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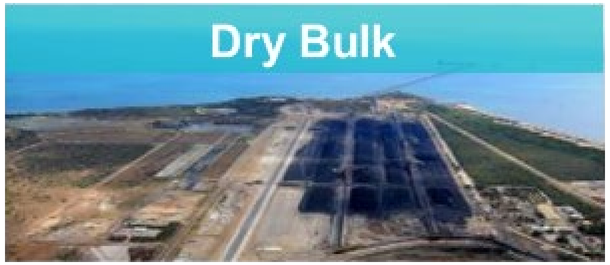
Decarbonization: Effects on Ports Operational Efficiency?

BIMP EAGA, 2023

23 Feb 2023

BMT in Asia Pacific

BMT APAC has been supporting **land-sea interface projects** since 1985.



What do we do?

"We provide innovative **products** and **consultancy** services to the Coastal Infrastructure, Transport & Energy sectors throughout the **lifecycle of an asset**, to ensure it is **optimised** in its **design and cost** and operates **safely** and **efficiently**"

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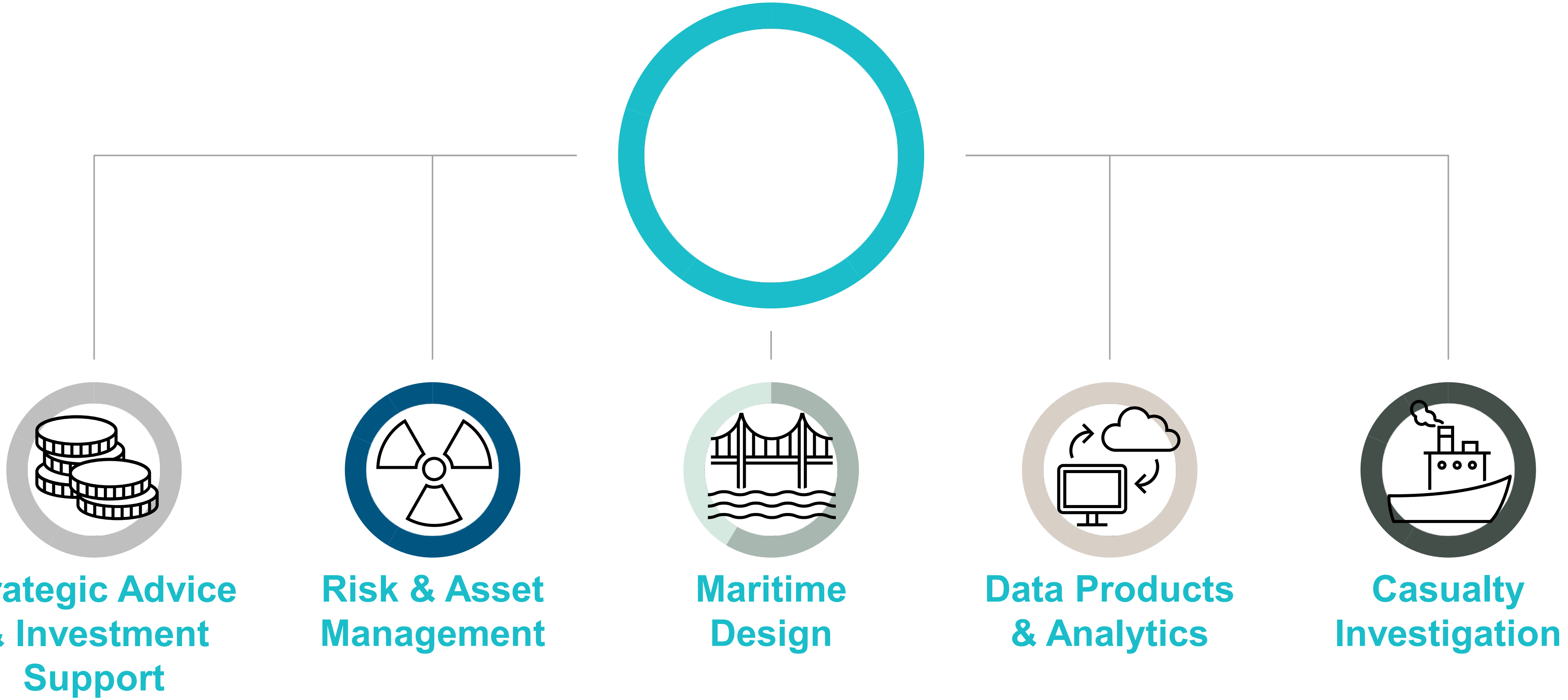
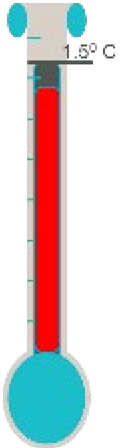
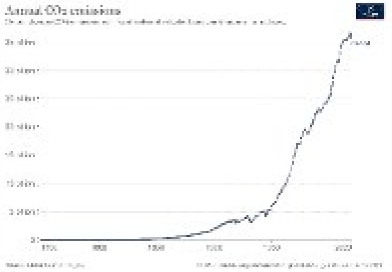
BMT in Asia Pacific



Why Decarbonization?

Consequence



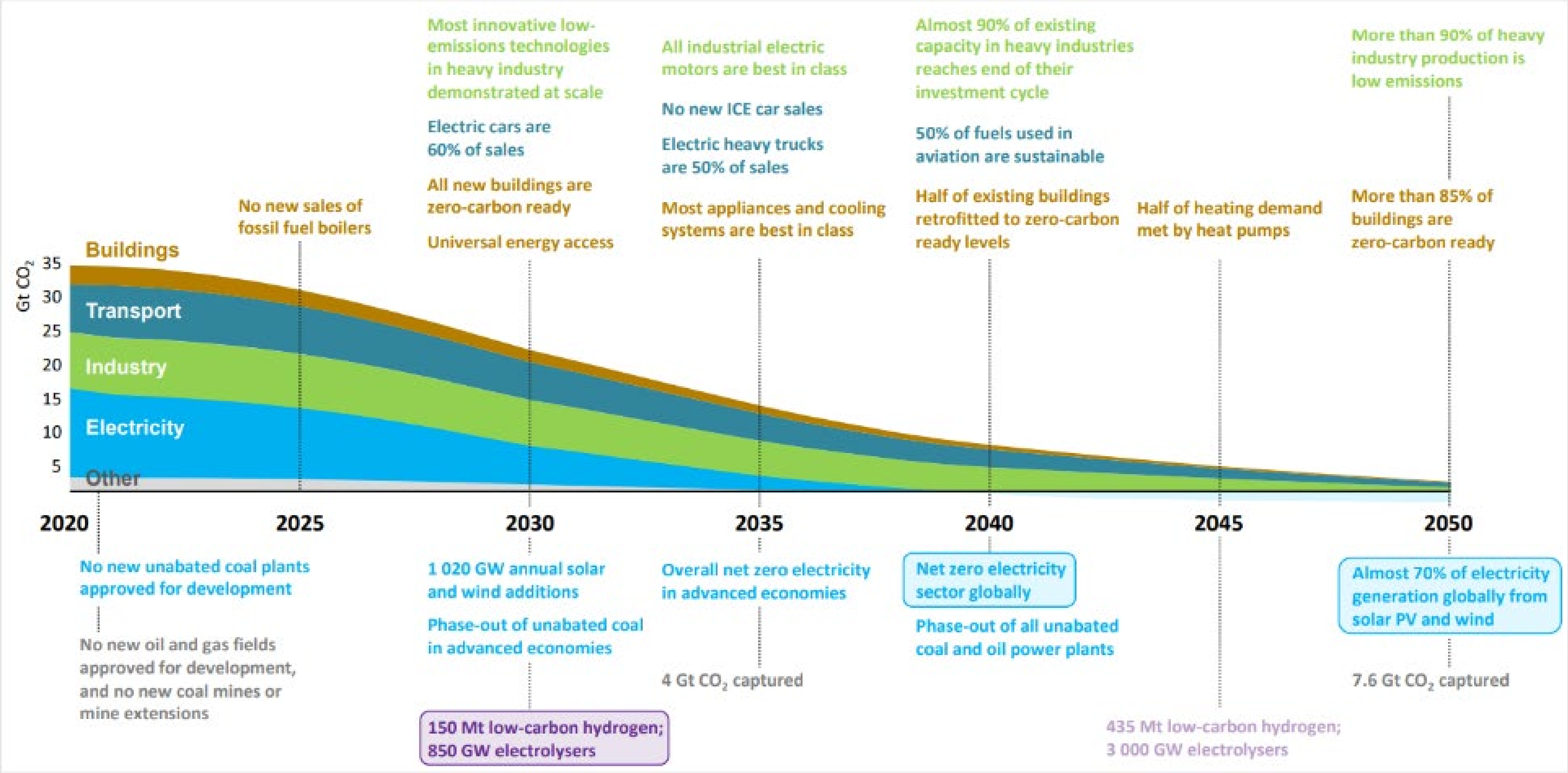


Carbon Budget

Climate Change and SGDs

- Climate Emergency
- Limit to 1.5 Deg C
- Decarbonization
- Sustainable Development

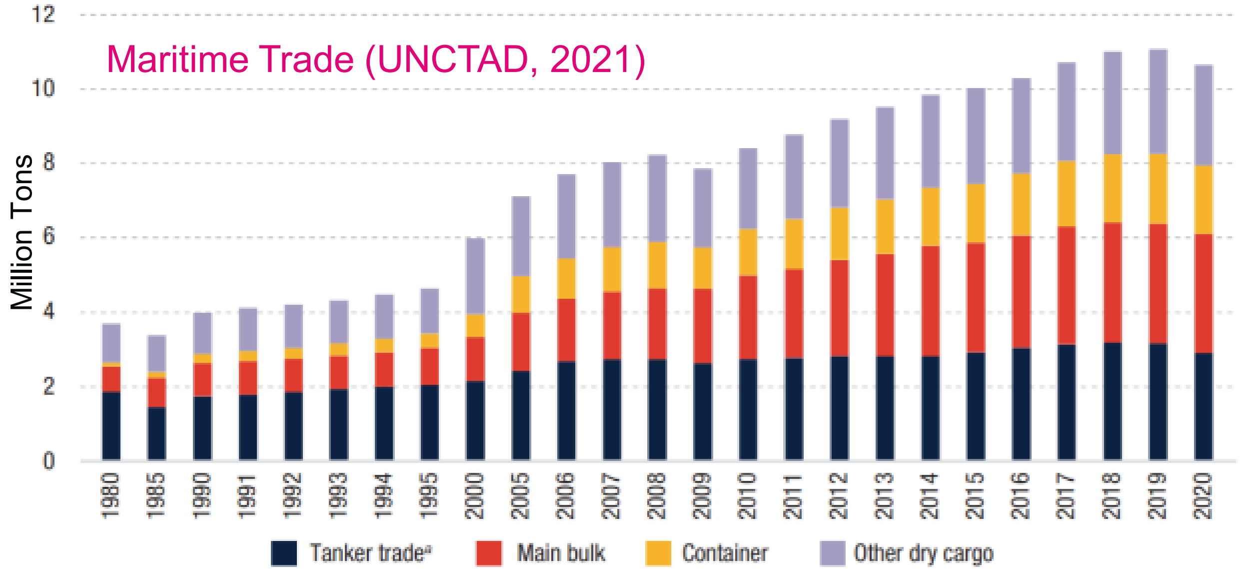
Global Race to Net Zero …



Source: IEA report Net Zero by 2050, 2021

Importance of Maritime Sector

- Global maritime transport plays a crucial role in both facilitating trade and fostering economic development at an international scale
- Carrying an estimated 70 percent of global trade by value and 80 percent by volume, maritime transport is an essential component of the global transportation network that underpins the daily functions of the world economy
- While COVID pandemic has disrupted the world economy, the maritime transport sector managed to navigate through the crisis and is rebounding to previous levels.

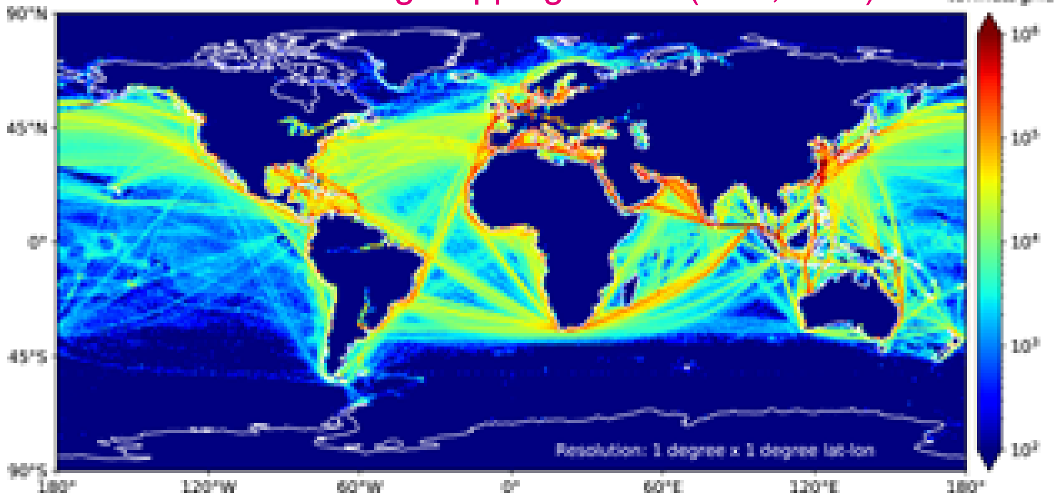


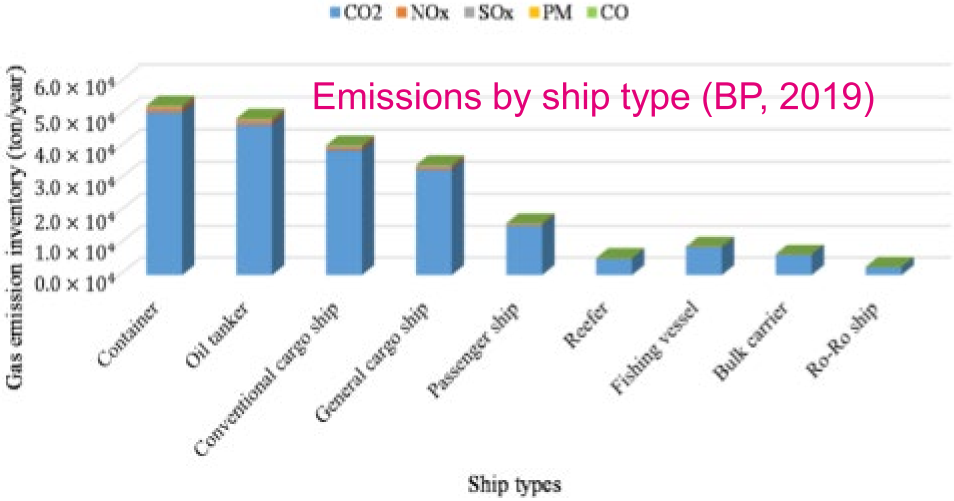
Source: UNCTAD

Global Maritime Emissions

- The shipping industry accounts for almost 3% of the world's emissions and arguably accounts for the largest proportion of many organizations' Scope 3 emissions
- The total shipping (international, domestic and fishing) emissions have increased from 977 million tonnes in 2012 to 1,076 million tonnes in 2018 (9.6% increase)
- The emissions from maritime activity are due to ships voyaging and calling at ports, and at the ports itself

Emissions along shipping routes (IMO,2015)



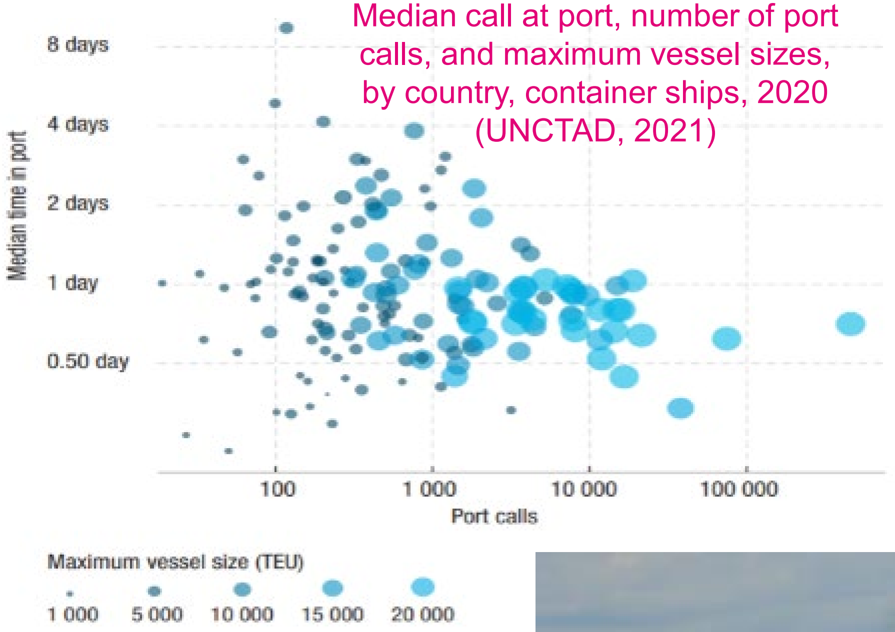


Emissions by ship type (BP, 2019)

Source: UNCTAD, BP

Port emissions

- Vessels typically spend 1 to 3 days at the port depending on the efficiency of the port
- In 2020, terminal operators, authorities, and intermodal transport providers took measures to contain COVID-19 and as a result ships had to spend more time in ports that were operating more slowly
- All this leads to emissions in the port area which affects the local communities and the environment
- BP study in 2019 indicated that more than 70% of the annual total fuel consumption may be attributed to maneuvering or cruising. About 25% is used while hoteling, and less than 2% is consumed while anchoring
- Depending on the fossil fuel (NG or coal) used for electricity generation, typical emissions are expected range from 6,000 tons to 20,000 tons PA depending on port size and characteristics.



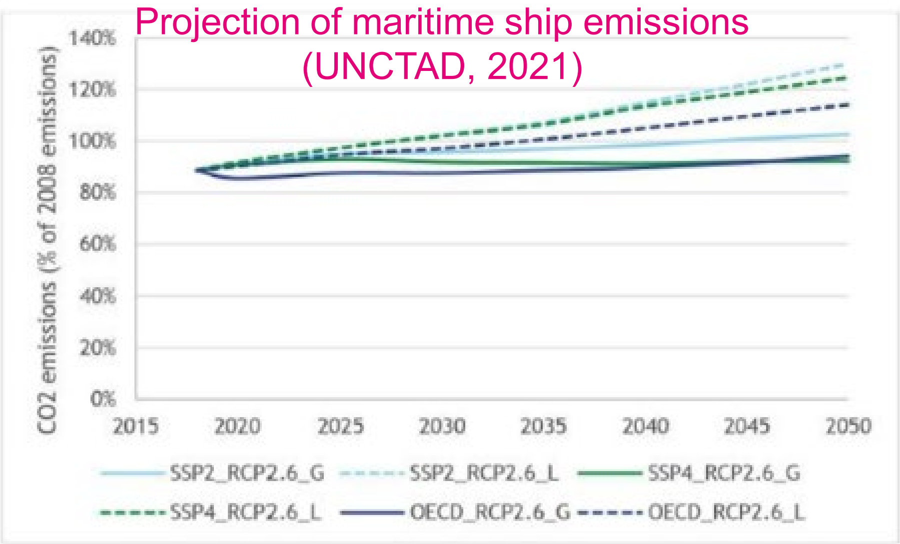
Median call at port, number of port calls, and maximum vessel sizes, by country, container ships, 2020 (UNCTAD, 2021)

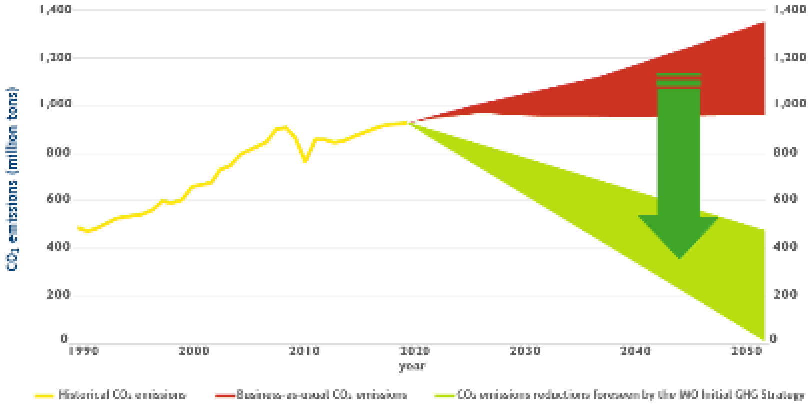
Port near Marseille (Robert Venturin)

Source: UNCTAD, IMO

Forecasted maritime emissions

- Emissions are projected to increase from about 90% of 2008 emissions in 2018 to 90-130% of 2008 emissions by 2050. Therefore, IMO is working on greenhouse gas emission reduction
- The trust is for shipping to change its fuel mix and use new technology and ship designs, alternative fuels and operational adjustments to cut its carbon and environmental footprint
- For energy, shipping is not just a large-scale user but also a major carrier, so the industry will have to respond to lower demand for oil tankers and coal carriers and more for ships transporting hydrogen, ammonia and other alternative fuels





Source: IMO (2020), IMO (2018b)

Source: UNCTAD, LR

Green Supply Chains

- The Maritime Green Corridor aims to reduce the environmental impact of shipping by promoting the use of low-carbon and zero-carbon fuels and technologies.
- Ports play a crucial role in this transition as they serve as gateways to the world, where ships can refuel and load or unload goods.
- Ports must make significant investments in renewable energy, energy-efficient infrastructure and technology to meet the demands of the green transition.
- For example, the Port of Rotterdam has set a target to become carbon neutral by 2050 and is investing in sustainable solutions such as electrification of cargo handling and hydrogen-powered ships.

Source ABS

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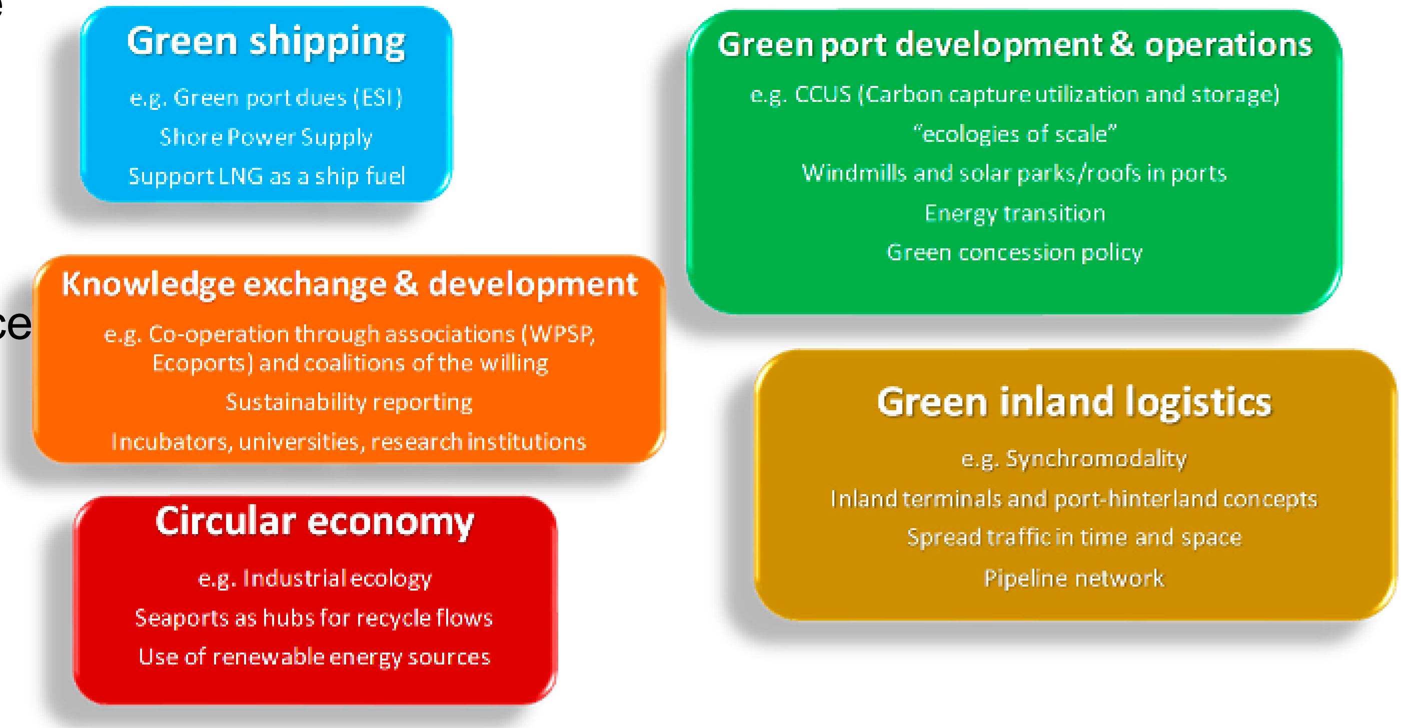
Green Port as important nodes

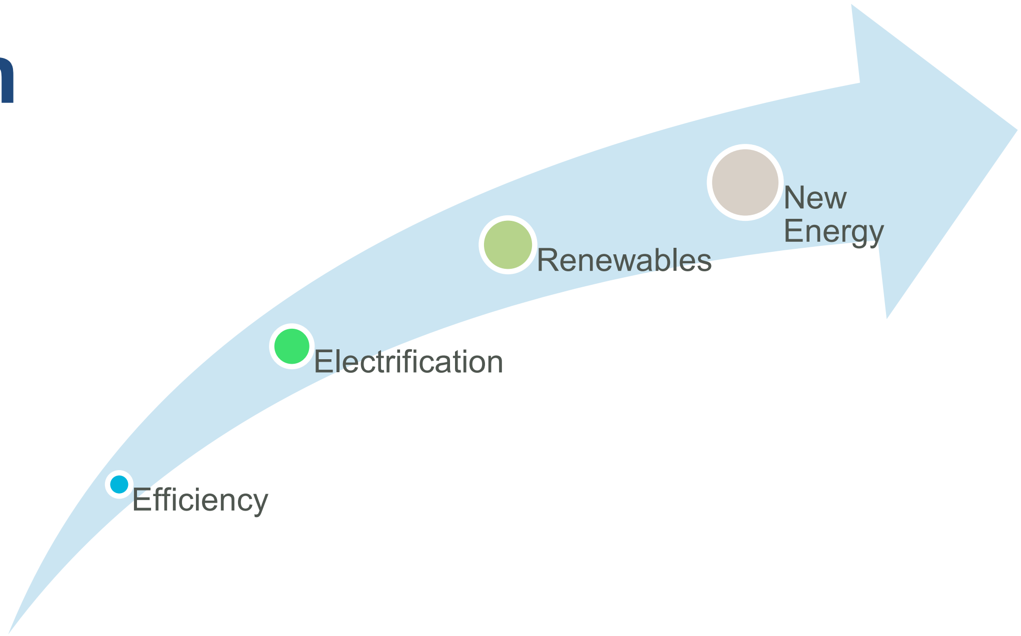
- Maritime ports will play an important role in the greening of supply chains
- Ports create concentrated cluster of economic activities where maritime shipping, trade and inland logistics confluence.
- From the perspective of attracting green finance there are five areas of critical infrastructure build-out that can maximize environmental outcome, i.e., green shipping; green port development and operations; green inland logistics; seaports and the circular economy and knowledge/digitization.
- Sectoral coupling with local abundant energy supplies such as LNG, biodiesel or solar will create synergies

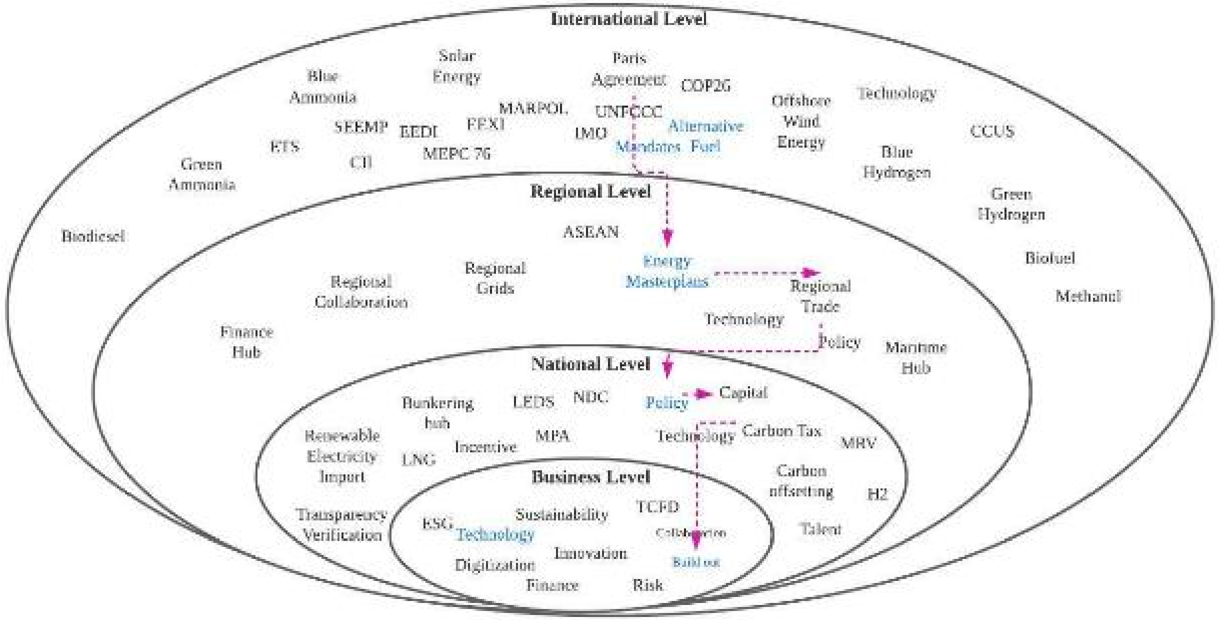


Source: UNEP Role of Seaports in Green Supply Chain; Theo et al

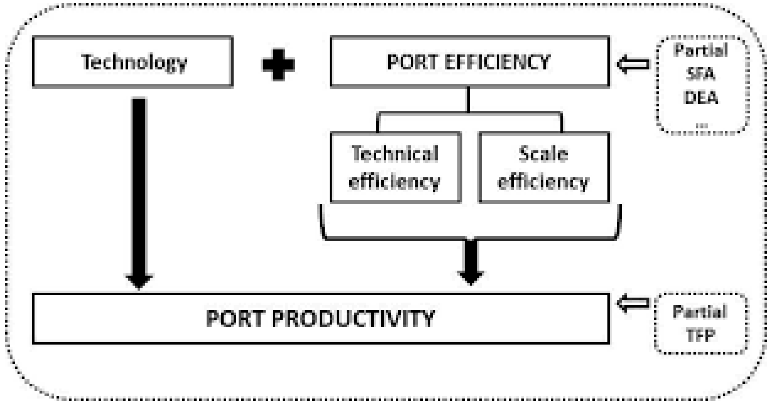
Overview of Port decarbonization

Reduce carbon foot print and at the same time improve shipping/port efficiency and competitiveness



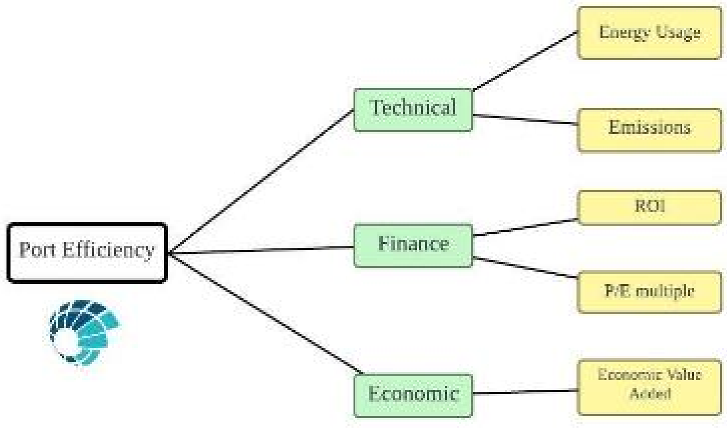


Multi-level alignment (BMT)

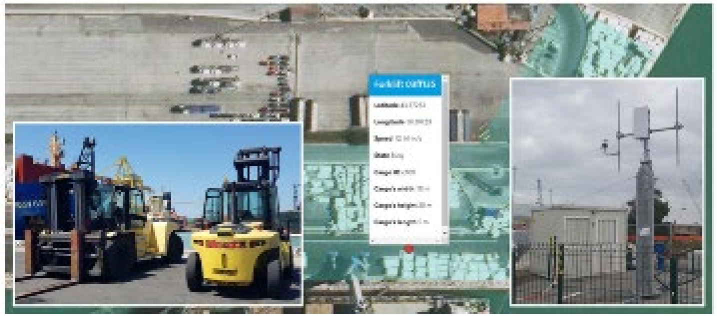


Dimensions to Port Efficiency

- Automation and digitalization: The use of automation and digital technologies such as IoT, machine learning, and artificial intelligence to optimize operations and improve efficiency.
- Sustainable and green ports: A growing focus on sustainable and green ports, which aim to reduce the environmental impact of ports and attract environmentally-conscious customers and partners.
- Decarbonization: The reduction of greenhouse gas emissions and the adoption of low-carbon practices to mitigate the effects of climate change.
- Cybersecurity: The implementation of cybersecurity measures to protect ports against cyber-attacks and to ensure the security and continuity of port operations.
- Resilience: The development of resilient ports that are able to withstand and recover from disruptions such as extreme weather events, natural disasters, and other crisis situations.

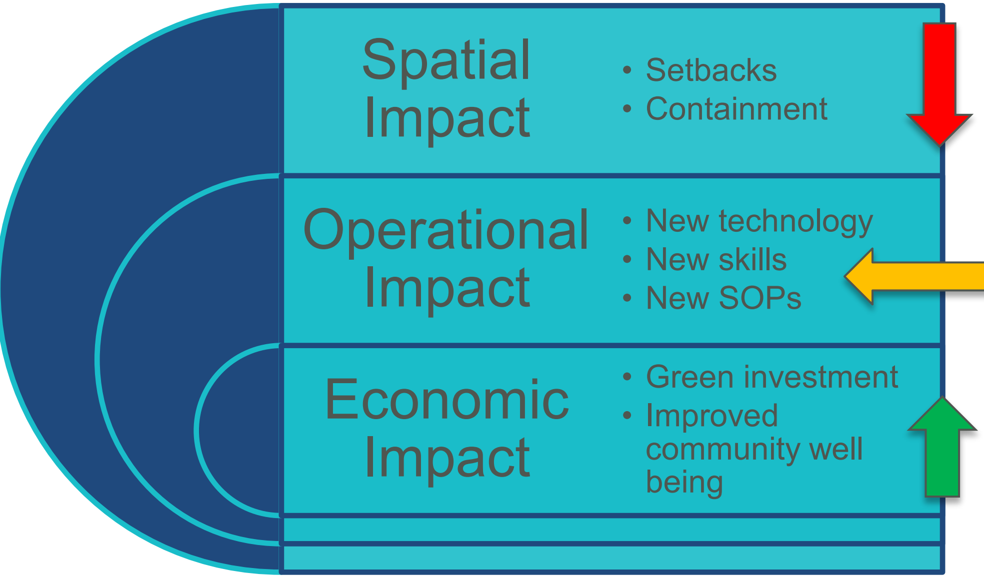


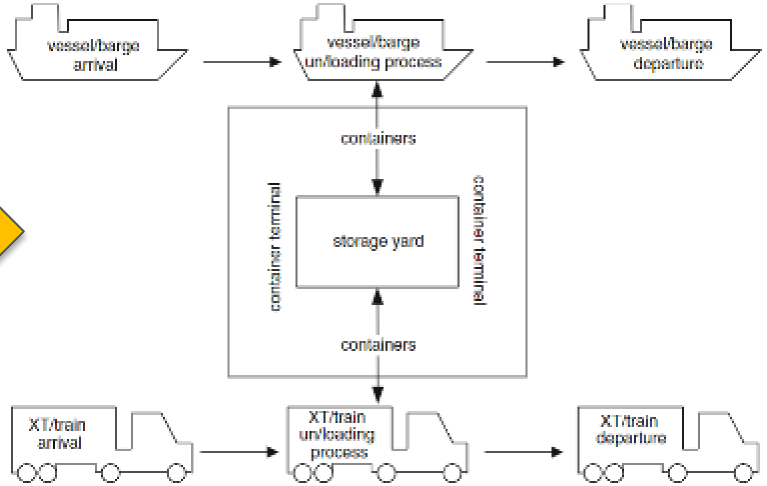
Dimensions of efficiency (BMT)



Berth Utilization
Equipment utilization
Yard area
Emissions
HSE
Service Levels

Decarbonization and Port Efficiency- a Balancing act





Trade-offs are required – is there a net gain?

- Ports are congested and any new fuel will have safety demands in spatial layout
- Existing operations will have to be reevaluated for new risks and opportunities
- Green investments will allow ports to offer premium services to their customers and meet government mandates

How to measure decarbonization impact on operational efficiency?

- **Identify the input and output variables:** The first step is to identify the input and output variables that will be used to measure the efficiency of the port.
  - For example, the input variables can be the amount of energy used, the number of vessels, or the size of the port,
  - while the output variables can be the amount of cargo handled, the number of vessels serviced, or the emissions produced.
- **Collect data**: The next step is to collect data on the identified input and output variables. This can be done using a variety of sources such as port records, surveys, or other databases.
- **Normalize the data:** Once the data is collected, it needs to be normalized so that each variable is on the same scale. This is important because the different variables may have different units or scales, which could affect the accuracy of the analysis.
- **Calculate the efficiency scores:** Input-Output Slack-Based Measure (SBM)-Data Envelopment Analysis (DEA) is a method used to evaluate the relative efficiency of decision-making units (DMUs) based on their inputs and outputs. The SBM-DEA model is used to calculate the efficiency scores for each port. This involves comparing the input and output values for each port and calculating the efficiency score.
- **Identify best practices**: The final step is to use the results of the analysis to identify best practices and areas for improvement. This information can be used to develop strategies for improving the operational efficiency of ports due to decarbonization.

Example of impact of Decarbonization – Marine Fuels

- Qualitative comparison of marine fuels was by Law, L. C et.al 2021, fossil-based marine fuel with the installation of CCS achieved the highest score, followed by biodiesel, hydrogen produced via steam reforming, and then electricity produced by various means.
- Ammonia and methanol produced from various pathways achieved lower scores and, hence, were deemed to have less potential as marine fuels.

Which one should I bet on?

Fuel type	Scalability (● Scalable, ■ Difficult, ▲ Unlikely)	Flammability, toxicity, corrosiveness (Follow the worst score)	Regulation & guidelines (● Completely Available, ■ Available, need amendment, ▲ Not Available)	Technology readiness (● Commercialized, ■ Small scale, ▲ R&D)
HFO (Base case)	● Scalable	● Safe,Non-toxic,Non-corrosive	● IGF Code	● Commercialized
HFO (CCS)	● Scalable	● Safe,Non-toxic,Non-corrosive	● IGF Code	● Commercialized
LNG	● Scalable	● Safe,Non-toxic,Non-corrosive	● IGF Code	● Commercialized
LNG (CCS)	● Scalable	● Safe,Non-toxic,Non-corrosive	● IGF Code	● Commercialized
BLUE H2	● Scalable	▲ Dangerous,Non-toxic,Non-corrosive	■ Require amendment of IGF Code	■ Small scale
BLUE H2 (FC)	● Scalable	▲ Dangerous,Non-toxic,Non-corrosive	■ Require amendment of IGF Code	■ Small scale
BLUE NH3	● Scalable	▲ Intermediate,Very toxic,Corrosive	▲ IGC not allow, IGF Code require approval	■ Small scale
BLUE NH3 (FC)	● Scalable	▲ Intermediate,Very toxic,Corrosive	▲ IGC not allow, IGF Code require approval	■ Small scale
MEOH	● Scalable	■ Intermediate,Acutely-toxic,Corrosive	■ Require amendment of IGF Code	■ Small scale
BLUE MEOH (CCS)	● Scalable	■ Intermediate,Acutely-toxic,Corrosive	■ Require amendment of IGF Code	■ Small scale
NG-E	● Scalable	● Safe,Non-toxic,Non-corrosive	● Part 6, Chapter 2, Section 1, Battery power	● Commercialized
BLUE E-H2 (FC)	■ Not economic	▲ Dangerous,Non-toxic,Non-corrosive	■ Require amendment of IGF Code	■ Small scale
BLUE E-NH3 (FC)	■ Not economic	▲ Intermediate,Very toxic,Corrosive	▲ IGC not allow, IGF Code require approval	■ Small scale
BLUE E-MEOH	■ Not economic	■ Intermediate,Acutely-toxic,Corrosive	■ Require amendment of IGF Code	■ Small scale
BIO-DIESEL	■ Challenging	■ Safe,Non-toxic,Corrosive upon degradation	● ISO 8217:2017 fuel standard	■ Small scale
BIO-MEOH	■ Challenging	■ Intermediate,Acutely-toxic,Corrosive upon degradation	■ Require amendment of IGF Code	■ Small scale
SOLAR E	▲ Unlikely	● Safe,Non-toxic,Non-corrosive	● Part 6, Chapter 2, Section 1, Battery power	● Commercialized
SOLAR E-H2 (FC)	▲ Unlikely	▲ Dangerous,Non-toxic,Non-corrosive	■ Require amendment of IGF Code	■ Small scale
SOLAR E-NH3 (FC)	▲ Unlikely	▲ Intermediate,Very toxic,Corrosive	▲ IGC not allow, IGF Code require approval	■ Small scale
SOLAR E-MEOH	▲ Unlikely	■ Intermediate,Acutely-toxic,Corrosive	■ Require amendment of IGF Code	■ Small scale
SOLAR T-H2 (FC)	▲ Unlikely	▲ Dangerous,Non-toxic,Non-corrosive	■ Require amendment of IGF Code	■ Small scale
SOLAR T-MeOH	▲ Unlikely	■ Intermediate,Acutely-toxic,Corrosive	■ Require amendment of IGF Code	■ Small scale

● = 10, ■ = 7, ▲ = 4

Law, L. C., Foscoli, B., Mastorakos, E., & Evans, S. (2021). A comparison of alternative fuels for shipping in terms of lifecycle energy and cost. *Energies*, *14*(24), 8502.

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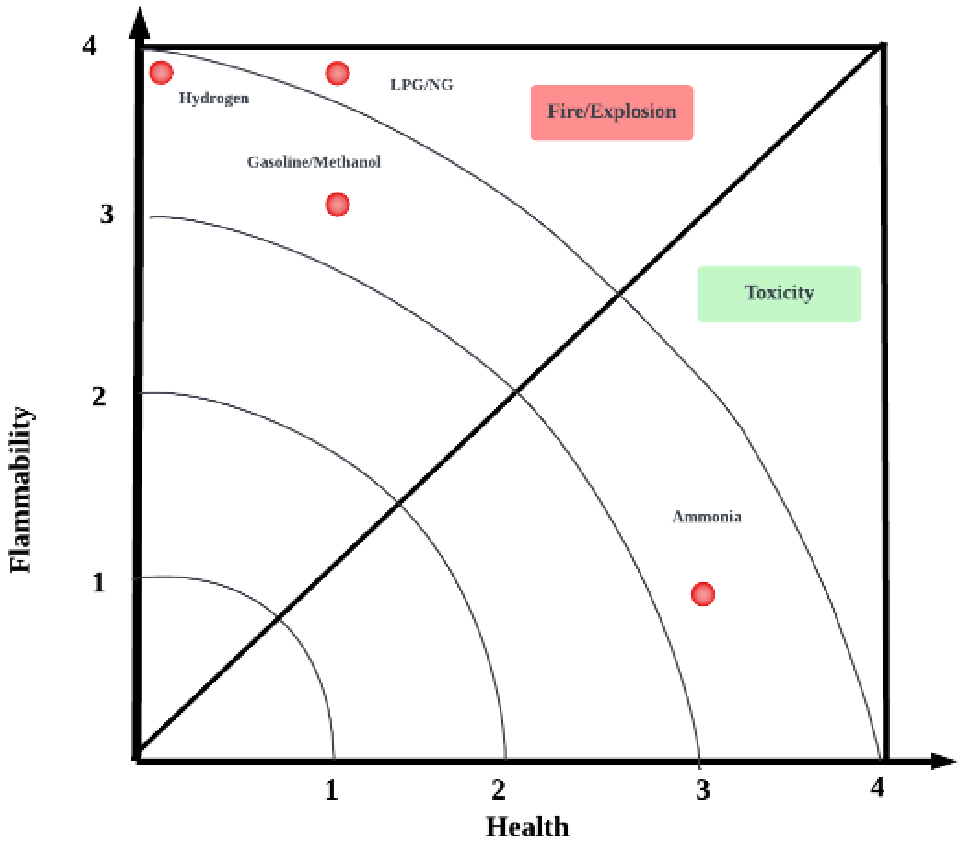
Example Ammonia as Fuel – Safety Impact

- NH3 is toxic and is lethal at 5000 ppm but can already be smelled at 5 ppm.
- The flammability of NH3 is very low, within a very limited window (15-28% in air). Explosive mixtures can generally only be found in confined spaces. Ignition energy is very high.
- NH3 has a strong affinity for water. This can be a risk (body contains mostly water) but also be used in treating incidents (dilution, catching a vapour cloud).
- Due to the violent reaction, water should never be applied as a fire extinguishing medium for burning liquid NH3.
- NH3 can cause stress corrosion cracking in carbon steel. This can be averted by adding small amounts of water to the NH3.



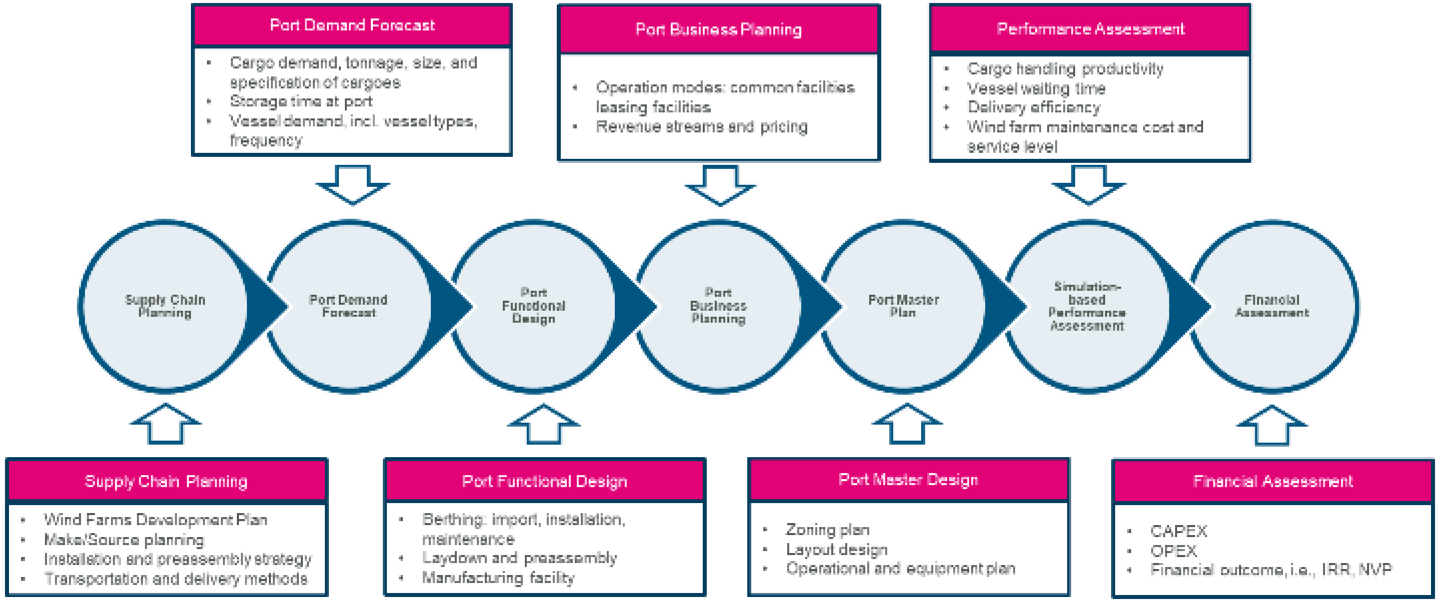
Can my port safely handle this new fuel?

Example of Port Readiness for Offshore Wind – Revenue Impact

Staging post port is important for offshore wind construction and operations.

Assessment of wind farm base port to best service the offshore wind farm in the region, while optimizing the logistics efficiency and service level for wind farms.

BMT has been contributing to the area repurposing existing ports to improve efficiency and capture value

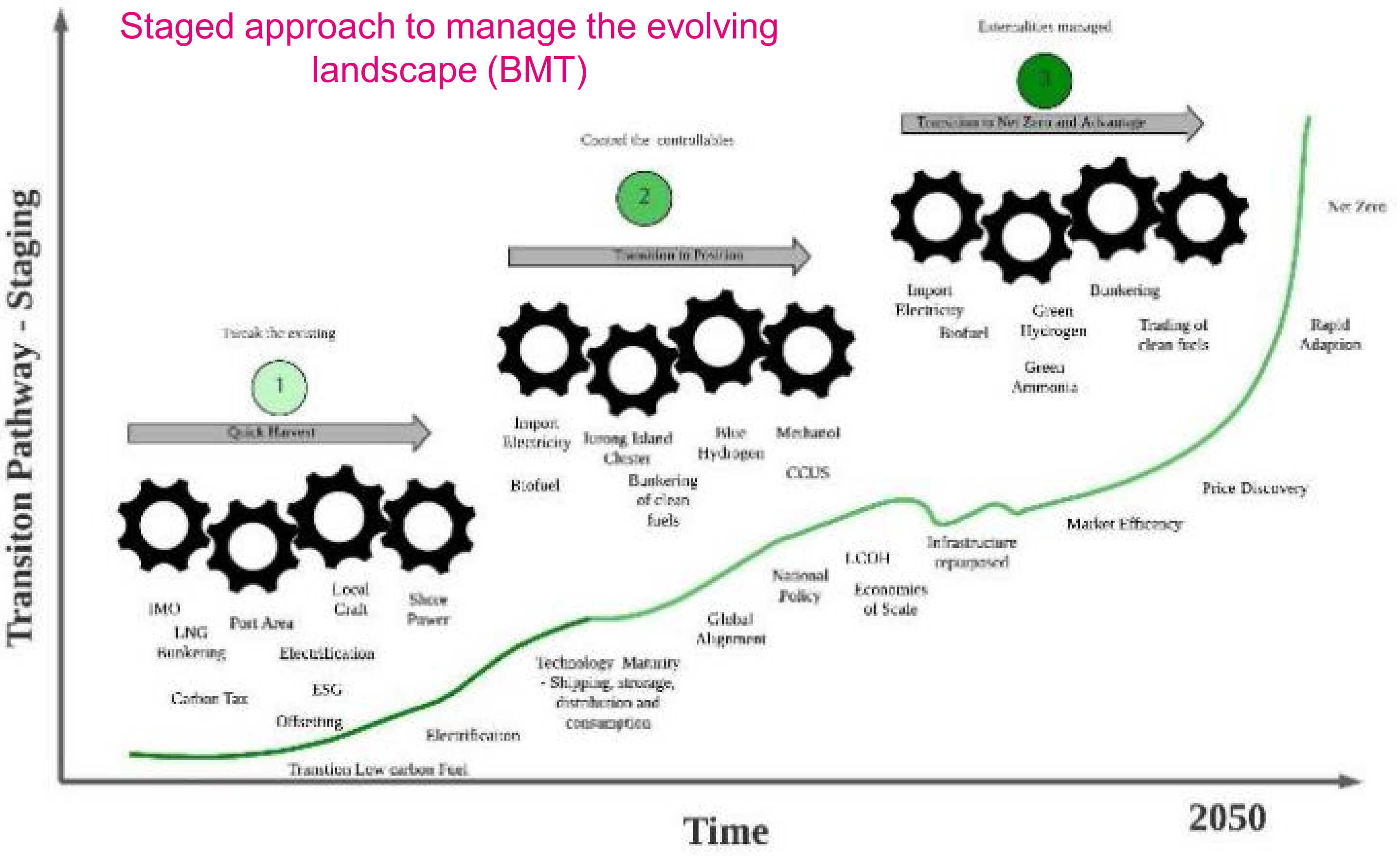


Source BMT

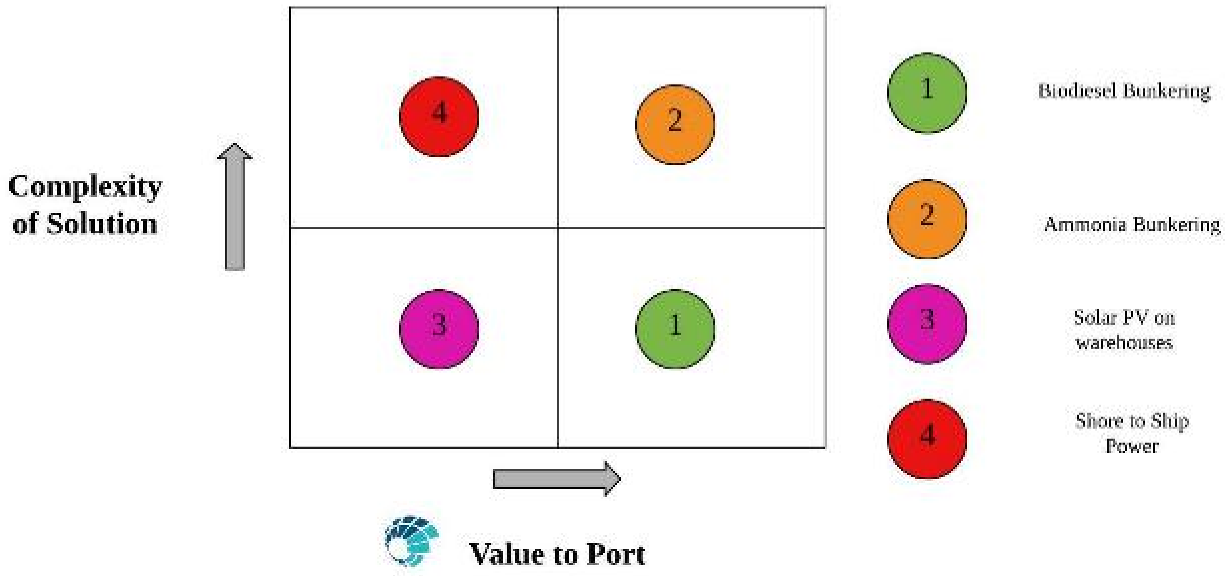
Factoring in Pathway(s) complexities

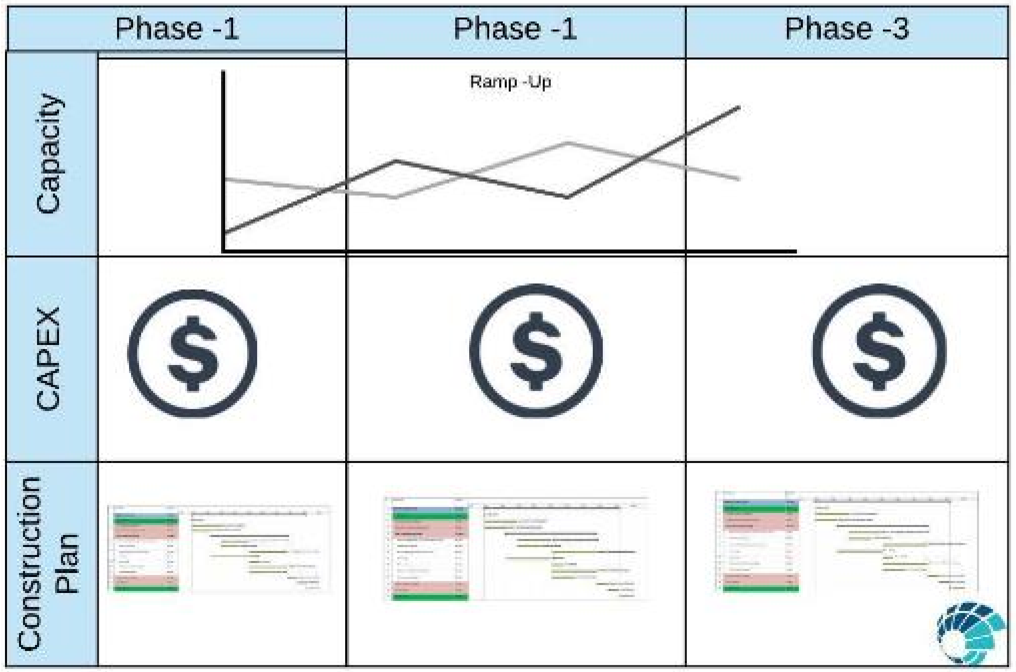
- Pathways are created when uncertainties are reduced, and goals are aligned at multiple levels starting from international level, regional level, national level and business level.
- The final risk is with the business or consumer, therefore the socio-economic context should be carefully managed
- Decarbonization hinges on alternative fuels and new technologies, both requiring replacing or repurposing existing assets.
- Businesses will bear the risk of stranded assets this needs to be addressed both at international and national level to ensure level playing field.
- Decarbonization is uncharted territory, pathways should be staged to manage the evolving landscape

Staged approach to manage the evolving landscape (BMT)



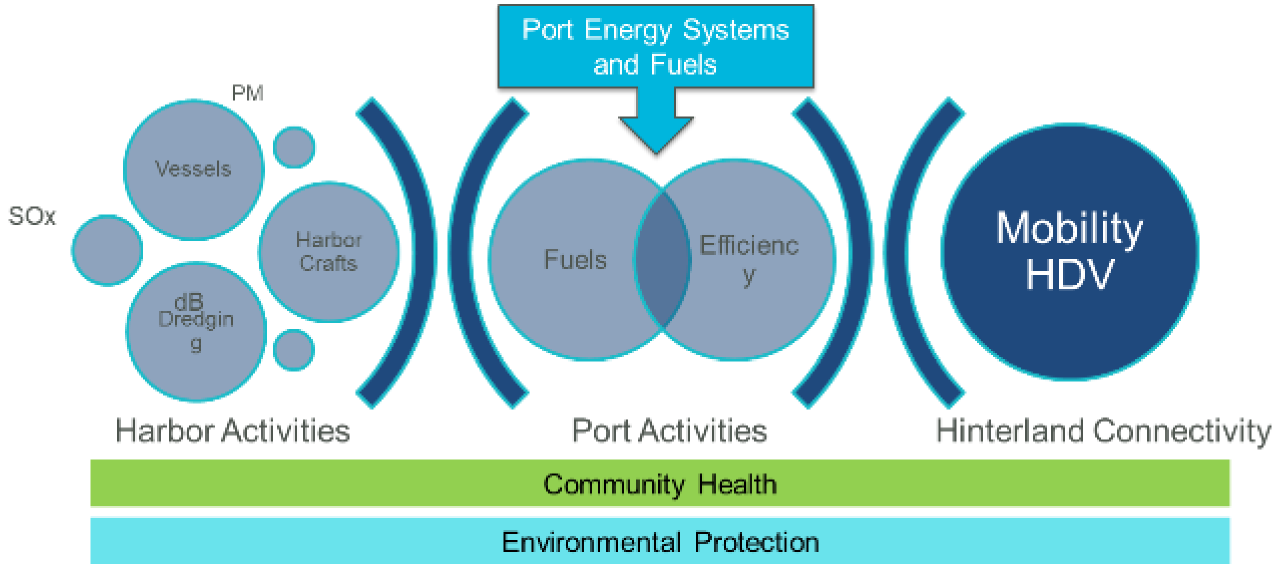
Complexity vs Value Add





Therefore, a calibrated approach towards port decarbonization

- Compared to international level, the important national considerations are to reach policy consensus, frame clear regulations, structure risk/reward sharing, citizen consultation and on ground implementation.
- For example, Singapore has defined its decarbonization strategy under Green Plan and Long-term low-emissions development strategy (LEDS)
- The low hanging controllable include,
  - Electrification of yard
  - Shore power
  - LNG bunkering
  - Electrification of short haul harbour crafts
- Singapore's approach takes an incremental approach wherein feedback is continuously taken from changes in the external environmental.

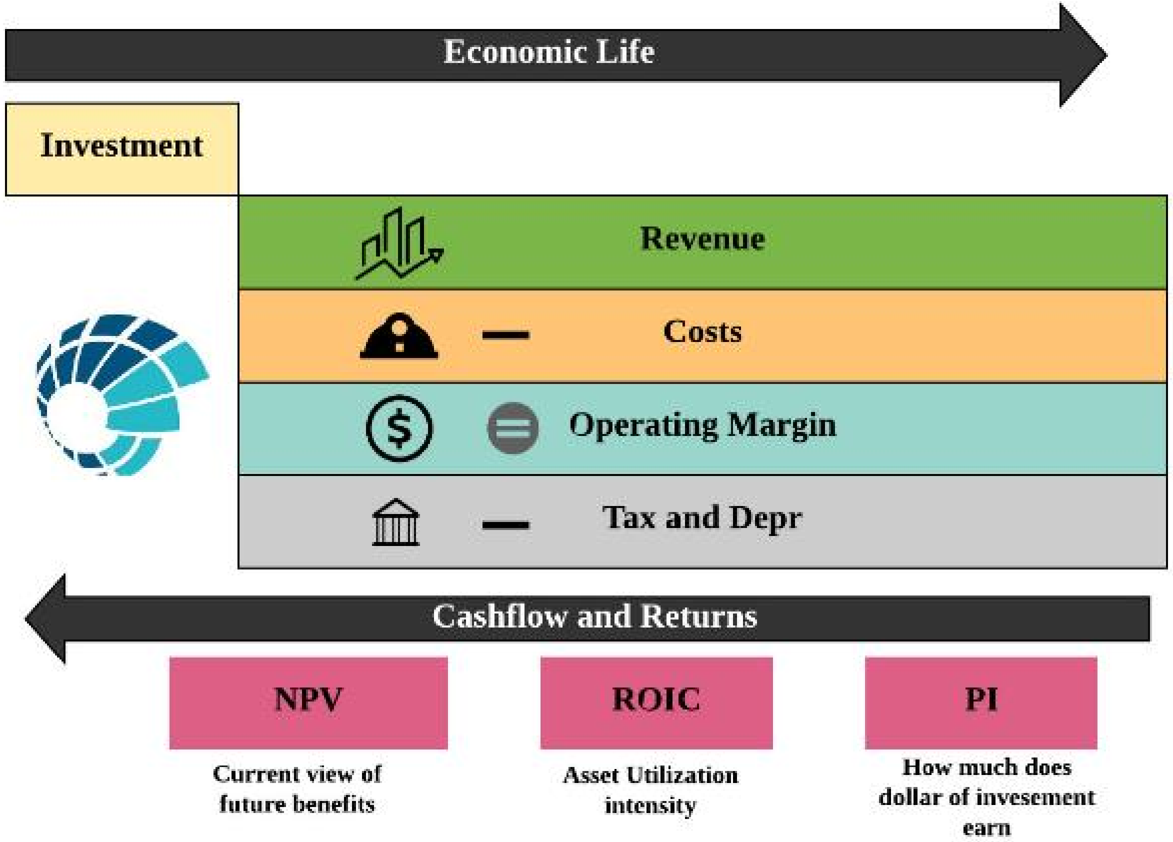


Source BMT

Can I de-risk my approach?

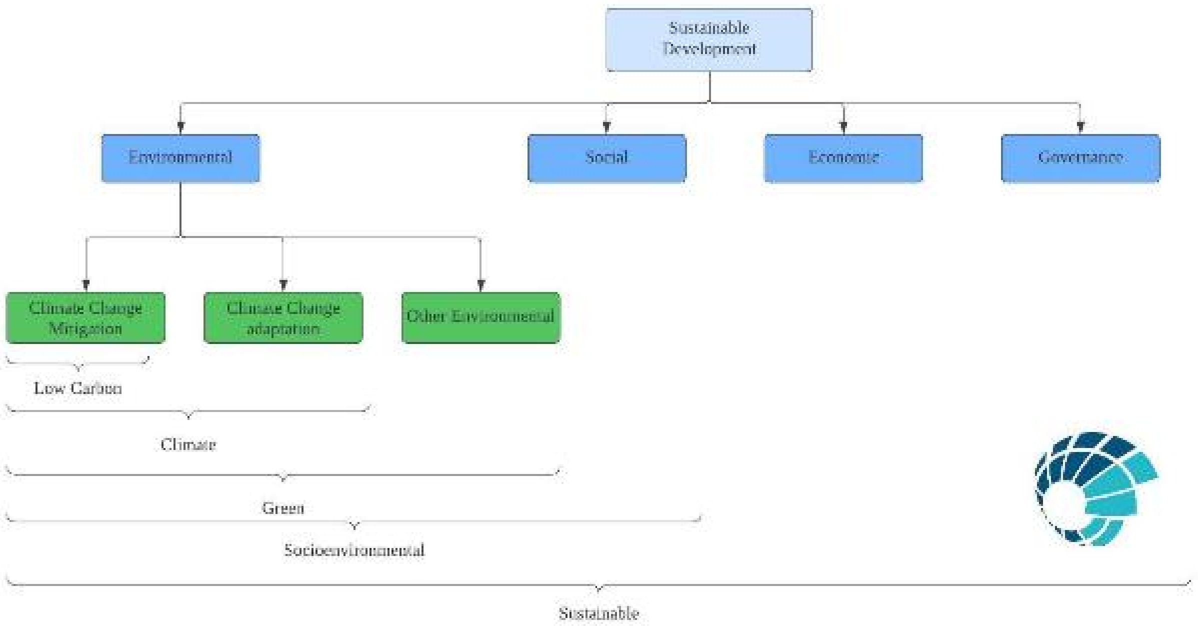
Deriving port's economic value from efficiency

- Add economic value to the port and the community, the socio-economic benefits
- Align with Net zero of the entity and the government
- Ensure coupling with local economy
- Contribute towards global energy transition efforts
- Foster collaboration with stakeholders, including ship owners, fuel suppliers, and government agencies, to align on decarbonization goals and ensure the seamless integration of clean energy technologies.
- Lead to development and training of the employees who can play a crucial role in driving decarbonization efforts, with ports providing training on clean energy technologies, energy-efficient practices, and sustainable practices.



Final thoughts – Sustainable Port Development

- Decarbonization of ports is a crucial step towards a more sustainable and responsible future, both for the ports and the global maritime sector
- By implementing operational efficiencies and adopting low-carbon or zero-carbon fuels, ports can play a major role in the transition to a more sustainable future.
- Decarbonization and operational efficiencies lead towards sustainability and ESG goals.
- Sustainable ports that prioritize ESG factors are not only better for the environment, but they are also more attractive investments.



The big picture of decarbonization and port efficiency

Questions?

Thank you

Speaker's BIO

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- Shivaprakash heads the Consultancy and Energy transition in BMT, he is responsible for initiatives related to Energy Transition which includes pivot towards Offshore Wind, maritime decarbonization and Hydrogen
- Shivaprakash has over 28 years' experience in executing projects in the Energy Sector. His expertise is in varied industries like LNG, bulk liquid storage terminals, FPSO, Gas platforms, petrochemicals, refinery, specialty chemicals, pharmaceutical bulk drugs and port development. He is a Chemical Engineer by training with MBA in Finance, and a PMI certified Project Management Professional (PMP). Shivaprakash's geographical exposure includes Americas, Europe, Middle East, India, Malaysia, Myanmar and Indonesia.
- Shivaprakash has successfully implemented several types of projects ranging from feasibility studies, basic design, FEED preparation, contracting, construction, commissioning and project close-out. Under project management, the span of functional experience includes all aspects of planning and controlling of the project cost, schedule and scope.
- Shivaprakash's area of expertise are Market Studies, Economic Appraisal, Project Management, Process Engineering, Piping Engineering, Risk Management, Capital Planning and Advisory services.
- Shivaprakash is passionate about climate change, renewable energy and decarbonization, he has been a speaker at ASEAN Wind (2020), JACKS Forum (2021), EIC Wind Energy (2021), (SMW Singapore (2021), OTC KL (2021), ASEAN Ports and Shipping (2022) and TOC Singapore (2022)