vs. less-urgent challenges)	– Current regulatory challenges – Chapter 6.3.A output
C	Identify **required policy changes** across the value chain and levels of governance **to realize or accelerate** the green corridor (e.g., policies to expedite safety measures) and map the **timing for expected policy changes**	– Current regulatory challenges – Chapter 6.3.A output
D	Identify **policy incentives and regulations** across levels of governance that could **narrow cost gaps** between fossil fuels vs. alternative fuels across the value chain (e.g., faster permitting procedures, capex subsidies) and map the **timing for expected policy changes**	– Map of policies that impact financials – Sources of key cost gaps across the value chain – Chapter 6.1 output
E	**Map and prioritize policy and regulatory changes** by expected **feasibility and impact,** identifying timeline implications (e.g., actions to put policy changes on appropriate agendas)	– Expected feasibility and impact of policy/regulatory changes
F	Assess the **overall regulatory feasibility** for green corridor, highlighting areas of concern	– Combination of the above

Illustrative examples



6.3.D

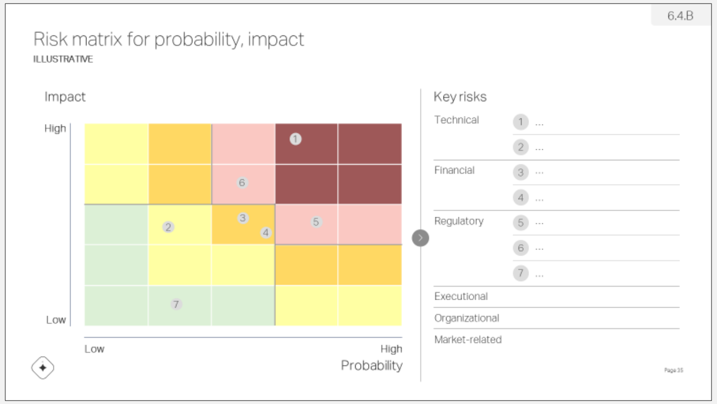


6.3.E

6.4 Develop a risk register and identify potential mitigation actions

	Methodology – steps	Inputs
A	Identify **risks** across dimensions, incl.: – Technical – Economic – Regulatory – Other (environmental, social, health & safety, etc.) – Executional – Organizational – Commercial	– Identified challenges – Chapters 6.1-6.3 output
B	Estimate the high-level **probability** and **impact** of each risk, quantifying the project's probability-adjusted risk	– Past examples of comparable projects – Stakeholder interviews
C	Identify **mitigation actions** to either reduce risk probability or impact in the green corridor, prioritizing risks with a high impact and/or high probability	– Risks identified – Chapters 6.1 – 6.3 output
D	Propose **metrics/indicators** to identify and measure risks throughout the project	– N/A

Illustrative examples



6.4.B

6.4.B,C

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04 Appendix

This document focuses on the feasibility phase of the green corridor project development

Project phases	Pre-feasibility	Feasibility	Select	Define	Execute	Operate
	Project baselining Value chain mapping Establish screening criteria (selection framework and justification) High-level screening of potential corridors Initial engagement with relevant regulatory bodies and government	Technical, economic, regulatory feasibility assessment Risk registry and mitigation plan Outline of decisions and commitments required by stakeholders Roadmap and milestones up to operation	Definition of criteria for selecting final concept Deep dive on key elements from feasibility phase as relevant to ranking criteria. Rank of concepts based on criteria and selection of final concept outlined in the feasibility study	FEED[1], detailed engineering design, and detailed commercial design related to (infrastructure, production, vessels, etc.) Contractual commitments between stakeholders, before final investment decisions (FID)	Finalized project details Project com-missioning and execution Preparation for handover	Operation of green corridor

Outputs and legal agreements (go/no-go decision points between phases):

- Letter of intent (Pre-feasibility → Feasibility)
- Memorandum of understanding (Feasibility → Select)
- Heads of agreement (Select → Define)
- Final investment decision (FID) and consortium execution contract (Define → Execute)
- Handover to operators (Execute → Operate)

Uncertainty

Focus of chapter 7 (Roadmap and milestones up to operation)

▲ Go/no-go decision point

1. Front-end engineering and design

Chapter 7: Roadmap and commitments

Key questions

I. What are the **commitments and investments/projects required** from each stakeholder to enable the integrated business case?

II. What are the **steps needed for an FID by project?**

III. What is the **overall roadmap toward operationalizing the green corridor** and what **actions does each stakeholder** need to take?

IV. What is the required **project governance** to deliver the roadmap for the next phases (Select and Define)?

V. What are the **resources and capabilities required to complete the next phases** (Select and Define) of the project?

VI. What is the **internal and external stakeholder communications plan?**

Chapter analyses

7.1 Catalog **investment decisions, expected lead times** to execute projects, and **required commercial arrangements** (e.g., offtake agreements, funding levers) **planned over time** by value chain participant

7.2 Build an **integrated roadmap for each value chain participant,** considering the sequencing and lead time of projects and risk scenarios, and map relevant **milestones:**

- Select and Define phases: Detailed roadmap
- Execute and Operate: High-level timeline

7.3 Define the **project governance and resourcing requirements** to complete the Select and Define phases

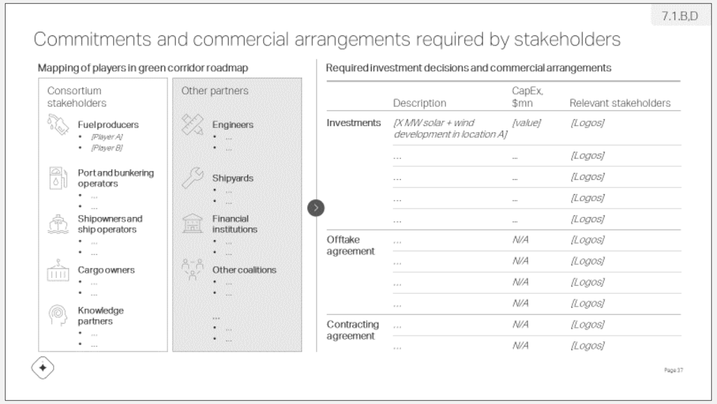
7.4 Develop a **communications and engagement plan** for internal and external stakeholders in the Select and Define phases

7.5 **Socialize and sign off** the integrated roadmap

7.1 Catalog investment decisions, lead times, and required commercial arrangements planned over time by value chain participant

	Methodology – steps	Inputs
A	**Catalog investments/projects required by stakeholder** in each step of the value chain **over time** for feasible solutions, clarifying specifications **per concept** (e.g., alternative fuel, propulsion engine), and identify expected **lead times per investment/project**	– Capex requirements per stakeholder over time – Chapters 2-5 output – Feasible solutions for corridor – Chapter 6 output
B	**Review commitments required by stakeholders** to enable the integrated business case for the green corridor for each feasible concept, incl.: – Offtake commitments (e.g., for fuel producers from shipping, other sectors) – Contracting commitments (e.g., from cargo owners) – Capex investments	– Commitments required per stakeholder – Chapter 6.2 output
C	Summarize the **financing needs over time** to secure the economic feasibility of the project	– Financing requirements and sources (e.g., public and private financing options, "green“ investment subsidies, local funding/subsidy programs) – Chapter 6.2 output
D	Catalog the **dependencies and commercial arrangements required with partners outside the consortium** (e.g., engineers, manufacturers, shipyards, financial institutions)	– Commitments and capacity requirements for external stakeholders – Chapters 2-6 output

Illustrative examples

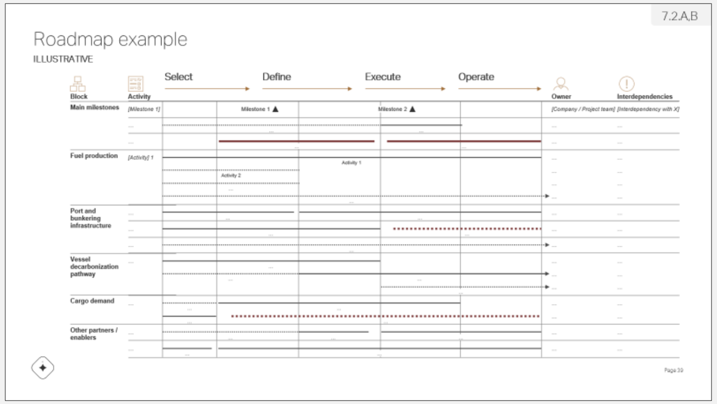


7.1.B,D

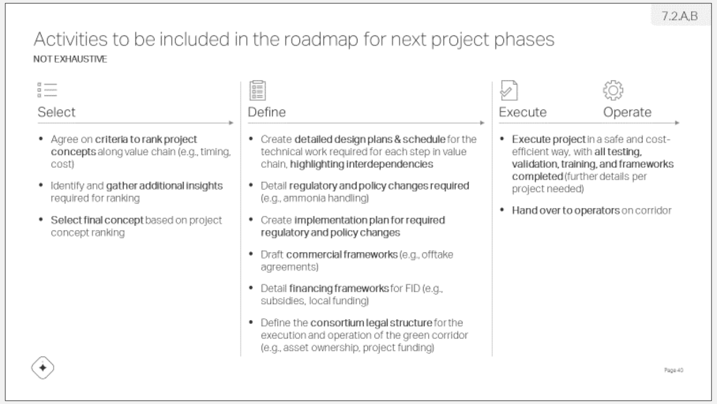
7.2 Build an integrated roadmap for each value chain participant and map relevant milestones

	Methodology – steps	Inputs
A	For the **Select** and **Define phases:** – Define the **list of activities/projects** required **across the value chain**, outlining **interdependencies,** and considering sequencing and lead times – Overlay **risk assessment** onto roadmap (e.g., high-probability execution risks built into the timeline) – Develop the **responsibility matrix (e.g., RACI[1])** for stakeholders for each of the above activities – Create a detailed **list of milestones planned over time,** linked to above activities	– Investment requirements and commitments per project concept – Chapter 7.1 output – List of stakeholders – Chapter 7.1 output – Risk register – Chapter 6.4 output
B	For the **Execute and Operate phases**, develop a **high-level view** on the **main milestones per phase** and **associated timeline for each activity**	– High-level schedule for execution by project, value chain, and milestones – Chapter 7.1 output – Decarbonization potential, ambition and timeline (if available) for the corridor

Illustrative examples



7.2.A,B



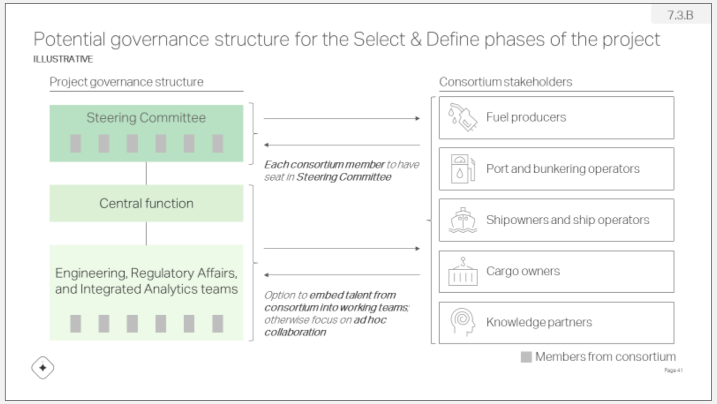
7.2.A,B

1.Responsible - Accountable - Consulted - Informed

7.3 Define the project governance and resourcing requirements to complete the Select & Define phases

	Methodology – steps	Inputs
A	**Map all stakeholders** (internal and external) for the green corridor, and **Define their roles in the project**, e.g., core consortium participants, knowledge partners, external stakeholder	– List of stakeholders – Chapter 7.1 output
B	**Define groups and capabilities required for the project governance** and their responsibilities, participants, resources, and cadence, for: – Decision making (steering committee) – Central coordination/PMO[1] group – Engineering teams from stakeholders – Central regulatory affairs group – Central business case analytics group	– Examples of other consortia – Engagement with consortium members
C	Determine the **processes** (i.e., cadence of meetings, participants, forum, escalation management) **and ways of working/reporting lines** within the project	– Consortium format – pre-feasibility input – Examples of other consortia – Engagement with consortium members
D	Define the **consortium configuration and structure,** considering the option to **establish a legal entity structure,** and define **implications for project funding**	– Discussion with stakeholders – Legal and economic considerations
E	Estimate **investments required to complete the next phases** (Select and Define) of the project, based on **outstanding steps toward FIDs** and **required project governance**	– Roadmap for Select and Define phases – Chapter 7.2 output – Resources for project governance – Chapter 7.3.B output
F	Identify **stakeholder appetite and funding availability to enter next phases** (Select and Define), given investment requirements	– Next-phase investment requirements – Chapter 7.3.E output – Discussion with stakeholders

Illustrative examples



7.3.B

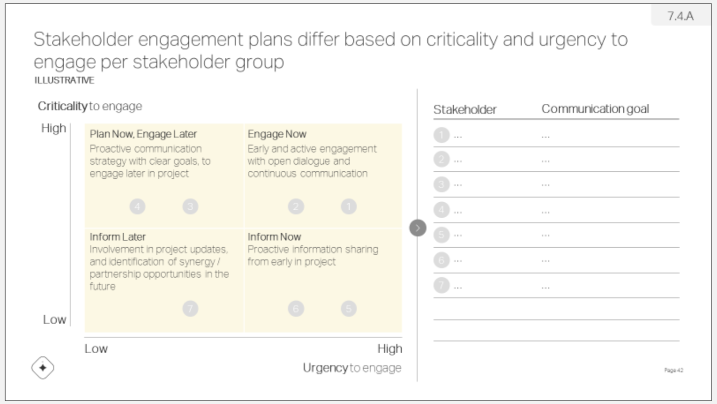
1.Project Management Office

7.4 Develop a communications and engagement plan for internal and external stakeholders in the Select and Define phases

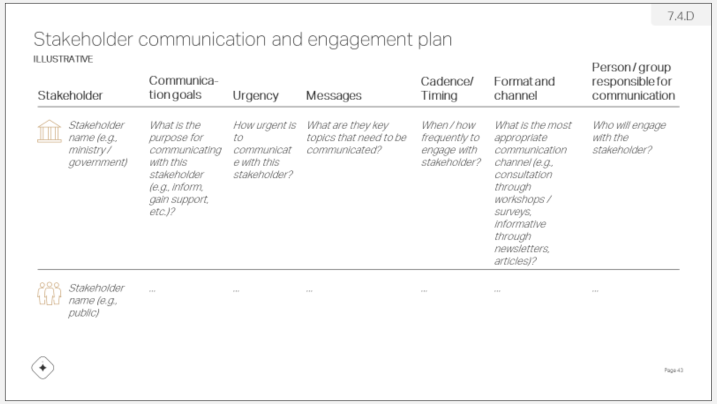
Methodology – steps	Inputs
A **Map all stakeholders** (internal and external – e.g., government, national/international regulators, industry leaders, industry coalitions, general public) for the green corridor and **assess prioritization of engagement by level of criticality** and **level of urgency to contact**	– List of stakeholders – Chapter 7.1 output
B Identify project **milestones that require/prompt** external communications	– Project phases and respective milestones – Chapter 7.2 output – Map of stakeholders – Chapter 7.3.A output
C Develop **core messages per external stakeholder for each phase** of the green corridor project, syndicating with project team and consortium stakeholders	– Communication milestones – Chapter 7.4.B output
D Build an **action plan for each stakeholder group,** incl. **mode, timing and cadence** of communication**,** and **person/group responsible for communication** per stakeholder group	– Combination of the above

Illustrative examples

7.4.A



7.4.D



7.5 Socialize and sign off the integrated roadmap

Output of feasibility study to be signed off

1 **Statement of feasibility**, a summary of the feasibility study output considering technical, economic, and regulatory aspects, with relevant data and exhibits

2 Proposed **integrated roadmap** and milestones for each stakeholder, incl.:

- **Investment decisions/**capex requirements
- **Required commercial arrangements** and **commitments**

3 **Immediate next steps and investment** requirements for next phases (Select and Define)

Responsible consortium stakeholders

Fuel producers

Port and bunkering operators

Shipowners and ship operators

Cargo owners

Knowledge partners

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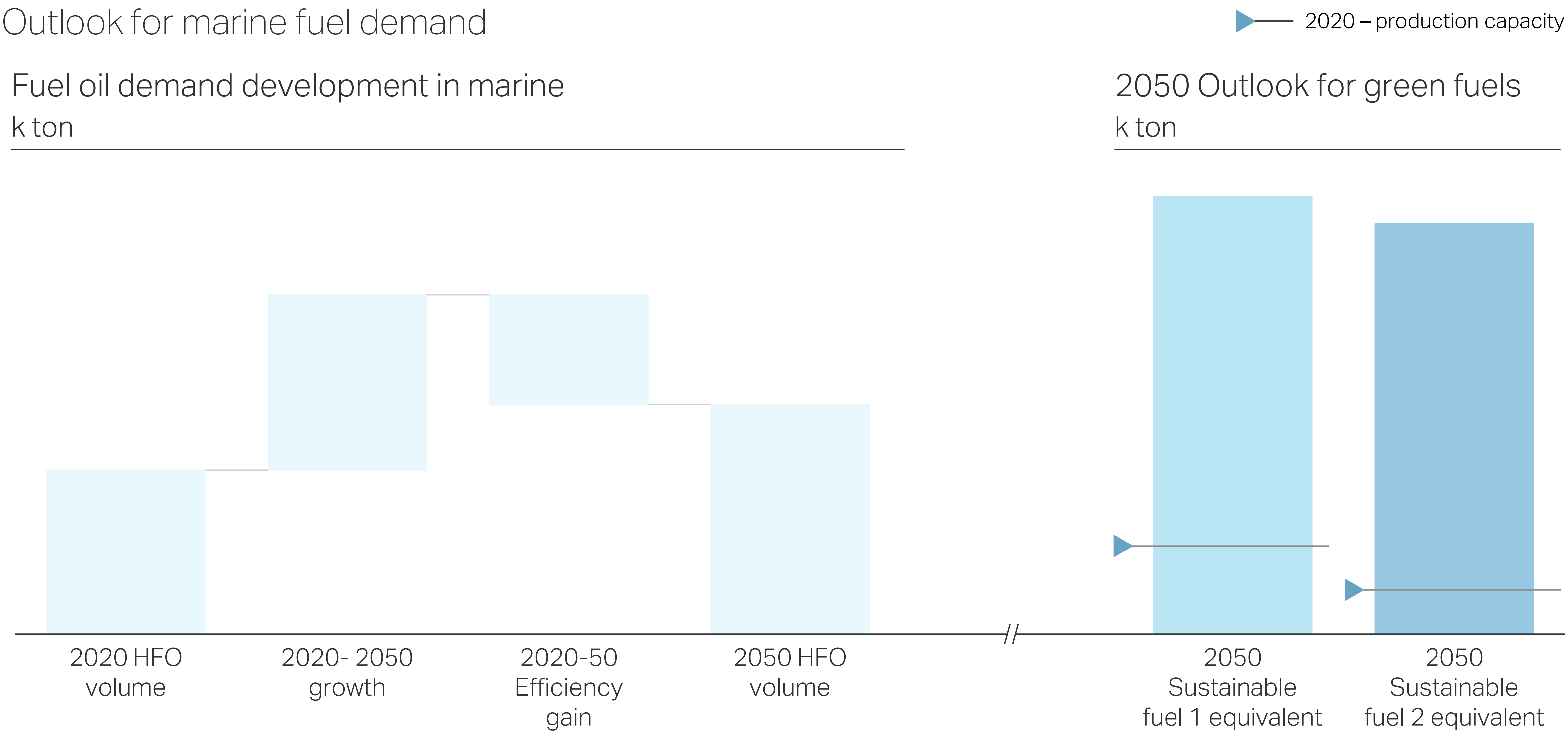
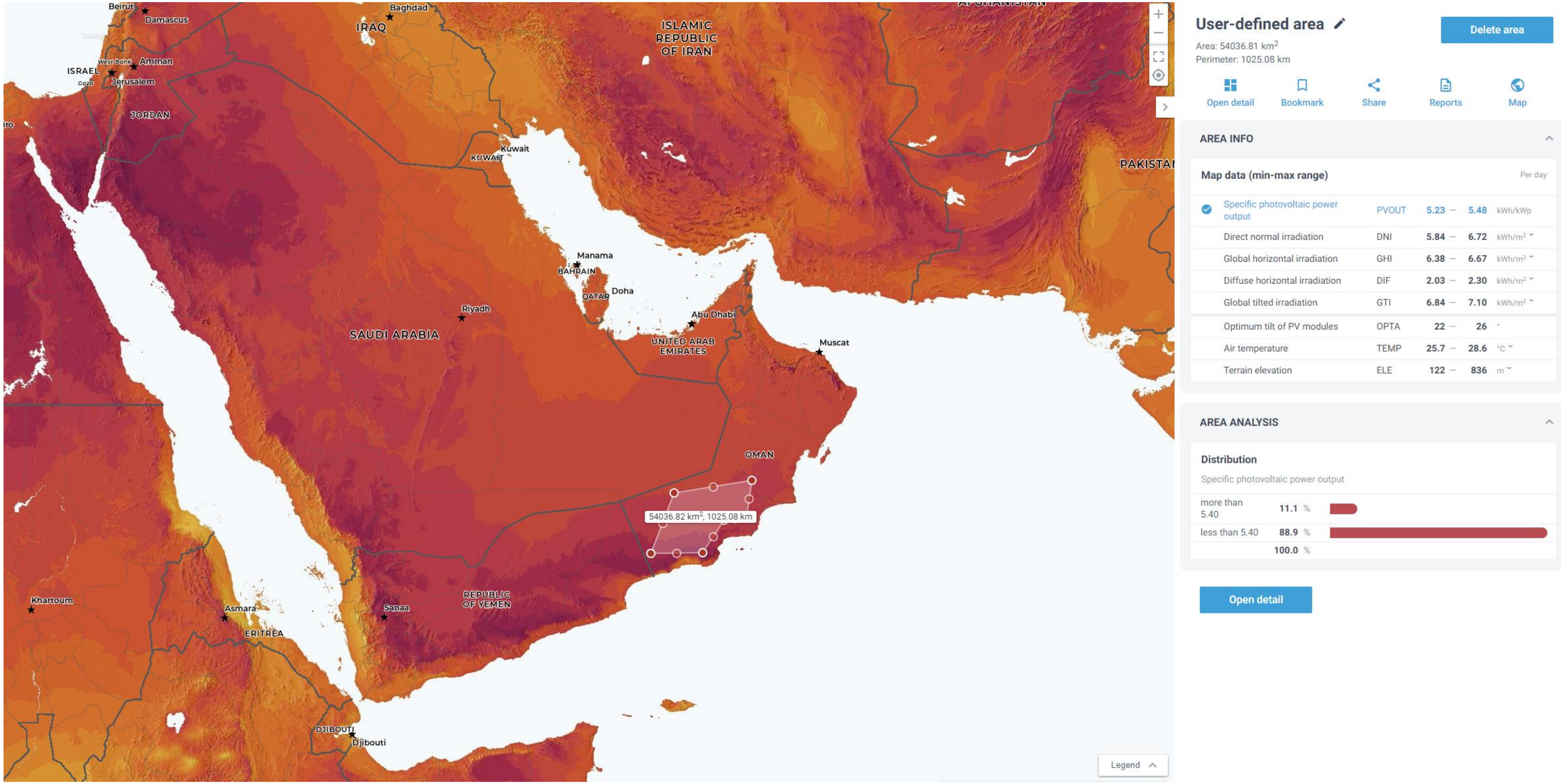
Expected demand for green fuel in corridor

Outlook for marine fuel demand



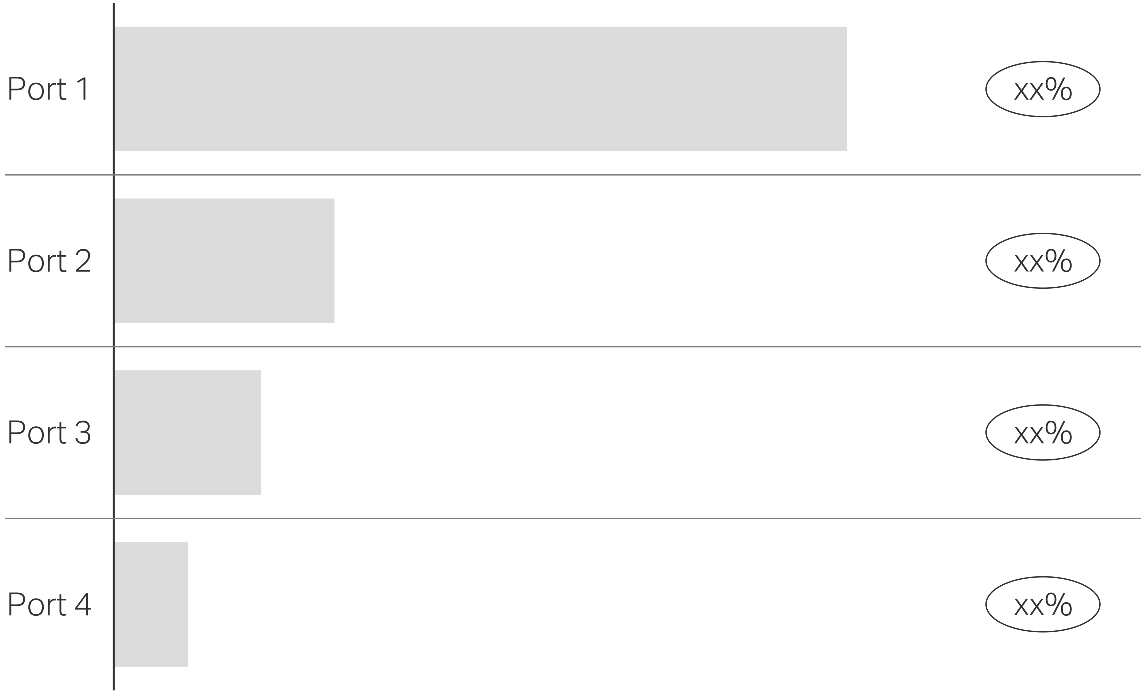
Illustrative solar potential geospatial assessment



Source: Global Solar Atlas

Bunkering volumes in ports for traffic in corridor

Annual estimated bunker volume by port (2020), Million tonnes — **% of total**

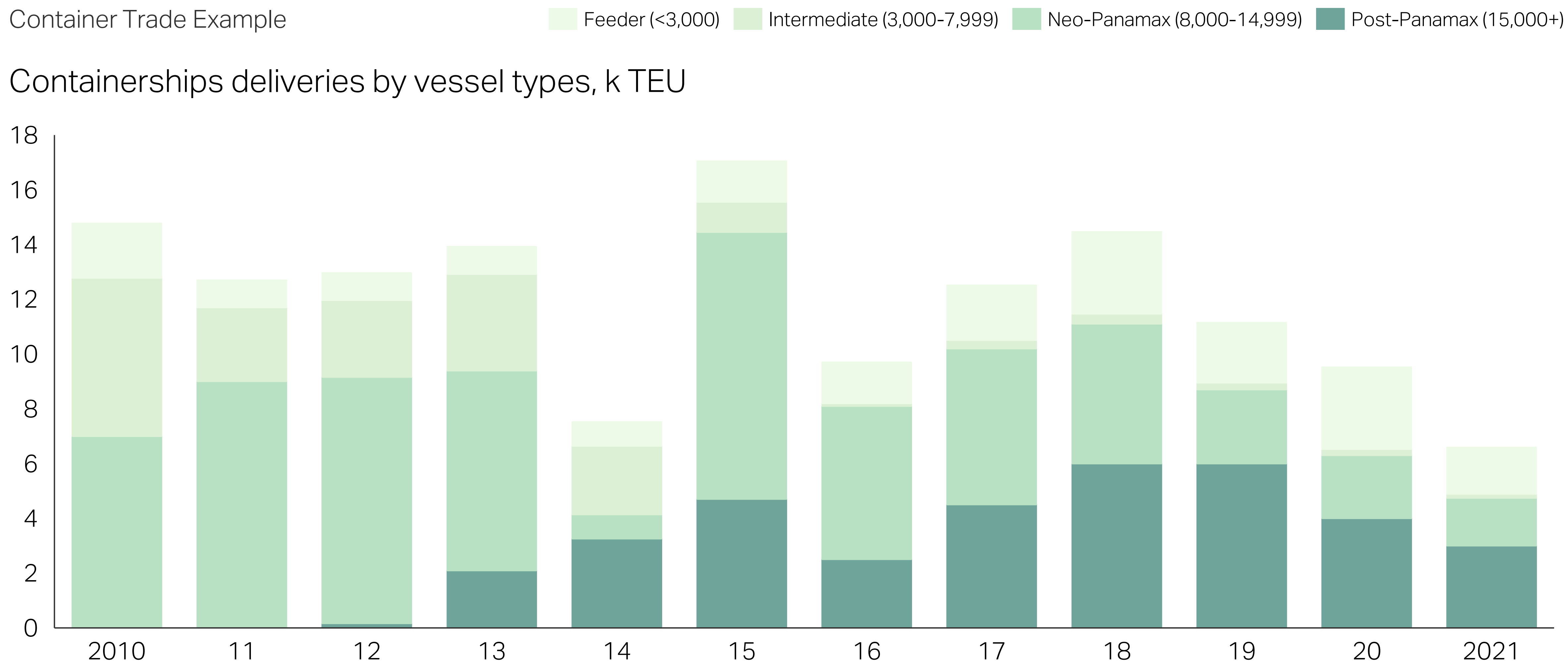


		Description	% of total
In-port	Port to ship	Dock the ship to port and directly fuel the ship using pumps Generally, cannot fuel while loading/unloading cargo	xx%
	Ship to ship	Small barge vessels load fuel by port-to-ship, then carries fuel to customer ship Ship can either be docked or anchored close by to port	xx%
Off-shore	Fishery	Fishing fleets that that stay at sea receive off-shore bunkering by barges Also delivers fuel, lubricants, food, etc.	xx%
	Oil rigs	Oil rigs and supporting structures (drill ships, seismic vessels, etc.) require bunkering during re-location for new projects	xx%

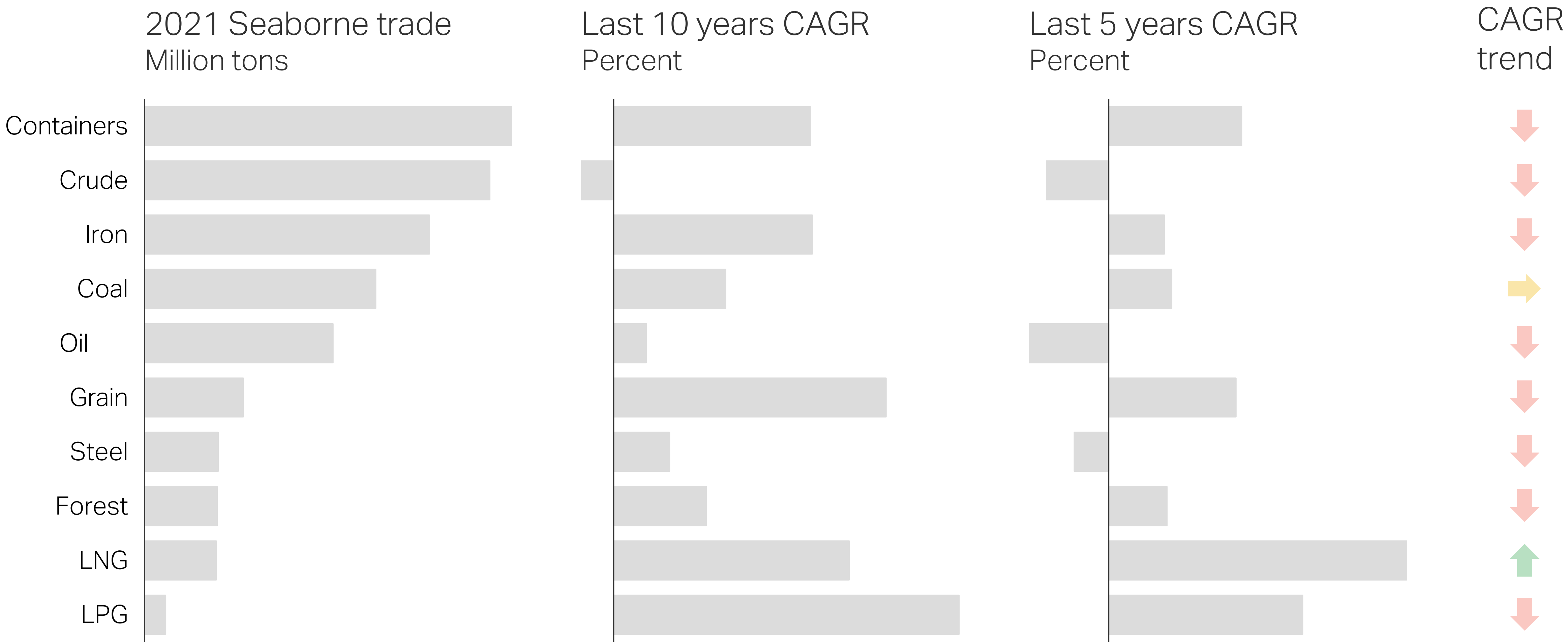
Historical container delivery volumes in corridor by vessel type

Container Trade Example

Containerships deliveries by vessel types, k TEU



Trade flows in corridor



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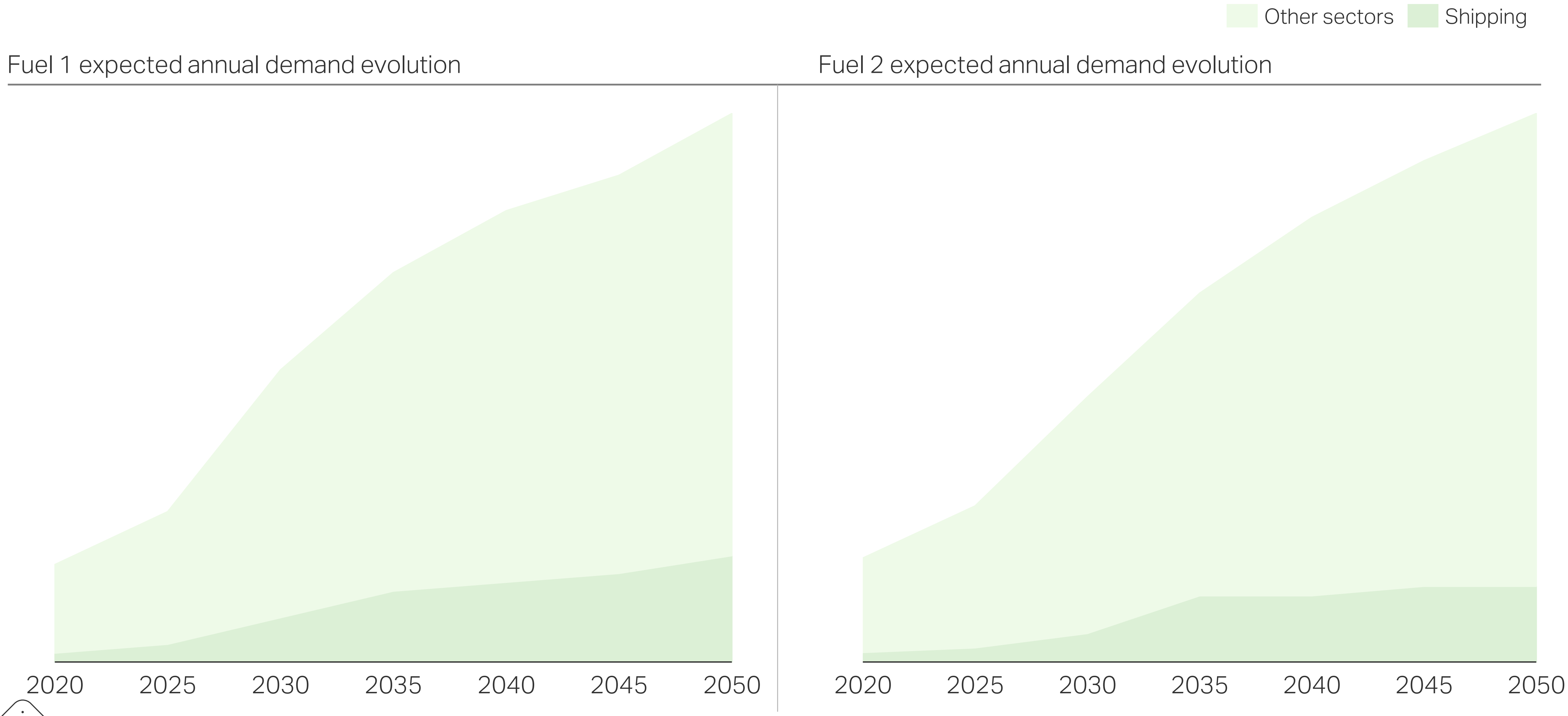
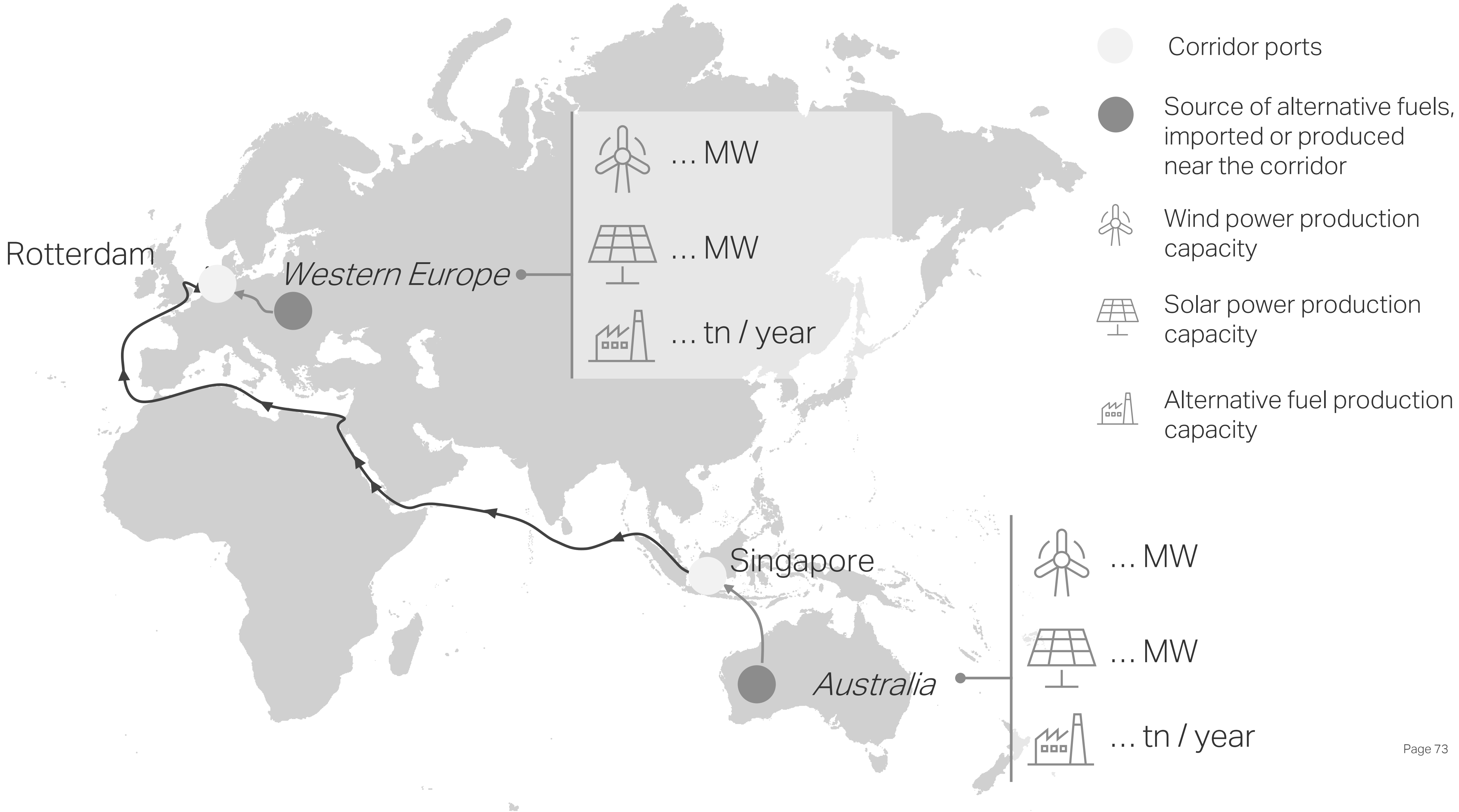
Expected demand for alternative fuels for shipping and other sectors

ILLUSTRATIVE



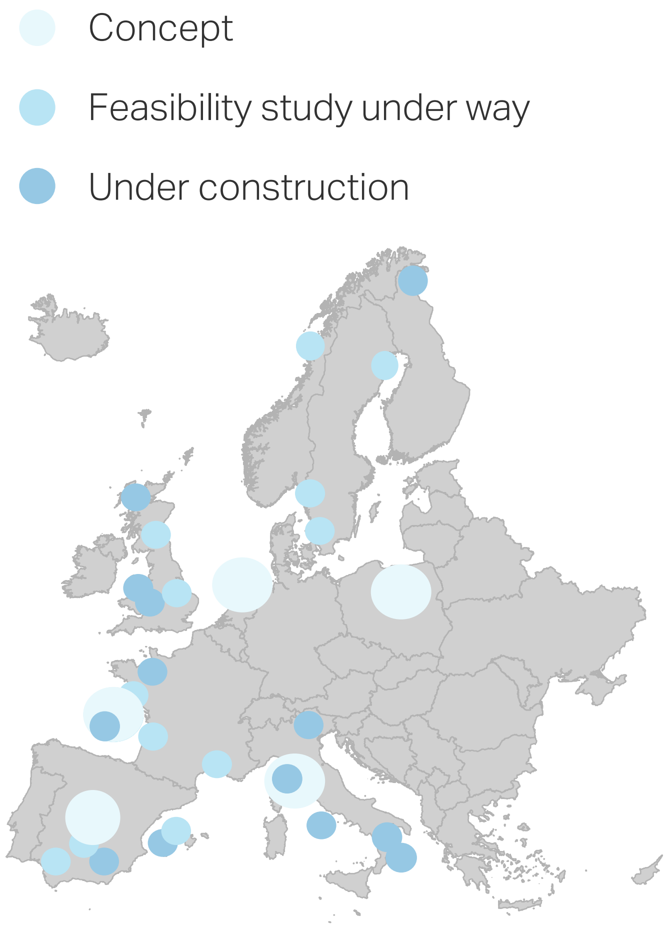
Import sources of fuel for the corridor



Pipeline of announced alternative fuel projects

ILLUSTRATIVE

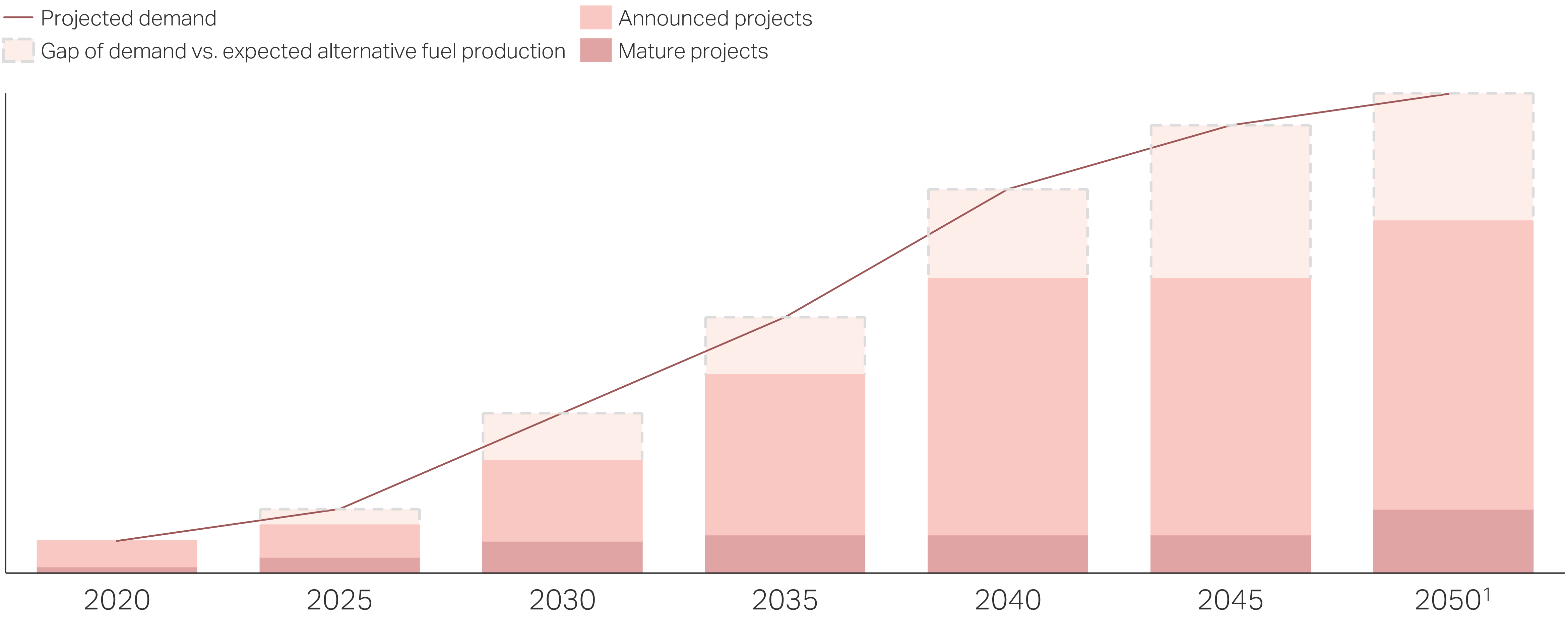
				Capacity		
Fuel	Region	Players	Timeline	Total	Committed to other sectors	Rest
Alternative fuel 1	NL	...	2030	X MW	Y MW	Y MW
	...	...	...	...	...	...
Alternative fuel 2	DK	...	2040	X tons/ year	Y tons/ year	Y tons/ year
	...	...	...	...	...	...



Timeline for availability of alternative fuels for shipping versus demand

ILLUSTRATIVE

Alternative fuel expected annual demand and supply evolution

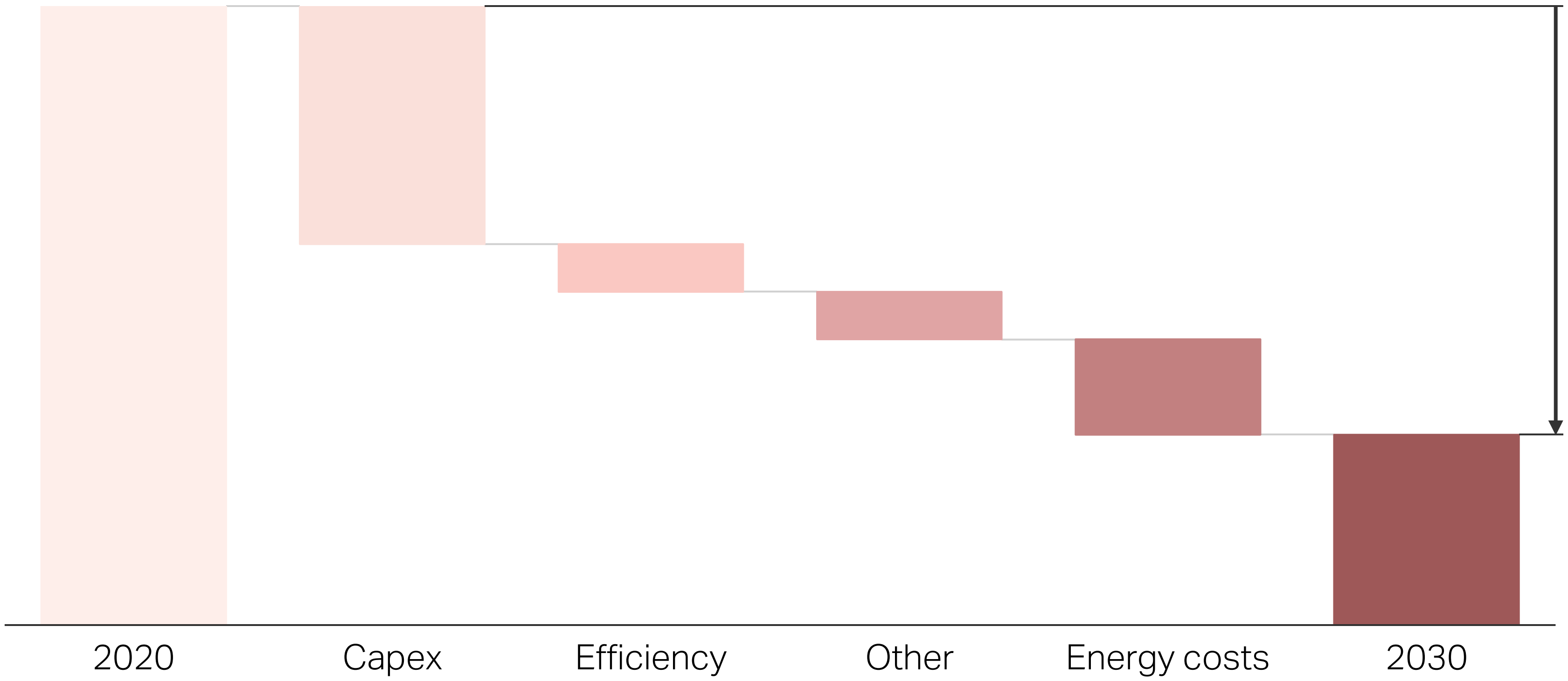


1- Time dependent on green corridor horizon

Expected evolution of fuel production costs based on driver evolution

ILLUSTRATIVE

Cost reduction levers for fuel production



CapEx decreases Xx% for the full system driven by...

Efficiency improves from ~Xx% to ~Xx% due to....

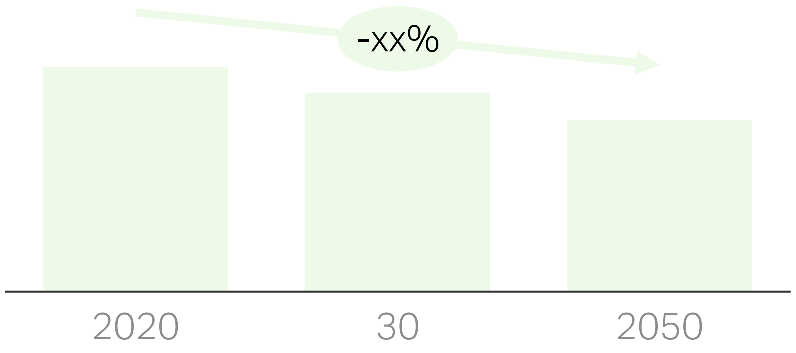
Other O&M costs go down following...

Energy costs combined wind onshore and solar PV LCOE decrease by Xx...

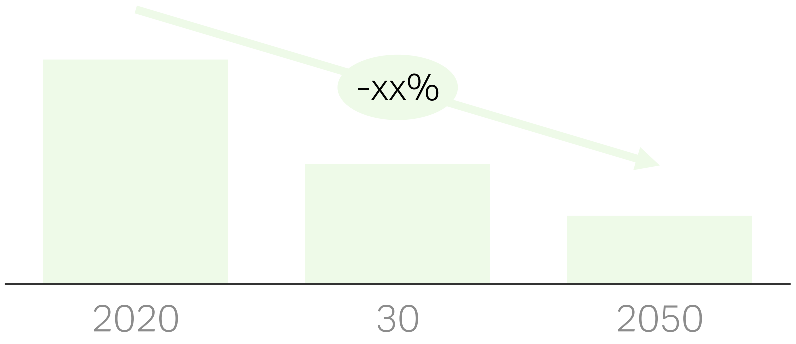
Expected fuel and feedstock technology CapEx evolution

ILLUSTRATIVE

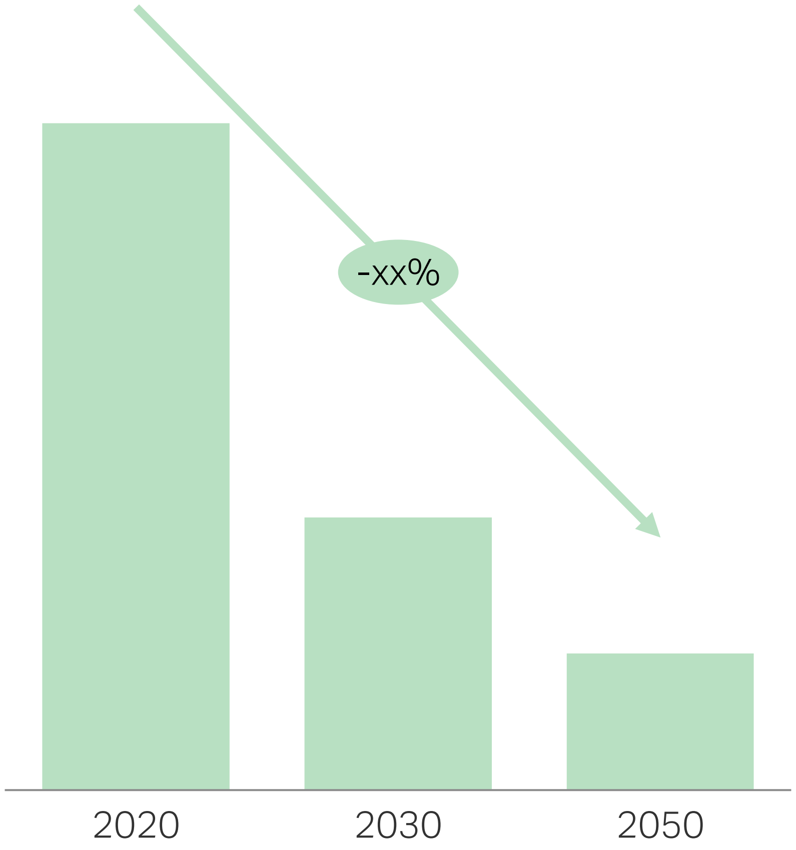
Onshore wind CapEx



Solar PV CapEx



Technology CapEx



Effect

- Lower capex of solar and wind are encouraging new ways to monetize low cost power
- Technology with significant cost down potential due to standardization and scaling of production units

Source: Team analysis, McKinsey Energy Insights 2018, Fraunhofer ISE, US DOE

Players along the alternative fuel production value chain

ILLUSTRATIVE

Upstream		Midstream			Downstream
Feedstock & electricity production	Fuel production	Fuel conversion	Transmission & Distribution	Storage & Dispensing	End-use applications

Feedstock & electricity production: bp, equinor, Sinopec, TOTAL, EDF, VATTENFALL, Ørsted, uniper, PGE, Verbund, CEEC 中国能建, Shell

Fuel production: SIEMENS, THE LINDE GROUP, equinor, AIR PRODUCTS, McPhy, nel, metacon, thyssenkrupp, ITM POWER Energy Storage | Clean Fuel, HYDROGENICS SHIFT POWER | ENERGIZE YOUR WORLD, Air Liquide, AsahiKASEI, GREENHYDROGEN, Fronius, hynamics, Logan Energy, sunfire, iht, HYGEAR, storengy, CCS Global, H2B2, NEOM

Fuel conversion: Port of Antwerp, MITSUI & CO., LTD., Kawasaki, JXTG, NEOM, H2V, KOGAS, hydrogenious LOHC TECHNOLOGIES, Iwatani, YARA, GRTgaz

Transmission & Distribution: snam, ENGIE, Northern Gas Networks, Cadent Your Gas Network, SoCalGas, amprion, Fronius, Open Grid Europe, enagas, GAZ system, Howden, FLUXYS, gasunie, ontras, HyET Hydrogen, gasunie, TERĒGA, WOIKOSKI, Wystrach

Storage & Dispensing: bp, TOTAL, THE LINDE GROUP, Air Liquide, FE FUEL, Sinopec, atawey, Fronius, Shell

Components

BALLARD, MITSUI & CO., LTD., Faber, HYDROGENICS SHIFT POWER | ENERGIZE YOUR WORLD, 3M, AngloAmerican, LIEBHERR, Vopak, Sumitomo Corporation, AFC Energy, EWII, TOYOTA TSUSHO, Helion, elcogen, AREVA, Advent, Nedstack, Swagelok, Ceres Power, Danish Power Systems, POWERCELL

End use

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Source: Hydrogen Council, FCU-JU, Company websites

Expected alternative fuel sources and costs for green corridor

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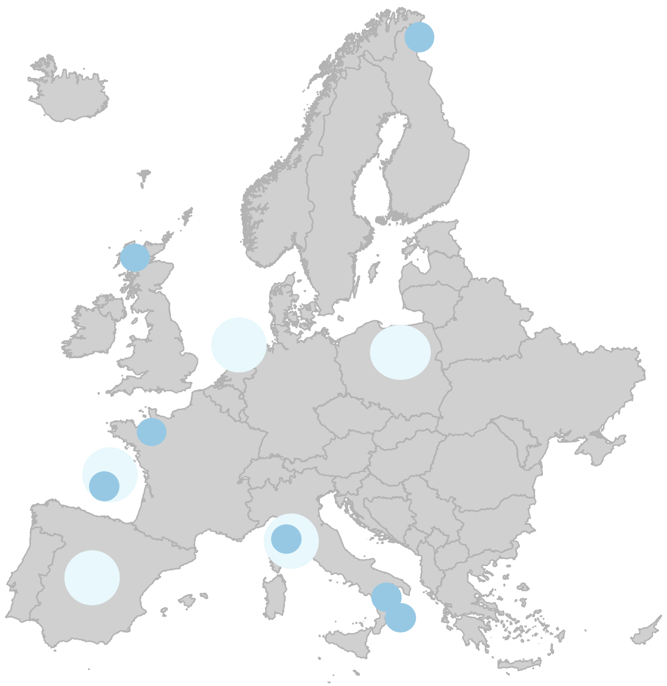
Region	Total produced capacity	Capacity available to corridor	Offtake potential	Expected price (2030)	CapEx required
Local – region A	X MW	Y MW	X%	$ X / MW	... $
Local – region B	...	...	...	... $ / MW	... $
Import – region C	...	...	...	... $ / MW	... $
Import – region D	...	...	...	... $ / MW	... $

Proposed
Already announced/ under construction

Map of expected production centers



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Proposed bunkering sites for the corridor

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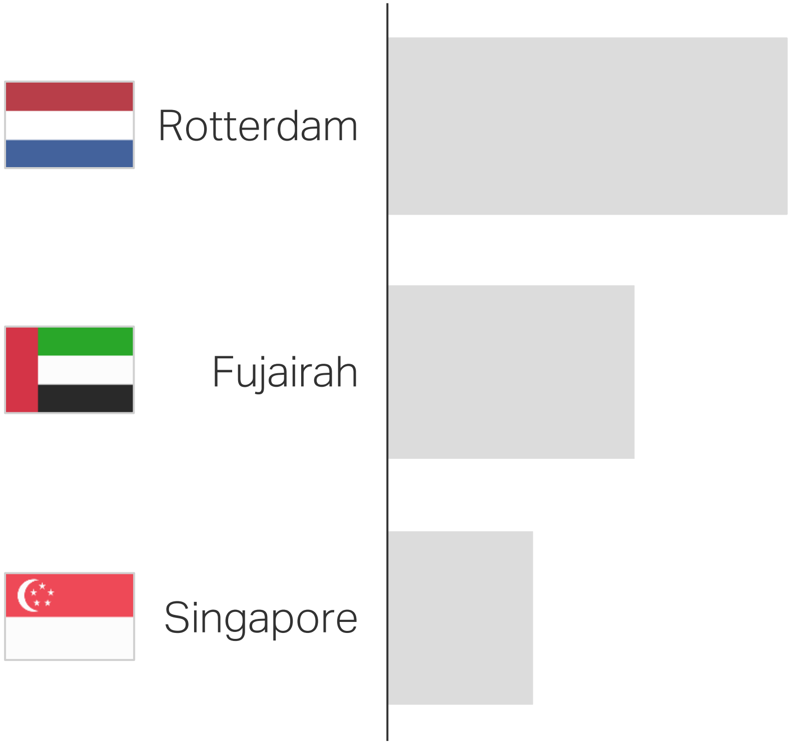
End points of corridor and initial bunkering sites

Additional bunkering site

Expected volumes by site
kt/year



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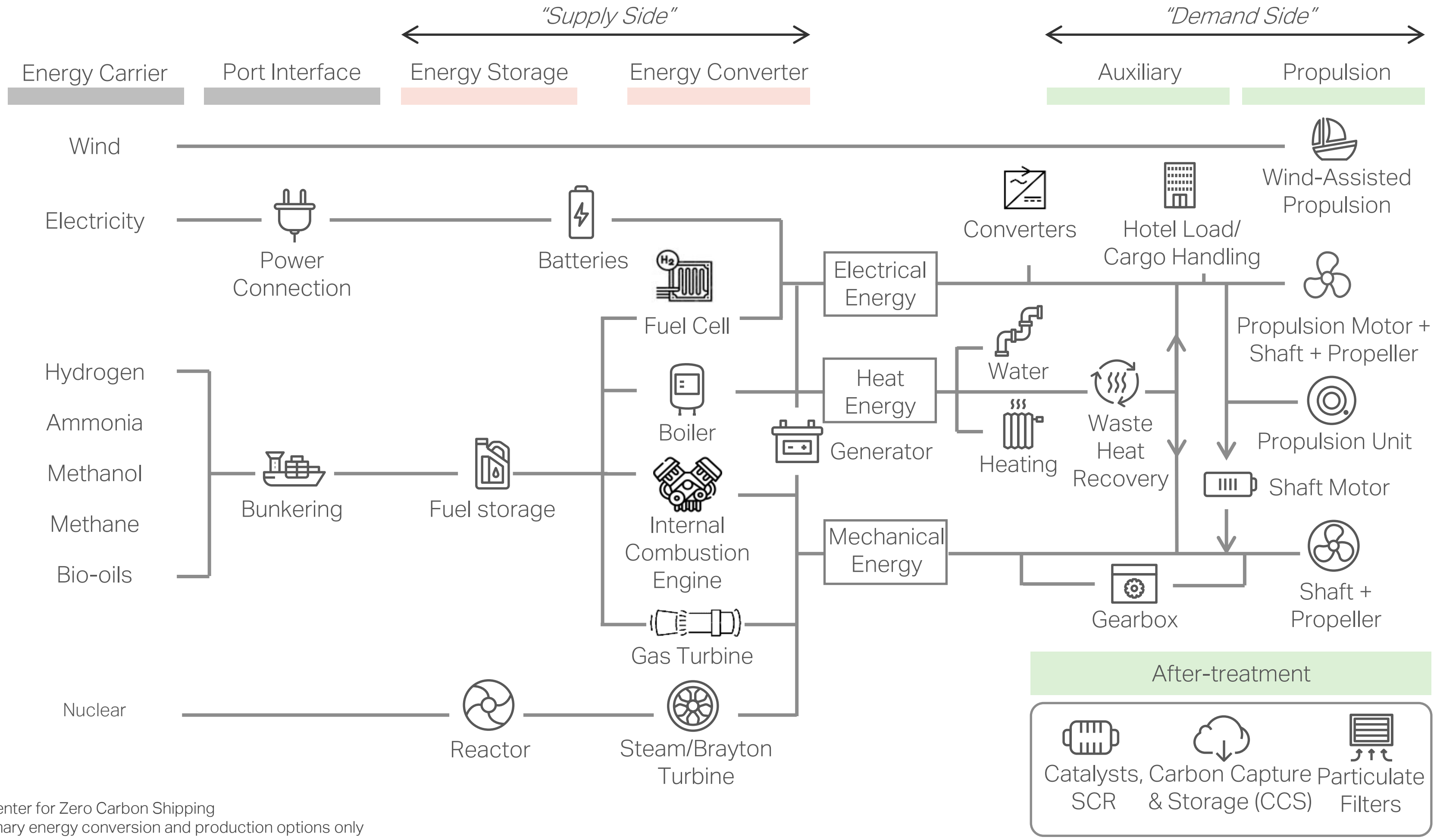
Vessel technology pathways: onboard energy demand can be met in different ways

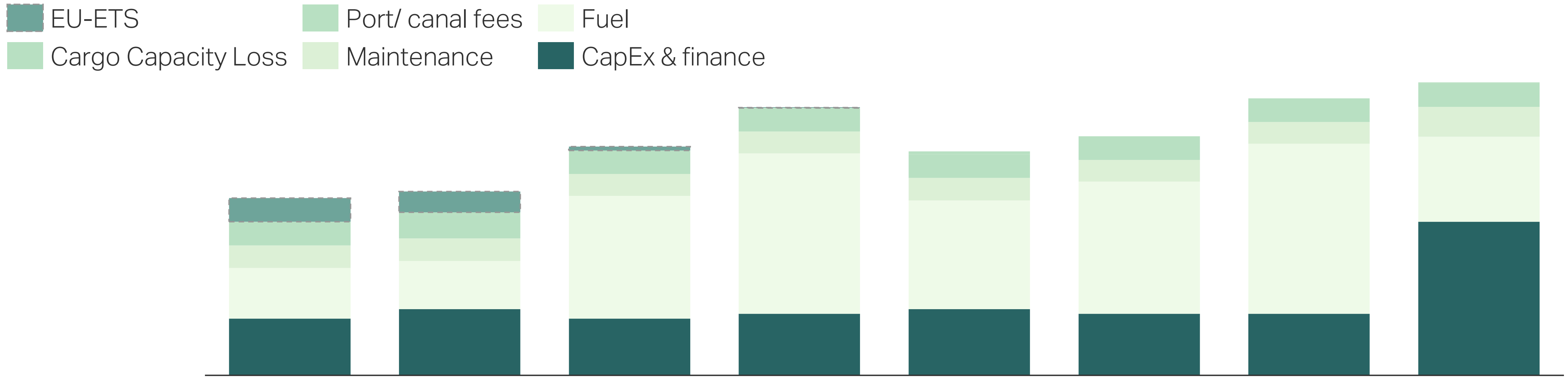
Maritime energy conversion and propulsion options[1]



Source: MMM Center for Zero Carbon Shipping
1 Represent primary energy conversion and production options only

Total cost of ownership (TCO) for traditional and alternative fuels by 2030

ILLUSTRATIVE



Avg fuel price (2030-2050)								
$ / ton	$ x	$ x	$ x	$ x	$ x	$ x	$ x	$ x
$ / ton-of-LSFO-eq	$ x	$ x	$ x	$ x	$ x	$ x	$ x	$ x
Fuel type	Fossil		Bio		E-fuel			
Propulsion	ICE							FC

Expected evolution of Total Cost of Ownership for fossil and alternative fuels

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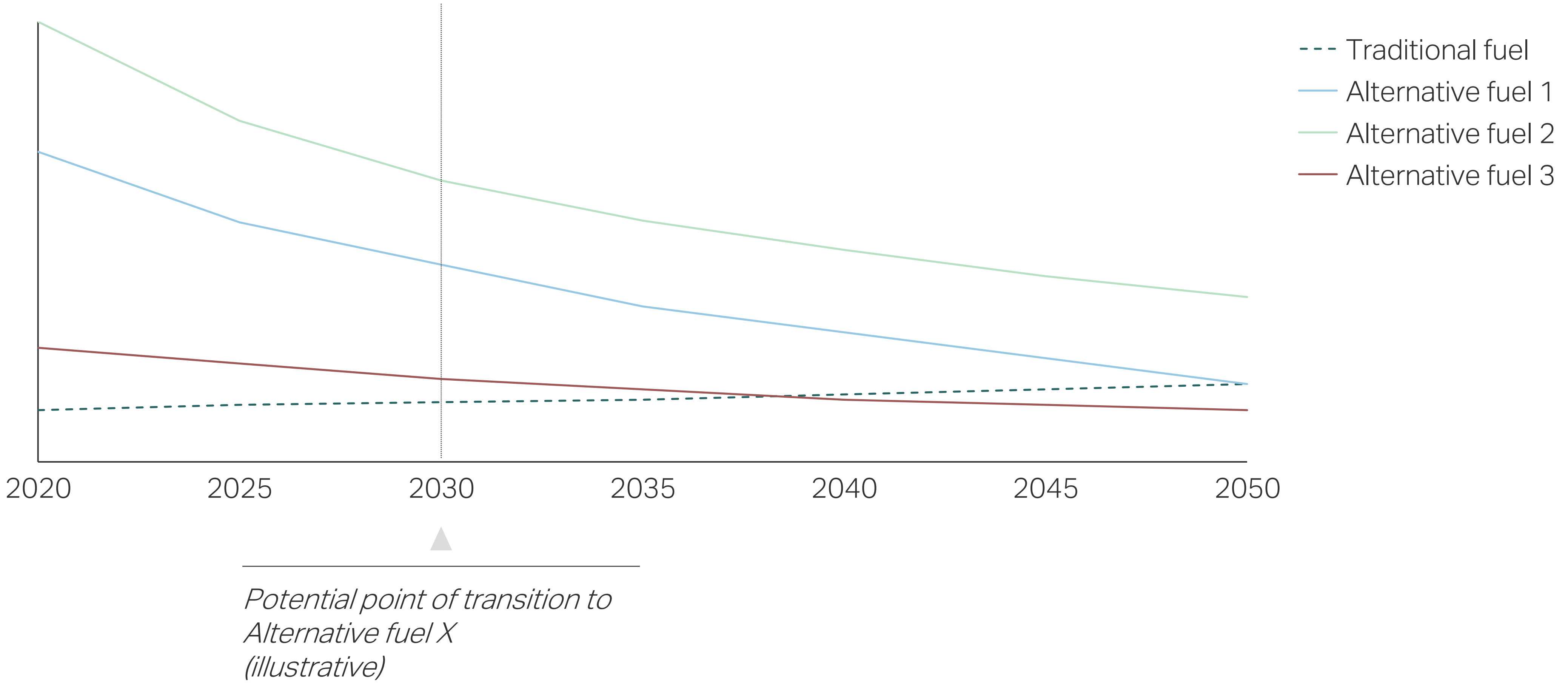
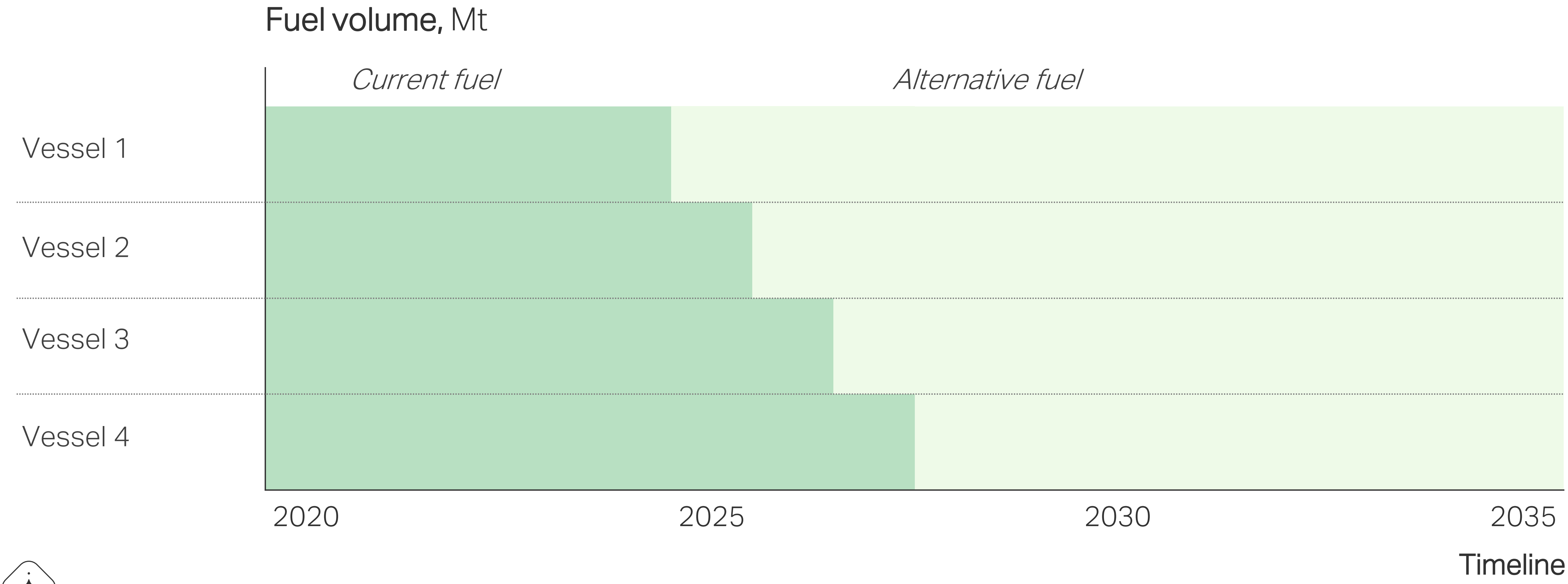
TCO evolution by fuel



Proposed sequence of fuel transition based on TCO, fuel availability and decarbonization timeline for the corridor

Fuel transition for 4 vessels in selected corridor



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Comparing the shipping / transport share of emissions vs. total lifecycle emissions, with the share of cost vs. total retail value

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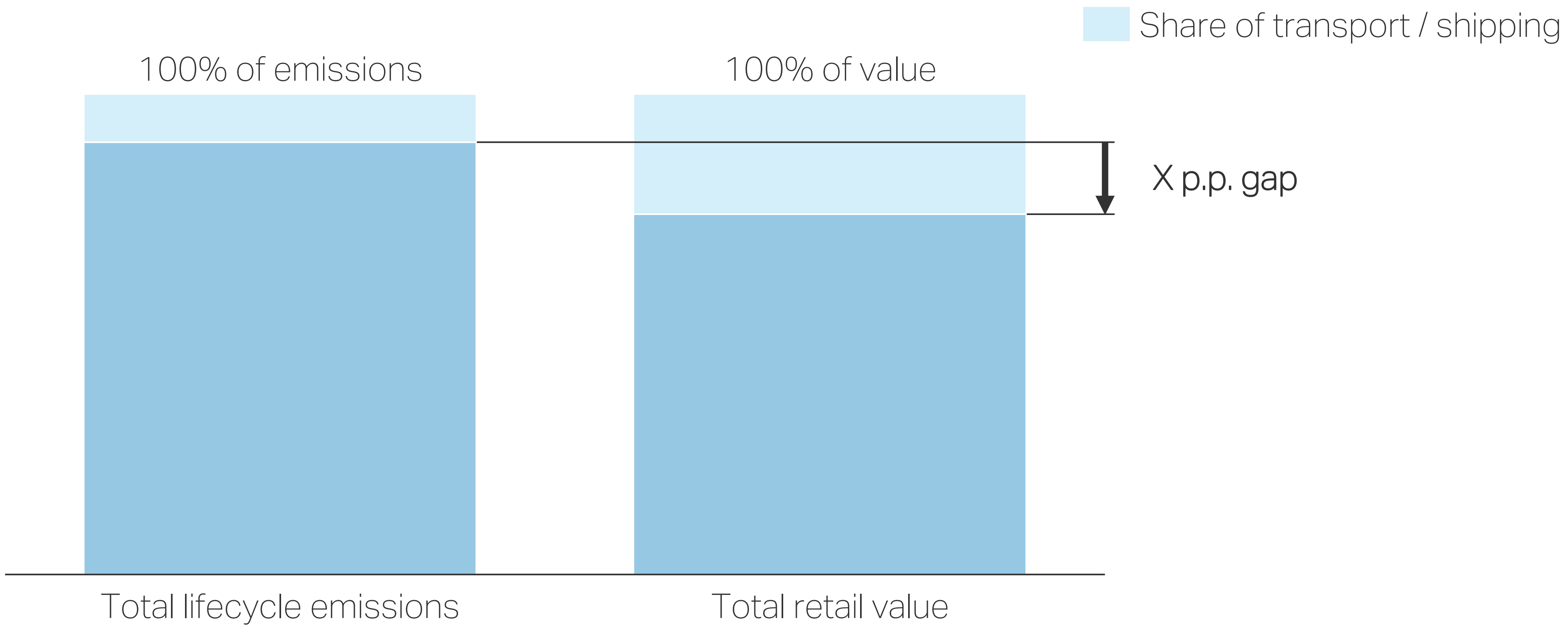

Alternative transport options and routes

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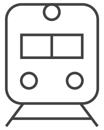
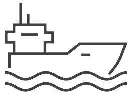
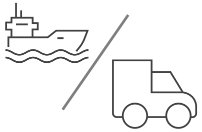
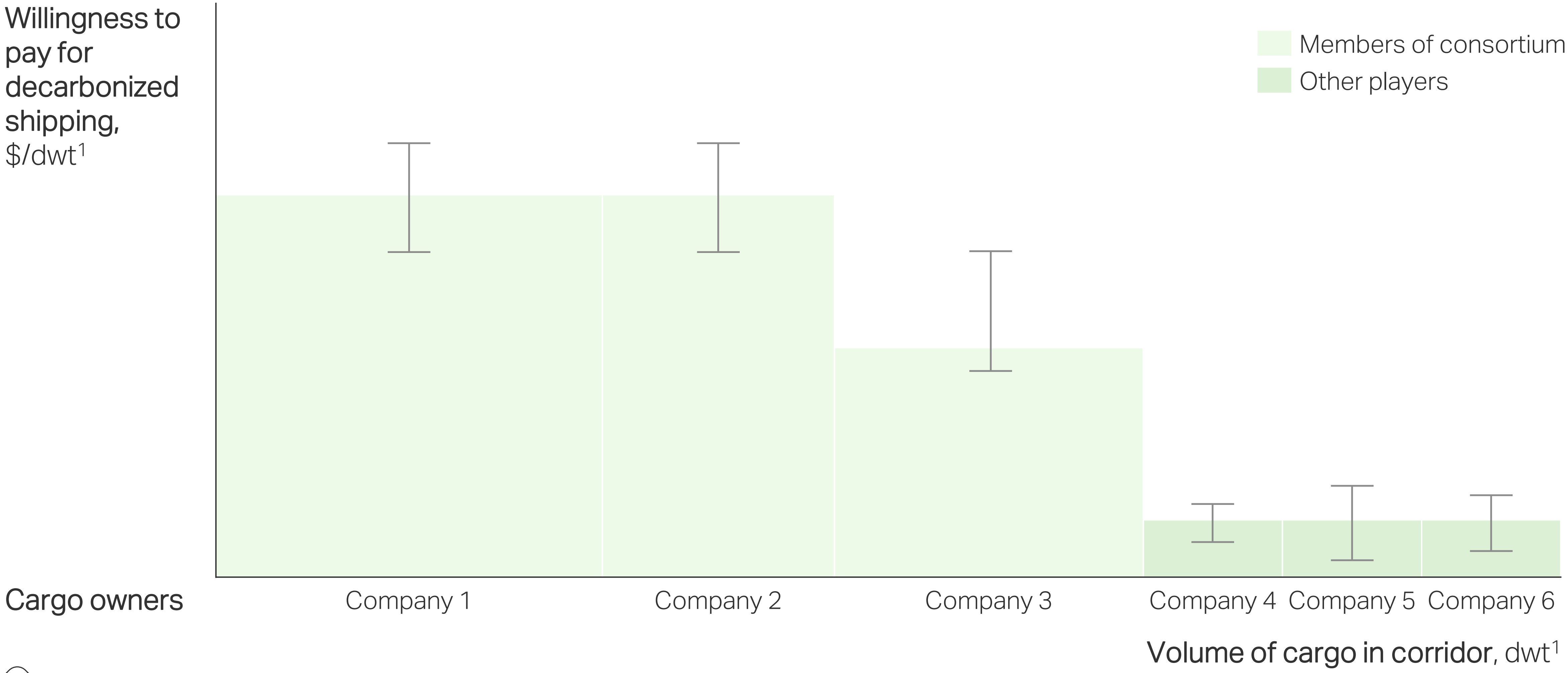
Favorable | Neutral | Unfavorable

Options	Mode	Fit to cargo	Regulatory	Cost / commercial
[Description – e.g., rail from location X to Y]		*[Comments / explanation]*	*[Comments / explanation]*	*[Comments / explanation]*
[Description – e.g., same route with fossil fuels]		...	...	...
...		...	...	...

Willingness to pay for decarbonized shipping services vary by cargo owner



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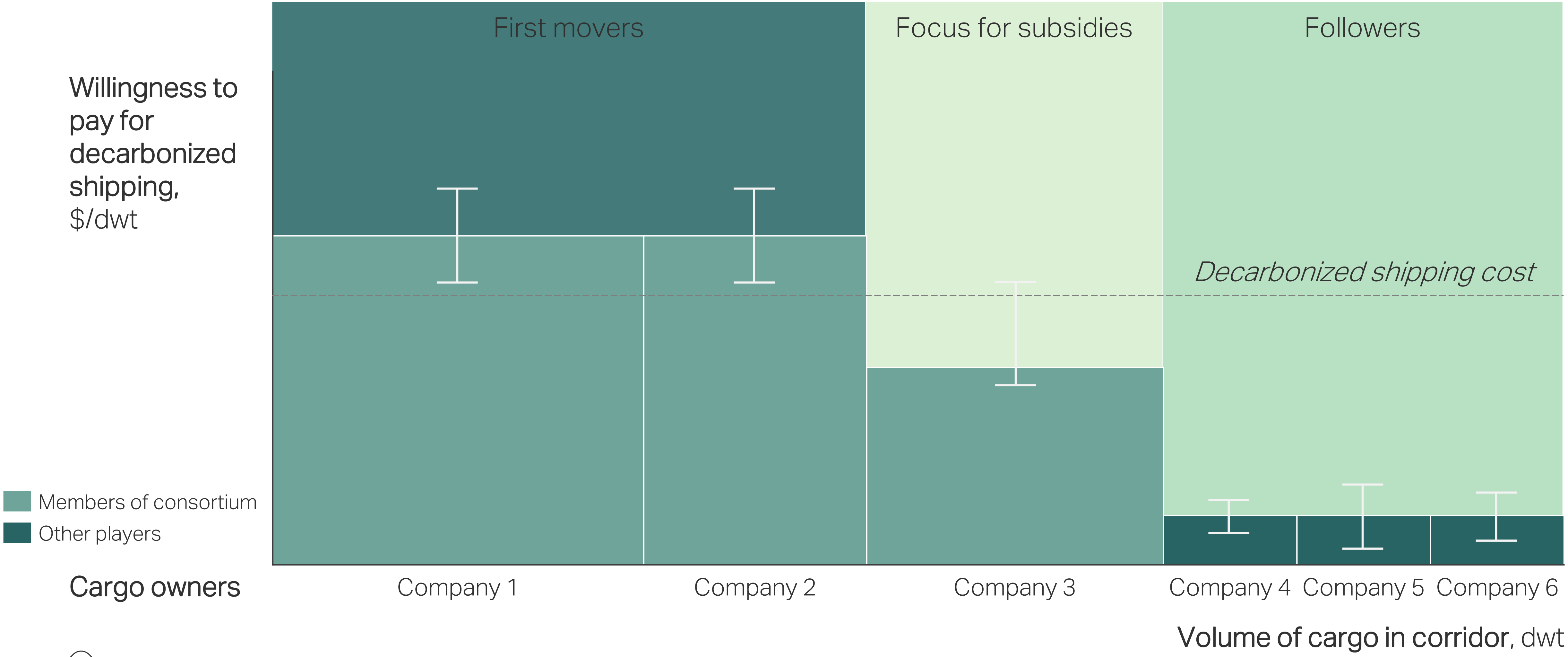
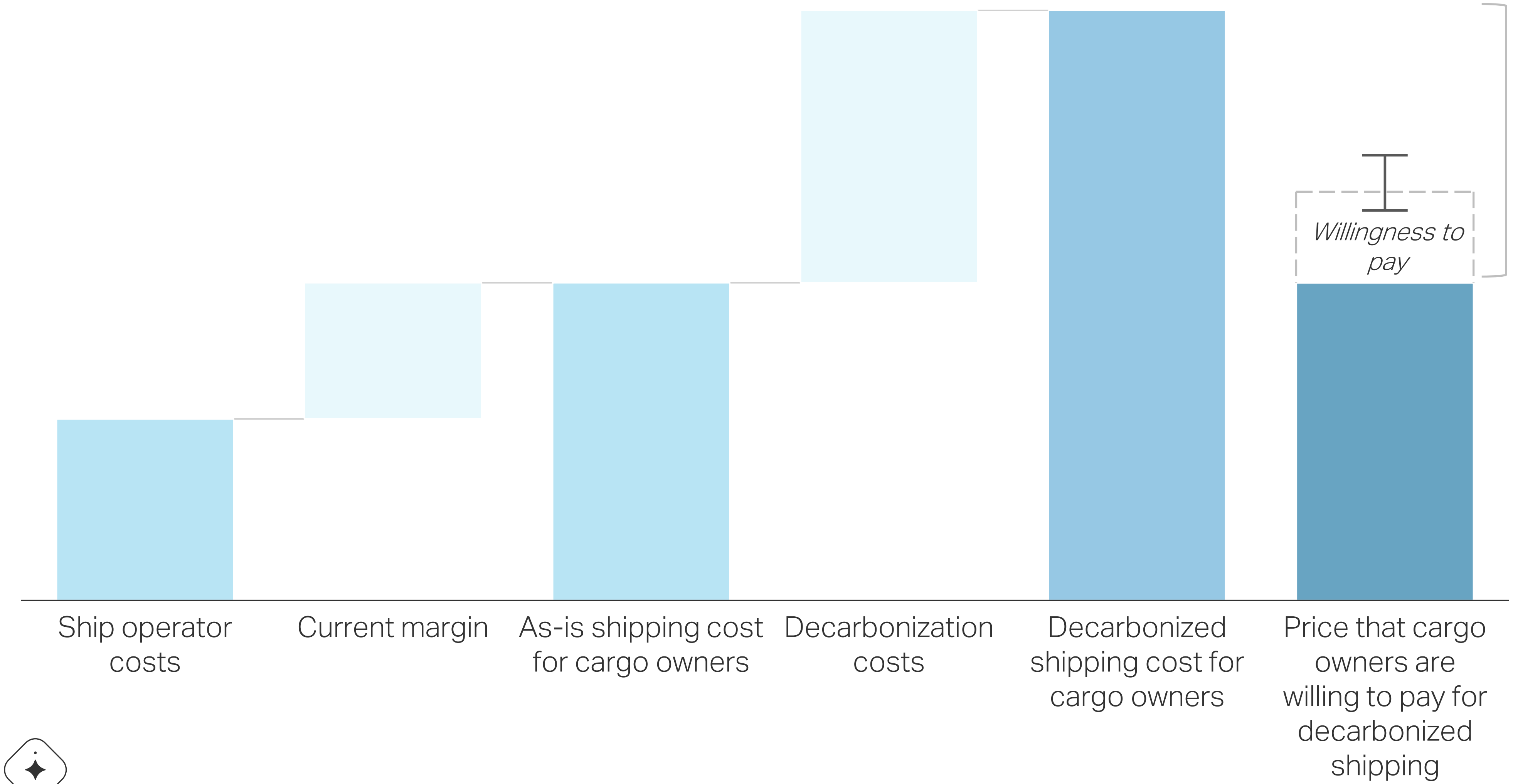
Willingness to pay for decarbonized shipping services vary by cargo owner, indicating which are expected first movers and followers



Comparison of decarbonization premium pricing to cargo owner's willingness to pay



Gap to be addressed by:

- Customer **willingness to pay**
- **Value chain players**
- **Additional financing and policy incentives**

Numerous incentives can support the project's financial viability

- ● Reduce Capital Expenditure (CAPEX)
- ●
- ● Reduce Risk (WACC)
- ✓ Applicable

Key Incentives	Description	Impact on financial viability: Reduce Capital Expenditure (CAPEX)	Impact on financial viability	Impact on financial viability: Reduce Risk (WACC)	Applicability to Chapters: 2 Alternative fuels supply chain	3 Port & bunkering infrastructure	4 Vessel decarbonization pathway	5 Demand dynamics
Land	Access to desired land plots in the most cost effective manner over the projects lifespan	●	●	●	✓	✓		
Grants	Direct cover of CAPEX and OPEX expenses as a % of total, set monetary sum or an investment match	●	●	●	✓	✓	✓	
Subsidies	Procure goods and services (i.e., wages, insurance, infrastructure and utilities) at lower than market prices	●	●	●	✓	✓	✓	✓
Taxes	Optimised tax structure (i.e., corporate tax, VAT and customs tax) to facilitate investment and distribution	●	●	●	✓	✓	✓	
Loans	Receiving loans at better than market rate or when they are not widely available	●		●	✓	✓	✓	
Monetary controls	Free currency convertibility and capital repatriation of profits amongst different geographies / companies			●				
Transactions	Reducing the cost of exporting alternative fuel to customers and promoting green certification		●	●				
Permits, rights and approvals	Fast track one stop government and subdivision approval process for all permits, licenses and rights	●		●				

Policy options to reduce fuel cost and create an enabling ecosystem for the corridor

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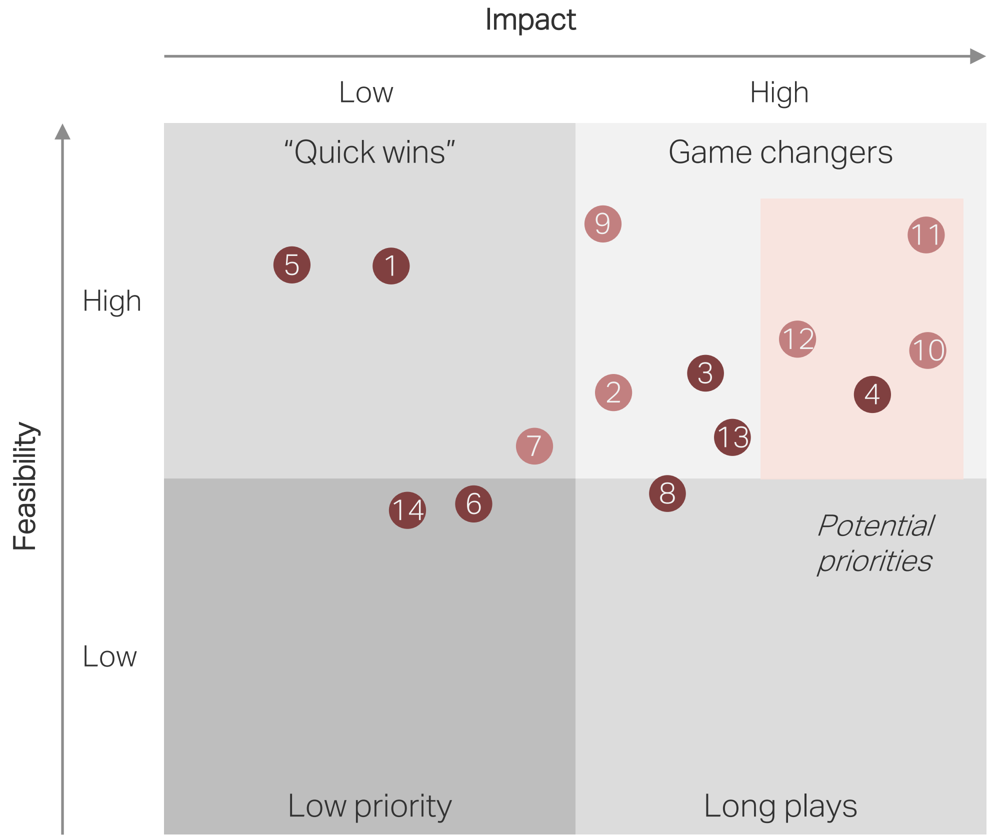
Green corridor policy framework



● Fuel cost reduction ● Enabling ecosystem

Main level of governance[1]	Policy options
Port authorities and state controls	1 Crew safety training for handling of zero-emission fuels and workforce retraining 2 Lower port fees for zero-carbon vessels
Classification societies	3 Additional bunkering capacity funding at ports
Government research agencies	4 Expedited standards on safety requirements (e.g., for bunkering)
State governments	5 Guidelines to accelerate fuel production project development 6 'Guarantees of Origin' (GO) schemes for green Hydrogen
Federal governments	7 Credit guarantees, anchored blended finance and grant finance 8 Zero-emissions fuel supply mandates for domestic shipping 9 Grid balancing compensation restructuring to include electrolyzers 10 Contract-for-Differences for zero-emissions fuels 11 Fossil fuel subsidies extension to zero-emission fuels 12 Expedited permitting for use of natural storage for Hydrogen storage
International regulatory bodies	13 Approval of global fuel standards 14 Renewable energy requirements for transport energy

1. Examples of key players; most policy actions require collaboration across governance levels
2. Contract-for-Difference

Source: Getting to Zero Coalition (2021). *The Next Wave Green Corridors. A special report for the Getting to Zero Coalition.*
See e.g.: https://www.globalmaritimeforum.org/content/2021/11/The-Next-Wave-Green-Corridors.pdf

Risk matrix for probability, impact

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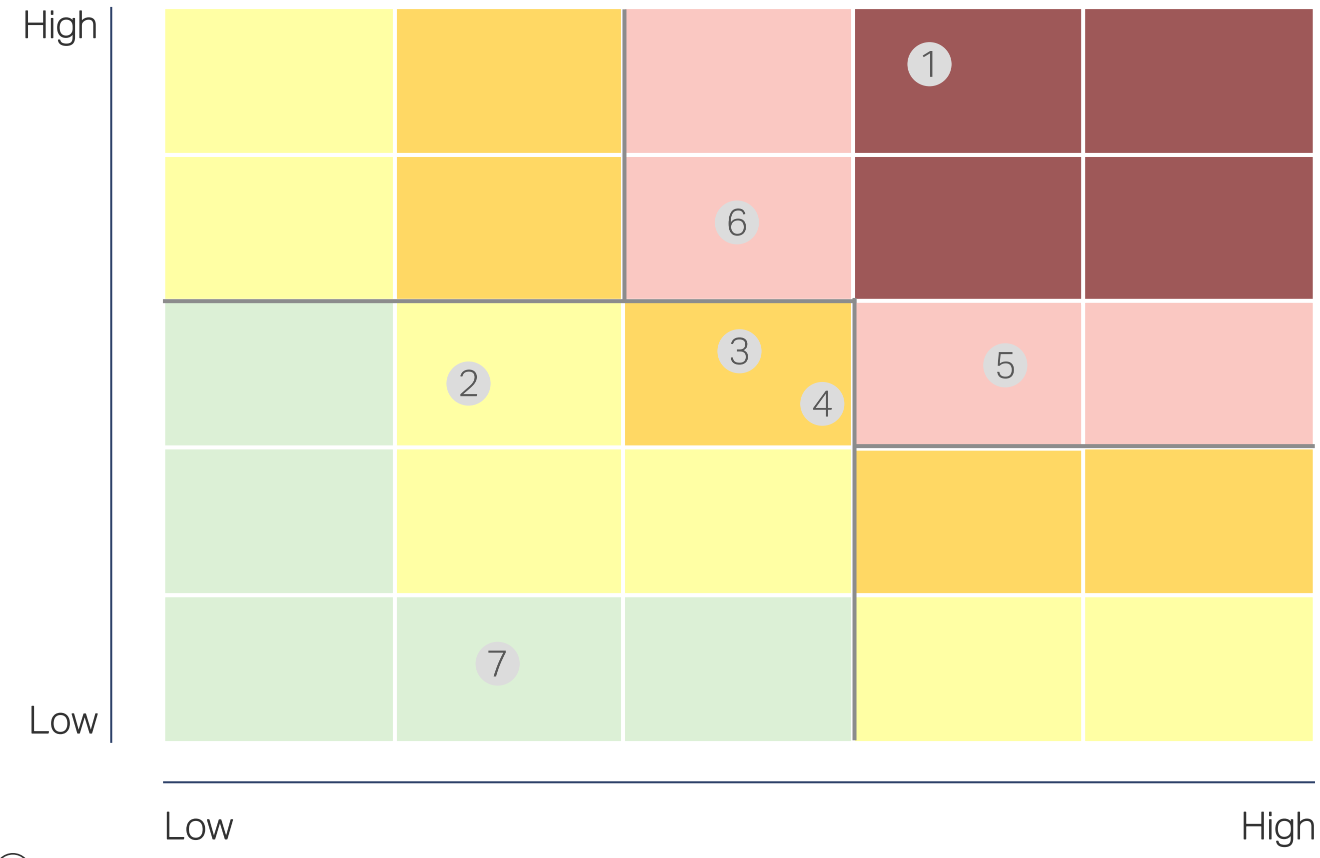
Impact



Probability

Key risks

Technical	1	…
	2	…
Financial	3	…
	4	…
Regulatory	5	…
	6	…
	7	…
Executional		
Organizational		
Market-related		

Risk registry for green corridor project

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Risk category	Risks	Probability	×	Impact (quantified)	=	Probability-adjusted risk	Mitigation actions
Technical	...	X%		$Y		$Z	...
Financial	...						
Regulatory	...						
Executional	...						
Organizational	...						
Market-related	...						
Total						**$...**	

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Commitments and commercial arrangements required by stakeholders

Mapping of players in green corridor roadmap

Consortium stakeholders

Fuel producers
- *[Player A]*
- *[Player B]*

Port and bunkering operators
- …
- …

Shipowners and ship operators
- …
- …

Cargo owners
- …
- …

Knowledge partners
- …
- …

Other partners

Engineers
- …
- …

Shipyards
- …
- …

Financial institutions
- …
- …

Other coalitions
- …
- …

…
- …
- …

Required investment decisions and commercial arrangements

	Description	CapEx, $mn	Relevant stakeholders
Investments	*[X MW solar + wind development in location A]*	*[value]*	*[Logos]*
	…	…	*[Logos]*
	…	…	*[Logos]*
	…	…	*[Logos]*
	…	…	*[Logos]*
Offtake agreement	…	*N/A*	*[Logos]*
	…	*N/A*	*[Logos]*
	…	*N/A*	*[Logos]*
	…	*N/A*	*[Logos]*
Contracting agreement	…	*N/A*	*[Logos]*
	…	*N/A*	*[Logos]*

Roadmap example

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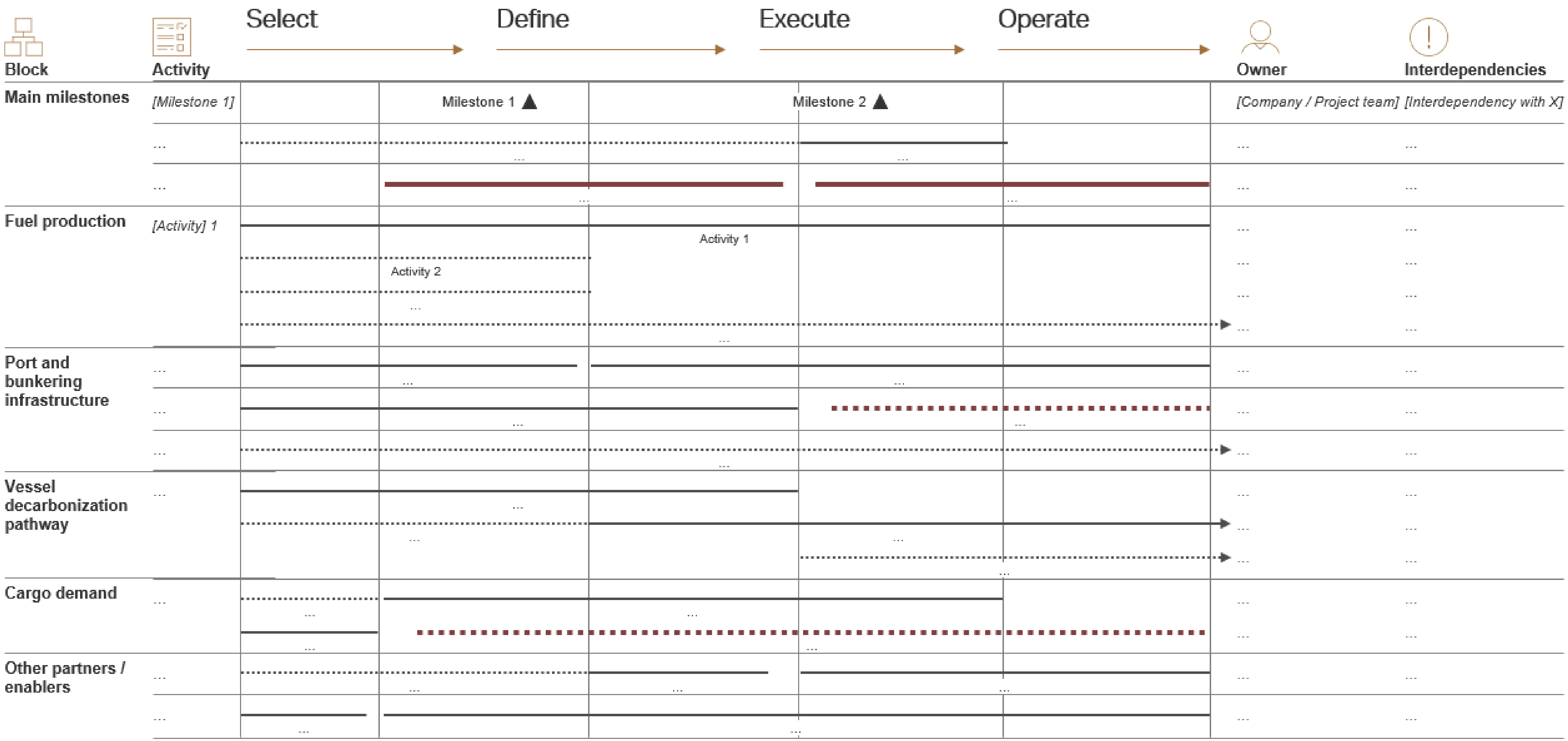

Activities to be included in the roadmap for next project phases

NOT EXHAUSTIVE

Select

- Agree on **criteria to rank project concepts** along value chain (e.g., timing, cost)
- Identify and **gather additional insights** required for ranking
- **Select final concept** based on project concept ranking

Define

- Create **detailed design plans & schedule** for the technical work required for each step in value chain, **highlighting interdependencies**
- Detail **regulatory and policy changes required** (e.g., ammonia handling)
- Create **implementation plan for required regulatory and policy changes**
- Draft **commercial frameworks** (e.g., offtake agreements)
- Detail **financing frameworks** for FID (e.g., subsidies, local funding)
- Define the **consortium legal structure** for the execution and operation of the green corridor (e.g., asset ownership, project funding)

Execute / Operate

- **Execute project** in a safe and cost-efficient way, with **all testing, validation, training, and frameworks completed** (further details per project needed)
- **Hand over to operators** on corridor

Potential governance structure for the Select & Define phases of the project

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Project governance structure

- Steering Committee
- Central function
- Engineering, Regulatory Affairs, and Integrated Analytics teams

Each consortium member to have seat in Steering Committee

Option to embed talent from consortium into working teams; otherwise focus on ad hoc collaboration

Consortium stakeholders

- Fuel producers
- Port and bunkering operators
- Shipowners and ship operators
- Cargo owners
- Knowledge partners

Members from consortium

Stakeholder engagement plans differ based on criticality and urgency to engage per stakeholder group

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Criticality to engage

High

Low

	Low urgency	High urgency
High criticality	**Plan Now, Engage Later** Proactive communication strategy with clear goals, to engage later in project 4 3	**Engage Now** Early and active engagement with open dialogue and continuous communication 2 1
Low criticality	**Inform Later** Involvement in project updates, and identification of synergy / partnership opportunities in the future 7	**Inform Now** Proactive information sharing from early in project 6 5

Low High

Urgency to engage

Stakeholder	Communication goal
1 …	…
2 …	…
3 …	…
4 …	…
5 …	…
6 …	…
7 …	…

Stakeholder communication and engagement plan

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Stakeholder	Communica-tion goals	Urgency	Messages	Cadence/ Timing	Format and channel	Person / group responsible for communication
Stakeholder name (e.g., ministry / government)	*What is the purpose for communicating with this stakeholder (e.g., inform, gain support, etc.)?*	*How urgent is to communicate with this stakeholder?*	*What are they key topics that need to be communicated?*	*When / how frequently to engage with stakeholder?*	*What is the most appropriate communication channel (e.g., consultation through workshops / surveys, informative through newsletters, articles)?*	*Who will engage with the stakeholder?*
Stakeholder name (e.g., public)	...	...	...	...	...	...