International Hydrogen Ramp-up Programme - H2Uppp

Diagnosis of Decarbonization, Infrastructure and Hydrogen Applications in Brazilian Ports

Guidelines

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

ANTAQ Agência Nacional de Transportes Aquaviários

MINISTÉRIO DE PORTOS E AEROPORTOS

GOVERNO FEDERAL BRASIL UNIÃO E RECONSTRUÇÃO

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"The International Hydrogen Incentive Program (H2Uppp) of the German Federal Ministry for Economic Affairs and Climate Action (BMWK) promotes projects and market development for green hydrogen in selected emerging and developing countries as part of the National Hydrogen Strategy."

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LIST OF ACRONYMS

ANTAQ – Brazilian Agency for Waterway Transportation
CDP – Carbon Disclosure Project
EPA – Environmental Protection Agency (United States Environmental Protection Agency)
ESI – Environmental Ship Index
EPI – Environmental Performance Index
ETC – Cargo Transshipment Station
GHG – Greenhouse Gases
GRI – Global Report Initiative
IAPH - International Association of Ports and Harbors
IMO – International Maritime Organization
IPCC – Intergovernmental Panel on Climate Change
LNG – Liquefied Natural Gas
MCTI – Ministry of Science, Technology and Innovations
MPOR – Ministry of Ports and Airports
OPS – On-shore Power Supply
SBTi – Science Based Targets Initiative
TA – Leased Terminal
TUP – Private Use Terminal
UNFCC – United Nations Framework Convention on Climate Change
WPSP - World Port Sustainability Program

1 INTRODUCTION

The H2Uppp International Hydrogen Program, funded by the German Ministry of Economy and Climate Action (BMWK) and implemented by the Brazil-Germany Cooperation for Sustainable Development through *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) *GmbH*, aims to identify, prepare and monitor the implementation of projects for the production and use of applications of green hydrogen and derivatives, as well as raising awareness and transferring knowledge for project development. Considering the importance of the port sector as a strategic actor in the implementation of the green hydrogen value chain, the H2Uppp program promoted the Diagnosis of Decarbonization, Infrastructure and Hydrogen applications in Ports project.

The project is carried out within the scope of a Technical Cooperation Agreement (ACT) between GIZ and the Brazilian Agency for Waterway Transportation (ANTAQ), which already has consolidated action in promoting the sustainability of Brazilian ports and terminals, through initiatives such as the Environmental Performance Index (EPI) and port, local and institutional environmental agendas. The present study was structured around three analytical axes: Axis 1 - Review of International Experience; Axis 2 - Diagnosis of Decarbonization, Infrastructure and applications of Hydrogen in Ports; and Axis 3 - Case Study. Axis 1 was prepared by ANTAQ and consisted of mapping the main regulatory measures adopted by the International Maritime Organization (IMO) and other countries to reduce Greenhouse Gas (GHG) emissions in maritime transport, in addition to a contextualization of measures to the decarbonization of transport carried out by vessels and the operation of ports.

WayCarbon was hired by the Brazil-Germany Cooperation - GIZ to prepare Axis 2 of the project, related to the Diagnosis of Decarbonization, Infrastructure and applications of Hydrogen in Ports. Its objectives are to evaluate the preparation of port infrastructures to receive vessels that use zero carbon fuels, map emission reduction initiatives in ports, identify the potential of green hydrogen for export and decarbonization of ports and, based on this diagnosis, publish guidelines on the subject. The diagnosis was carried out in cooperation with the Brazilian Agency for Waterway Transportation – ANTAQ and the Ministry of Ports and Airports (MPOR).

1.1 Objectives

In recent years, the urgency of reducing Greenhouse Gas (GHG) emissions has become more evident in the face of so many extreme weather events and significant changes in the planet's temperature. Among the various possible paths to reducing emissions, the energy transition is the basis, as it cuts across several sectors. Specifically for the port sector, the energy transition presents itself as both a challenge and an opportunity: a challenge given the countless actions that need to be put into practice in the short term, an opportunity given the competitive position that ports assume in this context of change. The location of ports subjects them to being highly exposed to extreme environmental events, such as winds, storms and rising sea levels, all resulting from the increase in the global average temperature. In addition to initiatives to adapt their infrastructure to climate change, ports position themselves as key elements in mitigation processes and achieving global emissions neutrality targets, a context in which the energy transition is inserted.

The present work has substantial relevance in placing Brazilian ports as protagonists in the transition process to a low-carbon economy, anticipating more restrictive regulations and pressures and becoming more resilient in the face of this new market. The objectives of this work are:

- Carry out diagnosis regarding the current situation of port infrastructures (*readiness*) to receive vessels that use low-emission fuels.
- Carry out diagnosis regarding decarbonization initiatives in ports and port services provided
- Identify the potential of low-carbon hydrogen and its derivatives for decarbonization of Brazilian ports.

- Disclose the diagnosis obtained.
- Create and publish a guide on good practices and recommendations for the decarbonization of ports.

This document presents the Axis 2 Guidelines document, which details recommendations for port facilities to reach greater maturity in relation to the decarbonization process and next steps for sectoral action. Additionally, Axis 2 covers the Diagnostic Final Report in its complete version and the Executive Summary.

The Guidelines document has a strategic bias, with the aim of supporting public and private agents to understand the impacts, challenges and opportunities of the energy transition for the port sector, including recommendations for actions at corporate level and actions to enhance the decarbonization of the port sector in a broad way, where companies could act together to strengthen the transformation needs and positioning of the sector.

2 METHODOLOGY

The project to develop the Decarbonization Diagnosis, Infrastructure and Hydrogen applications in Ports was divided into 3 stages, with the delivery of 6 products, as shown in Figure 1detailed below:

- **Stage 1 – Work Plan:** describes the associated products and activities corresponding to Product 1. Work Plan.
- **Stage 2 – Diagnosis:** presents the second part of the project, which includes the steps involved in carrying out the diagnosis of ports, mapping stakeholders, preparing the survey and holding a workshop, corresponding to P2 products. Diagnostic Planning, P3. List of Stakeholders, P4. Survey Application and P5. Partial Report.
- **Stage 3 – Results and Recommendations:** aimed at systematizing project results and preparing recommendations, corresponding to Product 6. Final Report, Executive Summary and Guidelines.

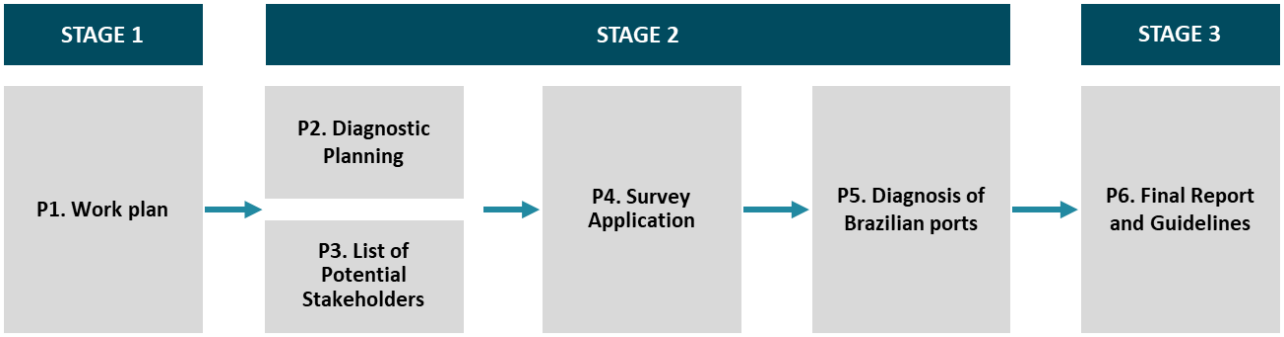

Figure 1. Stages of development of the Decarbonization Diagnostic Study, Infrastructure and applications of Hydrogen in Ports.
Source: Prepared by WayCarbon, GIZ, ANTAQ, MPOR (2023).

The Final Report presents the entire history of the project, including the selection of participants, the contextualization of the objective, the sector and the challenges, the process and methodologies for developing questionnaires and selecting groups, the application of the questionnaire, the assessment of adherence and completeness of responses, results and their critical evaluation.

This Guidelines document, prepared based on the results of the diagnosis presented in the Final Report, aims to present some of the steps necessary to advance decarbonization in the Brazilian port sector along **two axes**:

- **Recommendations for port** or corporate facilities, structured based on the steps necessary to achieve greater maturity in relation to the decarbonization process.
- **Next steps for sectoral action**, which outline possible paths for joint action by all actors to enhance the decarbonization of the port sector in a broad way.

3 RECOMMENDATIONS FOR PORT FACILITIES

The recommendations for port facilities cover the possibilities for action by Public Ports and Terminals (TUPs, TAs, and ETCs) to advance the emissions reduction strategy. Figure 2 presents a path of steps to be followed to mature and develop the decarbonization strategy in port facilities. Below, each of these recommendations is contextualized and detailed.

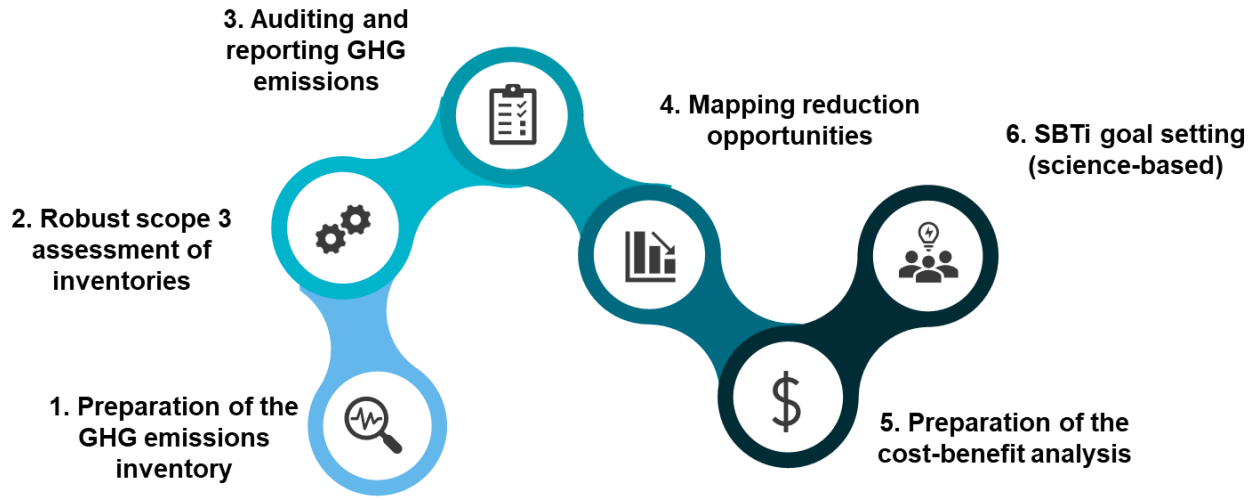

Figure 2. Path of actions to achieve greater maturity in the management of GHG emissions.
Source: Prepared by WayCarbon, GIZ, ANTAQ, MPOR (2023).

1. Prepare the GHG Emissions Inventory of port facilities.

As pointed out by the diagnosis, 35% of Terminals (TUPs, TAs and ETCs) and 81% of Public Ports still do not have an inventory of GHG emissions. Identifying, characterizing and quantifying emission sources is the first step on the decarbonization journey. The emissions profile of each port facility can vary significantly, depending on the type of operation and services provided, the vessels used, the fuels used and the technologies used in the port area, which makes it important to carry out a localized diagnosis and robust data collection. From the inventory, it is possible to identify trends and opportunities to reduce emissions, supporting the establishment of goals and prioritization of investments. Periodically updating the inventory leads to the construction of a historical series, which allows measuring the progress achieved with initiatives to reduce GHG emissions.

2. Robust Scope 3 Assessment of Existing GHG Emissions Inventories

In accordance with the GHG Protocol guidelines, GHG Emission Inventories are prepared considering three scopes: Scope 1 – Direct Emissions; Scope 2 – Indirect Electricity Emissions; Scope 3 – Other Indirect Emissions. According to the mapping carried out during the diagnosis, 54% of facilities that have an inventory report only scopes 1 and 2. The first inventories carried out by organizations generally present a more restricted number of emission sources. But it is important that, over time, they strive to mature and expand the scope of the inventory, as scope 3 is a requirement for establishing SBTi (Science Based Targets Initiative*)* goals.

3. Audit and publication of reports for greater reliability and transparency of GHG emissions inventories

An important factor that differentiates GHG emissions inventories is the level of transparency and reliability of the data. The GHG Protocol recommends that inventories be audited by a third party and made publicly available, which is the reality of

58% of facilities that stated they have an inventory. A significant portion (29%) has an inventory, but has not published it, while the remainder is still developing the inventory or has even published it, but has not yet hired an audit. Inventories are an instrument not only for management, but also for communication, as they allow the market and society as a whole to present the progress of decarbonization actions. In this same context, the publication of sustainability reports is included, such as the Institutional Environmental Agenda, the Sustainability Report, the GHG Protocol – Greenhouse Gas Protocol and the CDP – Carbon Disclosure Project. Following internationally recognized standards, such as the GRI – Global Report Initiative, is a differentiator for the positioning of ports and port facilities and can help to qualify them for investment opportunities and obtaining financing.

4. Mapping opportunities to reduce GHG emissions

Due to the complexity of port infrastructures and operations, developing a decarbonization strategy for this sector requires a combination of different types of actions to significantly reduce emissions, which must be evaluated according to the reality of each port facility. Opportunity mapping allows you to evaluate initiatives, projects and challenges to reduce emissions. Based on the diagnostic study carried out, the main opportunities for reducing emissions were grouped into three fronts:

- **Energy and operational efficiency:** mooring time, speed and waiting time for loading and unloading, among other operational indicators, vary within facilities and have implications for the GHG emissions of ships in the port. Intelligent port logistics systems work to optimize routes and processes and have already been implemented or are being implemented in 39% of facilities, a similar rate to energy efficiency measures. Another possibility is the generation of renewable energy for administrative and/or operational activities, implemented/being implemented by around 18% of respondents. Finally, electrification and the use of biofuels in operational equipment is a technology that is already available, but is already applied in only 5% of facilities.

- **Supply of less polluting energy and fuels:** one of the measures with the greatest potential for reducing emissions is the implementation of OPS (On -Shore Power Supply) systems, which provide the supply of energy on land and allow the vessels' auxiliary engines to be turned off while they are docked. None of the facilities that participated in the diagnosis have this system, due to the cost of the technology and the lack of regulation that standardizes and requires its implementation. As for the fuel used by vessels, 39% of facilities have the structure to supply it, with marine diesel and low sulfur bunker being the most common. In the case of alternative fuels, 6% indicated they had the structure to supply LPG, 4% for biodiesel and 2% for methanol. The International Maritime Organization (IMO) regulations for the decarbonization of maritime transport tend to progressively increase the demand for alternative fuels. Another way to enhance this process is the financial incentive for less polluting vessels, with a discount on port fees for those that have a good score in indexes such as the ESI[1] (Environmental Ship Index).

- **Operation in the value chain of low-carbon hydrogen and its derivatives:** to achieve the IMO's GHG emissions reduction targets for 2050, profound changes will be necessary in the technology and fuels used by vessels. One of the most promising long-term solutions is the use of low-carbon hydrogen and its derivatives, such as ammonia and methanol, to replace fossil fuels. This will require adaptations to production, storage and distribution infrastructure, and port facilities have the potential to lead this movement. However, technological challenges are still significant, both in relation to the safety and efficiency of transport and storage and the cost of production. The majority (60%) of the diagnostic respondents do not see the potential or are unaware of the applications of low-carbon hydrogen. On the other hand, 40% of respondents already understand the potential of this market, with around 7.5% seeing a vocation for hydrogen production, 5.4% for export, and 7.5% for vessels refuelling. Almost 11% of facilities see the

[1] The Environmental Ship Index (ESI) is an environmental performance index that classifies ships according to GHG emissions standards defined by IMO, allowing to identify those that meet or exceed current regulations. The initiative is led by the World Ports Sustainability Program (WPSP), an international sustainability program linked to the International Association of Ports and Harbors (IAPH) (WPSP, 2024).

creation of a low-carbon hydrogen and derivatives Hub as their vocation, which is already being planned or implemented in some Brazilian ports, with emphasis on the Pecém Complex.

Box 1: Green Hydrogen

Initiatives related to low-carbon hydrogen and its derivatives have been carried out in several port facilities. The complexity of the chain points to the construction of Hubs as a way to enable production, storage and transportation, through partnerships between governments, universities and companies. From hubs in ports, hydrogen production can be associated with the generation of electrical energy from renewable sources, especially photovoltaic solar and offshore wind, and with the proximity of industries that are part of this value chain. The establishment of partnerships with other countries has also been carried out by national port facilities, through the creation of green hydrogen corridors between countries and funding contributions for the development of the necessary structures.

It is important to highlight that green hydrogen and its derivatives are potential alternatives to fossil fuels used in maritime transport. To this end, the construction of hydrogen hubs in ports helps in the availability of fuel and its derivatives for vessels.

5. Preparation of cost-benefit analysis of emission reduction measures

Emissions reduction projects have associated costs that need to be measured to assess their effectiveness and cost-benefit. An example of tool used for this purpose is the Marginal Abatement Cost Curve (MAC Curve), which makes it possible to estimate the cost associated with reducing a certain amount of greenhouse gases for each of the projects analyzed. The cost is calculated by the Net Present Value, which considers, within the time horizon of project implementation and activity, the sum of year-to-year cash flows, subject to a discount rate, determined by the opportunity cost of money. Cash flow considers capital (CAPEX) and operational (OPEX) revenues and expenses. The calculation of reduced emissions from a project corresponds to the difference between the level of emissions in a baseline scenario (without project implementation) and the projection of emissions in the project scenario. The result of the MAC Curve is a graph that combines the axes of "cumulative emissions abatement [tCO_2e]" and "marginal cost of abatement [$\$/tCO_2e$]", allowing a ranking of decarbonization initiatives in terms of cost-effectiveness and the identification of whether the evaluated projects will be sufficient to achieve an already established goal.

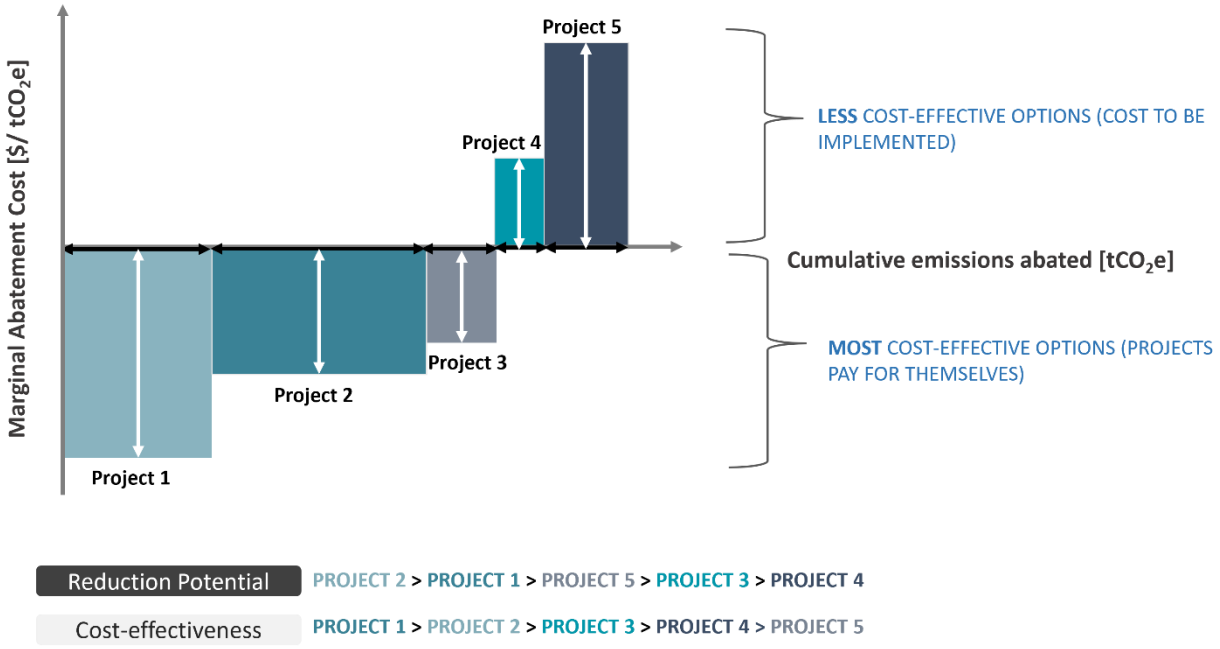

Figure 3. Example of Marginal Abatement Cost Curve (MAC Curve).
Source: Prepared by WayCarbon, GIZ, ANTAQ, MPOR (2023).

6. Establishment of SBTi target (based on science)

The Paris Agreement, approved in 2015 by 195 countries party to the United Nations Framework Convention on Climate Change (UNFCCC), stipulated the limit of global temperature rise to below 2°C above pre-industrial levels and striving to that does not exceed 1.5 °C, which implies achieving net zero emissions by 2050. This has led many public and private organizations to sign commitments and establish Net Zero targets. The SBTi Standard is based on the need to establish a common understanding of what net-zero emissions targets are, based on the most recent and updated climate science, providing guidance, foundations, criteria and recommendations for their definition. Science-Based Emissions Reduction Targets (SBTi) provide a solid foundation for organizations' long-term climate change strategies, including short-term targets aligned to 1.5°C trajectories, long-term targets to reduce emissions to a residual level, mitigation beyond its value chain and neutralization of any residual emissions.

4 NEXT STEPS FOR DEVELOPING A SECTORAL DECARBONIZATION STRATEGY

The next steps for sectoral action outline possible paths for joint action by all actors to enhance the decarbonization of the sector in a broad way. Table 1 presents a compilation, organized into some action categories: Training and Mobilization, Sector Study and Regulation. Then, each of them will be contextualized and detailed.

Table 1. Next steps for sectorial action.

No.	Category	Next steps
1	Training and Mobilization	Awareness program for preparing inventories and decarbonization strategies
2	Training and Mobilization	Structuring a national discussion forum that articulates the various networks that deal with decarbonization
3	Sectoral Study	Preparation of Sectoral Inventory of GHG Emissions
4	Sectoral Study	Development of a sectoral emissions trajectory with survey of projects and construction of the cost-benefit analysis
5	Sectoral Study	Incorporation of more questions about decarbonization in the EPI form
6	Regulation	Definition of inducing mechanisms for implementation of OPS System
7	Regulation	Regulation that promotes the use of alternative fuels on vessels, in conjunction with the Ministry of Mines and Energy

Source: Prepared by WayCarbon, GIZ, ANTAQ, MPOR (2023).

1. Awareness program for preparing inventories and decarbonization strategies

The preparation of a GHG emissions inventory is supported by the existence of international standards and databases, such as the GHG Protocol, the IPCC inventory guidelines and the ISO 14064-1:2016 Standard. However, the port sector has specificities for identifying and characterizing emission sources, defining and collecting input data, calculation methods and emission factors. At the same time, there is a very large variation in terms of the level of knowledge of port facilities about emissions management and the principles for building a decarbonization strategy. An international example is the Ports Initiative, an initiative of the United States Environmental Protection Agency (EPA) which, among other actions, published the *Ports Emissions report in 2022 Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions*. This is a detailed guide for estimating emissions from mobile sources in port areas, but it also contains assumptions that can be used to calculate other emission sources. It is important that this type of knowledge is adapted to the national reality and disseminated, contributing to the start of the decarbonization journey by port facilities and to mobilization around the issue.

2. Structuring a national discussion forum that articulates the various networks that deal with decarbonization

Faced with an uncertain scenario regarding the decarbonization of maritime transport and the need to overcome profound technological, financial and regulatory barriers to enable the transition of port facilities towards a low-carbon economy, the need to establish partnerships and spaces for cooperation, exchange of knowledge and experiences is clear. This perception is reinforced by the significant presence and visible interest seen in the interactive activities carried out within the scope of the "Port Decarbonization Study: Diagnosis": the Leveling and Engagement Workshop, which brought together 43 actors in person in Brasília, in addition to 45 participants in virtual mode, and the advisory meetings, in which 43 representatives from public ports, terminals and associations in the port sector were present. There are already some networks and coalitions that

discuss the topic, such as the Sustainability Committee of ATP - Association of Private Port Terminals - Sustentar and the Oceanic Business Working Group, launched this year by the UN Global Compact in Brazil. It is necessary, however, to create a space for articulation of existing networks, which mobilizes in a broad and comprehensive way all actors involved in the decarbonization of the port sector. The scope of this national discussion forum could cover the country's entire logistics sector, as reducing emissions in port facilities depends on their integration with road, rail and air transport modes, as well as the industrial sector.

3. Preparation of Sector Inventory of GHG Emissions

The preparation of an inventory of GHG emissions for the port sector will allow mapping the main sources of emissions from the operations of Brazilian public terminals and ports and identifying opportunities for reduction, which can support public policies and the construction of sectoral strategies. As an example, the IMO prepares the inventory of the maritime sector with a global scope, having published in 2020, the fourth edition of the report (*Fourth IMO GHG Study 2020)*. For the Brazilian port sector, the sectoral inventory can assist in the development of a decarbonization strategy and the establishment of reduction targets. Additionally, for facilities that have not yet prepared their inventory, the sectoral diagnosis can serve as a reference for understanding the most relevant emission sources.

4. Development of a sectoral emissions trajectory with survey of emission reduction initiatives and construction of the cost-benefit analysis

The development of a sectoral emissions trajectory with survey of projects and construction of the cost-benefit analysis complements and deepens the diagnosis of the sectoral inventory, as it includes the elaboration of future emissions scenarios and the mapping of estimates of reducing emissions and costs associated with different decarbonization actions. One of the methodologies used for cost-benefit analysis is the Marginal Abatement Cost Curve (MAC Curve), commonly applied in sectoral studies. An international example is the *National report Port Strategy Assessment: Reducing Air Pollution and Greenhouse Gases at US Ports*, published in 2016 by the EPA, which evaluates strategies for reducing emissions from mobile sources in port operations, through the construction of future scenarios. Another related example at the national level is the project Options for Mitigation of GHG Emissions in Key Sectors, developed by the Ministry of Science, Technology and Innovations (MCTI), in which an integrated analysis of initiatives to reduce GHG emissions in key sectors of the Brazilian economy (see Figure 4) was performed. The project included analysis of the industrial, buildings and transport sectors with the development of future GHG emissions scenarios and calculation of the marginal abatement cost for each of the mitigation options studied. Carrying out a study like this for the port sector is very important to broaden the actors' vision of the possibilities and scenarios for decarbonization, at the same time as it can inspire and support the development of action plans by port facilities. It is essential that this study is aligned with the development and guidelines of the National Climate Change Plan (*Plano Clima*), currently under discussion by the federal government.

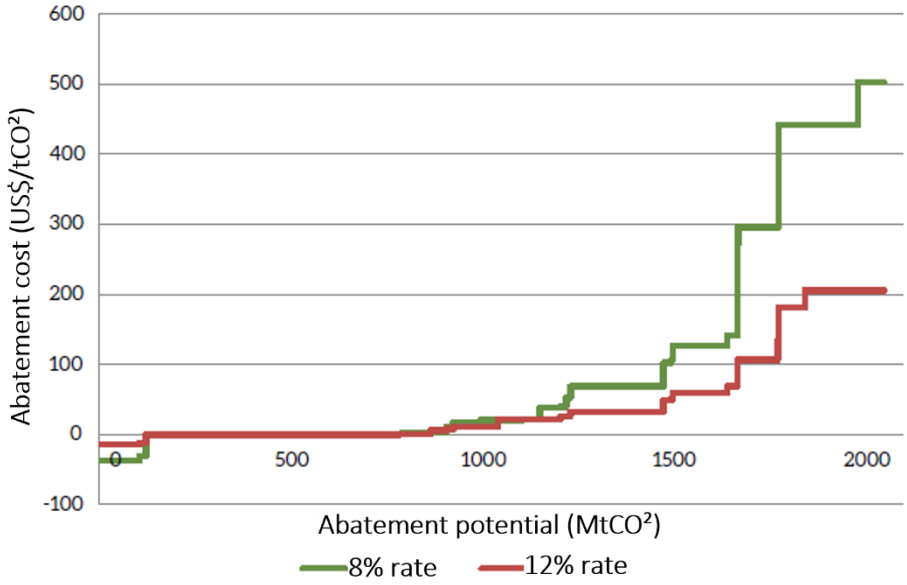

Figure 4. Marginal Abatement Cost Curve (MAC Curve) for the transportation sector
Source: MCTI (2018).

5. Incorporation of more questions about decarbonization in the EPI form

The Environmental Performance Index (EPI) is an initiative of the Brazilian Agency for Waterway Transportation (ANTAQ), which since 2012 has been mapping 38 indicators of the operation and management of Public Ports and Private Use Terminals (TUPs) in Brazil, related to topics such as environmental governance, security, energy management, environmental agenda, among others. Each indicator is assigned a weight, allowing the calculation of a general index and the creation of an annual ranking of port facilities. This initiative plays a very important role in monitoring, publishing information and mobilizing actors. In the advisory meetings held for the diagnosis, the index was cited by some participants as an incentive for advancement in the management of GHG emissions. The EPI already monitors important points in the area of decarbonization, such as the generation of clean and renewable energy and the supply of energy to ships, but it would be interesting to include more specific questions on the subject, in order to continue monitoring some aspects evaluated in this diagnosis. In a possible future review of the EPI methodology, it is suggested to include more questions about GHG emissions management, decarbonization actions not yet mapped, e.g. electrification of operational equipment, and the supply of less polluting fuels.

6. Definition of inducing mechanisms for implementation of OPS System

The OPS System (On -Shore Power Supply) is a technology for supplying onshore power to moored ships, replacing the use of auxiliary engines powered by fossil fuels, responsible for a significant portion of GHG emissions in the area of port facilities. In the diagnosis carried out, the measure was not implemented by any of the participating public terminals and ports. The main reasons cited are the high cost of implementing the system and the energy that would be supplied, which discourages its adoption, and the lack of standardization of the equipment used to implement this technology, which makes it difficult to standardize the system's operation in different port facilities and vessels. Another issue that needs to be studied is the suitability of the current electrical infrastructure and the need of any adaptations to enable the OPS to be implemented. It is important to note that this system is not technically of financially feasible for all facilities. In any case, there was a recurrent perception among diagnosis stakeholders that, as long as there is no national initiative on the subject to organize and induce its use, it is unlikely that there will be sufficient mobilization to carry out the necessary adaptations on ships so that they start using shore

energy while docked. Given the OPS System's high potential for reducing emissions, it is important that inducing mechanisms for OPS system implementation are discussed and implemented.

7. Regulation that promotes the use of alternative fuels on vessels, in conjunction with the Ministry of Mines and Energy

It is increasingly evident that it is necessary to accelerate the energy transition of maritime transport, but there is a widespread perception of uncertainty regarding the best alternatives to conduct this process. As mapped in the diagnosis, 98% of the fleet is still supplied with fossil fuels and only 21% of the ships being produced adopt alternative fuels, such as LNG and methanol. Over the last few years, the IMO has been adopting measures to encourage the reduction of emissions, which include an invitation to Member States to provide incentives to the port sector to support and promote the decarbonization of maritime transport, with emphasis on the safe and efficient supply of low carbon or non-emitting fuels. In addition to the uncertainties about the direction of the market, the investments necessary to make its production and supply viable are very high and can lead to increased costs and reduced profit margins in the short term. Therefore, regulation is needed to promote the use of alternative fuels on vessels, defining guidelines, goals and instruments to enable this transition, including financing mechanisms that help balance investor risk. One opportunity is the National Hydrogen Plan, which could include policies aimed at the maritime and port sector for hydrogen production in conjunction with renewable energy generation, such as offshore wind, biomass and solar photovoltaics.

5 FINAL CONSIDERATIONS

The decarbonization of the port sector requires an integrated approach, involving a combination of different types of actions to achieve a significant reduction in emissions, which must be evaluated and selected according to the local reality of each port facility. The recommendations and next steps proposed in this document aim to offer guidance for the action of port facilities and sectoral actors in a broad way, based on the gaps and challenges identified in the diagnosis. Considering that this is a topic that involves technological innovations and the prospect of major changes in the coming years, it is important to maintain periodic monitoring of the evolution of the port system, in order to reflect new technological advances and changes in the regulatory and marketing scenario. There is a clear need to carry out complementary research, through case studies, for example, and encourage the articulation of this network, so that new knowledge and opportunities can be disseminated effectively among the actors.

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