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international association of ports and harbors
The Clean Marine Fuels working group

WPCAP

Port Readiness Level For Marine Fuels (PRL-MF)

Assessment tool for bunker ports

This assessment tool is developed to assess the port readiness for the bunkering of a marine fuel that is still new to the port.

Index of topics

1. The Port Readiness Level for Marine Fuels Assessment Tool

Fighting climate change requires global coordination, with decarbonization actions from all industries and subsectors. In the maritime world, decarbonization can largely be divided into two: energy efficiency and the use of low- and zero-carbon fuels. Where the first is likely to have impact on short- and mid-term targets, the latter is largely seen as a preferred long-term pathway to helping shipping meet its IMO mandated greenhouse gas (GHG) emission targets. (ref. a.)
There is wide consensus in the industry that there will be multiple fuels in use in a decarbonized future. As more ships using new and emerging fuels make their way into the global fleet, ports must prepare to facilitate vessel calls and safe bunkering operations in a manner that aligns with their strategic objectives.

1.1 Port Readiness Level for Marine Fuels Overview

What is the Port Readiness Level for Marine Fuels (PRL-MF)?
The Port Readiness Level for Marine Fuels assessment tool (PRL-MF) has been designed by the World Port Climate Action Program (WPCAP) (ref.: b.) in conjunction with the International Association of Ports and Harbors' (IAPH) Clean Marine Fuels (CMF) (ref.: c.) group. It is an assessment framework that ports can use to self-assess their readiness and identify areas requiring further development in order to facilitate bunkering with a new fuel. The tool uses a series of checklists to help ports prepare for and execute bunkering with a new fuel.

The PRL-MF framework can be used by ports to assess readiness for bunkering operations of vessels using a new marine fuel. This document is developed for ports that will facilitate bunkering of the new marine fuels. For ports that only will have calls of vessels sailing on the new marine fuels without bunkering, a separate document is developed.

The PRL-MF framework is meant to be used as guidance by stakeholders in the port community to initiate dialogue, develop port infrastructure, allocate resources and strategies, and ensure appropriate governance in considering bunkering of a new fuel. While the idea of the tool is that all ports at the same readiness level for the same fuel should be in parity with each other, it is possible that larger ports or those with specific structures may achieve their objectives in ways that look different than smaller ports.

The PRL-MF tool is meant to assist ports in assessing their readiness for a single new fuel (referred to as the target fuel) and should be repeated for each new fuel for which the port is considering establishing bunker capabilities. Additionally, the PRL-MF tool can be used as a profiler for green corridor initiatives. More about green corridor initiatives can be found in part 2 of this document.

The framework is not meant to be mandatory, as not all strategies and tasks will be applicable for every port. Organizations can use this tool as guidance and take only those steps which are considered appropriate and relevant. If a strategy or task is deemed unfeasible or irrelevant for a specific port's needs, it can be well-substantiated and recorded moved into the optional category.

Who can use this tool?
Given the differences in the configuration for various ports and their stakeholders, it is vital to create a universal framework that allows port communities to prepare themselves, manage customer expectations, and meet their strategic, environmental, and social commitments.

The tool can be used by any relevant member of a port community including the port authority, national maritime authority, ship operating customers, regulators, governments, safety teams, regional first responders, as well as green corridor managers and many more. Tasks within each level can be fulfilled by a single entity or multiple entities. For example, a risk assessment can be performed by an external consultant; elements of the safety framework can be developed by a regulatory authority; and new infrastructure can be purchased and installed by bunker operator. The steps taken by individual ports will likely vary according to the specific operations and structure of the port community.

1.2 Port Readiness Level for Marine Fuels Structure and Checklist

The PRL-MF framework consists of nine readiness levels – largely following the schematic of the NASA Technical Readiness Level (TRL)[ref.: d.] . The first three levels concern the research phase (PRL-MFs 1, 2 & 3), the next three levels the development phase (PRL-MFs 4, 5 & 6), and the last three levels the deployment phase (PRL-MFs 7, 8 & 9). An overview of nine readiness levels is shown in Table 1. The format of the checklist is partly based on the OGSM methodology[ref.: e.] .

The goal of the research phase is to determine the relevancy of the fuel for the port and its stakeholders. This phase will help to identify information gaps, determine pros and cons, and ascertain the interest of port stakeholders. The goal of the development phase is to make strategic decisions about implementation, create a guiding framework based on assessments and testing, and run a pilot test for the target fuel. Finally, the deployment stage includes scaling-up operations, beginning with a project-based approach and growing into a systems approach that will create a regular port operation.

As noted, the PRL-MF tool is structured as a checklist for ports to self-assess their readiness across the nine readiness levels for every post fossil fuel. Each readiness level contains a list of strategies and tasks that, when completed, will help ports assess their current readiness for a target fuel. The nine levels have to be completed for all individual fuels. By examining the tasks required for each readiness level, ports can create a practical roadmap and timeline of the port ambitions for each new fuel. This information, along with the current port readiness level, can be made publicly available, so that stakeholders can make informed decisions when investing in fuel production, ships, equipment, planning, routes, green corridors, and more.

2. Outline of Port Readiness Level for Marine Fuels.

		Bunkering of target fuel
PRL-MF 9	Deployment	Market penetration and growth for bunkering of target fuel
PRL-MF 8		Full capabilities for bunkering of target fuel
PRL-MF 7		Bunkering of target fuel established on a project basis
PRL-MF 6	Development	Pilot-scale demonstration of bunkering of target fuel
PRL-MF 5		Framework for bunkering of target fuel implemented and tested
PRL-MF 4		Framework for bunkering of target fuel drafted, timeline developed
PRL-MF 3	Research	Detailed research, analysis, and conclusions
PRL-MF 2		Stakeholder interest and feasibility assessment
PRL-MF 1		Foundational background information

3. The PRL-MF checklist for Marine Fuels:

Use of the tool:
Each of the nine levels within this process has an objective or overarching goal that can be fulfilled by completing tasks and strategies within the level. It is possible to work in multiple levels at the same time; however, levels are arranged as to inform strategic decisions at the completion of each level. Tasks in each level cover all domains, including governance, safety, infrastructure, and market, and it is recommended that the most relevant entity for each task take charge of its completion.

Strategies, tasks and measures
These are plans and actions to be performed by appropriate stakeholders in the port community to achieve the level objective. When all relevant strategies, tasks and measures within a level are fulfilled, the level objective is achieved. However, in cases where a task or measure turns out to be not relevant, or will never be feasible in the port, the task or measure should be downgraded to optional.

Optional tasks and considerations
These include plans or actions that ports may wish to execute. The list of optional tasks and considerations within each level is meant to create structures of support for the port community towards reaching its objectives. These are generic suggestions that may not apply in every case – and are not exhaustive. It is recommended that ports consider any additional tasks or measure that may apply to their specific port.

NOTE: Not all strategies, tasks and measures will apply to all ports. There is an expectation that port communities will identify all strategies, tasks and measures that are applicable for their port and work towards achieving them. Ports should ensure that there are clear reasons and documentation as to why selected strategies, tasks and measures are not suitable for action.

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Port Readiness Level Checklist for Marine Fuels for bunker ports

This assessment checklist is developed to assess the port readiness for the bunkering of a marine fuel that is still new to the port.

Port:
Target Fuel:
☐ Swapping of Modular Energy Containment Systems (MECS) ☐ Bunkering from a shore-based bunker facility (LTS) ☐ Bunkering from trucks (TTS) ☐ Bunkering from a bunker vessel (STS) ☐ Other……

Level 1: Foundational background information

Level 1 Objective: **to gather pertinent background information that will help to form the foundation of research and inform decisions moving forward**

- Domain: Governance

Strategies, tasks and measures:

- ☐ Research present and upcoming regulations and incentives regarding shipping decarbonization and alternative fuel use including:
  - International regulations and incentives,
  - National regulations and incentives, and
  - Regional and local regulations and incentives.
- ☐ Research the maturity or technical readiness of the target fuel.
- ☐ Identify relevant port and industry stakeholders and create an open means for communication (e.g., commercial port operators, vessel operators, port authorities, port oversight commissions, etc.).
- ☐ Investigate means to assess public opinions and perceptions from surrounding communities.

Optional tasks and considerations:

- ☐ Assess (port-wide) emissions targets, and the effect that introduction of the target fuel may have on those targets.
- ☐ Research the environmental attributes of the target fuel.

- Domain: Safety

Strategies, tasks and measures:

- ☐ Research the requirements necessary to serve as a port to bunker the target fuel.
- ☐ Research and understand present national/international safety regulations for the target fuel.
- ☐ Identify regulatory authorities involved in bunkering/calling at the port and create an open means for communication (e.g., local, regional, and national government authorities; port authorities, safety agencies, environmental agencies, etc.).

Optional tasks and considerations:

- ☐ …….

- Domain: Infrastructure

Strategies, tasks and measures:

- ☐ Research the requirements necessary to serve as a port of call for vessels propelled via the target fuel or to bunker the target fuel.

Optional tasks and considerations:

- ☐ Asses the availability of space in the port to accommodate the increase of vessels sailing on the target fuel or bunkering of the target fuel.

- Domain: Market, supply/demand (If applicable)

Strategies, tasks and measures:

- ☐ Asses the basic commercial potential to become a bunker port for the target fuel
- ☐ Assess the likelihood to become an utilize port in the future as part of service string

Optional tasks and considerations:

- ☐ Research fuel trends within the shipping industry.
- ☐ Investigate anticipated supply and demand of the target fuel.

Level 1 objective is achieved: ☐ **Confirmed**

Sufficient background information is gathered to be able to form the foundation of research and decisions moving forward

- ☐ Information is gathered about the target marine fuel and energy transition within shipping.
- ☐ The target fuel is assessed to identify aspects that might be safety related showstoppers
- ☐ The basic potential to become a bunker port with infrastructure for the target fuel is assessed
- ☐ The basic commercial potential to become a bunker port for the target fuel is assessed

The strategies, tasks and measures of the domains within level 2 are being prepared

Level 2: Stakeholder interest and feasibility assessment

Level 2 Objective: **to assess the eagerness of stakeholders to pursue added capabilities for the target fuel at the port and gather information on the physical and market feasibility of bunker capabilities.**

The strategies, tasks and measures of the domains in level 1 have been evaluated and lessons learned are implemented.

- Domain: Governance:

Strategies, tasks and measures:

- ☐ Assess the opinions and support of relevant port and industry stakeholders for shipping decarbonization and alternative fuel use.
- ☐ Provide stakeholders with the background information gathered in Level 1 and assess their interest to invest in the target fuel.
- ☐ Assess stakeholders' perceived feasibility for entering the market for the target fuel.
- ☐ Implement strategies for assessing public opinion on adding capabilities for the target fuel at the port.

Optional task and considerations:

- ☐ Include green corridor stakeholders in discussions and assessments for the target fuel.

- Domain: Safety

Strategies, tasks and measures:

- ☐ Assess the budget and resources available for establishing a port-specific safety framework for calling or bunkering the target fuel.
- ☐ Acquaint relevant safety and environmental authorities with market trends and make them aware of the growing or future use of the target fuel in shipping.
- ☐ Create a network to involve all authorities and key players in the development of a safety framework.

Optional tasks and considerations:

- ☐ …….

- Domain: Infrastructure

Strategies, tasks and measures:

- ☐ Assess the physical feasibility of facilitating vessels sailing on the target fuel in the port.
- ☐ Identify if the target fuel would require new infrastructure at the port.
- ☐ Assess currently available port infrastructure, including the target fuel as commodity.

- ☐ Assess currently available fuel as commodity at the port
- ☐ Assess the physical feasibility of creating or utilizing a specific port area for bunkering of the target fuel and/or for establishing enough distance between bunkering of the target fuel and vulnerable areas.

- Domain: Market, supply/demand (If applicable)

Strategies, tasks and measures:

- ☐ Assess stakeholders' perceived feasibility for entering the market for the target fuel.
- ☐ Acquaint relevant port stakeholders with the value chain of the target fuel from well to wake.

Optional tasks and considerations:

- ☐ Create a coalition of stakeholders to establish the value chain for bunkering of the target fuel.
- ☐ Ensure stakeholders in the bunker market are equipped to stay informed on the future market conditions of the target fuel and will have the information necessary to balance demand and supply.
- ☐ Identify potential commercial partnerships as they relate to calling or bunkering of a new fuel.
- ☐ Consider initial options for attracting vessels/operators on the target fuel (e.g., reduced port fee, priority berthing, incentive programs etc.).

Level 2 objective is achieved: ☐ **Confirmed**

The interest of stakeholders to pursue bunkering or calling capabilities with the target fuel have been assessed. There is sufficient insight into the feasibility of adding bunkering or calling capabilities of the target fuel at the port.

- ☐ The port has sufficient insight in the bunker value chain stakeholder strategies for target fuel;
- ☐ The port has sufficient insight, budget and resources, to develop a safety framework for the target fuel;
- ☐ The port has sufficient insight in the present infrastructure, and the gaps for future needed infrastructure to know if it can facilitate bunkering of target fuel;
- ☐ The port is acquainted with the opportunities for port's stakeholders to enter the new market;

The strategies, tasks and measures of the domains within level 3 are being prepared

Level 3: Detailed research, analysis, and conclusions

Level 3 Objective: **Gather detailed information on all pertinent aspects of bunkering of the target fuel or calls of vessels fuelled with the target fuel so that an informed decision on moving forward with the target fuel can be made.**

The strategies, tasks and measures of the domains in level 2 have been evaluated and lessons learned are implemented.

- Domain: Governance

Strategies, tasks and measures:

- ☐ Conduct a gap analysis for calls of vessels fuelled by the target fuel or bunkering of the target fuel.

Optional tasks and consideration:

- ☐ Consult research reports and scientific papers to supplement information gathered.
- ☐ Recruit relevant port stakeholders to participate in research programs, consortiums, and partnerships to supplement information and gather knowledge.

- Domain: Safety

Strategies, tasks and measures:

- ☐ Conduct a GAP analysis on the safety issues and risks associated with the target fuel.
- ☐ Determine the aspects that need to be introduced in the safety framework for the target fuel including mitigation measures and incident response preparedness. The necessary aspects should be based on information previously gathered, including relevant safety standards, regulations, and industry best practices.

- Domain: Infrastructure

Strategies, tasks and measures:

- ☐ Research the exact infrastructure demand and the scale required for bunkering or calling the target fuel at the commercial level.
- ☐ Conduct a gap analysis on the nautical issues for calls or bunkering of the target fuel.

Optional tasks and considerations:

- ☐ Identify, if relevant, future required services such as gas freeing, maintenance or supply of auxiliary products for vessels sailing on the target fuel.

- Domain: Market, supply/demand (If applicable)

Strategies, tasks and measures:

- ☐ Research and develop a benchmark on market availability of the target fuel.
- ☐ Research detailed costs including capital expenses (CAPEX) and operating expenses (OPEX) for bunkering operations of the target fuel.

Optional tasks and considerations:

- ☐ Perform a SWOT analysis for the bunker market in the port related to changing bunker patterns.
- ☐ Identify the commercial impact of accommodating the target fuel on the present fuels supply and locally operating businesses.
- ☐ Provide an update to relevant green corridor projects or proposals on the research conclusions and decision to move forward.

Level 3 objective is achieved: ☐ **Confirmed**

Based on sufficient information about all aspects needed, the port decided on whether the port can support port calls of vessels sailing on the target fuel or bunkering of the target fuel, or will halt progress on this target fuel.

- ☐ The port has sufficient information to develop a policy and roadmap for the new fuels;
- ☐ All safety requirements and infrastructure demands can be met by the port to bunker the target fuel;
- ☐ The port has sufficient information on the necessary infrastructure and space for the new fuels used by vessels;
- ☐ Research showed that the market availability of the target fuel meets the ports demands and that costs will not be prohibitive in moving forward.

The strategies, tasks and measures of the domains within level 4 are being prepared

Level 4: Roadmap to proceed, framework and timeline developed

Level 4 Objective: **Announce proceeding with a plan or roadmap to facilitate calls of vessels using the target fuel or bunkering of the target fuel, and develop a detailed framework and timeline to serve as the guiding document for proceeding with the target fuel**

The strategies tasks and measures of the domains in level 3 have been evaluated and lessons learned are implemented.

- Domain: Governance

Strategies, tasks and measures:

- ☐ Draft a publicly available position or policy paper explaining the port's decision to proceed or halt with the target fuel.
- ☐ Record, based on the SWOT analyses, arguments and reasons to support or not to support the use of the target fuel in the Management of Change System, as part of the QMS
- ☐ Create a firm PRL-MF schedule including present standing and future ambitions for the target fuel within the port and communicate it publicly.
- ☐ Begin drafting the foundational framework that will serve as the guiding document for proceeding with calling or bunkering of the target fuel. The framework should include protocol for vessels sailing on the target fuel and/or any of the following bunker scenarios deemed relevant for the target fuel at the port: shore-to-ship, truck-to-ship, ship-to-ship, or transfer of modular energy containment systems.
- ☐ Draft a thorough engagement and communication plan for stakeholders, regulatory authorities, the press, and the public. This may include:
  - A strategy to manage the expectations of stakeholders.
  - A plan to disseminate transparent information, including pros and cons, to the public.
  - A frequently asked questions (FAQs) list to help inform relevant parties.
  - A streamlined and easily accessible feedback submission tool for parties to submit comments and feedback.
  - A robust system of communication amongst key players, including stakeholders in the bunkering value chain, port authorities, regulatory authorities, etc.
  - Relevant communication and publication tools such as a website, flyers, or one-pagers.

Optional tasks and considerations:

- ☐ Include the following in the foundational framework:
  - A detailed strategy for monitoring the environmental impact of the target fuel use, including GHG emissions and air quality in the port. This may include tracking of target fuel sales and comparison of emissions to the equivalent quantity of the fuel being replaced (e.g., HFO, MGO, diesel).
  - A strategy to set up green corridors and other coalitions that include the whole port value chain.

- Domain: Safety

Strategies, tasks and measures:

- ☐ Draft an in-depth safety and regulatory framework produced in concert with all relevant regulatory and safety authorities. This may include:
  - A plan to conduct HAZID and HAZOP studies to inform risk mitigation measures and safety procedures.
  - A review of all safety aspects and requirements researched in PRL-MFs 1 through 3 with associated implementation plans for the necessary elements.
  - Incident response management that includes clear delegation of responsibilities, scenarios and training of incident responders and port health organizations, and proper response equipment.
  - An initial boundary or limitation to guide where safety frameworks, based on QRA and, vapour/gas dispersion studies to set control zones, need to be developed. The boundary should include any areas where target fuel activities could potentially take place and exclude any areas where target fuel activities will absolutely not take place.
  - A plan to conduct credible spill scenarios and vapour/gas dispersion studies to help inform control, safety, and exclusion zones,
  - A plan to conduct a port specific risk assessment and spatial analysis that will guide control zoning for the target fuel.
  - A protocol for licensing or approval of target fuel operators and activities, including an audit of operators involved in bunkering of the target fuel
  - An overview of relevant bunker scenarios including bunker parameters to develop a target fuel bunker map with sites where bunkering of the target fuel is allowed.
  - Oversight and enforcement protocols and delegation of parties responsible for enforcement.
  - Options for a 'port of refuge' for vessels sailing on the target fuel in distress, even if the port decided against accommodating the target fuel.
  - Requirements and conditions for:
    - reporting the kind of fuel a vessel is using for propulsion or auxiliary equipment;
    - reporting of activities and operations;
    - interaction with other port stakeholders not involved in target fuel operations;
    - internal and external responsibilities;
    - terminals and other port users;
    - simultaneous operations (SIMOPS);
    - signalling or marking of vessels bunkering the target fuel;
    - approval or prohibition of activities;
    - the use of (IAPH/CMF) bunkering checklists.
  - A summary of relevant existing regulations including an overview of regulatory GAPS:
    - port bye laws or other relevant local regulations,
    - existing port safety procedures for bunkering,
    - environmental legislation,
    - water quality and water pollution prevention regulations,
    - regional and national legislations,
    - international legislation for vessels (IMO)

Optional tasks and considerations:

- ☐ A plan for digital support of operations, including a digital twin.

- Domain: Infrastructure

Strategies, tasks and measures:

- ☐ Draft a detailed plan for assessing and establishing necessary infrastructure. This may include:
  - A plan to adapt present infrastructure or develop relevant infrastructure to facilitate sailing on or bunkering of the target fuel based on engineering studies and other technical assessments.
    - Near-term accommodations may be achieved by modifying and adapting existing port infrastructure.
    - Long-term accommodations should focus on developing the suite of infrastructure necessary to regularly accommodate and bunker vessels on the target fuel.
  - A (hands-on) timeline for infrastructure that will develop from Truck-to-Ship to Ship-to-Ship
  - A plan to conduct nautical safety studies to ensure that vessels fuelled by the target fuel can enter the port safely, bunker locations offer a low risk of collision or allision, and tidal and current surge of passing vessels is considered.
  - A consideration of the potential infrastructure requirements, including:
    - Quays to host vessels and operations.
    - Bunker infrastructure scenarios.
    - Infrastructure for delivering and collection of auxiliary products.
  - A sustainable collection system for target fuel associated waste.

Optional tasks and considerations:

- ☐ A plan to develop, or to integrate target fuel, processes for Vessel Traffic Services (VTS) and Vessel Traffic Management (VTM) to support calling and bunkering of the target fuel, including IT and digital support of the VTM process.
- ☐ A strategy to provide a proper level of service. E.g., maintenance, cleaning, gas freeing facilities, etc.

- Domain: Market, supply/demand (If applicable)

Strategies, tasks and measures:

- ☐ Draft a management plan to support and guide bunkering of the target fuel at the port. This may include:
  - A plan to facilitate and support the use of the target fuel through policies and incentives such as:
    - Funding and support for demonstration projects or short-term or long-term funding for CAPEX or OPEX expenses.
    - A pricing strategy for vessels sailing on or bunkering the target fuel, and for vessels operating on conventional fuels. E.g., incentives or port dues.
  - A strategy to form a coalition of stakeholders involved in the bunkering supply and value chain.

Optional tasks and considerations:

- ☐ A market licensing scheme with permits for working in assigned areas to regulate the market (if allowed).
- ☐ Include the following in the foundational framework:
  - A strategy to measure the socio-economic impacts of calling or bunkering the target fuel at the port.
  - A strategy to support innovations and start-ups in the area of the target fuel.
- ☐ Draft a commercial management plan to support and guide bunkering of the target fuel at the port. This may include:
  - A plan for marketing, acquisition, and market communication
  - A detailed allocation of resources, work hours, and budget.
  - A plan to explore market niches and funding opportunities

Level 4 objective is achieved: ☐ **Confirmed**

A plan or roadmap to facilitate calling or bunkering of the target fuel is developed. A detailed framework has been created that will guide the remainder of activities involving the target fuel.

- ☐ The port established a governance policy that reflect the decision to proceed or not proceed with the specific fuel in the port
- ☐ The port developed a safety policy and roadmap for the call of vessels sailing on the specific marine fuel and/or bunkering of the specific marine fuel
- ☐ The port established an infrastructure policy and roadmap to develop sufficient infrastructure for the specific new marine fuel
- ☐ The port developed a commercial policy and strategy, and a roadmap for the specific low- and zero-carbon marine fuel

The strategies, tasks and measures of the domains within level 5 are being prepared

Level 5: Framework implementation, testing, and training

Level 5 Objective: **The framework drafted in PRL-MF 4 for calling or bunkering of the target fuel should be tested and implemented. Testing and implementation should inform any necessary revisions to the framework. The framework should be finalized and approved by all required entities**

The strategies, tasks and measures of the domains in level 4 have been evaluated and lessons learned are implemented.

- Domain: Governance:

Strategies, tasks and measures:

- ☐ Implement engagement and communication plan with stakeholders, regulatory authorities, the press, and the public. Share relevant pieces of the framework with each entity and request feedback where necessary.
- ☐ Obtain approval of the framework from all required entities.
- ☐ Create and open a submission system for fuel providers to request licensing / audit of their anticipated target fuel operations.
- ☐ Disperse a public guidance with the new reporting protocol and changing procedures for vessels entering the port.
- ☐ Update the Port Information Guide or website based on the guiding framework established.
- ☐ Continue implementing the communication and engagement plan by updating stakeholders, regulatory authorities, the press, and the public on progress following finalization of the framework.

Optional tasks and considerations:

- ☐ Establish a 'management of change' program to address and manage required changes based on the guiding framework for use of the target fuel at the port.

- Domain: Safety

Strategies, tasks and measures:

- ☐ Conduct a port specific risk assessment and spatial analysis. From the assessment, draft zoning for target fuel activities with an emphasis on maintaining a safe distance between target fuel activities and vulnerable or populated areas as well as a minimum distance required for passing vessels.
- ☐ Conduct credible spill scenarios and gas dispersion studies. From the results, add defined control, safety, and exclusion zones the framework.
- ☐ Establish a 'bunker map' that defines and communicates where bunkering of the target fuel can take place to the framework.

☐ Conduct HAZID and HAZOP studies. From the studies, define proper risk mitigation measures and safety procedures in the safety framework.
☐ Conduct a nautical safety study. From the study, make any changes or additions for vessels entering the port, bunkering locations, or vessel passing distance.

Optional tasks and considerations:

☐ Simulate in a test environment all relevant planning and procedures using computational fluid dynamics (CFD)

- Domain: Infrastructure

Strategies, tasks and measures:

☐ Begin adapting present infrastructure to facilitate pilot-scale demonstrations of calling and bunkering on the target fuel.

Optional tasks and considerations:

☐ Simulate processes with IT supported digital twinning.

- Domain: Market, supply/demand (If applicable)

Strategies, tasks and measures:

☐ Release an open call for applications from fuel providers and vessel operators to deploy the first pilot projects for calling and bunkering of the target fuel.

Level 5 objective is achieved: ☐ **Confirmed**

The framework for bunkering of the target fuel, was tested by simulation, implemented, and revised to create a final version that was approved by the required entities.

☐ The port implemented the roadmap of level 4
☐ The port created proper governance for bunkering the specific marine fuel
☐ The port developed a safety framework, regulatory framework and spatial planning for bunkering of this specific marine fuel, the framework was successfully simulated.
☐ The port developed infrastructure for bunkering of this specific marine fuel
☐ The port developed commercial support to explore and accelerate the new opportunities for the specific marine fuel.

The strategies, tasks and measures of the domains within level 6 are being prepared

Level 6: Pilot-scale demonstration

Level 6 Objective: **to perform a pilot-scale demonstration within a designated area of the port under tightly controlled conditions for a vessel sailing on the target marine fuel and / or bunkering the target marine fuel**

The strategies, tasks and measures of the domains in level 5 have been evaluated and lessons learned are implemented.

- Domain: Governance

Strategies, tasks and measures:

- ☐ Select an appropriate, small-scale pilot project for both calling and bunkering of the target fuel from the submitted applications.
- ☐ Disseminate the news of the selected pilot project(s) and timeline through the established communication channels.
- ☐ Assemble a project team responsible for overseeing the pilot project(s). This should include members to manage safety and infrastructure issues, as well as messaging and communication. Possible team members include:
  - The Harbour Master or representative
  - Competent authorities
  - The fuel supplier
  - Bunker operators
  - Vessel operator
  - Terminal or site owner
  - Vessel services
  - Port authority representative
  - Consultant or other specialists
  - Other agency or stakeholder representatives
- ☐ Once established, the project team should:
  - Review the results of all simulations conducted during Level 5, as well as the final framework.
  - Determine what parts of the framework are applicable to the pilot project(s) and define the necessary requirements.
  - Execute the project plan(s) for the pilot project(s).
  - Perform an in-depth analysis and review of the completed project(s) assessing strengths, weaknesses, successes, and failures. Provide recommended revisions to the framework based on the outcomes of the analysis.
- ☐ The recommendations provided by the project team should be assessed by the greater port community and the guiding framework modified accordingly.
- ☐ Disseminate the guiding framework.
- ☐ Share the news of the successful pilot(s).

Optional tasks and consideration:

- ☐ Implement and test the monitoring system to measure the effect of the target fuel on GHG emissions and air quality at the port.

- [ ] Provide an update to relevant green corridor projects or proposals on the pilot project outcomes and decision to move forward.

- Domain: Safety

Strategies, tasks and measures:

- [ ] Implement training of all required personnel involved in the safety framework, including site personnel, incident responders, and port health organizations, among others.
- [ ] Implement training of all other personnel involved in handling or delivering the target fuel. This may include utilizing industry, schools, or training institutes to develop and implement training courses or other training materials.
- [ ] Implement training of auditors or hire an outside agency to audit fuel providers for compliance with established protocol.
- [ ] Conduct any further simulation, testing, training, or due diligence required by the port authority or regulatory agencies to validate protocols and prepare for deployment of the target fuel.
- [ ] Revise and finalize the framework based on feedback received and results from testing and implementation.
- [ ] Once established, the project team should:
    - Draft a joint plan of bunker operation (JPBO), the plan of approach for the specific operation with guidance for all parties involved, based on the bunker management plan of the involved vessel(s) and local specific information. The JPBO should:
        - meet the safety and regulatory requirements in the guiding framework;
        - reflect best practice of the industry, guidance from branch organizations, and standards;
        - include a compatibility assessment;
        - include control zones;
        - include safety requirements;
        - include SIMOPS safety measures;
        - include port specific risk mitigation;
        - include operational safety checklists.
    - Develop a full project plan to bunker a vessel with the target fuel that includes:
        - Confirmation that bunkering will be performed in accordance with the developed JPBO.
        - Defined spatial planning for pilot operations to ensure sufficient distance between operations and vulnerable areas or the public.
        - Confirmation of the involved vessel, terminal, and bunker operator's state of preparedness.
        - A compatibility check
        - Supervision, if necessary, by relevant authorities during the call or bunkering.
        - Use of the proper mandatory operational bunker checklist (IAPH).
        - Enforcement by safety specialists.
    - Submit a request for approval from the competent authorities.
- [ ] Execute the project plan and perform the pilot with supervision of the safety experts of the project team.
- [ ] Monitor, evaluate and make a report of the pilot, including lessons learned and validation of the safety framework.

Optional tasks and considerations:

- [ ] …….

- Domain: Infrastructure

Strategies, tasks and measures:

- ☐ Once established, the project team should:
  - Develop a full project plan for a vessel sailing on the target fuel to enter the port that includes:
    - The admission policy for vessels sailing on a specific fuel
    - An approach and mooring plan
    - Defined spatial planning for locations where target-fuelled vessels can berth
    - Confirmation of the suitability of the berth
    - Confirmation of the terminal or site operators' preparedness
    - Informing VTM and VTS on the particulars of the vessel
    - Implementation and testing of STS and/or TTS checklists
- ☐ Inform relevant parties about the entry of the pilot vessel into the port and / or of the bunkering of the target fuel.
- ☐ Execute the project plan and perform the pilot with supervision of the experts of the project team.
- ☐ Monitor, evaluate and make a report of the pilot, including lessons learned and validation of the safety framework.

Optional tasks and considerations:

- ☐ …….

- Domain: Market, supply/demand (if applicable)

Strategies, tasks and measures:

- ☐ Release an open call for more projects utilizing the target fuel.

Optional tasks and considerations:

- ☐ …….

Level 6 objective is achieved: ☐ **Confirmed**

It is demonstrated by pilot-scale project(s) that the established framework and infrastructure for calls of vessels sailing on the target marine fuel or bunkering of the target marine fuel in the port are sufficient and effective.

- ☐ The port tested the governance arrangements and processed feedback in the arrangements
- ☐ The port performed a practical test of the developed safety arrangements and infrastructure for bunkering within a designated area of the port under tightly controlled conditions, to examine and improve the safety preparation for more frequent activities of vessels with the target fuel
- ☐ The port performed a practical test of the developed infrastructure, or roadmap for the further development of infrastructure, within a designated area of the port under tightly controlled conditions to examine and improve the infrastructural preparation for more frequent activities of vessels sailing on the target fuel
- ☐ To create market confidence, a pilot is performed to proof the port is ready for operations and is prepared to host larger or more frequent operations with the target fuel

The strategies, tasks and measures of the domains within level 7 are being prepared

Level 7: Project-based approach

Level 7 Objective: **to facilitate project-based calls of vessels sailing on the target fuel or bunkering of the target fuel in the port, controlled by safety protocols and project teams.**

The strategies tasks and measures of the domains in level 6 have been evaluated and lessons learned are implemented.

- Domain: Governance

Strategies tasks and measures:

- ☐ Encourage operators and fuel providers to continue to submit requests to call or bunker the target fuel.
- ☐ Vet proposals and projects as they are received.
- ☐ Assemble project team(s) to lead and or support each project, as in PRL-MF 6.
- ☐ Apply the port call and bunkering framework to multiple project scenarios as listed above and incorporate review and learnings from each project.
- ☐ Continue to support schooling and training institutes to prepare port staff and operators for more regular, larger-scale calling and bunkering of the target fuel.
- ☐ Update the port information guide.
- ☐ Engage in communication to share knowledge and experience with other ports.
- ☐ Provide public communications announcing initiation of more regular calls or bunkering of the target fuel at the port.
- ☐ Project based operations are monitored and evaluated and lessons learned are used for further adjustment of the frameworks for Governance, safety and infrastructure.

Optional tasks and considerations:

- ☐ Monitor the effect of the use of the target fuel in the port on GHG emissions and air quality.
- ☐ Monitor and publish the quantities bunkered of the target fuel.

- Domain: Safety

Strategies, tasks and measures:

- ☐ Project teams should plan and execute each new call or bunkering with the target fuel as was done in PRL-MF 6, including receiving approval from relevant competent authorities and ensuring safety protocols for every project.
- ☐ Competent authority is granting project based licences or exemptions for operations.

Optional tasks and considerations:

- ☐ …….

- Domain: Infrastructure

Strategies, tasks and measures:

- ☐ Implement the admission procedure for vessels sailing on the target fuel.
- ☐ Ensure necessary infrastructure to execute the projects exists or is developed for (if applicable) STS, TTS, or LTS bunkering, depending on project relevancy; and "spin-off" infrastructure, such as gas-freeing services or delivery of auxiliary products.
- ☐ Aid port operations with strong IT support that is adapted to the target fuel

Optional tasks and considerations:

- ☐ Develop procedures, or integrate the target fuel in the procedures, for Vessel Traffic Services (VTS) and Vessel Traffic Management (VTM)

- Domain: Market, supply/demand (if applicable)

Strategies, tasks and measures:

- ☐ Implement a market strategy that identifies new opportunities and supports the uptake of the target fuel and technologies through:
  - Funding and support for demonstration projects,
  - Short-term or long-term funding of CAPEX or OPEX,
  - A pricing incentive for vessels sailing on or bunkering the target fuel vs vessels operating on conventional fuels.
- ☐ Monitor funding and pricing opportunities.

Optional tasks and considerations:

- ☐ Explore niches in the bunker market and market opportunities.
- ☐ Connect stakeholders within the supply chain with potential customers.

Level 7 objective is achieved: ☐ **Confirmed**

Calls of vessels sailing on the target fuel, and bunkering of the target fuel can take place in the port on a project bases and are controlled by safety protocols and project teams.

- ☐ The port's formal policy on how to facilitate vessels using or bunkering the target fuel on a project bases, has been accepted by relevant stakeholders. The port governance is able to support regular calls of vessels sailing on the target fuel and the bunkering of this target fuel
- ☐ Ports safety and regulatory framework is project based fit for facilitating calls of vessels sailing on the target fuel, or bunkering of the target fuel, controlled by safety protocols and project teams.
- ☐ Ports infrastructure is project based fit for facilitating calls of vessels sailing on the target fuel or bunkering of the target fuel, controlled by safety protocols and project teams.
- ☐ A starting bunkering market is developed, the port is exploring business opportunities for the target fuel and is prepared to host larger and more frequent operations with the target fuel.

The strategies, ta and measures of the domains within level 8 are being prepared

Level 8: Full capabilities for port calls or bunkering of the target fuel

Level 8 Objective: to facilitate full capabilities for port calls or bunkering of the target fuel in the port, operations are system based managed by audits, licensing, and continuous monitoring

The strategies, tasks and measures of the domains in level 7 have been evaluated and lessons learned are implemented.

- Domain: Governance

Strategies, tasks and measures:

- ☐ Perform a full audit and assessment to fully license operators who executed port calls or bunkering of the target fuel in PRL-MFs 6 or 7.
- ☐ Initiate the system of auditing and licensing determined in the guiding framework for any additional operators seeking to call or bunker the target fuel.

Optional tasks and measures:

- ☐ Measure and report the effect of the target fuel use on GHG emissions and air quality.
- ☐ Report and publish the quantity of target fuel bunkered.
- ☐ Continue to share experiences and lessons learned with other ports.

- Domain Safety

Strategies, tasks and measures:

- ☐ Scale-up operations according to the guiding framework to perform calls or bunkering of the target fuel as part of normal port operations, ensuring all safety and regulatory requirements are met and port-wide organizational oversight is in place.
- ☐ Arrange on-going training and drills for the port's emergency response organization in concert with other stakeholders such as vessel or bunker operators.
- ☐ Continuously monitor bunker operations and operators to ensure compliance with the safety and regulatory framework.
- ☐ Competent authority is granting system based licences or exemptions for operations.

Optional tasks and considerations:

- ☐ …….

- Domain: Infrastructure

Strategies, tasks and measures:

☐ Ensure dedicated infrastructure is in place for the target fuel, including tanks or land-based infrastructure, bunker vessels, and sufficient services.

Optional tasks and considerations:

☐ …….

-.Domain Market, supply/demand (If applicable)

Strategies, tasks and measures:

☐ …….

Optional tasks and considerations:

☐ Customers may set ambitions and clear timelines for decarbonization.

Level 8 objective is achieved: ☐ **Confirmed**

The port supports full port of call or bunkering capabilities with the target fuel, and capabilities are successfully system based managed through audits, licensing, and monitoring.

- ☐ The port governance is able to support regular calls of vessels sailing on the target fuel and bunkering of the target fuel controlled by safety management
- ☐ Port's safety and regulatory framework is system based fit for facilitating calls of vessels sailing on the target fuel, or bunkering of the target fuel, controlled by safety management and compliance checks
- ☐ Port's infrastructure is system based fit for facilitating calls of vessels sailing on the target fuel and bunkering of the target fuel
- ☐ A growing bunkering market is developed, the port is exploring business opportunities of the target fuel

The strategies, tasks and measures of the domains within level 9 are being prepared

Level 9: Market penetration and growth

Level 9 Objective: **To expand the market and demand for the target marine fuel and to offer a competitive environment for calls of vessels or bunkering of the target fuel.**

The strategies tasks and measures of the domains in level 8 have been evaluated and lessons learned are implemented.

-.Domain: Governance

Strategy, tasks and measures:

- ☐ Licensed bunker operators provide the target fuel to vessels.
- ☐ A plan, do, check, act (PDCA) cycle and evaluation based system is in place for all aspects of the safety framework and bunker chain.
- ☐ Develop a network strategy to remain up to date with innovations and new trends on infrastructure and technical improvements for the target fuel.

Optional tasks and considerations:

- ☐ Develop key performance indicators (KPIs) for port's environmental performance.
- ☐ Develop and implement a system to track all fuel sales at the port to aid in monitoring GHG impacts of the target fuel and new low- or zero-carbon marine fuels that are introduced.

-.Domain: Safety

Strategy, tasks and measures:

- ☐ Incorporate a plan, do, check, act (PDCA) cycle in the port's safety management system to check and improve its safety framework regularly.

Optional tasks and considerations:

- ☐ …….

-.Domain: Infrastructure:

Strategy, tasks and measures:

- ☐ Ensure the port is capable of regular bunkering of the target fuel.

Optional tasks and considerations:

- ☐ …….

-.Domain: Marked, supply/demand (If applicable)

Strategies, tasks and measures:

- ☐ Assess the quality and effectiveness of the market arrangements for the target fuel, including the market strategy and supply chain arrangements, port incentives for supporting the target fuel, the port pricing strategy, and market communication. The market should support:
  - Multiple suppliers supplying the target fuel,
  - Multiple bunker operators providing the target fuel to vessels,
  - A balanced supply and demand, and
- ☐ Fuel contracts or agreements between suppliers and vessel operators
- ☐ Ensure the port is capable to allow stakeholders to make final investment decisions (FID) on new target fuel projects.

Optional tasks and considerations:

- ☐ Develop a strategy to phase out or reduce the market for conventional fuels and replace them with the target fuel or other low- or zero-carbon marine fuels.
- ☐ Provide an update to relevant green corridor projects or proposals on the new status of the port as a port of bunker or call for the target fuel.

Level 9 objective is achieved: ☐ **Confirmed**

The port offers a competitive environment for calls of vessels sailing on the target fuel and bunkering of the target fuel. Target fuel capabilities are incorporated into regular port processes to ensure commercial success of the port

- ☐ The port is future proof for vessels sailing on the target fuel and the bunkering of the target marine fuel
- ☐ Ports quality and safety management is future proof prepared for facilitating calls of vessels sailing on the target fuel, and bunkering of the target fuel
- ☐ Ports infrastructure is future proof prepared for facilitating calls of vessels sailing on the target fuel and bunkering the target marine fuel
- ☐ The port contains a mature bunker market for the target fuel

Port Readiness Level in a Green Corridor

For the first decade(s) of deploying low- and zero-emission fuels, the deployment is likely to take place on dedicated routes, where sufficient benefits (technical, policy, commercial) exists. These routes will be known as green corridors. Green corridors will require a minimum of one bunkering option on the route, and will require all ports on the route to accept port of call for the fuels they are traveling on. Ports with a clear view on their future port readiness level are more likely candidates green corridor projects, and green corridor projects can be strengthened by ports determining their PRL-MF.

Example of using PRL-MF in a green corridor.

Green corridors are specific commercial shipping routes where the initial deployment of low- and zero-emission fuels take place. The corridor project gathers information on the full port value chain to inform an assessment of the feasibility of the green corridor concept. As part of this assessment, it is necessary that the port(s) on the corridor demonstrate their technical maturity. For corridor projects to move beyond the pre-feasibility stage, the ports of relevance need to have reached a minimum of PRL-MF 2 (See Figure 1).

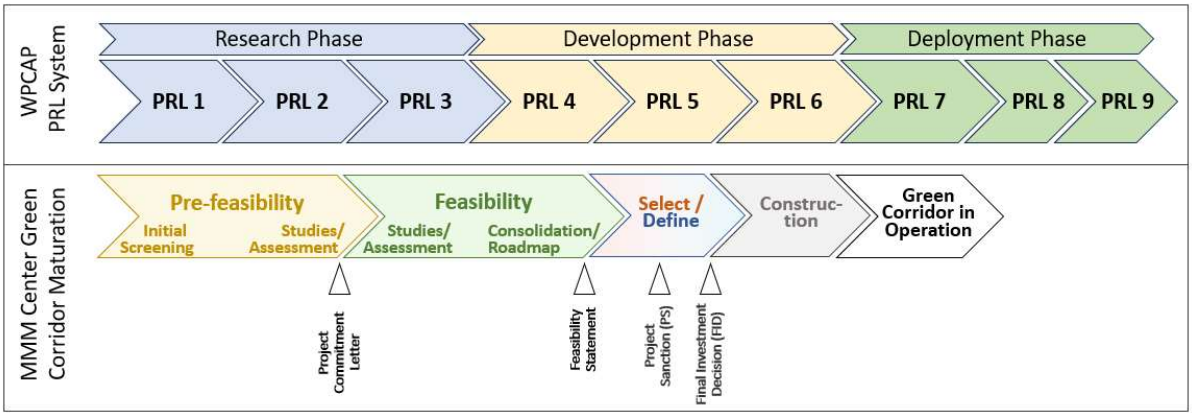
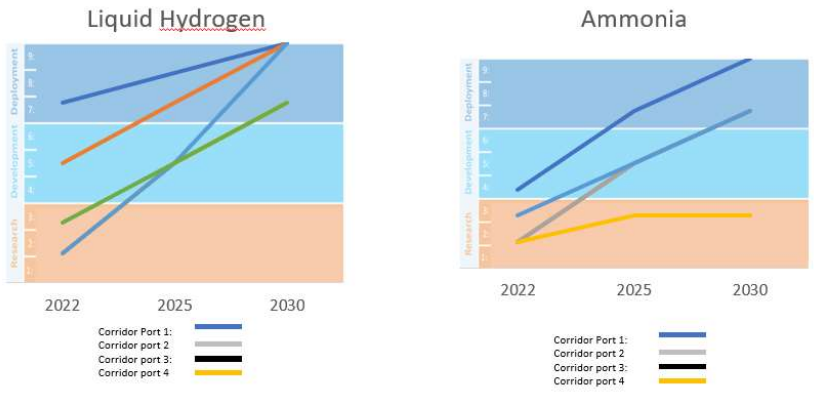


Figure 1. Mapping for PRL-MF to MMM Center green corridor roadmap.

As shown in Figure 1, for a complete feasibility study and feasibility roadmap to be produced for the corridor, the ports need to be at minimum of PRL-MF 4, and so on. Green corridor operation is reached in part when at least one of the participating ports reaches PRL-MF 7 for bunkering of key identified fuel(s).

For initial green corridor screening (pre-feasibility) ports need to indicate or communicate their expected PRL-MF development over time and indicate when they anticipate reaching PRL-MF 2, 4, 6 and 7 for both *bunkering* and *call of a given fuel*. With this information, the green corridor pre-feasibility assessment can pin-point ports which are better suited for being part of green corridors than others, though no irreversible de-selection takes place.



Example of the result of a green corridor study

Additionally, when ports have made a quantified PRL-MF, it encourages the remaining value chain members to conduct studies at similar level of details. In this way, the PRL-MF tool can provide an important driver for establishing green corridors in a very timely manner.

5. References

a. IMO mandated greenhouse gas (GHG) emission targets
b. World Ports Climate Action Program – World Port Sustainability Program (sustainableworldports.org)
c. About our CMF Working Group – World Port Sustainability Program (sustainableworldports.org)
d. https://www.nasa.gov/general/technology-readiness-level/
e. OGSM Frameworks - Making Your Strategy a Reality (mindtools.com)