Green corridors

On Tuesday 16th of May 2023, Manila (Philippines)

Aixa Pérez – Regulatory Affairs Manager, MMMCZCS
Situational assessment for shipping in this area
Emissions will continue to increase if relying on current decarbonization efforts

If just energy efficiency measures are currently considered, the expected GtCO2eq in 2050 is 9% > present. Why? Because the sector is expected to grow.
Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS)
Our vision is to sustainably decarbonize the maritime industry by 2050.

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

The Center is built around a simple but ambitious vision to accelerate collaborative climate action.

Not-for-profit
Money earned by or donated to the Center is used entirely to finance Center work.

Independent
We are un-biased, solution agnostic and have no vested interest in any technology. We work collaboratively and bring together key players across the value chain.

Science-based
We commit to climate science and use a data driven approach to explore viable decarbonization pathways.
Our Partners share the zero-carbon vision and are committed to climate action.

24 Strategic Partners

13 Knowledge Partners
First movers and green corridors
Accelerated progress is needed in four areas during the next decade to make the 2050 target

- A level playing field with global regulation
- Alternative fuels available at scale.
- Energy efficiency support across the value chain
- Support to first movers.

Source: MVM Center for Zero Carbon Shipping
First movers and green corridors

- Decarbonizing the maritime industry will require transitioning to low- and zero-carbon fuels.
- Clydebank Declaration (COP 26): green corridors as the catalyst for the green transition.
- MMMCZCS has developed a framework to bring green corridors from concept to execution.
Methodology for green corridors: Prefeasibility study

Overall sections
- Introduction to Area / Region & Constraints
- Decarbonization Vision for Area / Region
- Objectives and Project Governance

Chapter insights
- Introduction
- Data, interviews and results
- Interpretation and discussion

Chapter
- Output

Introduction
- Fuel Production
- Local Storage
- Port Storage & Bunkering
- On-board Storage
- ICE / Fuel Cell
- Vessels
- Cargo
- Financing

Feedstock A
Feedstock B
Fuel Production
Port logistics & bunkering
Bunkering
Port & Bunkering
Cargo, Services, Trade Routes & Vessel
Regulatory Landscape

Data gathered and selection criteria defined
List of recommended corridors based on selection criteria
Estimate Cost and CO₂e emission for relevant corridors
Consortium Incubation Workshop
First wave corridors
Proposed way of moving forward into the Feasibility Phase

Green Corridors
Green corridors - ongoing green corridor projects in various phases

- **Green Hydrogen Catapult**: Possible deep sea green corridor out of Los Angeles / Long Beach
- **Chilean Green Corridors Network**: Possible national and international green corridors out of Chile
- **AmMorocco**: Connecting the shipping value chain to P2X projects
- **European Green Corridors Network**: Possible green corridors in North Sea and Baltic Sea, as well as the Mediterranean region
- **Rotterdam-Singapore**: Options of alternative fuel for container vessels between some of the largest ports
- **Australia-New Zealand**: Continental options for producing alternative fuels and transport for use in relevant ports

Map of ongoing green corridor projects in various phases.
Proposed Chilean Green Corridors

<table>
<thead>
<tr>
<th>Loc.</th>
<th>ID</th>
<th>Short description</th>
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<tbody>
<tr>
<td>D</td>
<td>1</td>
<td>Chilean Powerplant Ammonia</td>
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<td>2</td>
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<td>D</td>
<td>3</td>
<td>Austral Ferries</td>
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<td>D</td>
<td>4</td>
<td>Austral Cruise</td>
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<td>I</td>
<td>5</td>
<td>CuS Corridor</td>
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<td>6</td>
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<td>I</td>
<td>7</td>
<td>Green Cupper Europe</td>
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<td>I</td>
<td>8</td>
<td>Car Import from Japan/South Korea</td>
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<td>I</td>
<td>9</td>
<td>Agri/Aqua-culture Corridor</td>
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<td>10</td>
<td>ContainEurope</td>
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<td>I</td>
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<td>12</td>
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<td>I</td>
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<td>Ammonia Exp Rotterdam</td>
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<td>D</td>
<td>16</td>
<td>Austral Fish/Aqua</td>
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<td>D</td>
<td>17</td>
<td>Tug/service</td>
</tr>
<tr>
<td>D/I</td>
<td>18</td>
<td>H₂SO₄ Carrier for mining</td>
</tr>
</tbody>
</table>

D: Domestic, I: International
The Asia-Pacific region and the potential for green corridors
What is needed to initiate a Green Corridor

[Map showing installed renewable energy capacity across Asia with color codes for different capacity levels]

Installed Renewable Energy Capacity (MW)
- 1 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10,000
- 10,000 - 50,000
- 50,000 - 100,000
- >100,000

Large Ports
Ongoing Center
Green Corridor Activity

[Diagram showing feedstock pathways to fuel production]

Feedstock A → Fuel Production
Feedstock B → Fuel Production
Potential for green corridors in the Asia-Pacific region
Green corridors and the feasibility consideration
Feasibility of the GCs: Cost gap analysis to be considered
First-mover initiatives – It is happening

CMA CGM and biomethane
CMA CGM launches the first low-carbon shipping offer by choosing biomethane

NYK and ammonia
NYK: Project to commercialize ammonia-fueled ships set to begin

Maersk and methanol
“Designing the future of our customers’ supply chains with carbon-neutral methanol vessels”
15 kTEU container vessels
Questions?

Thanks for your attention!

More info:
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Contact:
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Extra
When is the GC a business opportunity?

We to close the GAP?

CCFD

Strike price

AF price > strike price, government is providing money
AF price < strike price, the company has to pay the delta
**US scenario**

### Cost Comparison of Key Fuels [k USD / route]

- **VLSFO**
- **E-Ammonia**
- **E-Methanol (point source)**

### Alternative Fuel Difference with VLSFO for Tankers in 2030

- **E-Ammonia (point source)**: -11%
- **E-Methanol (point source)**: 42%
- **E-Methanol (DAC)**: 85%
- **E-Methane**: 18%
- **E-diesel**: 59%
- **Blue Ammonia**: 5%

*Source: Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping*
Hybrid scenario: USA and EU

Cost Comparison of Key Fuels [k USD / route]

Alternative Fuel Difference with VLSFO for Tankers in 2030
Tipping points and correlation with traffic density
The diversity of alternative fuel options makes it difficult to agree on a common pathway.

- Green electricity
- Electrolysis of water
- Natural gas
- Steam methane reforming
- Carbon storage
- Biomass
- Biowaste

**Fuel production**

- Liquefaction
- Haber-Bosch process
- Synthesis
- Carbon capture
- Synthesis & Liquefaction
- Biofuel synthesis

**Fuels**

- e-Hydrogen
- Blue hydrogen
- e-Ammonia
- Blue ammonia
- e-Methanol
- Bio-methanol
- e-Methane
- Bio-methane
- Bio-oils

**Feedstocks**

- Feedstocks
- Fuel production
- Fuels

**Emissions¹ (vs. LSFO)**

<table>
<thead>
<tr>
<th>Emissions</th>
<th>1%</th>
<th>17%</th>
<th>1%</th>
<th>19%</th>
<th>1%</th>
<th>12%</th>
<th>6%</th>
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</thead>
</table>

¹ Source: MMM Center for Zero Carbon Shipping
Alternative fuels have varying maturity levels and challenges in the early years of transition

The systemic maturity map presents in a simple, interactive overview the readiness for solutions in the entire value chain. Can vessels, fuel production plants or bunkering vessels be ordered without technical risk, at realistic price levels and with underlying regulation in place. The maturity map is to be updated with e-diesel.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Feedstock availability</th>
<th>Fuel production</th>
<th>Fuel storage, logistics and bunkering</th>
<th>Onboard energy storage &amp; fuel conversion</th>
<th>Onboard safety and fuel management</th>
<th>Vessel emissions</th>
<th>Regulation &amp; certification</th>
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**MATURE**
Solutions are available with no or limited barriers remaining.

**SOLUTIONS IDENTIFIED**
Solutions exist, but there are some challenges on e.g. maturity and availability.

**MAJOR CHALLENGES REMAIN**
Solutions are not developed or lack specification.
Maturing them is a complex task that depends on key market, regulatory and technical developments.

Bio-fuels availability to shipping

Renewable electricity cost development

Safety case for ammonia

Main scenario

“A Path to Zero”

Alternative scenarios

Reaching zero with: Scarce / Abundant biofuels

Reaching zero with: More / less costly electricity

Reaching zero with: No ammonia acceptance

Alternative possible fuel composition outlooks
Ship efficiency technology is available and could reduce emissions if adopted more widely.

<table>
<thead>
<tr>
<th>Area</th>
<th>Attainable efficiency gains</th>
<th>Efficiency technology</th>
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<tbody>
<tr>
<td>Technical efficiency</td>
<td></td>
<td>Hull form optimization</td>
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<tr>
<td>hull &amp; Propeller</td>
<td>5-15%</td>
<td>Hull coating – advanced antifouling</td>
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<td>Engines</td>
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<td>Air cavity lubrication</td>
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<td>Additional power generation</td>
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<td>Hull retrofit (e.g., bulb)</td>
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<td>Aux power demand</td>
<td></td>
<td>Propeller re-fitting</td>
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<td>Boiler systems</td>
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<td>Propulsion improvement devices</td>
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<tr>
<td>Wind</td>
<td>0-8%</td>
<td>Steam plant operation</td>
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<tr>
<td>Wind</td>
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<td>Exhaust gas boiler on AE</td>
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<td>Underwater operations</td>
<td>4-10%</td>
<td>Cargo systems (e.g., cargo pumps)</td>
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<tr>
<td>Voyage planning &amp; execution</td>
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<td>Maneuvering equipment (e.g., thrusters)</td>
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<tr>
<td>Speed reduction</td>
<td>10-15%</td>
<td>Waste heat recovery system</td>
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<td>Cargo utilization optimization</td>
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<td>Engine de-rating</td>
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<td>Shaft generator</td>
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<td>Shaft tuning</td>
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<td>Shaft motor (WHRS)</td>
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<td>Variable Freq drive</td>
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<td>Lighting systems (e.g., LED)</td>
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<td>A/C and heating systems (HVAC)</td>
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<td>Maneuvering equipment (e.g., thrusters)</td>
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<td>Engine Load optimization</td>
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<td>Engine Load optimization</td>
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<td>Trim/draft optimization</td>
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<td>Engine load limitation</td>
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<td>Overall trade slow down</td>
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<td>Just in time principles</td>
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<td></td>
<td>Engine power limitation</td>
</tr>
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</table>

Source: MMM Center for Zero Carbon Shipping
Onboard energy demand can be met in different ways leading to added complexity.

Maritime energy conversion and propulsion options

Source: MMM Center for Zero Carbon Shipping
1 Represent primary energy conversion and production options only
Vessel fuel flexibility via fuel conversion and dual-fuel engine configurations allow for multi-fuel pathways

1) Bio-oil Ready requires less preparation compared to Methanol Ready and Ammonia Ready, which are much more extensive

Source: DNV "Maritime Forecast to 2050: Energy Transition Outlook 2021"