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Brazilian coastal shipping: New prospects for growth with decarbonization

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Executive summary

Brazil's geography and colonization process helped to make coastal navigation, commonly referred to as cabotage, the main mode of long-distance cargo transportation for most of its history. However, in the second half of the 20th century, coastal navigation activity declined in importance in the country. Given its economic benefits and the fact that Brazil is a continental-size country with around 80% of its population living near the coastline, one might expect coastal navigation to be utilized to a greater degree today. Despite a modest increase in recent years, cabotage represents only 11% of cargo transported in the country, measured in tonne-kilometers.

Some characteristics of cabotage in Brazil reduce its competitiveness and hamper its utilization for cargo transport over long distances. Such bottlenecks include strict regulation of chartered vessels[1] and imports, high transportation costs pushed largely by fuel and labor expenses, excess bureaucracy, and lack of investment in infrastructure and the shipbuilding industry, among others. On the other hand, it is considered the most competitive, safest, and least-polluting mode of long-distance cargo transport in the country.

In this context, the federal government created a project in 2020 called BR do Mar that focuses on incentivizing cabotage transport; it was recently approved into federal law. The project aims to (i) promote greater balance in the transport matrix, which is heavily focused on road transport; (ii) reduce cabotage transportation costs and bureaucracy; (iii) increase chartering possibilities and vessel supply and (iv) encourage market competition. BR do Mar is expected to lead to a 40% increase in the cabotage fleet in three years and a 65% increase in the amount of cargo transported by containers.

In this context, this study identified opportunities in the new regulatory framework for contributing to the international maritime sector's decarbonization goals. Even though the expansion of the cabotage sector would provide benefits in terms of balancing

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1 Chartering means that a company holds another company's vessel by contract for a certain period or under certain conditions.

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cargo transport and reducing costs, some trade-offs exist. While the displacement of cargo transport from road to cabotage would reduce GHG emissions at the national level, an increase in cabotage-sector GHG emissions and air pollution in coastal areas should be expected. Estimates performed in this study indicate that the expected increase in cabotage activities would raise its CO_2e emissions by 28% from 2020 to 2031. Even though emissions from cabotage do not stand out at the national or transport-sector levels, the projected increase in CO_2 emissions would put national maritime transport out of step with the international decarbonization targets set by the maritime sector for 2050.

Given that national and international maritime transport share the same infrastructure and operational profile (in terms of ships, fuels, bunkering procedures, maintenance, and other dimensions), the alignment of objectives across the two scales of shipping would favor the transition to cleaner maritime transport. Consequently, the provision of bunkering infrastructure for low- and zero-emission fuels and onshore power for ships at ports is crucial and will require capital-intensive investments. In this sense, the expected cabotage expansion in the new regulatory environment represents a great opportunity to attract investments for efficient and clean infrastructure development in the country. However, to make this happen, government support is essential for creating favorable institutional and market conditions.

Background

Coastal navigation activities in Brazil date to the period of colonization in the 16th century, when maritime shipping was the only way to transport goods over long distances. At that time, commercial activities, which played a very important role in the country's economic growth, were heavily dependent on maritime coastal navigation. On the other hand, before the 18th century the shipbuilding industry in the country did not develop its infrastructure and had limited port capacity. Only after 1808 were investments in ports made, driven mostly by the arrival of the Portuguese Royal Family in Brazil (which was a Portuguese colony at that time) and the promulgation of a Decree that opened Brazilian ports to "friendly nations" (Teixeira et al., 2018).

After that, the peak of the Brazilian shipbuilding industry occurred between the 1950s and the 1970s, stimulated by government policies and financial opportunities. At the end of the 1970s, Brazil was considered second in the world in shipbuilding (behind only Japan), activity that generated more than thirty-nine thousand direct jobs. Since then, coastal shipping has registered modest growth in Brazil. Currently, it represents less than 11% of the total cargo transport in the country (in tonne-kilometers) and is far behind road transport, which accounts for 65% (Teixeira et al., 2018). Also, cabotage represents around 23% of the cargo handled in Brazilian ports, while long-haul shipping accounts for 70% (ANTAQ, 2021a).

Despite its modest increase in recent years, cabotage is considered the most competitive, safest, and least-polluting mode of cargo transport in the country (EPL & ONTL, 2021). Moreover, cabotage is an attractive choice for cargo transport because several important cities, industrial centers, and around 80% of the population are located near or along the vast 7.400 km coastline. The imbalance in the country's transport mix, which heavily favors road transport, undermines the efficiency of transportation and increases costs, risks, and emissions (Alvarenga, 2019). For example: (i) road transport freight rates are on average 20% higher than those of cabotage; (ii) the risk of theft in road transport has driven up insurance costs and contingencies; (iii) about one-third of on-road accidents are associated with cargo transport; (iv) poor road conditions imply high maintenance costs for trucks (almost 15 times higher than for cabotage vessels, in

BRL/tonne-kilometer); and (iv) road transport emits on average 85% more CO_2[2] than cabotage (in CO2/tonne-kilometer) (Alvarenga, 2019; EPL, 2021).

With this background, greater use of cabotage transport might be expected in the country. In practice, the coastal navigation transport in Brazil has a series of peculiarities that reduce the competitiveness of cabotage operators and increase costs, limiting investment (Alvarenga, 2019). For example, cabotage activities are restricted to national companies, a practice also common in the United States, Japan, Australia, and Germany. In addition, legislation in place before January 2022 established (with some exemptions) that only vessels built in the country could operate in cabotage transport and restricted the chartering of foreign vessels, which made investment in fleet formation necessary. At present, cabotage relies on the Merchant Marine Fund (FMM) as a capital source for ships' construction (Alvarenga, 2019; Teixeira et al., 2018).

Nonetheless, to expand coastal navigation in the country, a favorable environment is needed to attract investments, with careful consideration of opening operations to foreign companies. Opening the market would hamper achievement of the operational scale suitable for generating profits, and might threaten operations' regularity (Alvarenga, 2019). Cabotage operators envisage a stable regulatory environment that would allow for the large-scale investments typical of this activity, reducing potential risks.

In this context, the Brazilian Federal Government created a program to develop cabotage transport entitled 'BR do Mar', under bill Nº 4,199/2020 (BRASIL, 2020). Besides creating the BR do Mar program, the bill proposes amendments to decrees already established and related to coastal navigation. The project, which was approved and became federal law in January 2022 (Law Nº 14,301) (BRASIL, 2022), aims to expand coastal cargo transportation, provide a stable and safe regulatory environment to attract new players and investments, and ensure the regularity, stability, and predictability of prices and services (Ministerio da Infraestrutura, 2020b).

However, even though the expansion of the cabotage sector would provide benefits in terms of balancing cargo transport and reducing costs, some trade-offs regarding greenhouse gas (GHG) emissions exist. This is because, while the modal shift in cargo transport from road to cabotage may reduce national GHG emissions, it would increase the cabotage sectoral GHG emissions and air pollutant emissions in coastal areas. This would place national coastal navigation at odds with those of international transport, which has set decarbonization targets for 2050 (IMO, 2021)[3]. On the other hand, cabotage expansion represents an excellent opportunity to attract investments for efficient and clean infrastructure development in the country.

Before exploring the BR do Mar project, it is necessary to understand the profile of cabotage transportation and its regulatory framework. Thus, the next section characterizes Brazilian coastal navigation according to types of ships, fleet profile, companies operating, type of cargo, and main ports. Then, the current regulatory framework is explored, followed by the proposed bill and the new legislation designed to stimulate coastal navigation. Finally, arguments in favor of and against the project are presented, along with discussions about the trade-offs and opportunities for the cabotage sector to cooperate with the development of a clean maritime infrastructure in Brazil.

2 Combustion/tailpipe emissions

3 More details about the IMO GHG Reduction Strategy can be consulted in (Rutherford & Comer, 2018).

Brazilian coastal navigation

Characterization

Cabotage is transport activity between two ports or facilities of a country by maritime or inland waterways. Such activities can be performed by different types of ships. According to the Brazilian National Agency of Waterway Transport (ANTAQ), the Brazilian cabotage fleet is composed of 184 ships, which can be divided into 15 categories and which total around 4 million tonnes of capacity, measured in deadweight tonnage (DWT)[4].

Considering only ships that transport significant amounts of a single type of cargo, such as bulk carriers, container ships, and tankers that carry chemicals, liquid, and gas, the total number of ships and capacity drops to 75 ships and 3.7 million DWT, respectively. Oil tankers represent the largest share of vessels operating in cabotage (63%), followed by containers (20%) and dry bulk (10%). Figure 1 shows the number of ships per type and their share in the total cargo capacity.

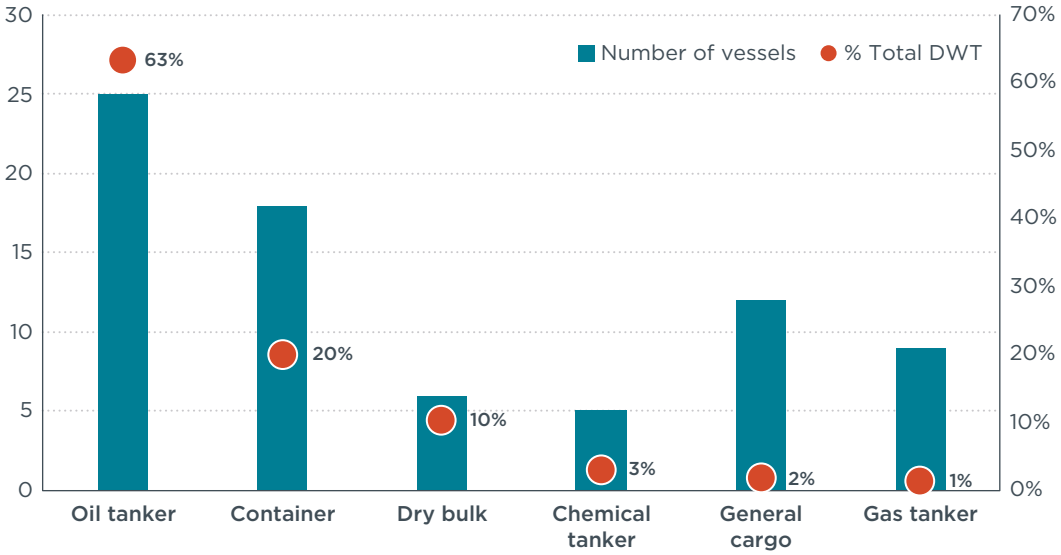

Figure 1. Ships operating in coastal navigation and their share in total cargo capacity
Source: (ANTAQ, 2021b)

The 25 oil tankers total 2.4 million DWT, the largest group capacity among all types of ships and equivalent to 63% of the total capacity. General cargo and gas tankers registered the smallest group capacity, less than 1 million DWT and equivalent to 2% and 1%, respectively, of the total.

The fleet under analysis is composed of vessels of different ages, the vast majority (88%) built since 2000. The fleet of oil tankers and containers were mostly built after 2010, while general cargo is the oldest type, with ships dating from the '70s. Figure 2 shows the additions of new vessels to the fleet since 1980 by ship type.

4 The deadweight tonnage measures how much weight ships can carry. It represents the sum of the cargo, fuel, passengers, provisions, crew, fresh and ballast water.

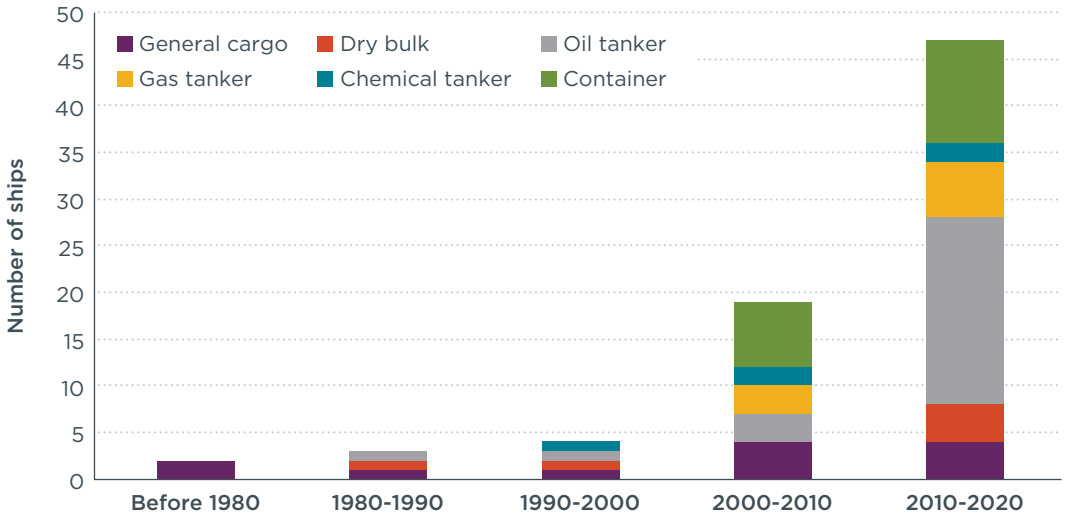

Figure 2. New vessel additions to cabotage fleet per ship type
Source: (ANTAQ, 2021b)

Currently, 32 companies own the fleet operating in Brazilian cabotage, of which 22 are responsible for operational activities. The companies with the largest number of vessels are also responsible for operating their fleet. Also, around three-quarters of the fleet under analysis is owned by the companies and the remainder is chartered. Currently, four companies own most of the vessels used in cabotage. Transpetro is by far the major owner and operator, with a fleet of 27 vessels, followed by Aliança, Elcano, and Transhipp. Figure 3 shows each company's fleet size, by ship type. Transpetro activities are focused on oil and gas transportation and the company is the largest owner of oil and gas tankers, while Aliança and Transhipp services focus exclusively on container and general cargo transportation, respectively. Elcano has more diversified operations covering dry bulk, oil, gas, and chemicals transport.

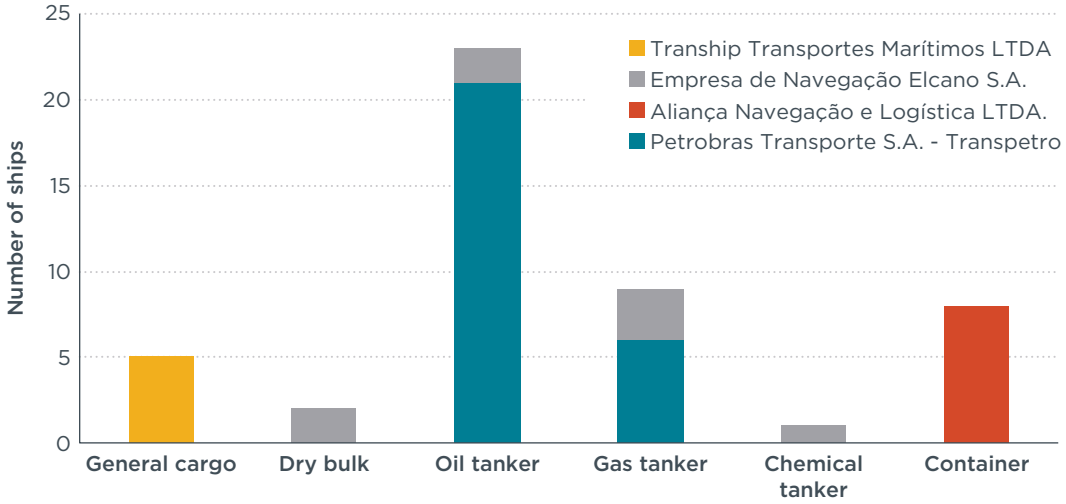

Figure 3. Companies operating in Brazilian cabotage transport
Source: (ANTAQ, 2021b)

In 2020, around 197 million tonnes of cargo were transported by cabotage activities in Brazil, which represents an increase of 44% compared to 2012. The major part is composed of liquid bulk transport, followed by transport of dry bulk, containers, and general cargo. Oil transport represents by far the highest share of coastal navigation transport in Brazil, accounting for 77% of the total mass transported in 2020. Interestingly, from 2012 to 2020 container transport registered the greatest increase

among all categories (122%), followed by liquid and gaseous bulk (38%), dry bulk (35%), and general cargo (24%), as shown in Figure 4 (ANTAQ, 2021a).

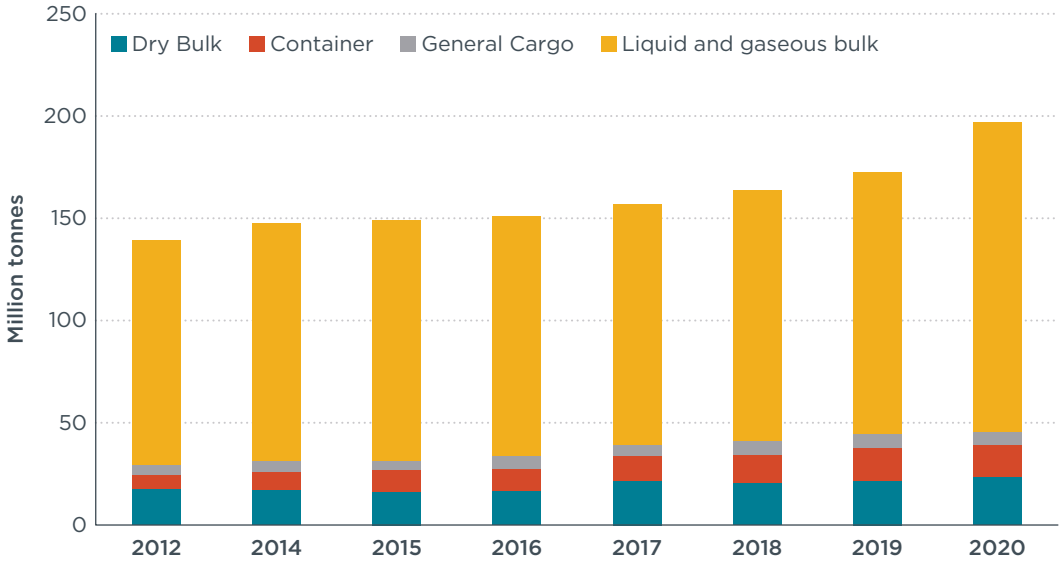

Figure 4. Cargo transported in cabotage activities since 2012
Source: (ANTAQ, 2021a)

A number of ports on the Brazilian coast participate in cabotage activities. Currently, Brazil has 36 ports and 202 terminals that are under public and private administration (ATP, 2021; Ministério da Infraestrutura, 2021b). In cabotage transport, the public ports handle the largest share of cargo transported, accounting for almost 80% (ANTAQ, 2021a). Figure 5 shows the Brazilian main ports and the cabotage transport lines.

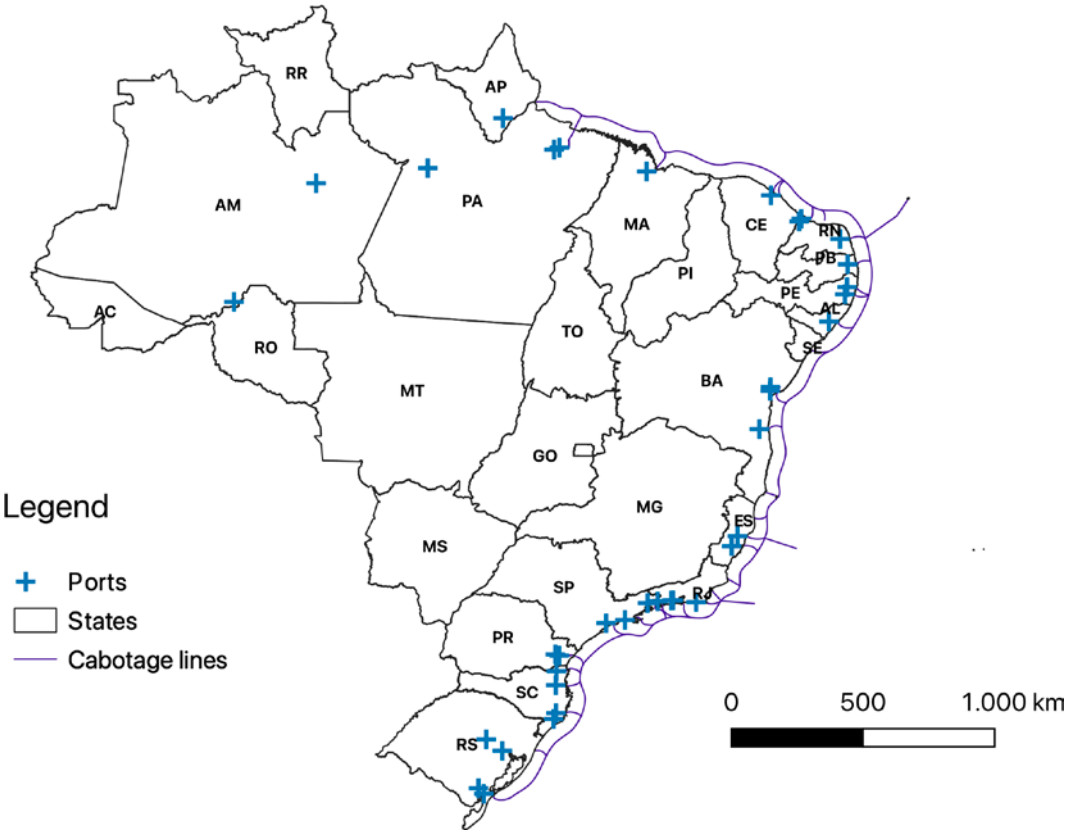

Figure 5. Ports and cabotage lines in Brazil

Analysis of import and export flows among Brazilian states through cabotage transport (Figure 6) reveals that almost 60% of cargo transported is associated with crude oil supply from platforms, and that Rio de Janeiro and São Paulo receive most of the cargo transported by cabotage (ANTAQ, 2021a). These two states host the major oil refineries, accounting for almost 50% of the refinery capacity in the country (ANP, 2021).

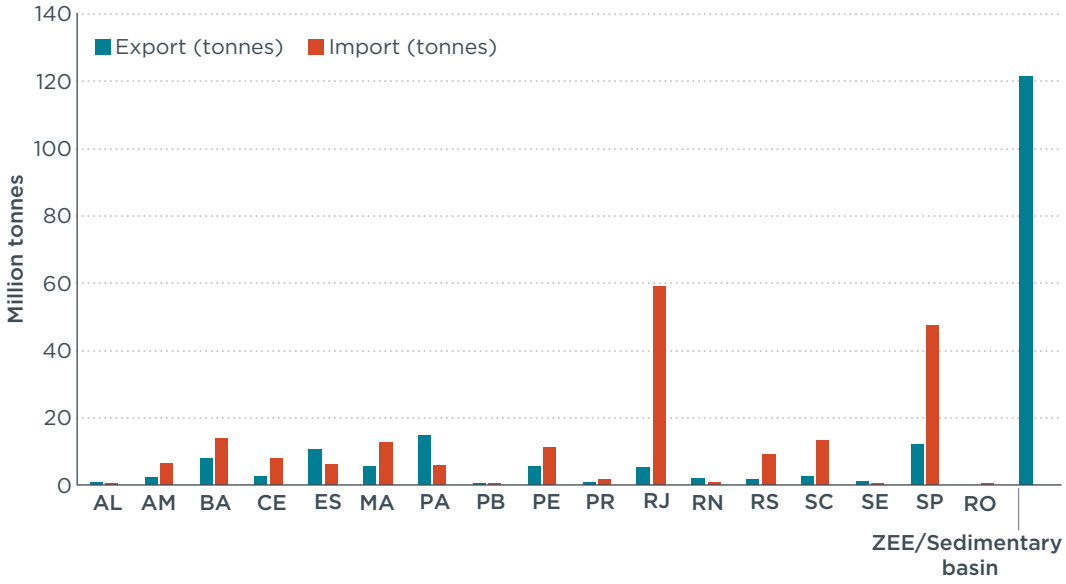

Figure 6. Cargo flows between states[5] in cabotage activities
Source: (ANTAQ, 2021a)

Regulatory framework until 2022

Cabotage transport in Brazil is regulated by the National Waterway Transport Agency (ANTAQ) whose main purpose is to implement policies defined by the Ministry of Infrastructure. It was created to regulate, supervise, and inspect activities related to waterway transport services and the exploration of national waterways and ports infrastructure. ANTAQ has several responsibilities including granting permission or authorization for the provision of transport services by river, lake, crossing, maritime support, port support, cabotage, and long-haul transportation. It is also responsible for managing contracts and other administrative instruments, as well as supervising the operation and services supply of companies that operate in waterway-related activities.

The legislation in place before January 2022 (Law N° 9,432/1997) stipulated that only Brazilian Navigation Companies (EBNs) were allowed to operate in cabotage transport. The EBNs are legal entities funded according to the Brazilian law, headquartered in the country, and authorized by ANTAQ to operate. EBNs operate using their own fleet or by chartering vessels. Chartering means that a company holds another company's vessel by contract for a certain period or conditions. Thus, the charterer is the agent that rents vessels for transport activities. Several types of chartering contracts for ships exist worldwide, but only three are possible for cabotage in Brazil: the bareboat charter, the time charter, and voyage charter (BRASIL, 1997).

The bareboat charter is the arrangement whereby no crew or provisions are included as part of the agreement. The EBN is responsible for the entire operation, from loading and

5 Abbreviations represent Brazilian States (see also Figure 5): AL – Alagoas; AM - Amazonas; BA - Bahia; CE – Ceará; ES – Espírito Santo; MA – Maranhão; PA – Pará; PB – Paraíba; PE – Pernambuco; PR – Paraná; RJ – Rio de Janeiro; RN – Rio Grande do Norte; RS – Rio Grande do Sul; SC – Santa Catarina; SE – Sergipe; SP – São Paulo; RO – Rondônia. ZEE is the abbreviation for Exclusive Economic Zone, the area within 200 nautical miles of the coast, where the State has special rights to explore and use marine resources. Figure 4 shows the 17 (of 26) Brazilian states that have port facilities.

unloading to hiring crew. In this type of contract, the ship must be registered in Brazil and thus, have Brazil as its flag state[6]. Alternatively, in the time charter arrangement, the EBN reserves the right to use and control the vessel for a pre-determined time and is free to sail to any port and transport any cargo, subject to legal regulations. In this arrangement, the EBN contracts all the operation (including crew), and the ship remains with its original flag state, generally a low-tax country. Finally, in the voyage charter, the vessel is leased out for a particular voyage and the agreement lists the ports of call, destination, and cargo restrictions (if any), among others. Besides the vessel, the charterer may rent the entire operation or part of it (including crew) for the trip.

According to Law N° 9,432/1997, cabotage activities were restricted to Brazilian vessels, that is, ships constructed in the national territory, not merely registered in the country. Foreign vessels could operate in coastal navigation only if chartered by EBNs and authorized by regulatory bodies, and only in specific cases:

» In the absence or lack of Brazilian vessels of the type and size required

» To meet a verified public interest that is properly justified

» To replace vessels under construction in national shipyards with contract validity during the construction time for a maximum period of 36 months and up to the limit of the deadweight tonnage (for cargo ships) or the gross tonnage (for supporting vessels) under contract.

Additionally, chartering foreign vessels in bareboat modality with flag suspension was limited to ships of twice the capacity of similar vessels, with construction ordered by an EBN in a national shipyard, plus half of the capacity of the fleet owned by the EBN, with the EBN guaranteed the right to charter at least one vessel of equivalent size. Thus, this legislation restricted foreign vessels' freedom of action in the national territory. Companies seeking to operate in the cabotage activities needed to invest in local construction of ships, or buy vessels with a Brazilian flag, which was believed to ensure competitiveness for local vessels (BRASIL, 1997). The main reasons behind the restriction of cabotage transport for domestic vessels are the protection of the shipbuilding industry, development of the merchant marine, and protection of the fleet for national security reasons. These restrictions in cabotage are a common practice in countries like the United States, Japan, Australia, and Germany, which can maintain such restrictions because of their competitive operating costs or subsidy policies (ABTC, 2021; Ministerio da Infraestrutura, 2020a).

Another regulatory feature of Brazilian cabotage is the mandatory charge applied to freight expenses known as Additional to Freight to the Renewal of Merchant Marine (AFRMM). This contribution is part of the Merchant Marine Fund (FMM) and is intended to support the development of the merchant marine and the Brazilian shipbuilding and ship repair industries. Under this regulation, freight is defined as the payment for waterway transportation of any cargo unloaded in Brazilian ports. The AFRMM is levied on the freight related to all types of cargo transport. It is charged to Brazilian and foreign shipping companies operating in the country at the unloading port. The rates applied on freight are 25% for long-haul shipping, 10% for cabotage, and 40% for inland waterway navigation in the North and Northeast regions when transporting bulk liquids (BRASIL, 2004).

However, in the past 10 years, the Brazilian shipbuilding industry has only delivered 4 vessels for cabotage transport, excluding the ones operating with petroleum products (26 vessels) (Ministerio da Infraestrutura, 2020a). Also, the number of projects funded

6 "Flag state" refers to the country where the ship is registered. Ships follow the regulations (regarding taxes, labor, and other matters) of the country where they are registered. Flag state is not necessarily the country where the ship was built.

by FMM dedicated to cabotage and shipyards is well below the total delivered projects (Figure 7), indicating that it has not been effective in promoting the shipbuilding industry in the country (BRASIL, 2021).

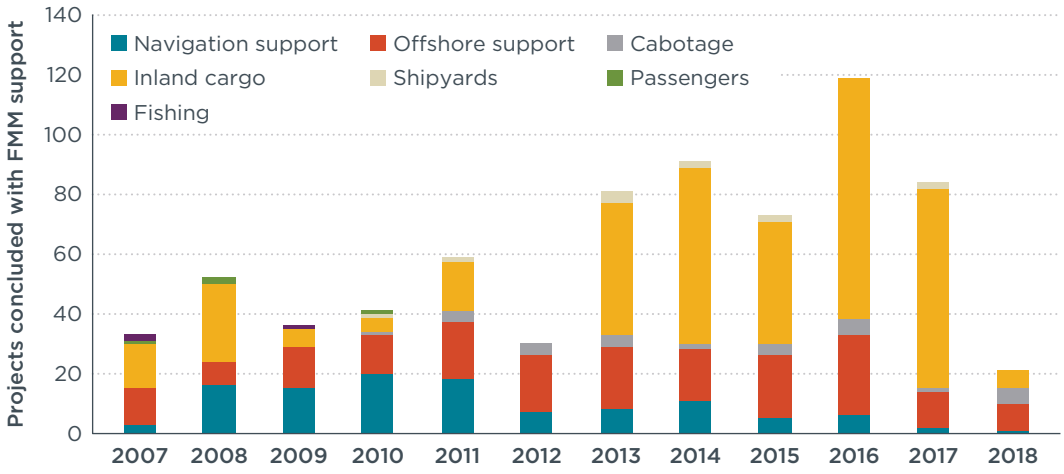

Figure 7. Number of projects funded by FMM.
Source: (Ministério da Infraestrutura, 2021a)

One of the main bottlenecks of cabotage in Brazil is the high taxation levied on this transport mode. Such expenses are absorbed into freight rates and reflected in the final cost of the transported goods. The operational costs of cabotage can be divided into three large groups: fuel expenses, port costs, and crew (salaries, social charges, and others.). Figure 8 presents the composition of operational costs of cabotage; it is dominated by fuel expenses, followed by taxes and maintenance costs (EPL, 2021).

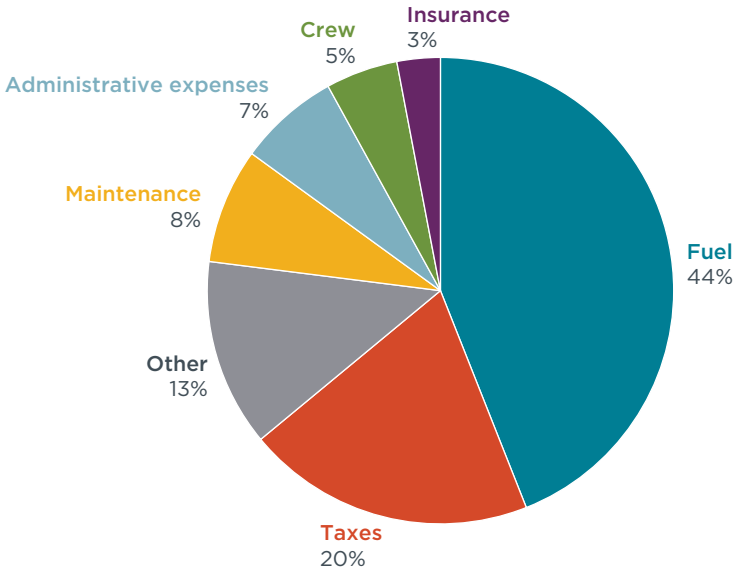

Figure 8. Operational cost share in cabotage transport
Source: (EPL & ONTL, 2021)

Law N° 9,432/1997, the decree of waterway transport, establishes that the fuel price charged to long-haul vessels is the same as the rate charged to cabotage transport (BRASIL, 1997). However, fuels used in cabotage transportation do not receive the same

tax exemptions (such as ICMS[7]) as long-haul shipping and cabotage vessels pay around 20% more for fuel than vessels that serve international transport (Alvarenga, 2019; BRASIL, 2008; EPE, 2019, 2021b). In addition to the price of marine fuels, shipowners and operators consider other factors when deciding where to bunker, such as payment schedule, credit availability, quality of operations, delivery time, and receiving mode (EPE, 2019).

Port costs include not only the port charges, but also the mandatory pilotage services. Pilotage in Brazil occurs under a monopoly framework and, in contrast to other regions, has no economic regulation. This combination of factors leads to high maneuvering costs, which is critical for coastal navigation since some ships must call at several ports in a short trip. Besides the costs, the bureaucracy in ports also hampers cabotage activities. Regarding the crew, cost issues are mainly associated with high labor charges (Alvarenga, 2019). Additionally, vessels operating in cabotage transport must carry AFRMM as discussed in the next section.

BR do Mar

A policy to incentivize cabotage transport in Brazil was included in 2019 in the country`s Investment Partnership Program (PPI), which focused on expanding and strengthening the interaction between the federal government and the private sector through partnership contracts and privatization measures (BRASIL, 2019). The Cabotage Incentive Policy shaped a program called BR do Mar whose objective is to improve coastal waterway transport in Brazil in order to increase transport matrix efficiency, reduce logistics costs, optimize the allocation of public resources in infrastructure investments, and increase private participation in projects that focus on logistics infrastructure. The BR do Mar project was then embodied in bill N° 4,199/2020 which aims to develop cabotage transport by focusing on four action areas: fleet, shipbuilding industry, costs, and ports (Ministerio da Economia, 2020). In January 2022 the bill was sanctioned by the federal government under Law N° 14,301/2022 and is in effect after receiving several proposals for amendment and approval from the national congress and senate (BRASIL, 2022).

Fleet

The program aims to increase cabotage operations so that the EBNs have greater control and security when operating their fleet. To this end, the project proposes more flexible conditions for chartering agreements, so EBNs can benefit from chartering foreign vessels that have lower operating costs. EBNs would be allowed to charter by time vessels from their own foreign subsidiary companies or from foreign subsidiaries of any EBN company, defined as Brazilian Navigation Investment Company (EBN-i). The EBN-i represents the company whose purpose is to charter vessels to Brazilian (or foreign) shipping companies. Thus, EBNs will be allowed to charter foreign vessels from the EBN-i, provided that these vessels are on their property or under their custody, use, and control through bareboat chartering agreements (BRASIL, 2022).

According to the project, such time chartering possibilities would be permitted only under certain conditions: to expand the capacity of the EBN fleet (that is, vessels registered in the name of the economic group to which the company belongs); to replace similar vessels that are under repair or construction in Brazil (up to 200% of its DWT) or abroad (up to 100% of its DWT); to exclusively serve special cabotage

7 The ICMS (a tax on operations related to the trade of goods, provision of interstate and intermunicipal transport, and communication services) is a tax on aggregate value applied to all sales made in the fuels supply chain. The ICMS applied to oil products is disbursed entirely to states, but more than 25% is passed to their municipalities. Until 2008, other charges were applied to fuels purchased for cabotage transport such as PIS and Cofins (social contribution taxes applied to the income of economic agents). The decree N° 11,774/2008 (BRASIL, 2008) suspended the requirement of these charges on fuels used in cabotage transport (EPE, 2019, 2021b).

operations (services that do not yet exist); and to exclusively fulfill long-term contracts (BRASIL, 2020, 2022).

Additionally, the project authorizes the bareboat chartering of foreign vessels regardless of the ownership of a Brazilian vessel or possession of a vessel under construction in the country. In the first 12 months of the law's entry into effect, bareboat chartering is limited to one foreign vessel and will be expanded to two vessels after 12 months, three vessels after 24 months, and four vessels after 48 months. From then on, bareboat chartering of foreign vessels will be unrestricted. In this sense, the proposal allows new entrants or smaller companies to sign bareboat chartering agreements without the obligation to own vessels (BRASIL, 2022).

It is noteworthy that under the new legislation, the captain, the cabotage master, the chief engineer, and the engine operator of chartered vessels must be Brazilian. The original bill drafted in 2020 (N° 4,199/2020) established that at least 2/3 of the crew should be Brazilian. However, this more restrictive requirement was deferred by the federal government (BRASIL, 2020, 2022).

Shipbuilding industry

Several actions are proposed to promote the shipbuilding industry, especially regarding maintenance and repair activities. The new regulatory framework opens the possibility for national and foreign companies to use the FMM to expand, repair, restore, dry-dock[8], and construct vessels when these activities are carried out in Brazilian shipyards or by Brazilian companies, and to invest in ports and waterway infrastructure development. Thus, it is expected to improve the waterway transport infrastructure and to increase the scale of shipyard operations. This would benefit the EBNs that currently use foreign shipyards for docking activities. Also, the new regulation allows the use of FMM resources as a guarantee in financial contracts for vessel construction.

Costs

Regarding costs, the project includes actions to increase the competitiveness of cabotage operations by modifying charges, taxes, and bureaucracies that overload cabotage operations. For example, chartered vessels authorized to operate in the cabotage transport would be automatically submitted to a temporary admission regime, without needing the registration of import declaration and with total suspension of federal taxes, including the AFRMM. The original bill proposed reducing to 8% the AFRMM rate charged to vessels operating in cabotage, but this was declined in the final presidential approval.

Ports

Finally, besides the possibility of using FMM resources to invest in infrastructure, another initiative is the permission of temporary contracts for cargo that does not have operations in certain ports. Such a measure is expected to speed up the development of exclusive cabotage terminals. Additionally, the inclusion of new investments in existing contracts is proposed to ensure that ports are prepared for the increased demand for cabotage operations (Ministerio da Infraestrutura, 2020b). Furthermore, to be qualified under the BR do Mar, the navigation company must periodically provide information related to its operation regarding, among other parameters, the development of activities in the cabotage value chain and their contribution to scientific and technological innovation. In this sense, the project expects to attract investment in port infrastructure and to stimulate support from EBNs.

8 Dry-docking is the process of removing the vessel from water and placing it in a dry place to carry out maintenance, cleaning, painting, treatment, etc. of the ship's hull and accessories. Some floating structures are used in the process to lift the ship and access the hull.

Discussion

Criticism and support

The main critique of the BR do Mar project relates to the provisions that facilitate chartering of foreign vessels (ABTC, 2021; Agência Infra, 2020; Fontes, 2022; Furtado, Costa, & Maia, 2021; Portos e Navios, 2020; Sinaval, 2020). According to some stakeholders, the new chartering dynamics proposed could result in regulatory asymmetries, by enabling the entry of new companies into the cabotage market, without their investing in fleet formation. Also, they claim that the new chartering arrangements might affect service regularity, because reliance on foreign vessels makes cabotage operations subject to international market availability (Furtado et al., 2021). This means that any imbalance in world freight or demand could make the chartered vessels operate in other markets, compromising Brazilian cabotage activities (ABTC, 2021). Additionally, the project has been criticized by the heavy-duty sector (truck transport), because the expected modal shift could cause them to lose business to ships (Fontes, 2022).

On the other hand, the Ministry of Infrastructure argues that the BR do Mar will truly promote the national cabotage sector. In its understanding, the project will not only unlock the supply of vessels from the shipbuilding industry, which registered slow progress in recent years, but will also increase the sector's competitiveness, reducing costs and encouraging economic activity. According to the Ministry of Infrastructure, the BR do Mar takes into account investments already made by companies operating in the sector at the same time which allows for the entry of new players, thereby increasing competition (Furtado et al., 2021). Furthermore, the government denies that there will be losses to the heavy-duty sector and truck drivers, arguing that road transport will continue to be necessary to carry products to ports and to distribute them within the country.

With the BR do Mar project, the Ministry of Infrastructure aims to expand the volumes of container trade and increase the cabotage fleet by 40% in the next three years, excluding the ships dedicated to oil and oil products transport (Ministerio da Infraestrutura, 2020b). Additionally, a reduction of 15% in the operating costs of cabotage transport is expected, given the fleet expansion, flexibility in chartering agreements, and tax reductions (EPL, 2021).

Trade-offs

Cabotage transport allows the transport of large volumes of cargo in a practical and efficient way over great distances, which is a valuable option in a large country like Brazil. Avoiding the interruptions and hazards caused by irregular roads and weather and traffic conditions, ships can undertake operations with predictable schedules and routes, providing more reliability for cargo tracking. In general, cabotage is considered a safer mode of transport relative to both theft and accidents (Alvarenga, 2019; Teixeira et al., 2018). Also, compared to road transport, cabotage transport releases fewer GHGs to the atmosphere per unit of transport work. On average, while cabotage emits 8 grams of carbon dioxide (CO_2) per net ton per kilometer (TKU), road transport emits around 52 grams of CO_2 per TKU[9] (EPL, 2021).

According to EPL[10] a 60% increase in container volume transported by cabotage would reduce CO_2e by more than 530,000 tonnes per year compared to road transportation (EPL & ONTL, 2021). However, even though a modal shift in cargo transport from road to cabotage would provide benefits in terms of national GHG emissions reduction, it would increase cabotage sectoral emissions. This would place the national coastal navigation at

9 Tank-to-wake (TtW)/combustion emissions.

10 *Empresa de Planejamento e Logística* (Planning and Logistics Company).

odds with the goals of international shipping, which seeks to reduce GHG emissions by 50% by 2050 in relation to 2008 levels.

The Brazilian Energy Balance (BEN) offers statistics on energy supply and consumption in Brazil, covering the exploration and production of primary energy resources, conversion into secondary forms, imports and exports, distribution, and end-use energy. BEN provides data on fuel consumption in national waterway transportation, which is mostly represented by cabotage activities given that inland waterway transport represents a very small share (5%) of cargo transportation in the country (EPL & ONTL, 2021). Figure 9 shows the fuel consumption in cabotage activities between 2008 and 2020, split into the two types of fuel used in this activity: marine diesel (MGO) and heavy fuel oil (HFO). It is worth mentioning that since 2020, bunker fuels sold in Brazil have a sulfur limit of 0.5% (by mass), according to the "IMO2020" rule that limits the sulfur content in the fuel oil used onboard ships (which means that for ships that do not use scrubbers, HFO will be very low sulfur fuel oil, VLSFO) (EPE, 2019; IMO, 2019; Oliveira, 2021; Petrobrás, 2020).

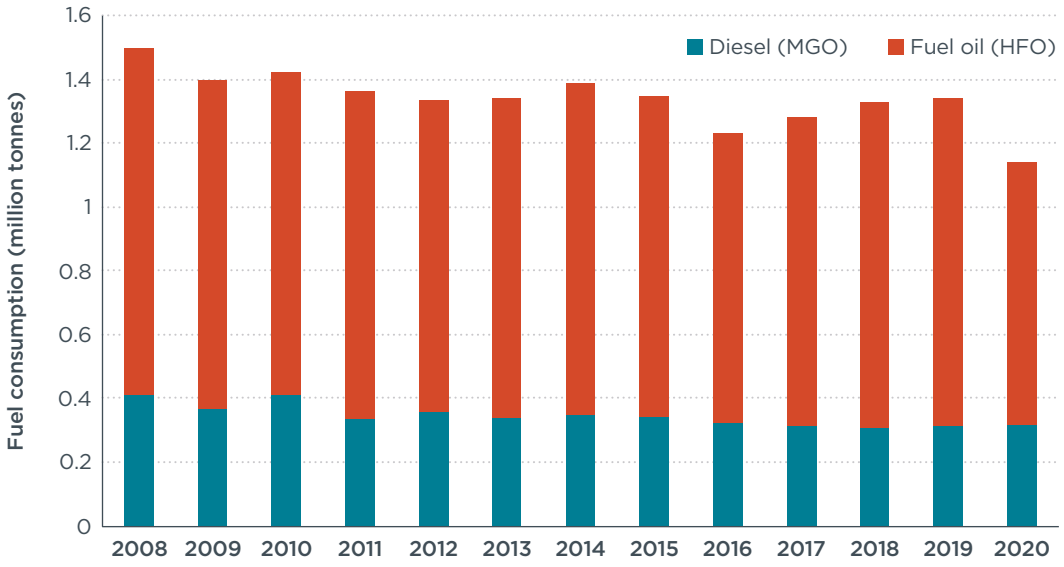

Figure 9. Estimated fuel consumption in cabotage activities between 2008 and 2020
Source: (EPE, 2021a)

Using fuel consumption values for cabotage activities, the tank-to-wake (TtW)[11] GHG emissions were determined (Figure 10). Emission factors associated with fuel combustion for the principal GHGs (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) were taken from Comer & Osipova (2021) and MEPC (2018). Emissions are reported on a CO_2-equivalent (CO_2e) basis that used IPCC AR6 values for 100-year GWP[12] to normalize CH_4 and nitrous oxide N_2O emissions (Forster, P. et al., 2021). Figure 10 also shows the level of emissions in 2050 (red line) if the national maritime transport strictly followed the IMO GHG strategy.

11 TtW refers to the emissions associated with fuel combustion in the ships' engines.
12 See table 7.15 in Forster, P. et al. (2021): CH_4 = 29.8; N_2O = 273

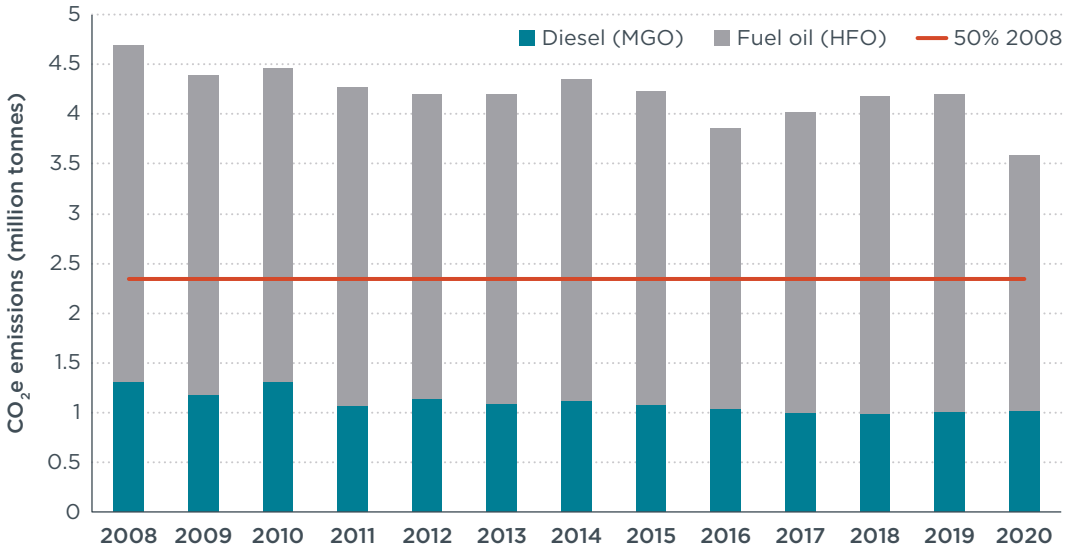

Figure 10. Estimated GHG emissions from cabotage transport in Brazil and emissions level required to comply with IMO GHG strategy

Emissions in 2020 totaled 4.7 million tonnes of CO_2e, 15% lower than 2019 levels. Figure 10 shows some progress in reducing emissions between 2008 and 2020, even if the steeper reduction in 2020 could be explained by the COVID-19 pandemic. However, the sector is expected to expand in the coming years, given the economic recovery and the approval of the BR do Mar bill. Thus, a significant increase in cabotage emissions should be expected. This caveat notwithstanding, such an increase may not be significant in absolute terms given that cabotage transportation represents a small share of national and transport sector GHG emissions,[13] accounting for 0.3% and 3.0%, respectively (IEMA, 2020; SEEG Brasil, 2021).

According to the Brazilian Energy Planning Company (EPE), the projected increase in the transport of liquid bulk (given the expected rise in oil production), agricultural products in the North region, and other products associated with the BR do Mar Program is likely to promote cabotage and waterway transport activity (EPE, 2022). EPE estimates a 2.7% annual increase in energy consumption for waterway cargo transport from 2019 to 2031. Figure 11 shows the projected GHG emissions for cabotage transport until 2031 and compares it with the 2050 emissions needed to comply with IMO GHG strategy. If the expected increase in waterway cargo transport is realized, cabotage emissions could grow by 28% from 2020 to 2031, reaching 4.68 million tonnes of CO_2e, nearly the same level as 2008 (4.76 million tonnes of CO_2e). Also, despite the benefits of shifting cargo transport from roads to sea, only a portion of on-road transport could realistically be shifted to cabotage (Winebrake, 2009).

13 National = 1,972 million tonnes CO_2e; Transport sector = 196.5 million tonnes CO_2e.

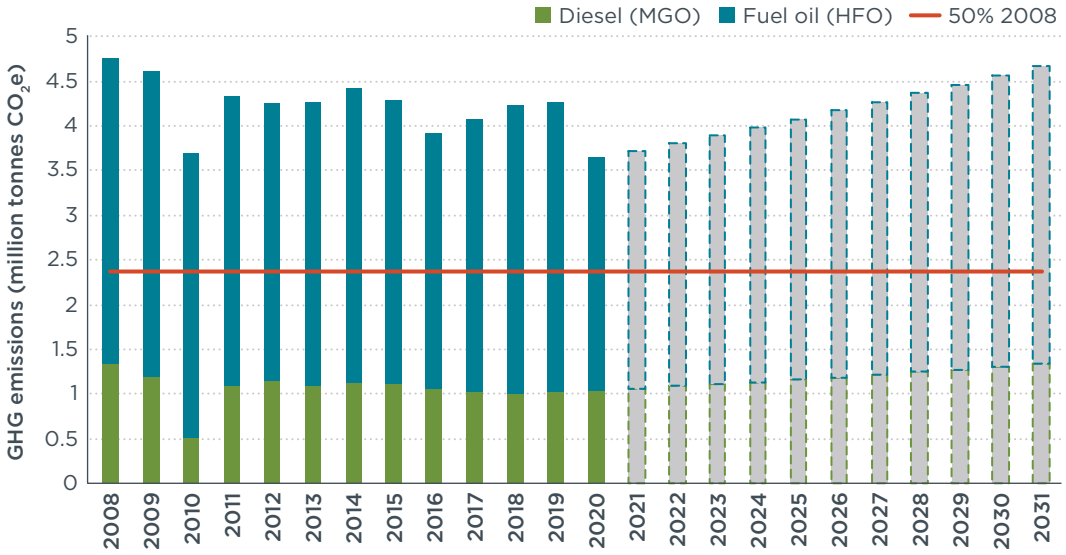

Figure 11. Projected GHG emissions from cabotage in Brazil through 2031

Beyond the climate impacts, the fuel burned in ships' engines is also a source of air pollutants, which have significant impacts on human health. The main air pollutants are sulfur oxides (SO_x), nitrogen oxides (NO_x), particulate matter (PM) with diameters less than 10 microns (PM_{10}), volatile organic compounds (VOCs), carbon monoxide (CO) and black carbon (BC). High atmospheric levels of SO_x and NO_x are linked to respiratory problems, increased ocean acidification, and the formation of PM in combination with other atmospheric components. $PM_{2.5}$ emissions are associated with an increased incidence of lung cancer and cardiopulmonary diseases. Secondary emissions/pollutants, such as ozone, formed when NO_x and VOCs react in the presence of sunlight, also lead to respiratory illness (Cullinane & Cullinane, 2013).

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international body governing maritime pollution from ships. Its Annex VI regulations focus mainly on limiting NO_x emissions and the sulfur content of fuels. Recent revisions established progressive reduction goals for emissions of SO_x, NO_x, and PM, and introduced the concept of emission control areas (ECAS) to reduce emissions of such pollutants in designated areas (IMO, 2019; US EPA, 2013).

Under the revision of MARPOL Annex VI, which entered into force in January 2020, the sulfur content of fuels used globally in ships is limited to 0.5%, a substantial reduction from the previous level of 3.5%. Shipping companies that do not comply with the new regulations will be subject to sanctions and penalties imposed by the governments of IMO member countries, by ports, and by insurance companies. Because Brazil is an IMO member state that has ratified MARPOL Annex VI, all ships that call on Brazilian ports and all Brazilian-flagged vessels must comply with the IMO 2020 regulations (EPE, 2019).

Opportunities

The BR do Mar law aims to increase cabotage activities in Brazil, promoting cargo transport efficiency. Even though cabotage currently contributes minimally to national and transport sector emissions, the growth in cabotage would not only increase the sector's contribution to global climate change, but would also degrade air quality in coastal areas. Given that around 80% of the population lives in areas near the coastline (Alvarenga, 2019), impacts on human health should be expected. Additionally, as cabotage activities serve mostly the oil industry in Brazil (in great part by transporting crude oil from platforms to land), the expected rise in oil production in Brazil portends an increase in oil transportation to land (EPE, 2022). In this sense, reducing emissions

in cabotage activities could be a way to reduce oil industry emissions and assist its energy transition.

Reducing emissions of GHG and air pollutants can be achieved through the implementation of new technologies and through technical and operational measures. Among the new technologies are more efficient engines, and low- or zero-carbon and low-sulfur fuels. Alternative fuels are diverse and include drop-in fuels derived from biomass, hydrogen, ammonia, and e-fuels (DNV GL, 2019; Wang & Wright, 2021). Additionally, wind-assisted propulsion can reduce fuel consumption by using rotor sails or other wind capture devices (Comer, Douglas, & Elise, 2022). Technical and operational measures include the use of electricity in coastal operations (shore-side power), the application of stricter specifications for auxiliary engines, and slow steaming. Shore-side power allows ships to turn off auxiliary engines and connect to power supplied at the port, reducing fuel combustion and emissions, while slow steaming saves fuel and reduces emissions (Alamoush, Ölçer, & Ballini, 2022).

In addition, ports can facilitate shipping decarbonization through measures beyond the provision of onshore power supply (which preferably should come from renewable sources) and alternative fuels bunkering infrastructure. The utilization of digital technologies to facilitate a ship's arrival, berthing, and speed reduction, the reduction of ship turnaround times through scheduling and automated systems, and the provision of miscellaneous services, such as hull cleaning and propeller polishing, among others, are examples of how ports can further contribute to maritime decarbonization (Alamoush et al., 2022).

As of mid-2022, investments on the order of US$ 22 billion for construction of green hydrogen plants in Brazil have been announced, and all of them are placed in ports—in Pecém, Suape, Pernambuco and Açu. These ports combine numerous strategic advantages for the development of a green hydrogen chain, such as well-developed export logistics, proximity to industrial zones, and access to renewable power sources. If the announced projects are successful, Brazil could become a global leader in green hydrogen (Bnamericas, 2021; Gabriel Chiappini, 2021; Victor Uchôa, 2021). Also, a memorandum of understanding between a Canadian company and Porto Central, located in the Espírito Santo state in the Southeast region, was signed to develop a facility to produce, store, and distribute green ammonia. Porto Central is expected to be an energy hub that will provide energy for domestic use and green ammonia to maritime vessels (Porto Central, 2021; The Maritime Executive, 2021).

Even though coastal navigation is not included in the IMO 2050 strategy, international shipping will have to move toward decarbonization in coming years and oceangoing ships may also engage in cabotage. In this context, the provision of bunkering infrastructure for low- and zero-emission fuels and onshore power for ships at berth will be needed and will require capital-intensive investments. In addition, besides serving the shipping industry with novel fuel bunkering facilities, ports have the potential to become future energy hubs by storing electricity in the form of fuels, such as hydrogen, for example. Consequently, ports are expected to play an important role in maritime decarbonization, serving as a link between land-based fuel producers and sea-based fuel consumers (IAPH, 2021; MEPC, 2021). However, the transition to cleaner and possibly more expensive technologies and fuels could undermine cabotage competitiveness. For this reason, favorable institutional and market conditions are necessary to provide an attractive investment environment.

Conclusions

The BR do Mar project, embodied in the recently approved law N° 14,301/2022, proposes to update legislation applied to coastal navigation transport to increase the

supply and quality of cabotage in Brazil, promote the competitiveness of Brazilian shipping companies, reduce costs, and develop the national shipbuilding industry. The project is considered an important step towards changing the dynamics of long-distance cargo transport in the country by increasing the availability of vessels for regular transport of cargo along the coastline. Also, it is expected to attract investment in port facilities and to optimize the use of resources in the development of shipbuilding industry and infrastructure.

However, the development of cabotage activities would lead to an increase in the sector's emissions of GHG and air pollutants, particularly in coastal areas. If the expected increase in national coastal navigation occurs, emissions may increase by 28% in 10 years. Even though cabotage contributes minimally to national and transport sector emissions, and despite the benefits of shifting cargo transport from roads to sea, this would put national maritime transport on a trajectory opposite that of the international sector, which has set decarbonization targets for 2050. Given that Brazilian cabotage and international shipping share infrastructure and have similar operational profiles, the alignment of the two would favor the transition to cleaner maritime transport. Further, because most of the population lives near coastal areas, impacts on human health should be expected.

In this sense, the BR do Mar project represents a great opportunity for development of efficient and clean maritime infrastructure in the country. The expected investments in maritime infrastructure with the new regulatory environment could be harnessed to the development of bunkering facilities for alternative and low-emission fuels, the construction of modern and efficient ships, and port infrastructure. Also, decarbonizing cabotage activities would support reducing emissions in the oil industry. However, this transition requires deep infrastructural changes that will not be achieved by private initiative only. Thus, government support is crucial for creating institutional and market conditions that provide an attractive environment for such investments.

References

ABTC. (2021, março 30). BR do Mar pode expandir setor de navegação de cabotagem no Brasil—Associação Brasileira de Logística e Transporte de Cargas—ABTC. Recuperado de Associação Brasileira de Logística e Transporte de Carga https://www.abtc.org.br/index.php/noticias/noticias-do-setor/item/6801-br-do-mar-pode-expandir-setor-de-navegacao-de-cabotagem-no-brasil

Agência Infra. (2020). BR do Mar: Críticas antes do envio ao Congresso—Agência Infra. Recuperado de https://www.agenciainfra.com/blog/br-do-mar-criticas-antes-do-envio-ao-congresso/

Alamoush, A. S., Ölçer, A. I., & Ballini, F. (2022). Ports' role in shipping decarbonisation: A common port incentive scheme for shipping greenhouse gas emissions reduction. *Cleaner Logistics and Supply Chain*, *3*, 100021. https://doi.org/10.1016/j.clscn.2021.100021

Alvarenga, H. (2019). Cabotagem no Brasil: Importância, benefícios e crescimento. Recuperado de ILOS https://www.ilos.com.br/web/cabotagem-no-brasil-importancia-beneficios-e-crescimento/

ANP. (2021). Anuário Estatístico 2021. Recuperado de Agência Nacional do Petróleo, Gás Natural e Biocombustíveis https://www.gov.br/anp/pt-br/centrais-de-conteudo/publicacoes/anuario-estatistico/anuario-estatistico-2021

ANTAQ. (2021a). Estatístico Aquaviário. Recuperado de Agência Nacional de Transportes Aquaviários http://anuario.antaq.gov.br/QvAJAXZfc/opendoc.htm?document=painel%5Cantaq%20-%20anu%C3%A1rio%202014%20-%20v0.9.3.qvw&lang=pt-BR&host=QVS%40graneleiro&anonymous=truema%C3%A7%C3%A3o%20de%20Pre%-C3%A7os%20de%20Combust%C3%ADveis_2021.07.02.pdf

ANTAQ. (2021b). Frota—ANTAQ. Recuperado de Navegação Marítima—Frota Geral—Analítica http://web.antaq.gov.br/Portal/Frota/ConsultarFrotaGeral.aspx

ATP. (2021). DATA PORT. Recuperado de portosprivados.org.br/publicacoes/data-port

Bnamericas. (2021, junho 12). How Brazilian ports are advancing with green hydrogen projects. Recuperado de BNamericas https://www.bnamericas.com/en/features/how-brazilian-ports-are-advancing-with-green-hydrogen-projects

BRASIL. *Lei n.9432, de 8 de janeiro de 1997. Dispõe sobre a ordenação do transporte aquaviário e dá outras providências.* , Pub. L. No. 9432 (1997).

BRASIL. *Lei 10.893—Dispõe sobre o Adicional ao Frete para a Renovação da Marinha Mercante—AFRMM e o Fundo da Marinha Mercante—FMM.* , Pub. L. No. 10.983 (2004).

BRASIL. *Lei n.11,774 de 17 de setembro de 2008—Altera a legislaçao tributária federal e dá outras providências.* , Pub. L. No. 11,774 (2008).

BRASIL. *RESOLUÇÃO Nº 70, DE 21 DE AGOSTO DE 2019—DOU - Imprensa Nacional.* , (2019).

BRASIL. *Projeto de Lei n.4199/2020—Institui o Programa de Estímulo ao Transporte de Cabotagem—BR do Mar.* , Pub. L. No. 4199/2020 (2020).

BRASIL. (2021). Conjuntos de dados—Portal Brasileiro de Dados Abertos. Recuperado de https://dados.gov.br/dataset?_organization_limit=0&organization=ministerio-da-infraestrutura-minfra&tags=FMM

BRASIL. *LEI Nº 14.301, DE 7 DE JANEIRO DE 2022—DOU - Imprensa Nacional.* , Pub. L. No. 14,301 (2022).

Comer, B., Douglas, S., & Elise, G. (2022). *Decarbonizing bulk carriers with hydrogen fuel cells and wind-assisted propulsion: A modeled case study analysis*. International Council on Clean Transportation. Recuperado de International Council on Clean Transportation https://theicct.org/publication/hydrogen-and-propulsion-ships-jan22/

Comer, B., & Osipova, L. (2021). *Accounting for well-to- wake carbon dioxide equivalent emissions in maritime transportation climate policies*. Washington, D.C.: International Council on Clean Transportation. Recuperado de International Council on Clean Transportation https://theicct.org/publication/accounting-for-well-to-wake-carbon-dioxide-equivalent-emissions-in-maritime-transportation-climate-policies/

Cullinane, K., & Cullinane, S. (2013). Atmospheric Emissions from Shipping: The Need for Regulation and Approaches to Compliance. *Transport Reviews*, *33*(4), 377–401. https://doi.org/10.1080/01441647.2013.806604

DNV GL. (2019). *Comparison of Alternative Marine Fuels*. Recuperado de https://sea-lng.org/wp-content/uploads/2019/09/19-09-16_Alternative-Marine-Fuels-Study_final_report.pdf

EPE. (2019). *Precificação de óleo combustível marítimo para cabotagem*. Recuperado de https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-454/EPE_Nota%20T%C3%A9cnica_Pre%C3%A7os%20Combust%C3%ADveis%20Mar%C3%ADtimos%202019.pdf

EPE. (2021a). *Balanço Energético Nacional—Ano 2020. Brazilian Energy Balance—Year 2020*. Recuperado de https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-601/topico-596/BEN2021.pdf

EPE. (2021b). *Entendendo a formação dos preços finais de combustíveis no Brasil*. Recuperado de https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-413/topico-594/Entendendo%20a%20Forma%C3%A7%C3%A3o%20de%20Pre%C3%A7os%20de%20Combust%C3%ADveis_2021.07.02.pdf

EPE. (2022). *Plano Decenal de Expansão de Energia 2031* (p. 411). Brasilia. Recuperado de https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/Documents/PDE%202031_RevisaoPosCP_rvFinal.pdf

EPL. (2021, maio 3). Boletim de Logística: Programa BR do Mar pode reduzir custos da cabotagem em mais de 15%. Recuperado de EPL - Empresa de Planejamento e Logística S.A. https://www.epl.gov.br/boletim-de-logistica-programa-br-do-mar-pode-reduzir-custos-da-cabotagem-em-mais-de-15

EPL & ONTL. (2021). *Boletins de Logística – ONTL*. Empresa de Planejamento e Logística. Recuperado de Empresa de Planejamento e Logística https://ontl.epl.gov.br/publicacoes/boletins-de-logistica/

Fontes, G. (2022, outubro 1). O que muda com a BR do Mar, sancionada hoje e criticada por caminhoneiros. Recuperado de UOL Economia https://economia.uol.com.br/noticias/redacao/2022/01/10/br-do-mar-o-que-e-projeto-sancionado-bolsonaro.htm

Forster, P., Storelvmo, T., Armour, K., Collins, W., Dufresne, J., & Frame, D. (2021). The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 923–1054. https://doi.org/10.1017/9781009157896.009.

Furtado, L. C., Costa, V. C. G. da, & Maia, G. C. (2021, agosto 5). BR do mar: Comentários sobre as principais inovações do PL 4.199/2020 - Migalhas. Recuperado de https://www.migalhas.com.br/coluna/migalhas-maritimas/349622/br-do-mar-comentarios-sobre-as-principais-inovacoes-do-pl-4-199-2020

Gabriel Chiappini. (2021, julho 16). Portos brasileiros se movimentam para projetos bilionários de hidrogênio [News]. Recuperado de EPBR https://epbr.com.br/portos-e-eolicas-offshore-sao-modelos-preferidos-preferidos-para-hidrogenio-verde-no-brasil/

IAPH. (2021). *IAPH Annual Report 2020-2021* (p. 12). Tokyo, Japan: International Association of Ports and Harbours. Recuperado de International Association of Ports and Harbours https://www.iaphworldports.org/n-iaph/wp-content/uploads/2021/10/IAPH_annual_report_2020-2021.pdf

IEMA. (2020, dezembro 1). As emissões brasileiras de gases de efeito estufa nos setores de Energia e de Processos Industriais em 2019. Recuperado de IEMA - Instituto de Energia e Meio Ambiente https://energiaeambiente.org.br/as-emissoes-brasileiras-de-gases-de-efeito-estufa-nos-setores-de-energia-e-de-processos-industriais-em-2019-20201201

IMO. (2019). Prevention of Air Pollution from Ships. Recuperado de https://www.imo.org/en/OurWork/Environment/Pages/Air-Pollution.aspx

IMO. (2021). Initial IMO GHG Strategy. Recuperado de International Maritime Organization https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx

MEPC. (2018). *ANNEX 5—RESOLUTION MEPC.308(73) 2018 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX (EEDI) FOR NEW SHIPS* (Nº MEPC 73/19/Add.1). London: International Maritime Organization.

MEPC. (2021). *Port's perspective on mid- and long-term measures to serve an equitable energy transition of shipping* (Nº MEPC 77-7-28; p. 4). London: IMO. Recuperado de IMO https://sustainableworldports.org/wp-content/uploads/MEPC-77-7-28-IAPH-Commenting-Paper-01102021.pdf?utm_source=Wake+Media+Master+List&utm_campaign=49f818c7e4-Chevron+White+Paper_COPY_01&utm_medium=email&utm_term=0_c91fb95122-49f818c7e4-444233281

Ministerio da Economia. (2020). Política de estímulo a cabotagem denominada BR do Mar. Recuperado de Programa de Parcerias de Investimentos—PPI http://ppi.gov.br/politica-de-estimulo-a-cabotagem-denominada-br-do-mar

Ministerio da Infraestrutura. (2020a). *BR do Mar—Cabotage incentive program*. Recuperado de https://www.gov.br/infraestrutura/pt-br/NEWSLETTERBRDOMAReng.pdf

Ministerio da Infraestrutura. (2020b, janeiro 9). BR do Mar. Recuperado de https://anchor.fm/caminhos-do-brasil/embed/episodes/BR-do-Mar-e-o-desenvolvimento-da-cabotagem-no-Brasil-ek5o3l

Ministério da Infraestrutura. (2021a). Entrega de projetos do FMM até 2020. Recuperado de http://dados.transportes.gov.br/dataset/entrega-projetos-fmm

Ministério da Infraestrutura. (2021b). Sistema Portuário Nacional. Recuperado de Ministério da Infraestrutura https://www.gov.br/infraestrutura/pt-br/assuntos/transporte-aquaviario/sistema-portuario

Oliveira, D. (2021). EBNs dizem que há disponibilidade de bunker padrão IMO 2020. Recuperado de Portos e Navios https://www.portosenavios.com.br/noticias/navegacao-e-marinha/ano-de-ajustes

Petrobrás. (2020). Revap alcança recorde mensal de produção de Bunker 2020 | Agência Petrobras. Recuperado de https://www.agenciapetrobras.com.br/Materia/ExibirMateria?p_materia=983164

Porto Central. (2021, julho 26). AmmPower assina MOU para fornecer soluções de energia de amônia verde no Porto Central. Recuperado de Porto Central https://portocentral.com.br/pb/ammpower-assina-mou-para-fornecer-solucoes-de-energia-de-amonia-verde-no-porto-central/

Portos e Navios. (2020). BR do Mar vai ao Senado, mas ainda com trechos polêmicos para o setor. Recuperado de https://www.portosenavios.com.br/noticias/navegacao-e-marinha/br-do-mar-vai-ao-senado-mas-ainda-com-trechos-polemicos-para-o-setor

Rutherford, D., & Comer, B. (2018). *The International Maritime Organization's initial greenhouse gas strategy*. Washington, D.C.: International Council on Clean Transportation. Recuperado de International Council on Clean Transportation https://theicct.org/publication/the-international-maritime-organizations-initial-greenhouse-gas-strategy/

SEEG Brasil. (2021). Seeg Brasil | Download base de dados. Recuperado de http://seeg.eco.br/download

Sinaval. (2020). Esquenta debate sobre propostas do BR do Mar. Recuperado de SINAVAL http://sinaval.org.br/2020/08/esquenta-debate-sobre-propostas-do-br-do-mar/

Teixeira, C. A. N., Rocio, M. A. R., Mendes, A. P. do A., & d'Oliveira, L. A. S. (2018). *NAVEGAÇÃO DE CABOTAGEM BRASILEIRA* (p. 46). Brasil: BNDES - Banco Nacional de Desenvolvimento. Recuperado de BNDES - Banco Nacional de Desenvolvimento https://web.bndes.gov.br/bib/jspui/bitstream/1408/15385/1/BS47__Cabotagem__FECHADO.pdf

The Maritime Executive. (2021, julho 29). Green Ammonia Facility for Brazil's New Deepwater Port. Recuperado de The Maritime Executive https://www.maritime-executive.com/article/green-ammonia-facility-for-brazil-s-new-deepwater-port

US EPA, O. (2013, maio 3). MARPOL Annex VI and the Act To Prevent Pollution From Ships (APPS) [Overviews and Factsheets]. Recuperado de https://www.epa.gov/enforcement/marpol-annex-vi-and-act-prevent-pollution-ships-apps

Victor Uchôa. (2021, novembro 18). Brazil sets its sights on the global green hydrogen market. Recuperado de Dialogo Chino https://dialogochino.net/en/climate-energy/brazil-sets-sights-green-hydrogen-market/

Wang, Y., & Wright, L. A. (2021). A Comparative Review of Alternative Fuels for the Maritime Sector: Economic, Technology, and Policy Challenges for Clean Energy Implementation. *World*, *2*(4), 456–481. https://doi.org/10.3390/world2040029

Winebrake, J. (2009). *Improving the energy efficiency & environmental performance of goods movement*. Apresentado em Asllomar 2009 conference on transportation and energy. Recuperado de https://www.yumpu.com/en/document/read/25943227/improving-the-energy-efficiency-environmental-performance-of-