

The Chilean Green Corridors Network Pre-Feasibility Study Summary



Foreword and overview

Following a Consortium Incubation Workshops in Chile (December 2022) the Ministries and the MMM Center decided to create a publicly available summary report of the key findings from the **Chilean Green Corridors Network Pre-Feasibility Study***. Furthermore, the MMM Center uses this summary as an example to support the understanding of the **Pre-Feasibility Phase Blueprint**, which was launched in January 2023.

Green Corridors

Pre-Feasibility Phase Blueprint



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping



Setting the scene for the Pre-Feasibility Blueprint

Introduction

How-to guide

The framework
for the
Pre-Feasibility
Phase
Blueprint

1. Introduction, vision and project setup
2. Alternative fuels: Timing, capacity, emission and cost
3. Port, storage, and bunkering infrastructure
4. Trade routes, vessel, cargo and services
5. Policy, regulatory and funding
6. Potential green corridor selection frameworks
7. Next steps



Gobierno de Chile

* For the detailed report which contains much more data and many more insights, please contact the Chilean Ministries of Energy, Transportation or International Affairs.

Chilean Green Corridors Pre-Feasibility Summary Report



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping



**Ministerio de
Energía**



Ministerio de
Transportes y
Telecomunicaciones

Gobierno de Chile



Ministerio de
Relaciones
Exteriores

1. Green Corridors
2. Methodologies for Green Corridors Maturation
3. The Mærsk Mc-Kinney Møller Center
4. Motivation for Chile

Preface

1. Introduction, vision and project setup
2. Alternative fuels: Timing, capacity, emission and cost
3. Port, storage, and bunkering infrastructure
4. Trade routes, vessel, cargo and services
5. Policy, regulatory and funding
6. Potential green corridor selection frameworks
7. Next steps

Summary of the Chilean Green Corridors Network Pre- Feasibility Study

1. Consortium Incubation Workshop
2. Moving into Feasibility Phase – Important first steps
3. Suggested 'First Wave Projects'
4. The authors

Way forward

Preface

- 01 Green Corridors
- 02 Methodologies for Green Corridors Maturation
- 03 The Mærsk Mc-Kinney Møller Center
- 04 Motivation for Chile



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Green corridors are a grouping of likeminded companies throughout the value chain, aiming to deliver maritime transport with alternative fuel

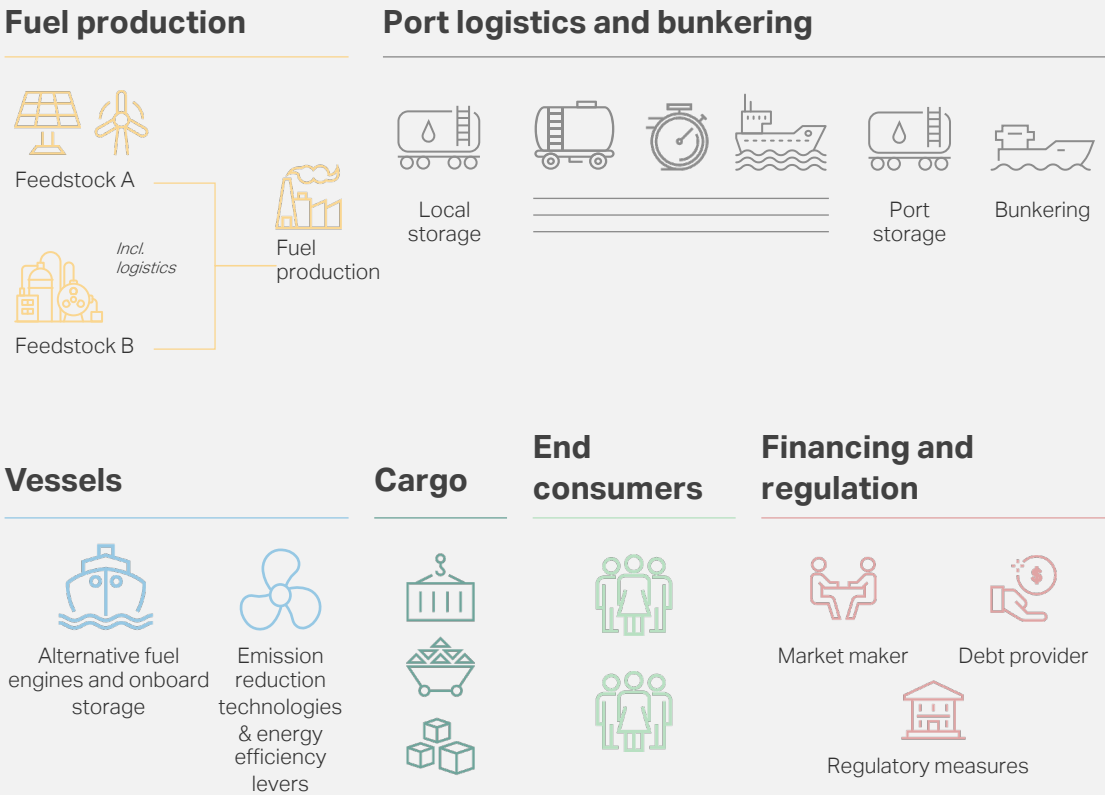
What are green corridors?

Green corridors are shipping routes on which there are commercially operating ships using exclusively¹ **alternative fuels**. They demonstrate to **regulators**, that a technical option for zero-emission shipping is possible.

Why are green corridors important?

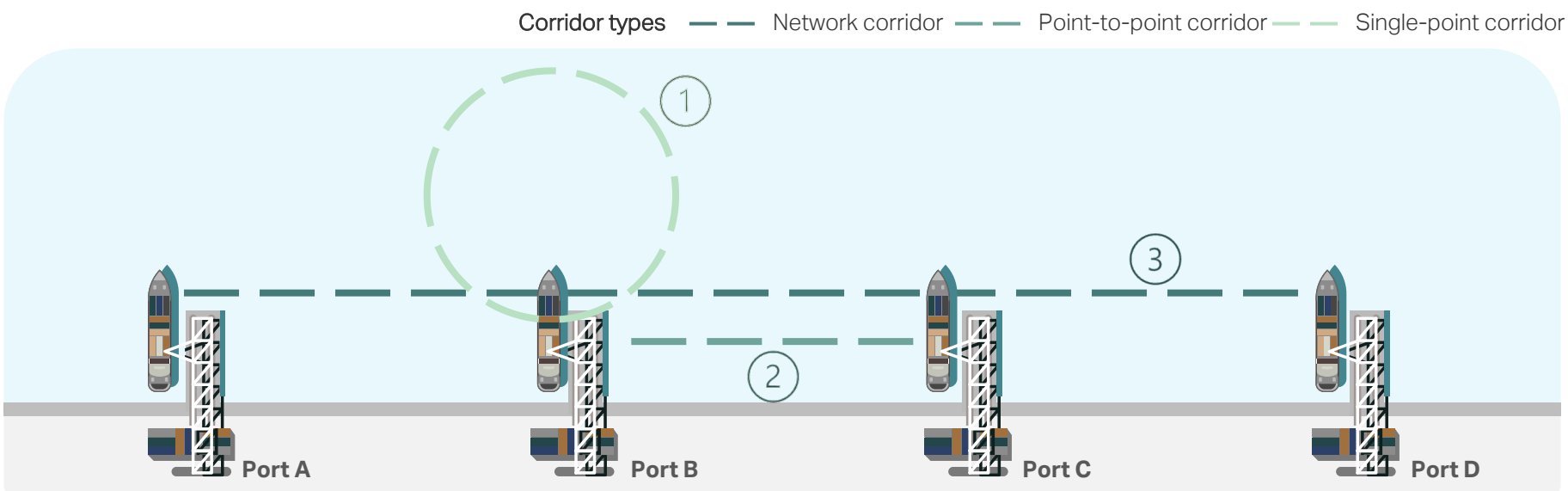
- 1 Provide an approach and design for industry players to gain confidence and embark on an accelerated decarbonization journey
- 2 Initiate end-to-end decarbonization within a supply chain
- 3 Promotes closer dialogue and collaboration between public and private stakeholders involved in the overall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



The green corridor blueprints 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



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

Pre-Feasibility and Feasibility methodology

The collaborative nature of green corridors creates a space for pre-competitive testing and commercial trials of technologies and market solutions. A **'ring-fenced' partnership approach** (e.g., consortium) between public and private players promotes collaboration across the supply chain and sharing of costs and benefits.

To accelerate the generation of green corridors, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping and selected partners have developed blueprints for both the **Pre-Feasibility**¹⁾ and the **Feasibility**²⁾ phase. These blueprints serve as ready-to-use guides for any stakeholder involved or wanting to get involved in green shipping corridors.

	 Pre-Feasibility	 Feasibility
Definition	- Preliminary assessment of main components of possible green corridors to outline promising corridors - Based on data insight from the full value chain and interview confirmation - Outcome to determine whether further maturation of the outlined green corridors is justified (i.e. moving to the feasibility phase)	- Deeper assessment and evaluation of the selected green corridor scenario(s) determining viability and actions to mitigate gaps and risks - The assessment is based on an evaluation of the technical, economic, and regulatory feasibility of a corridor - Outcome to determine whether the 'project' should advance involving increasing commitment and resources
Key activities	- Project baselining and value chain mapping - Establish screening criteria for green corridor - High-level screening and selection of potential corridors - Initial engagement with stakeholders for potential green corridors - No optimization or detailed consideration	- Technical, economic and regulatory feasibility assessment - Outline main gaps, risks and mitigation plan - Outline decisions and commitments required by stakeholders - Build a roadmap and milestones for the next project phases until operation



Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (Center) - Setup

The 'A.P. Møller og Hustru Chastine Mc-Kinney Møllers Fond til almene Formaal' (The A.P. Møller Foundation)¹⁾ is a commercial foundation founded in 1953 by shipowner A.P. Møller.

The purpose of the foundation was to ensure that the company A.P. Møller - Mærsk was also run in the spirit of A.P. Møller in the future and to support a number of areas of importance to the ship owner.

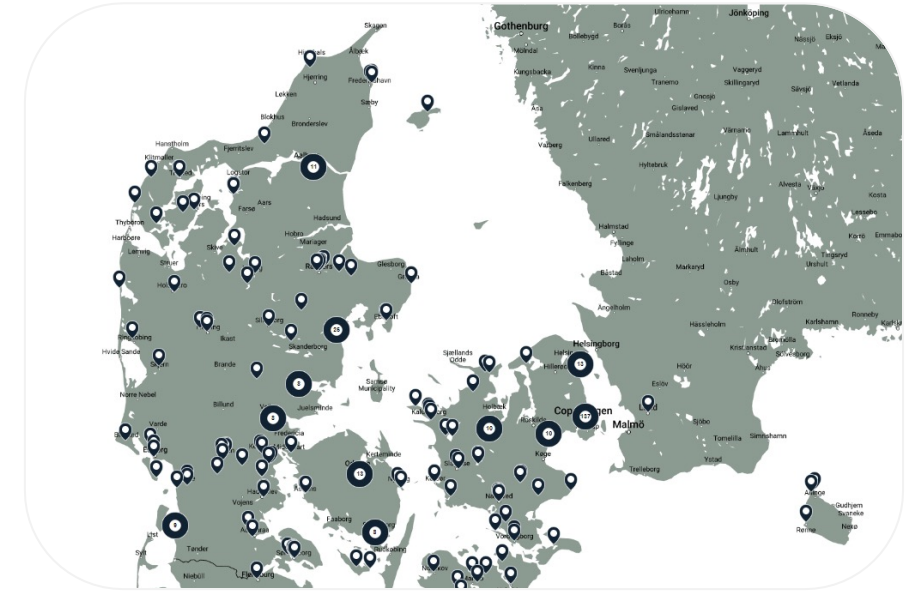
These areas are, amongst others: Promotion of Danish shipping and industry, Scientific purposes - especially medical science & Public benefit in general. The foundation has supported more than 100 projects¹⁾.

The Center is based on a €100m donation from the A.P. Møller Foundation, as a not-for-profit, independent research and development organization.

The Center aims to accelerate the transition towards a net-zero future for the maritime industry.

With the Strategic and Knowledge partners, the Center drives and facilitates the development and implementation of new technologies; build confidence in new concepts and mature viable strategic ways to drive the required systemic and regulatory change.

Projects supported by the A.P. Møller Foundation



Partners of the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping



¹⁾ <https://www.apmollerfonde.dk/projekter/>

The Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping - Strategy

Center Vision

Sustainable decarbonization of the maritime industry by 2050

Center Mission

An independent and significant driver of a sustainable maritime decarbonization



In line with Center values: Determination, Collaboration, Courage and Care and the right focus on diversity, health and inclusion to nurture an innovative and productive environment where people can thrive and grow.



Gobierno de Chile

[1\) Home | Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping](#)



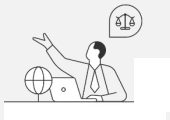
Strategic objectives



We set the course for a sustainable transition

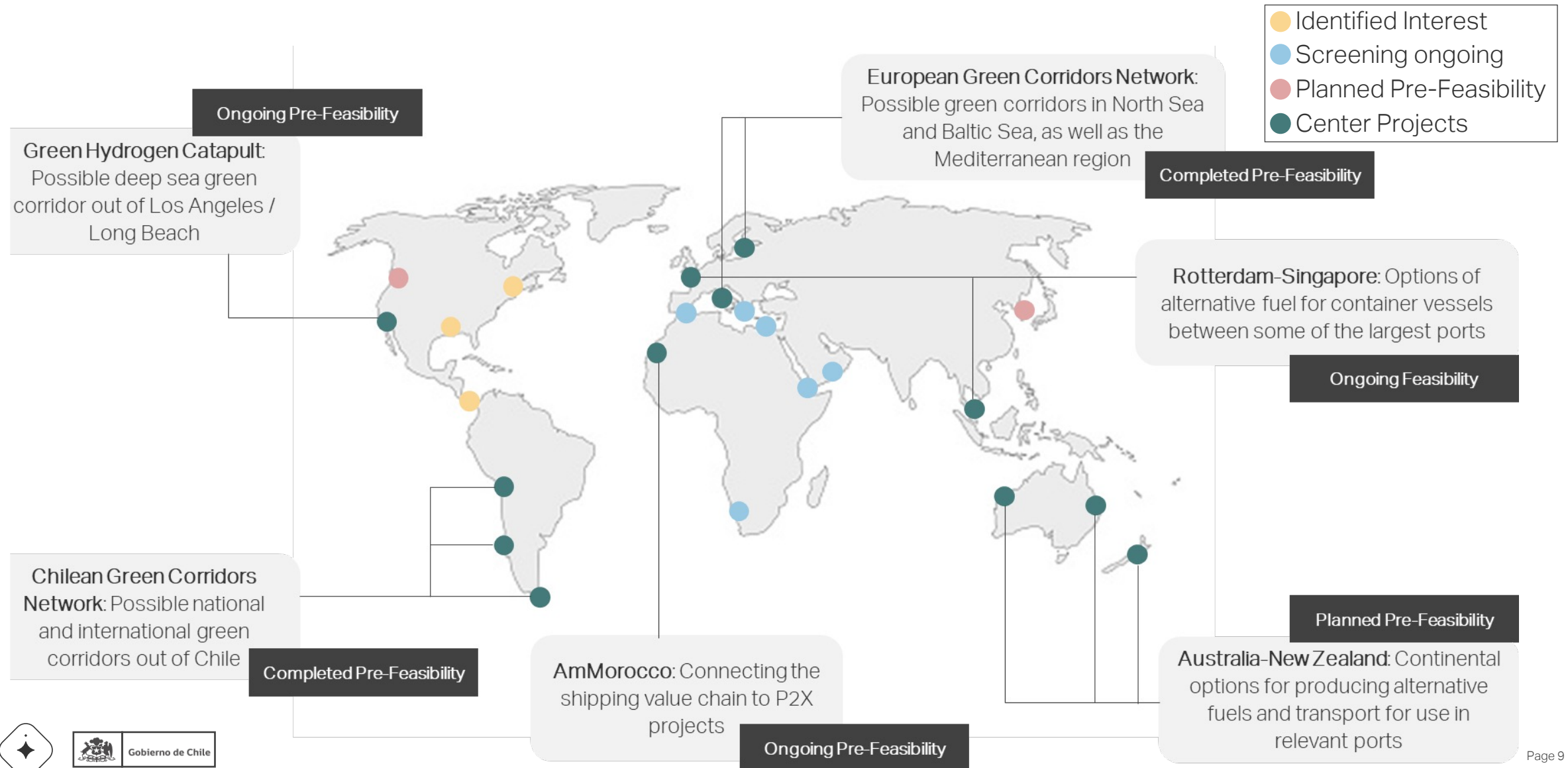


We drive collaborative research, development, and innovation



We advocate industry action and regulatory reforms

Green corridors activity: location and phases



Motivation for corridor projects in Chile

The MMM Center, and its strategic partners, has a keen interest in working with the Chilean Green Corridors, as Chile is one of the regions, which are expected to be global leaders of renewable energy for the remainder of this century.

As a natural consequence, ministries and authorities in Chile, as well as commercial companies, are evaluating and exploring the options for production of green hydrogen and alternative fuels in the country. At present, the predominant fuel for production (planned for in this decade) is green ammonia, with minor amounts of green methanol and green kerosene (diesel).

An anticipated sectoral competition is expected at the short time frame (10y), but at a longer perspective, the production capacity of alternative green fuels significantly outperforms the domestic use, hence, export of fuel / energy is being considered as well.

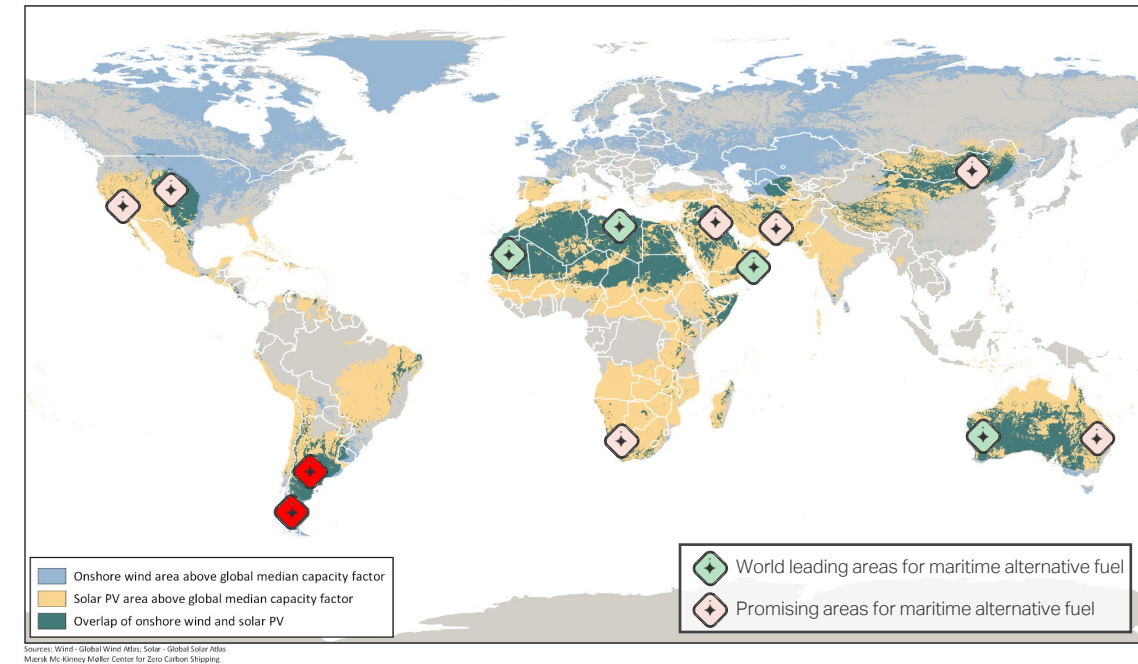
Chile has two critical elements related to its geographic nature, when it comes to the decarbonization of shipping (the propulsion of vessels and all of the supporting infrastructure):

- 1) The spatial orientation of the country means that 95% of all international transport in Chile occurs by water
- 2) Enormous solar and wind capacity, substantially exceeding the need by the population

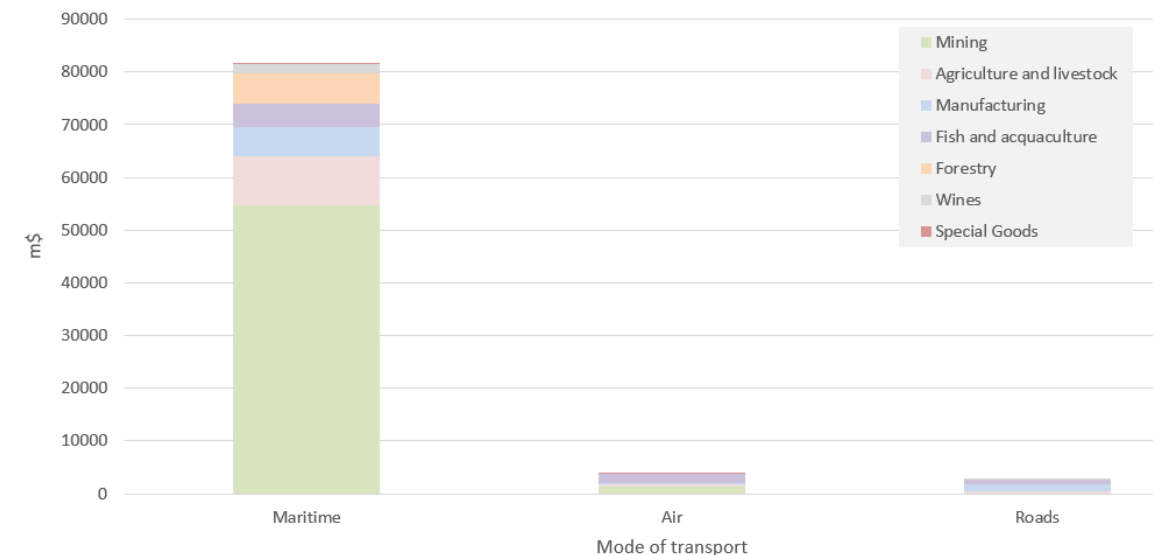


MMM Center view on future green fuel hubs in the World

Area with High Solar and Wind Capacity



Value of transported goods (Import & Export) by mode of transport



Motivation for corridor projects in Chile

Chile has made important progress in its development, which is reflected in international and national indicators. Chile's National Energy Policy 2050 (updated in 2022) is in direct relation with its international mitigation commitments (Chile's updated Nationally Determined Contribution):

Mitigation N°1: Chile commits to a GHG emission budget not exceeding 1,100 Mt CO₂eq between 2020 and 2030, with a GHG emissions maximum (peak) by 2025, and a GHG emissions level of 95 Mt CO₂eq by 2030.

"The use of hydrogen produced from renewable energy sources for cargo transportation will play a crucial role in reaching the emissions neutrality goal, and it would be economically convenient. However, this technology remains in a development stage and may be commercially competitive only from 2030."

Mitigation N°2: Reduce total black carbon emissions by at least 25% by 2030,

"The main sources of black carbon in Chile are the use of diesel for transportation, firewood for heating and residential cooking, and biomass used as an energy source in the industrial sector."

Ambition: Chile will seek to reach GHG neutrality by 2050.

"Cargo transportation: 71% Carbon Neutrality Scenario in cargo transportation by 2050."

The concept and vision of green corridors, can be directly linked to the mitigations and ambitions on a Chilean level, as the maritime activities play an important role for realizing the decarbonization.

The vision for Chile is that domestic and international maritime transportation will move towards decarbonization in the following decades by using alternative fuels generated with its abundant renewable energy. This transition shall be fostered by the early introduction of a number of domestic and international Green Corridors in Chile to be operational by the end of this decade.

CHILE'S NATIONALLY DETERMINED CONTRIBUTION

UPDATE 2020



Summary of the Chilean Green Corridors Network Pre-Feasibility Study

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- 02 Alternative fuels: Timing, capacity, emission and cost
- 03 Port, storage, and bunkering infrastructure
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Introduction, vision and project setup

This Pre-Feasibility Study aims to map the options for Chile to establish a number of Green Shipping Corridors which can be a means of decarbonizing the Chilean transport (domestic and international) and related industries, as well as be an export commodity.

For shipping, the pursuit of alternative fuels (ultimately zero-emission fuels) has started, and the production of hydrogen, ammonia and methanol from renewable power has been demonstrated, and now requires a massive and prompt scale-up, for shipping to deploy these fuels. Chile can be such a place for such a scale-up and deployment.

The Project aims to outline and recommend a number of different Green Corridors, either differentiated by their proposed alternative fuel and / or the ports of interest and / or the vessel types of interest and / or the cargo type.

The Project executes this assessment in line with internationally recognized responsible business conduct standards and principles, including the 10 Principles of the UN Global Compact. Green Corridors in Chile will strongly support the following UN Sustainability Goals: 5, 7, 8, 9, 10, 13, 14 and 17.

A just transition is characterized by some core foundational principles: respect for human rights and labor rights, underpinned by stakeholder engagement and social dialogue, protection of the environment and

ecosystems, as well as the assurance of transparency and avoidance of corruption.

Additional ambitious actions are: ensure fairness and energy equity, create fair and decent green jobs through a well-managed process, develop resilient, environmentally and socially responsible green assets and infrastructure and promote social inclusion and support community participation.

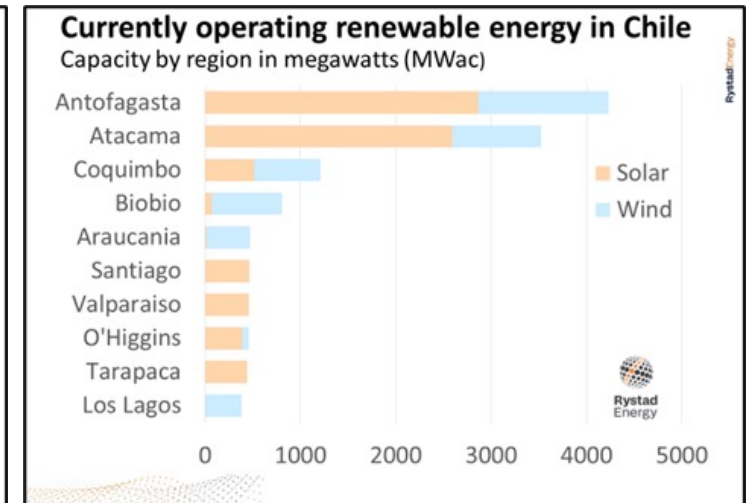
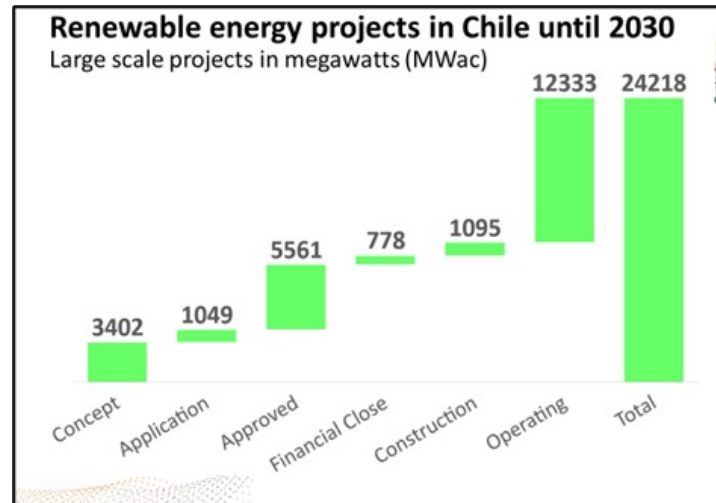
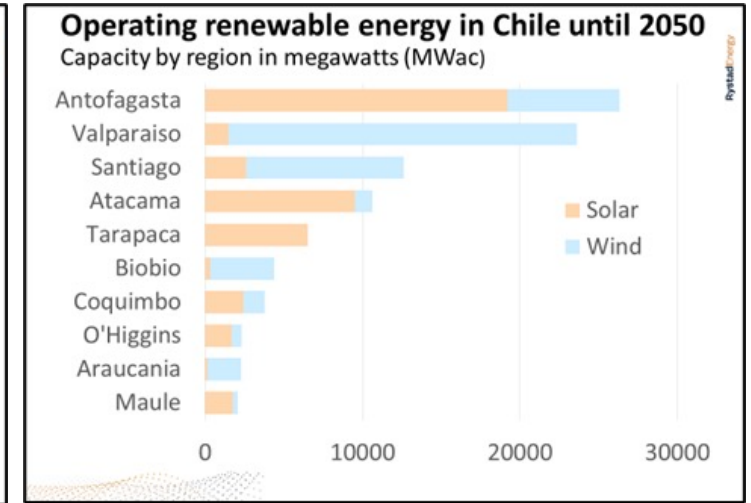
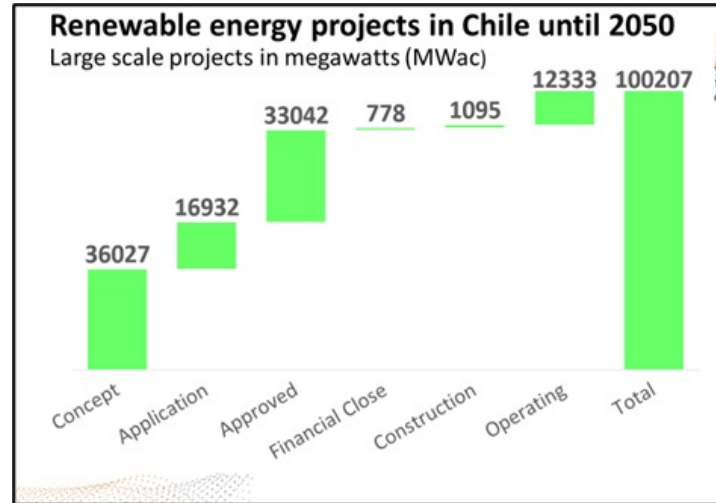


Alternative fuels: Timing, capacity, emission and cost

Chile has the best solar radiation in the world and some of the strongest winds of the region. The country is also the second largest renewable energy producer in Latin America (following Brazil), with a planned production of ~100GW in 2050. Largest production is expected from the Antofagasta region with more than a quarter of the national production.

This demonstrates that Chile, with the right focus on development in this decade, can become a major fuel producer in the decades to come. But it is important that full-scale demonstration and commercial use is shown before 2030.

For the green corridors assessed in this study, the main focus is on the energy production within this decade. At present (2023) ~12GW is in operation, with a similar amount in various development phases, providing a total production of ~25GW by 2030. The vast majority of the operating plants supporting the 12GW are solar plants in the Antofagasta and Atacama Regions.



Alternative fuels: Timing, capacity, emission and cost

More than 40 renewable energy projects aiming to produce hydrogen and derivatives, such as ammonia (primary), e-methanol and e-gasoline (minor amounts) have been announced in Chile. Ammonia safety studies will therefore be key on the way forward. The lack of e-methanol and e-diesel in the mix will potentially limit the alternative fuel availability for passenger vessels like ferries and cruises.

Several corridors may be de-selected during the Feasibility Phase, due to low methanol volumes being available. Bio-methanol from AgriCulture Waste or Forestry Production could enable a number of corridors in this decade.

All renewable projects in Chile involving ammonia production in their downstream production are based on well-known and proven technologies, industrially demonstrated for ammonia production elsewhere or for other applications (TRL 9).

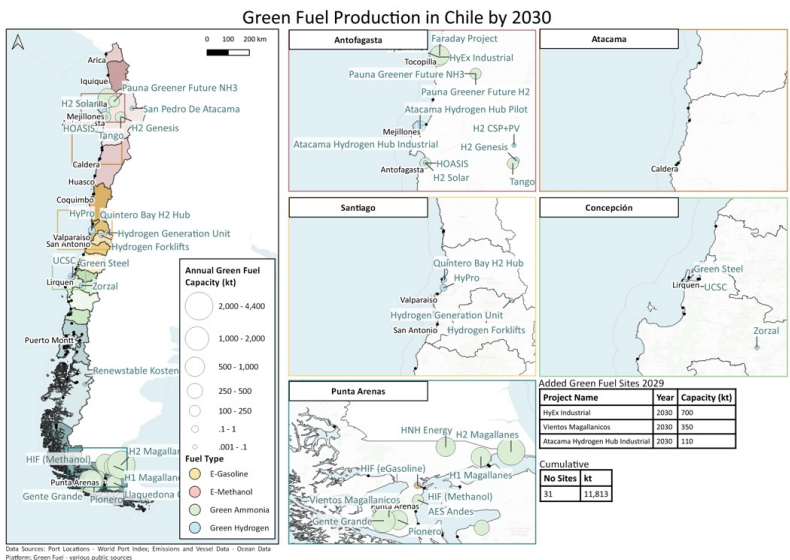
Technical challenges in relation to the application of ammonia as marine fuel, emerges downstream the fuel production, in relation to bunkering (for reference: Magpie project / Sabre project) and onboard utilization for propulsion (engine technology ready in 2024 / 2025).

Project developers in Chile have advanced the projects considerably and several are far with off-take agreements and have an outlook towards attractive production costs. Many of the developers have already ensured land for their projects and primarily focus on two regions in Chile: 1) Antofagasta area – solar power and grid availability – and 2) Punta Arenas area – wind power.

The relative cost levels are estimated to be among the most attractive in the world, but actual cost and pricing have not been obtained. Estimates by the MMM Center points towards production costs being in the

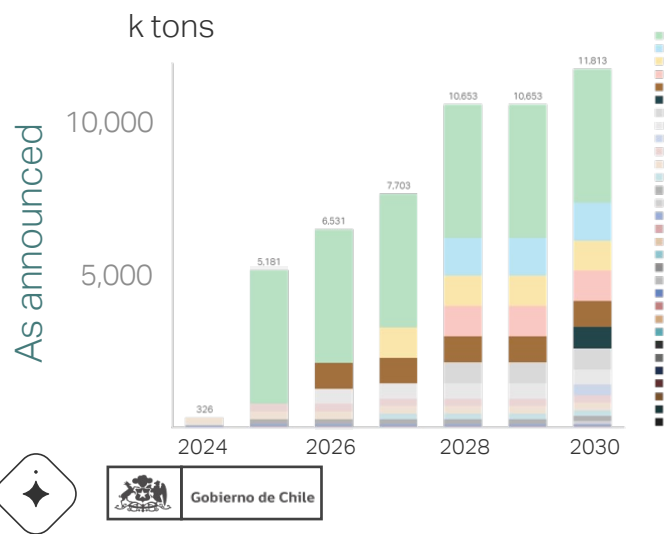
range between 500 and 800 USD/ton, all depending on the cost of electricity.

Social acceptance will be a challenge for the projects, due to the pristine and relatively untouched environment and nature (esp. in the Southern Area), as massive changes with installation of thousands of windmills and several chemical plants are foreseen. The Northern Area has already numerous solar plants, as well as a chemical industry.

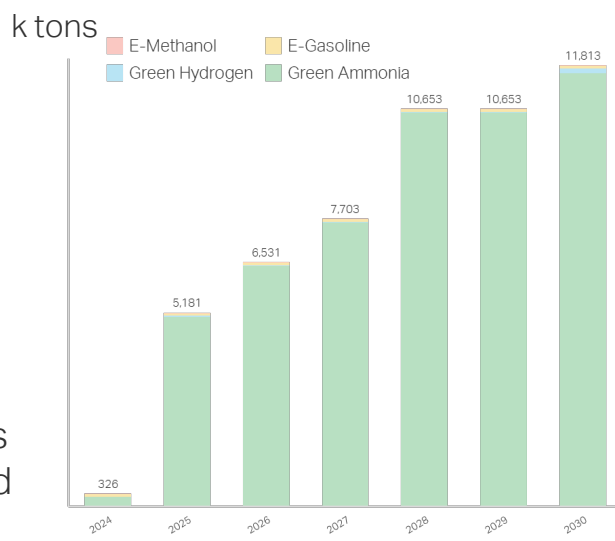
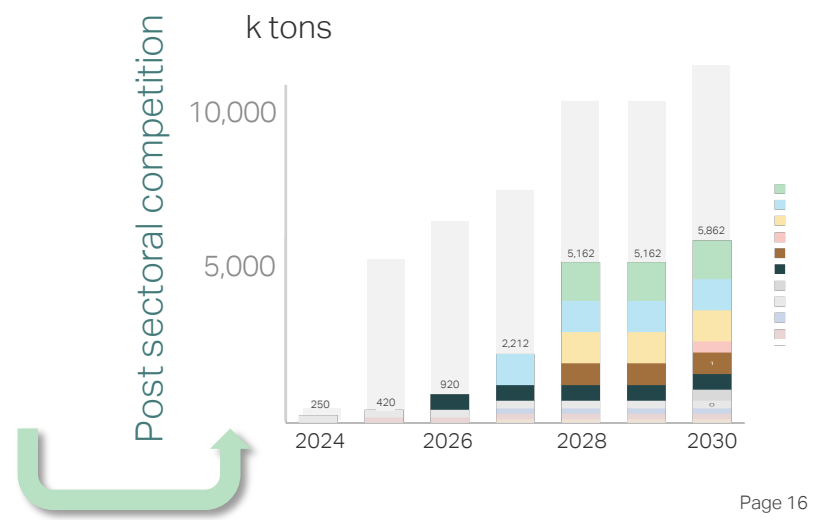
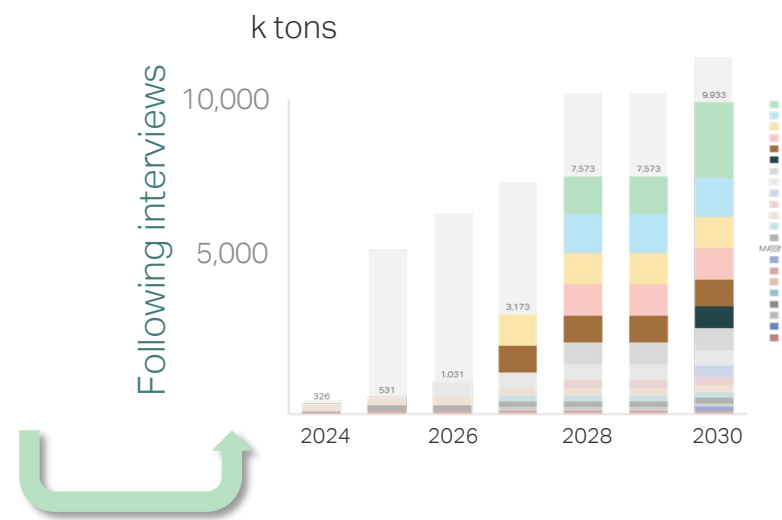


Alternative fuels: Timing, capacity, emission and cost

The publicly available data from the energy projects show that ammonia is the dominant hydrogen derivative pursued (up to 12 Mio. tonnes by 2030). The stand-alone production of hydrogen, e-Methanol and e-Gasoline is not only limited in capacity, but typically these projects are also limited to pilots and demonstrations and have not developed into production at the scale relevant to mobility and maritime transport in this decade. Thus, for first movers and deployment of early Green Corridors, primarily ammonia can be expected to be available in significant quantities as fuel to the maritime sector.



A main output of the conducted interviews (Q2 2022) was that project delays on the one hand, and gradually increasing production capacity on the other, will result in a reduction of the available fuel in comparison to the announced production capacities. Additionally, sectoral competition will result in 'only' 30-40% of the produced fuel being available for the maritime sector. One example for sector competition is the process of phasing-out coal fired powerplants. Here, a total of 5.5 GW needs to be replaced by renewable energies like solar, wind and biomass.



Port, storage, and bunkering infrastructure

Port development and operation is challenging because of a mix of state and private ownership. State-owned ports are also separated by giving concessions to public companies either in mono-operated ports or multi-operated terminals. Ownership and operations are mainly focused on Chilean actors, with some foreign interests in key ports. Mainly involved are players from different segments including shipping actors, major financial groups, industrial groups, private equity and family-owned enterprises.

There exists a clear delink between ports handling highest volume vs. highest value (FOB).

In general, there are significant differences in which ports rank highest for exports and imports.

Additionally, there is a large difference in port specialization both in terms of exports and imports and in terms of handling individual cargo types. Especially those ports handling copper concentrate require special infrastructure. The same goes for the ports able to handle chemical substances.

The ports for Green Corridors will be selected through their development plans and engagement as well as their specific trade, rather than enabling a perfect match of trade.

Tonnage of cargo per port in tons (t)

Exports (TOP 5)	Imports (TOP 5)
Caldera / Calderilla	San Antonio
Huasco / Guacolda	San Vicente
San Antonio	Mejillones
Coronel	Quintero
Punta Patache	Valparaíso

Tonnage of cargo type per port in tons (t)

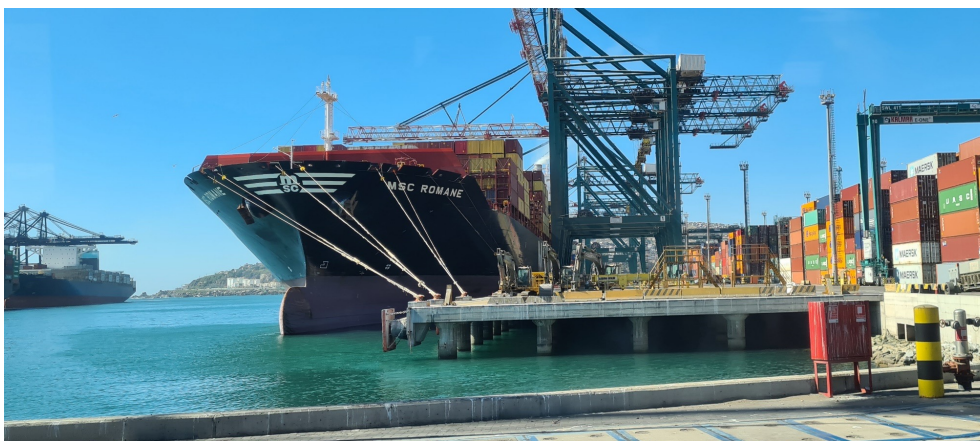
Top Export - General cargo	Top Import - General cargo
San Antonio	San Antonio
Top Export - Refrigerated cargo	Top Import - Refrigerated cargo
San Antonio	San Antonio
Top Export - Bulk cargo	Top Import - Bulk cargo
Caldera / Calderilla	Mejillones
Top Export - Liquid cargo	Top Import - Liquid cargo
Cabo Negro	San Vicente

Value (FOB) of cargo per port in Mio. US Dollar (\$)

Exports (TOP 5)	Imports (TOP 5)
San Antonio	San Antonio
Puerto Angamos	Valparaíso
Caleta Coloso	San Vicente
Valparaíso	Quintero
Antofagasta	Puerto Angamos

Value (FOB) of cargo type per port in Mio. US Dollar (\$)

Top Export - General cargo	Top Import - General cargo
Puerto Angamos	San Antonio
Top Export - Refrigerated cargo	Top Import - Refrigerated cargo
San Antonio	San Antonio
Top Export - Bulk cargo	Top Import - Bulk cargo
Caleta Coloso	San Antonio
Top Export - Liquid cargo	Top Import - Liquid cargo
Cabo Negro	San Vicente



Port, storage, and bunkering infrastructure

H₂SO₄ jetty at the Interacid site in Mejillones

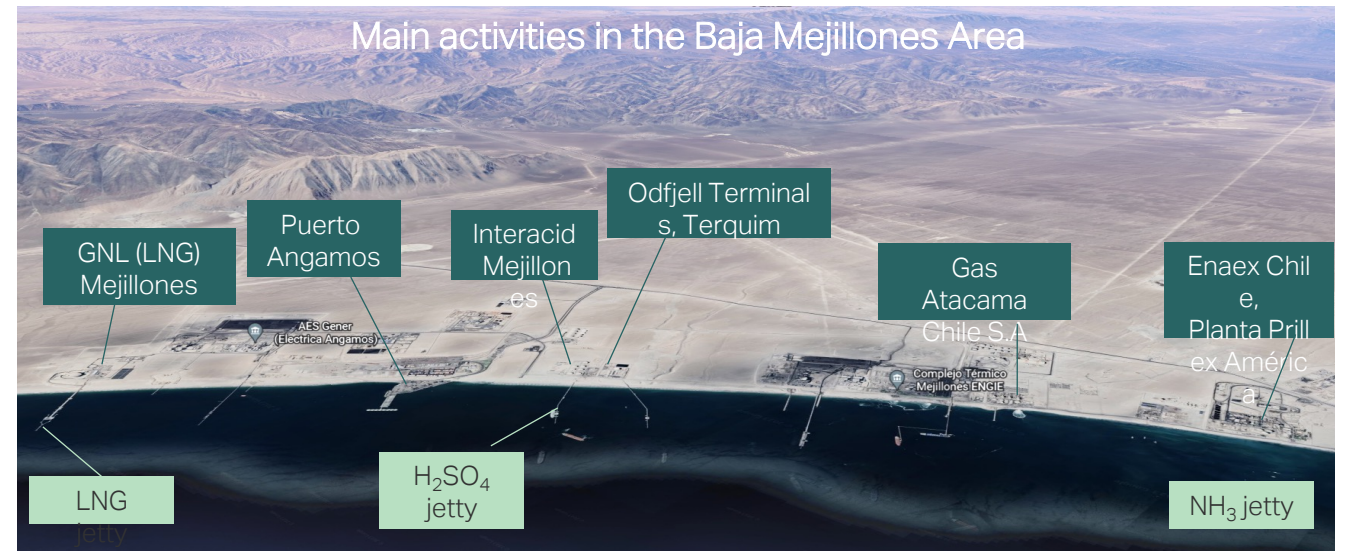


Traditional bunkering of HFO and MDO is not common in Chile due to weather / swell exposure. However, it takes place across key ports, facilitated by a relatively limited number of providers. Given the restrictive weather conditions, truck bunkering is the most common solution, followed by barge and pipes.

Handling of alternative fuel (although not used as fuel) is currently limited to one methanol (Cabo Negro) and one ammonia (Mejillones) plant in operation.

The future handling of alternative fuels will either be via jetties or port expansion. Initial investments for some of these are made, but delays and space restrictions complicate the timeline in several ports.

It is a complicated and time intensive procedure to build new ports (land permissions, regulations, environmental studies etc.). There is a clear strategic benefit, if there are ports which can be retro-fitted / enlarged.

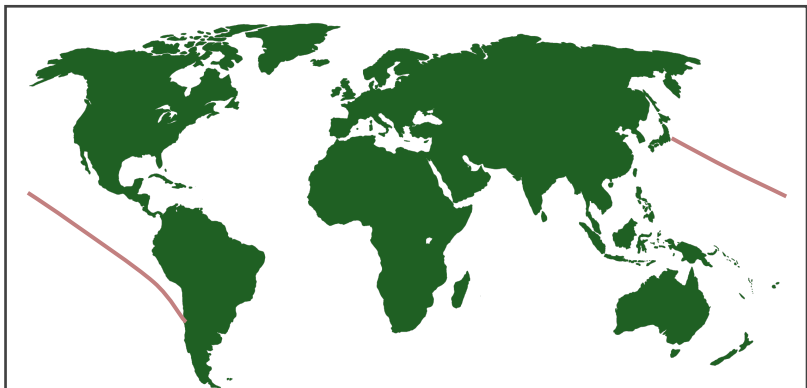


Trade routes, vessel, cargo and services

General and refrigerated cargo:

Large export of refrigerated cargo vs. import of general cargo complicates ballast optimization for both legs of the route. Close cooperation with major operators is critical, in order to capture differences in trade coverage by different operators and identify synergies. Despite these overall challenges, similar trading routes, value, volume and projected growth of cargo are favorable for the development of green corridors.

Commodity	Value	Volume	Projected growth	Fit with current / announced fleet	Possible vessel deployment	Primary routes		
						1	2	3
Agricultural products, incl. cherries, berries, apples, as well as fish products	◆	◆	◆	◆	Reefer containers Reefers	Chile – US	Chile to Europe	Chile to Asia
Forestry products	◆	◆	◆	◆	Container	Chile to China, Japan, South Korea	Chile to US, Mexico, Peru	Chile to Europe
Refined copper, copper cathodes and anodes	◆	◆	◆	◆	Container	Chile to China, South Korea	Chile to United States, Brazil	Chile to Europe, incl. Germany and Spain
Car trucks	◆	◆	◆	◆	RoRos	Japan to Chile		



Trade routes, vessel, cargo and services

Bulk cargo:

Significant misbalance between import (e.g. coal, grains, fertilizers) and export (mainly copper and by-products). Trade routes are also different regarding their origin / destination with imports coming from US, Colombia, Canada and Australia whereas exports are mainly going to Asia, especially China. In light of the key role played by Chilean bulk exports for both the Chilean economy and global commodity trading (copper as a mandatory element for the green transition), it is crucial to find a way to overcome the aforementioned challenges, e.g. by revising the cargo and routing options for the inbound leg from Asia.

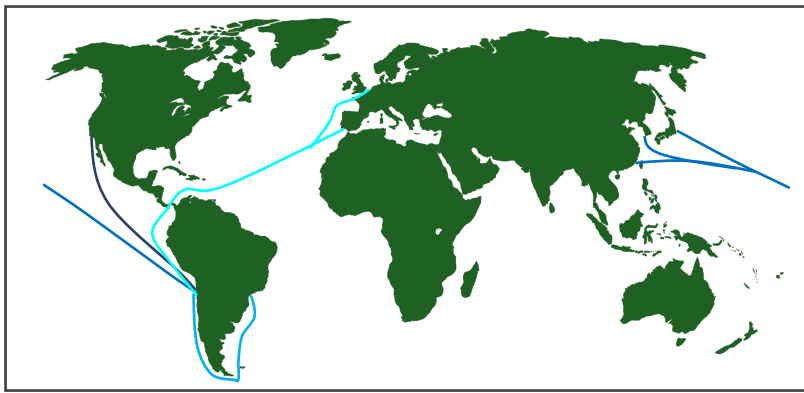
Commodity	Value	Volume	Projected growth	Fit with current / announced fleet	Possible vessel deployment	Primary routes		
						1	2	3
Copper, incl. concentrates	◆	◆	◆	◆	Bulker – different sizes	Chile to China, Japan, South Korea		
Iron ore concentrates	◆	◆		◆	Bulker – Capesizes	Chile to China, Japan, South Korea		
Salt		◆		◆	Bulker – different sizes	Chile to United States, Brazil and Canada		



<https://www.drycargomag.com/crss-coaltainer-designed-to-cope-with-the-rigours-of-coal-handling>



<https://splash247.com/navision-revealed-as-taker-of-nyk-handymax/>



Trade routes, vessel, cargo and services

Liquid cargo:

The significant development of green ammonia and the strong market for this in Japan, the US and Europe, creates a very strong demand basis for the development of Green Corridors with ammonia as cargo. Current demand signals, price movements, and MoUs in place between government and industry, indicate that sufficient margins can be created for the maritime overseas transportation of ammonia on, amongst others, LPG carriers.

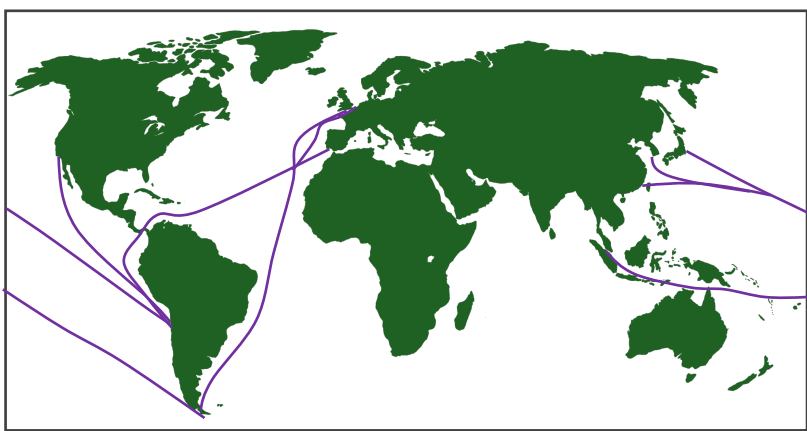
Commodity	Value	Volume	Projected growth	Fit with current / announced fleet	Possible vessel deployment	Primary routes		
						1	2	3
Ammonia as cargo					LPG carrier with option for Ammonia	Chile to Japan	Chile to Europe, incl. Netherlands	Chile to United States



<https://www.safetyandhealthmagazine.com/articles/19111-first-aid-for-ammonia-exposure>



https://www.nyk.com/english/news/2020/20200812_01.html



Trade routes, vessel, cargo and services

Specialized cargo (ferries, cruises, tugboats, fishing fleet):

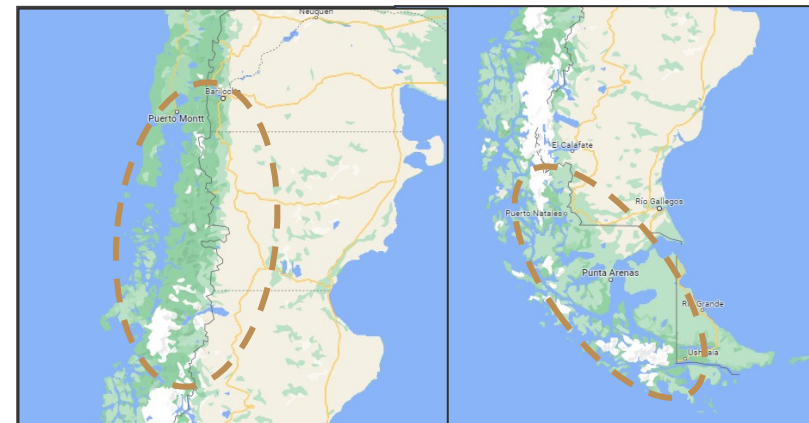
Specialized Cargo type	Main opportunities	Main challenges
Ferry & cruise	Extensive coastline Age and technical similarities borne by the fleet National emission impact	Safety concerns and timeline for ammonia uptake by these industries
Tugboats	Stable and regulated market for tugboats National shipbuilding capacity Capital availability Age of the Chilean tugboat fleet	Lower emission reduction impact
Fisheries	Additional opportunities are present for the decarbonization of the Chilean fishing fleet in light of the central role played in the local economy and employment. Two of the largest fishing ports (in terms of volume of commercial fish landed) are located in Chile.	Such initiatives will be carefully considered to identify ports with a critical mass of fishing vessels, as well as ports with sufficient demand from international shipping, in order to create cost synergies.



<https://elmagallanico.com/2018/03/mi-primera-vez-en-el-pathagon>



Naviera Austral



Policy, regulatory and funding

Climate Action Tracker currently rates Chile’s global warming engagement as “insufficient” but adds that Chile has “made very substantial progress on climate action over the past year”. Chile was the first Latin American country to present a long-term climate strategy (COP26 in Glasgow) and has a dedicated focus on hydrogen development. Chile was ranked the best country for investment in renewable energy among emerging markets in 2022 by Bloomberg New Energy Finance.

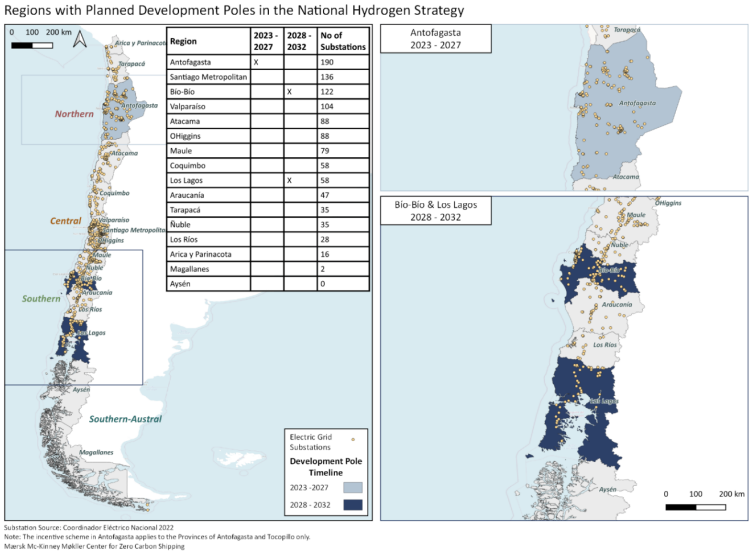
Most of Chile’s climate change and energy-related legislation is anchored at the national level. This includes rules on land acquisition, maritime concessions, public port concessions, grid connection, fuel storage, taxes etc.

The primary obstacle for enterprises seeking to invest in ports is the acquisition of maritime port concessions. Companies interviewed in this study said the approval time was 3-5 years. Regulations for storing and bunkering fuel are under development to accommodate for the future uses. Current legislation does not specify a maximum amount of fuel that can be stored, or the exact conditions under which it must be stored. Going forward, clear rules on portside storage and bunkering of alternative fuels will be necessary to support the development of green shipping.

In addition, land acquisition and environmental impact assessments of a project must be submitted through the Environmental Impact Assessment System

(SEIA). The expected approval time for such a study is at least 2-3 years.

Grid connection and transmission costs are an important consideration. To encourage economic development, the Chilean government is planning to improve grid connection by supporting “development poles” in the most suitable areas (see Figure below). Costs can be further improved by re-assessing the tariff structure.



Policy, regulatory and funding

Many Chilean regions are currently in the process of making strategies for encouraging renewable energy investment. They include tax credits, reimbursement of taxes and duties, subsidies for remuneration of employees, etc. Economic incentive schemes are concentrated geographically in the north and the south. For Green Corridor developers this is beneficial as these regions are likely hubs for green fuels.

Chile's draft Framework Law on Climate Change defines a system in which the Ministry of Environment would establish GHG emissions limits for individuals or groups of emitting sources (in tCO₂e / year), as well as GHG taxes (between USD 35-40 / tCO₂).

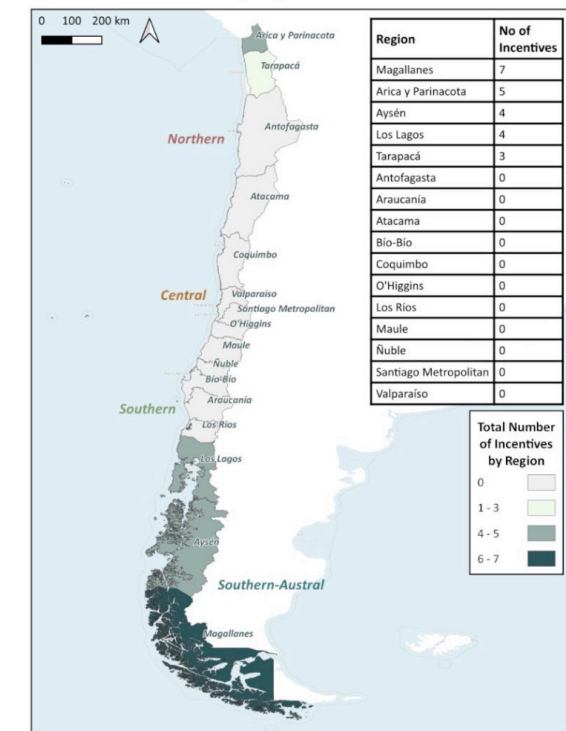
There is a need to establish a "one-stop shop" for permitting, including for environmental assessments, port infrastructure etc.

There are five overall funding possibilities: 1) Export Credit Agencies, 2) Multilateral & development financial institutions, 3) Commercial bank term debt providers, 4) Government & other International Organizations and 5) Others like institutional investors, green bonds or other capital market instruments (list of possible funding is available in the detailed report). The financing of a corridor will be much dependent on the individual Green Corridor characteristics like type, location or consortium members.

The location of the Green Corridor (domestic versus international) will dictate the funding bodies. On a national level it is mainly CORFO, its supporting programs and tax incentives to focus on. The international funding relies on where the non-Chilean port is located. Examples in Europe might be Horizon Europe or Innovation Fund, for Japan it's the Japan

Science and Technology Agency or for the US it's the US Department of Energy, Office of Energy Efficiency and Renewable Energy.

Number of Incentives by Region in Chile



Note: Some incentive schemes marked by region are limited to provinces within that region and may not apply to all ports.
Maersk McKinney Møller Center for Zero Carbon Shipping

Potential green corridor selection frameworks

The green corridors to be generated are depending on what criteria the decision maker(s) puts in place. If the most important criterion for generating a corridor is CO₂ emission reduction potential, the corridors will be those with the largest vessels and most frequent operation. But if the criteria are timing / urgency, the most appealing corridors are those with already qualified engines and with a simple stakeholder configuration – preferably with state involvement. It is important to keep in mind, that selecting certain criteria will select certain corridors, as

well as deselecting other corridors. The criteria selection will generally be driven by, or strongly guided by, the vision laid out for the Green Corridor project.

The vision of the Chilean Maritime Decarbonization has been a strong driver for the criteria, to ensure that the suite of corridors support:

- A just and equitable transition.
- Corridors to enable local and regional development.
- Focus on main import and export.

The Chile specific selection criteria

	AREA	CARGO	OTHER
- Criteria sub-set 1 - Domestic use of Ammonia as Cargo and Ammonia as fuel before 2030			
- Criteria sub-set 2 - Transport of People internally in Chile on vessels by non-Ammonia Alternative Fuel before 2030			
- Criteria sub-set 3 - International Transport of a Top 10 Export & Import (by value) good in 2030			
- Criteria sub-set 4 - One of the Top 10 most CO₂ emitting vessels (in 2020) to be on Alternative Fuel by 2030			
- Criteria sub-set 5 - International transport of Ammonia to enable ammonia as a future commodity before 2030			
- Criteria sub-set 6 - Any vessels and cargos which can sustain a corridor by 2027 by 5000 (?) t fuel/y			

The method deployed by the MMM Center Methodology, allows the user to propose several sub-sets of criteria, upon which a sub-set of corridors are generated. A total suite of corridors will be the final outcome.

Potential green corridor selection frameworks

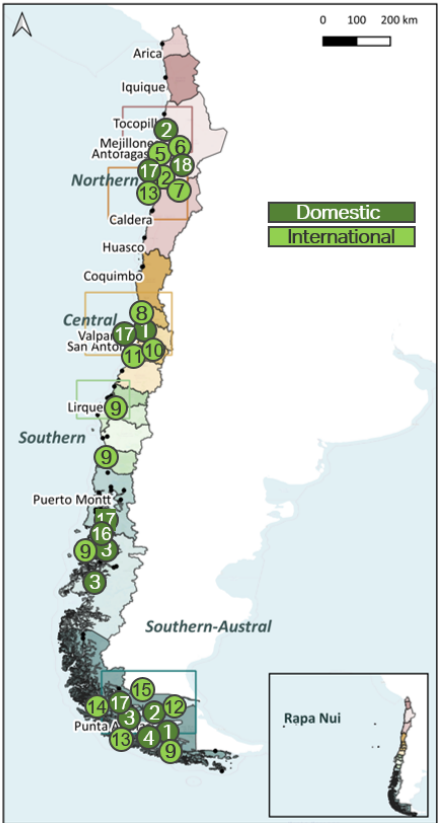
Chile has, at present, the strategic advantage of being the first country in the world with a Pre-Feasibility report incl. a full set of concrete corridor examples.

The goal is to move the most promising of the corridors to the next level and into the Feasibility phase. Therefore, it is crucial that 'first moving' and likeminded companies are taking the lead and building a project consortium as soon as possible, to keep the momentum within the first half of 2023.

Possible next steps and the process to an operating Green Corridor are described in the third section of this report

The Chilean Pre-Feasibility project was initiated at the COP 26 in Glasgow 2021. The official kick-off took place in March 2022 and the final report was available in September 2022. The results were presented at COP 27, and at the Consortia Incubation Workshops in December 2022 which marked the official end of the Pre-Feasibility phase. It was subsequently agreed to create this high-level summary. So, the official end date is updated to the 31.01.2023.

Loc.	ID	Ref to Pre-Feasibility Report	Short description
D	1	Corridor 11.1.1	Chilean Powerplant Ammonia
D	2	Corridor 11.1.2	Chilean Mining Explosives Ammonia
D	3	Corridor 11.2.1	Austral Ferries
D	4	Corridor 11.2.2	Austral Cruise
I	5	Corridor 11.3.1	CuS Corridor
I	6	Corridor 11.3.2	Copper China Corridor
I	7	Corridor 11.3.3	Green Cupper Europe
I	8	Corridor 11.3.4	Car Import from Japan
I	9	Corridor 11.3.5	Agri/Aqua Culture Corridor
I	10	Corridor 11.4.1	ContainEurope
I	11	Corridor 11.4.2	CircumSouthAmericas
I	12	Corridor 11.5.1	Ammonia Exp Japan
I	13	Corridor 11.5.2	Ammonia Exp Rotterdam
I	14	Corridor 11.5.3	Ammonia Exp Los Angeles
I	15	Corridor 11.5.4	Ammonia Exp Singapore
D	16	Corridor 11.6.1	Austral Fish/Aqua
D	17	Corridor 11.6.2	Tug/service
D/I	18	Corridor 11.6.3	H2SO4 Carrier for mining



Way forward

- 01 Consortium Incubation Workshop
- 02 Moving into Feasibility Phase – Important first steps
- 03 Suggested 'First Wave Projects'
- 04 The authors



Consortium Incubation Workshop

The Consortium Incubation Workshop (CIW) is the final step of the Pre-Feasibility Phase as outlined by the MMM Center. The scope of the CIW is to present the results of the Pre-Feasibility to relevant stakeholders throughout the public and private sectors, and to receive critical and constructive feedback. The CIW is at the same also meant as the initial kick-start of the Feasibility Phase where the possible future consortium can meet for the first time.

The CIW related to the Chilean Green Corridors Project was conducted in Week 50 2022, in Santiago and Antofagasta respectively. The two workshops gathered more than 60 people / organizations / institutes with a Chilean focus – but with a global outreach.

The Santiago workshop was conducted at the premises of the Chilean Ministry of Foreign Affairs and was kicked-off by the Chilean Minister of Energy, Diego Pardow and Chilean Minister of Transportation and Telecommunications, Juan Carlos Muñoz Abogabir.

The workshop in Antofagasta was held at the auditorium of the Antofagasta Industrial Association with a welcome greeting by the Regional Secretary of the Chilean Ministry of Energy, Dafne Pino Riffo and the Regional Secretary of the Chilean Ministry of Transport and Telecommunication, Romina Vera Butt.



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Consortium Incubation Workshop – in between the phases

An initial gathering of likeminded companies and stakeholders

To keep the momentum, it is crucial to initiate the next steps from Pre-Feasibility to a Feasibility phase as soon as possible. It is important to know that the way forward is only possible and successful when the actual stakeholders of the respective value chain are deeply involved in the consortium.

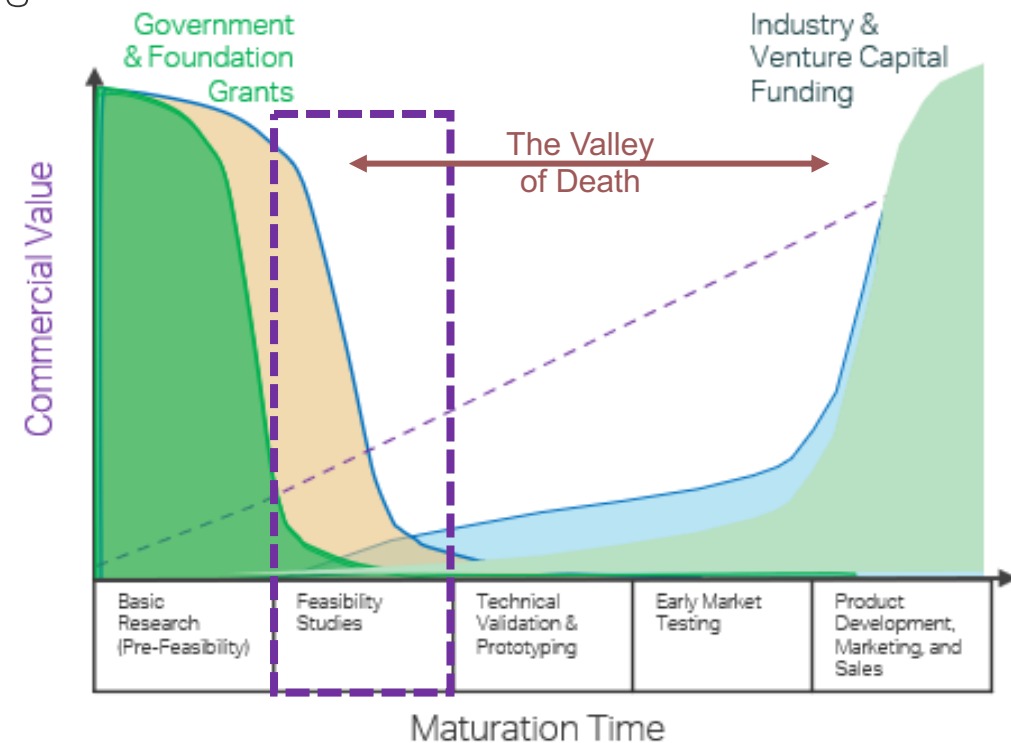
A change from an overall view - which was needed in the Pre-Feasibility phase - to a holistic view - in the Feasibility phase, is necessary.

To make a Green Corridor Feasibility phase, data / insights of the involved companies are required. Which also means, that with time and throughout the upcoming phases, the stakeholders' investments and commitments to the project will rise.

To bridge the “valley of death”, identified as a challenge between the two phases of Pre-Feasibility and Feasibility, the MMM Center can Co-Lead the initial phase of the Feasibility (purple dashed box), using its funding (orange area) and network together with the Ministries, to bring respective companies to the table and assist in building the project consortium.

The initial phase of the Feasibility project will provide details in terms of project planning and governance, helping to answer the companies' questions of what kind of involvement is needed at what time.

For a Feasibility project to start, there needs to be an anchor company/ies which has / have a commercial role in the future deployment.



Finding likeminded companies who are willing to join forces and share the initial risks, is key at this stage to make the Green Corridors happen.



Consortium Incubation Workshop

Out of the sticker exercises that were conducted during the CIWs in Chile, there are in essence four corridors that we are focusing on, to try and bring to the Feasibility phase. In addition to the results above, there might be corridors that will be selected out of strategic or other priorities from the Ministries or other companies in Chile.

Loc.	ID	Ref. to Pre-feasibility report	Short description	Number of stickers
I	6	Corridor 11.3.2	Copper China Corridor	9
I	13	Corridor 11.5.2	Ammonia Exp Rotterdam	9
I	12	Corridor 11.5.1	Ammonia Exp Japan	8
I	15	Corridor 11.5.4	Ammonia Exp Singapore	7
D	17	Corridor 11.6.2	Tug/service	6
I	7	Corridor 11.3.3	Green Copper Europe	5
D/I	18	Corridor 11.6.3	H2SO4 Carrier for mining	5
I	5	Corridor 11.3.1	CuS Corridor	4
I	9	Corridor 11.3.5	Agri/Aqua Culture Corridor	3
I	8	Corridor 11.3.4	Car Import from Japan	2
I	10	Corridor 11.4.1	ContainEurope	2
I	11	Corridor 11.4.2	CircumSouthAmericas	2
D	1	Corridor 11.1.1	Chilean Powerplant Ammonia	1
D	2	Corridor 11.1.2	Chilean Mining Explosives Ammonia	1
I	14	Corridor 11.5.3	Ammonia Exp Los Angeles	1
D	16	Corridor 11.6.1	Austral Fish/Aqua	1
D	3	Corridor 11.2.1	Austral Ferries	0
D	4	Corridor 11.2.2	Austral Cruise	0

4 focus corridors

Copper Corridor
Ammonia Exp
H2SO4 Corridor
Tug/service

Corridor sticker exercises:

Workshop in Santiago

Loc.	ID	Ref to Pre-Feasibility Report	Short description
D	1	Corridor 11.1.1	Chilean Powerplant Ammonia
D	2	Corridor 11.1.2	Chilean Mining Explosives Ammonia
D	3	Corridor 11.2.1	Austral Ferries
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I	15	Corridor 11.5.4	Ammonia Exp Singapore
D	16	Corridor 11.6.1	Austral Fish/Aqua
D	17	Corridor 11.6.2	Tug/service
D/I	18	Corridor 11.6.3	H2SO4 Carrier for mining

Workshop in Antofagasta

ID	Ref to Pre-Feasibility Report	Short description
1	Corridor 11.1.1	Chilean Powerplant Ammonia
2	Corridor 11.1.2	Chilean Mining Explosives Ammonia
3	Corridor 11.2.1	Austral Ferries
4	Corridor 11.2.2	Austral Cruise
5	Corridor 11.3.1	CuS Corridor
6	Corridor 11.3.2	Copper China Corridor
7	Corridor 11.3.3	Green Copper Europe
8	Corridor 11.3.4	Car Import from Japan
9	Corridor 11.3.5	Agri/Aqua Culture Corridor
10	Corridor 11.4.1	ContainEurope
11	Corridor 11.4.2	CircumSouthAmericas
12	Corridor 11.5.1	Ammonia Exp Japan
13	Corridor 11.5.2	Ammonia Exp Rotterdam
14	Corridor 11.5.3	Ammonia Exp Los Angeles
15	Corridor 11.5.4	Ammonia Exp Singapore
16	Corridor 11.6.1	Austral Fish/Aqua
17	Corridor 11.6.2	Tug/service
18	Corridor 11.6.3	H2SO4 Carrier for mining

Suggested corridors – Workshop in Santiago

ID	Short description	Stickers
19	NH3 Terminal in the North	3
20	Cabotage Feeders in Chile	3
21	Magallanes -> India	1

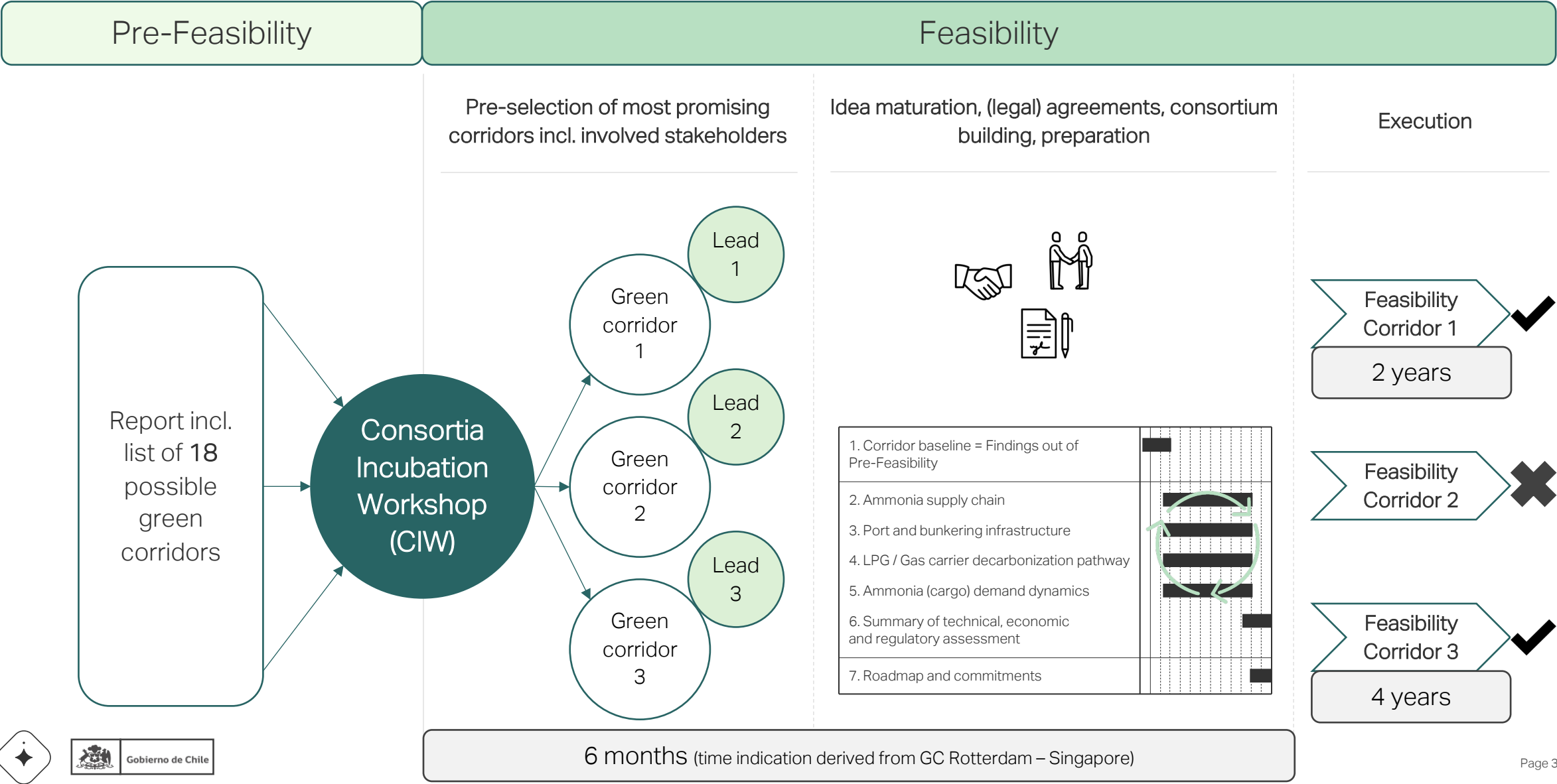
Suggested corridors – Workshop in Antofagasta

ID	Short description	Stickers
22	Corredor Brocamico	1
23	Lithium Export	2
24	Export of prime material for fertilizers	1
25	Copper	2
26	Transito Boliviano x Puertos del Norte	1
27	Export of synthetic combustibles	1
28	Transit of H2SO4	1
29	Ammonia for domestic agriculture	1

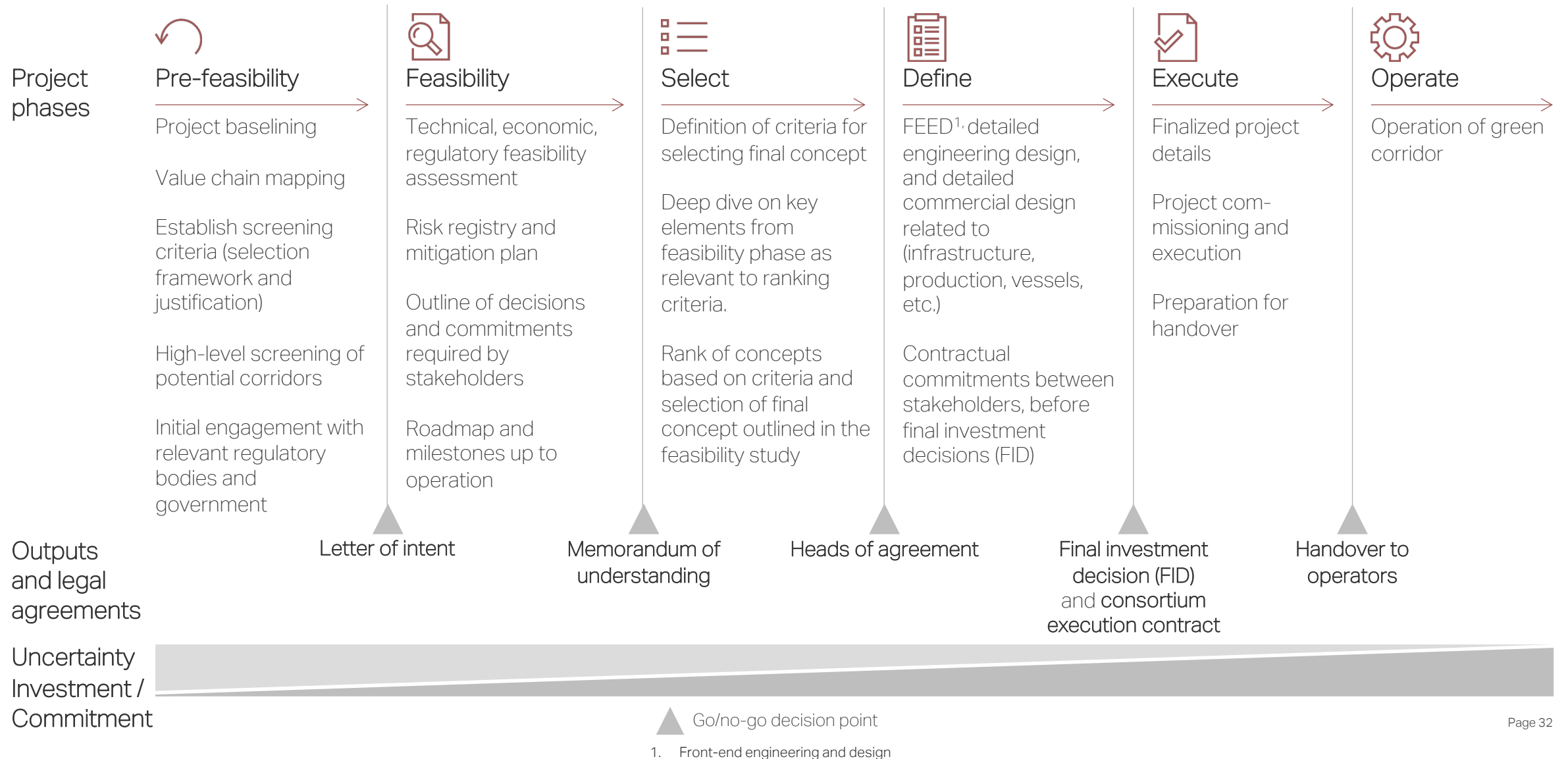


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How to get from Pre-Feasibility phase to Feasibility phase



Next steps to make a green corridor run



Suggested First Wave

Despite alternative fuels having been available for several years (at least for bio-oil, methanol, hydrogen), no green corridors have been established. The challenge is to get a group of likeminded companies, covering the involved value chain, to join forces. So, which of the proposed corridors (see section Consortium Incubation Workshop) are the most likely and should therefore be considered in the first wave of attempts to establish the necessary consortia? This will be driven by the attitude of the consortium members, the commercial

appetite to engage in the project, the size of the commercial gap to be closed and regulatory / policy awareness around the corridor.

Based on the 'sticker exercise' in the Consortium Incubation Workshop, a list of four corridors has been identified, for which the necessary commercial, stakeholder and political interest combined is on a high level. Consequently, these four corridors generate a suggested First Wave of corridors

to test for interest to move into Feasibility Phase, with the aim of delivering zero emission shipping by the end of this decade. These four suggested First Wave corridors are shown below.

Besides this list of four corridors reviewed potential, new data or shifts in strategic visions can lead to future re-consideration of corridors. So, this list should be considered as an initial suggestion based on the current methodology and data.



Copper export from Northern Chile to Asia / Europe



Ammonia carrier from Chile to Europe / Asia (NYK concept)



Sulfuric acid from Chile / Peru / Asia to Northern Chile



Tugboats in Chilean Ports

This report was generated by the **Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping** and supported by the **Chilean Ministry of Energy**, the **Chilean Ministry of Transportation and Telecommunication** and the **Chilean Ministry of Foreign Affairs**.

The content of *Summary of the Chilean Green Corridors Network Pre-Feasibility Study* reflects the outcome of the main Pre-Feasibility Study Report, which was written by the MMM Center with contribution from the aforementioned ministries, as well as input from the World Bank and the UN Global Compact.

In addition, this report contains a Preface which was presented at the Consortium Incubation Workshop in Chile in December 2022. Finally, a Way Forward with the outcome of the Consortium Incubation Workshop is included.

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